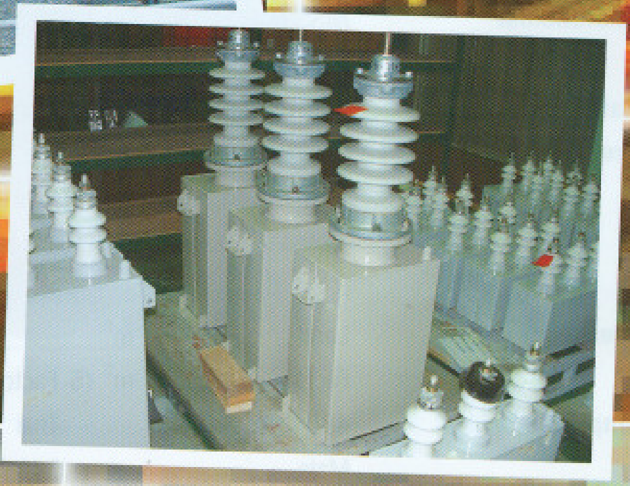
WORK ALL METAL CO.,LTD.
1995 Moo 3 Sukhumvit Road, Tambol Taibanmai,
Muang, Samut prakan 10280 Thailand
Tel: 081 315 3833, 081 694 2521
email: wam@workallmetal.com

THIS IS NET



ISO 9001 UKAS

NISSIN ELECTRIC (THAILAND) CO., LTD.

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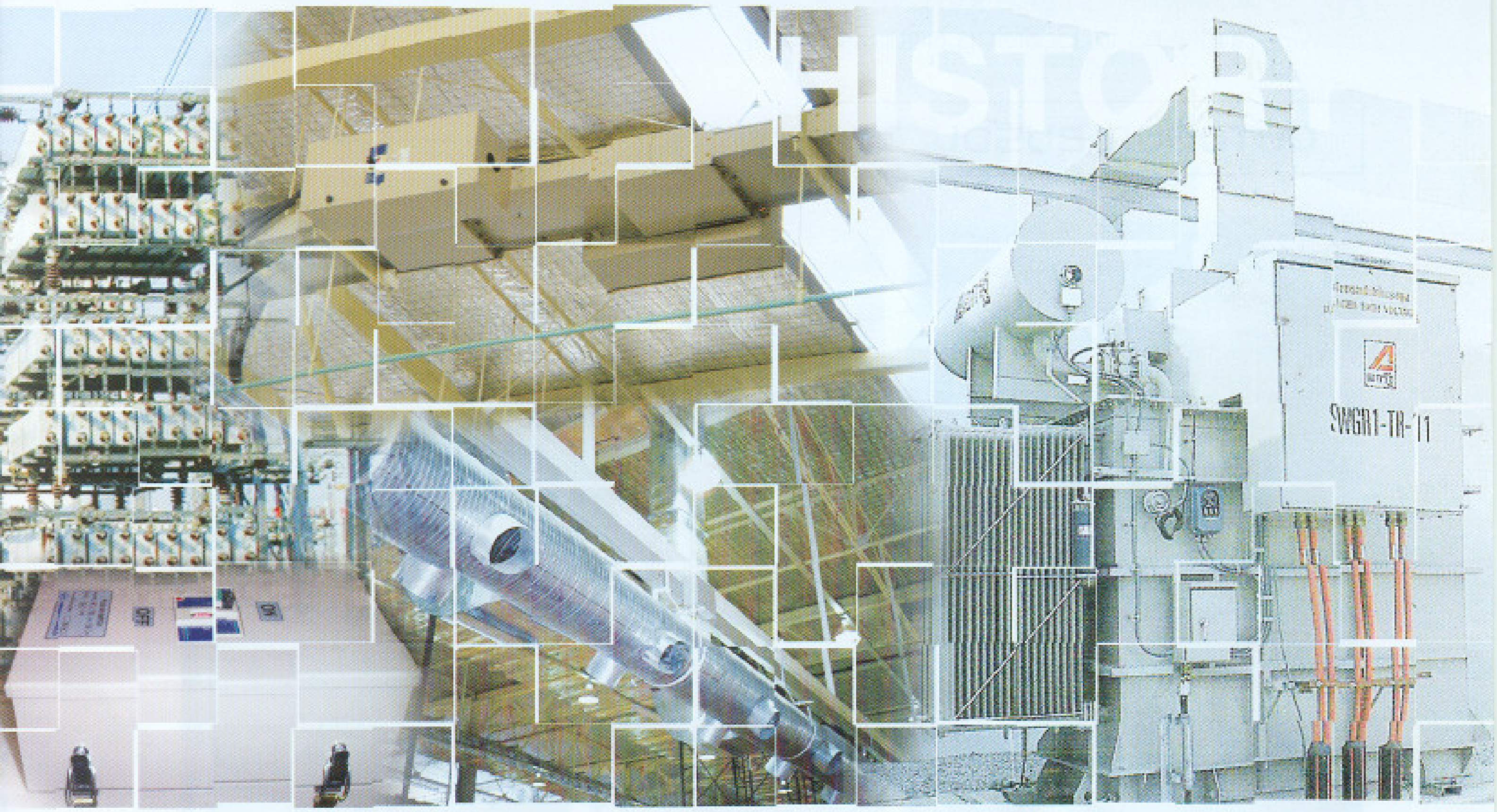
Tel: 081 315 3833, 081 694 2521
email: wam@workallmetal.com

THIS IS
NET

COMPANY PROFILE

Name	NISSIN ELECTRIC (THAILAND) CO.,LTD.		
Abbreviation	NET		
Address	60/64 Moo 19 Navanakorn 2 Phahonyotin Rd., Klong Luang, Pathumthani 12120 Thailand.		
Paid up Capital	160 Million Bath (3.9 million US dollar)		
Shareholder	NISSIN ELECTRIC CO.,LTD.	97.6 %	
	SUMITOMO Trading etc.	2.4 %	
Sales Amount	674 million baht (16.4 million US dollar)		
Productions	- parts manufacturing service, Factory equipment service		
	- Low voltage busduct , Hight voltage busduct 3.6 KV - 36 KV		
	- Medium voltage gas circuit breaker, Medium voltage capacitor		
	- SF_6 Pole mount load break switch, Fine coating service		
Area	Land ; 32,000 m^2		
	Factory ; 17,500 m^2 (5 Factory)		
Employee	480 People	Thai	Japanese
	Male	348	3
	Female	112	2
	Temporary	15	

NISSIN ELECTRIC (THAILAND) CO., LTD.



WORK ALL METAL CO.,LTD.

1995 Moo 3 Sukhumvit Road, Tambol Taibanmai,
Muang, Samut prakan 10280 Thailand

Tel: 081 315 3833, 081 694 2521
email: wam@workallmetal.com

HISTORY

NET manufacture busduct under sub-license from SUMIDEN ASAHI INDUSTRIES, LTD. of JAPAN (SAI)

Oct. 1987 Company establishmen

Jun. 1988 Sprit house ceremony

Oct. 1988 Start operation

Nov. 1989 License of bonded warehouse

Oct. 1995 2nd factory operation

Dec. 1998 Receiving ISO9002 certificate (BVQI)

Sep. 1999 Start of Part Business

Feb. 2001 Receiving ISO9001 certificate (BVQI)

Apr. 2003 Start of Fine Coation Service 3rd factory operation

Nov. 2003 Start of Packing Business 4 th factory operation

Aug. 2005 5th factory operation

Nov. 2005 Busduct Business

NET NISSIN ELECTRIC (THAILAND) CO.,LTD.

e-mail:bds@nissin-thai.com
www.nissin-thai.com

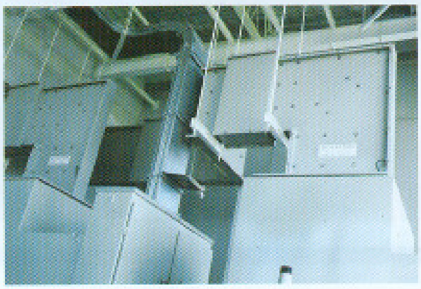
THIS IS
NET

Busduct System
For New Installation and Renewal of
Power Systems in Building and Factories

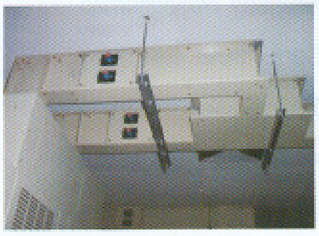
OUTDOOR BUSDUCT

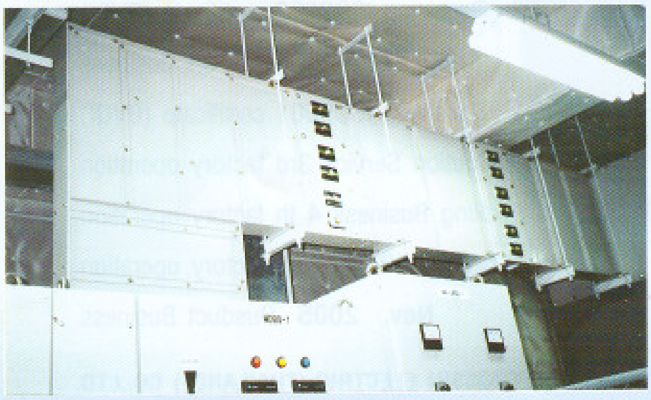


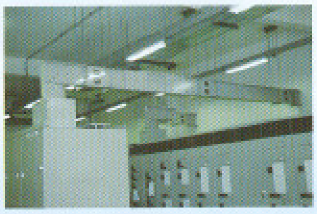
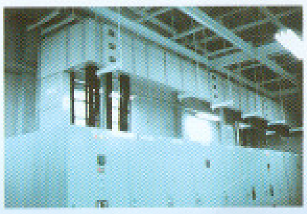


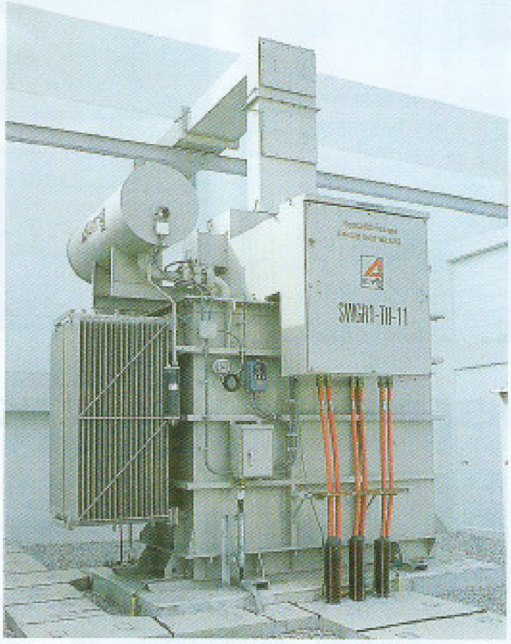
INDOOR BUSDUCT

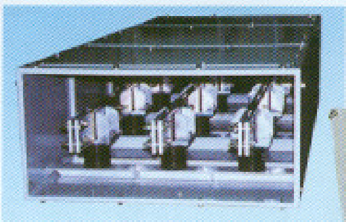


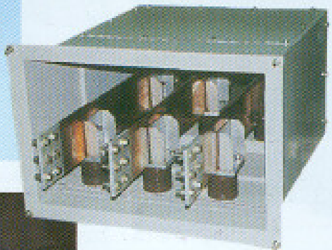


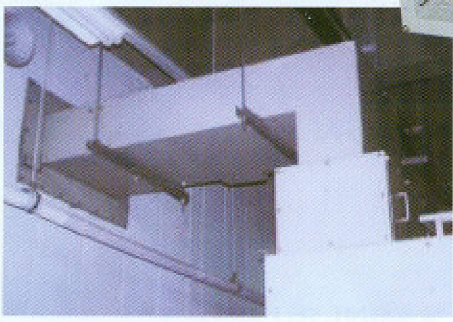



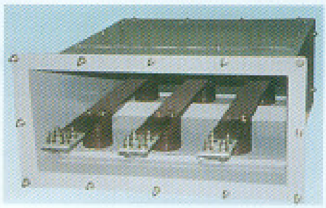
HV BUSDUCT

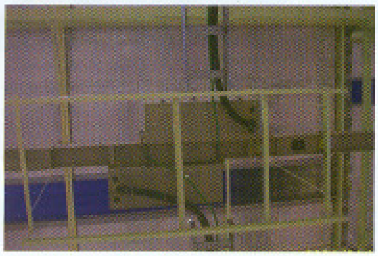




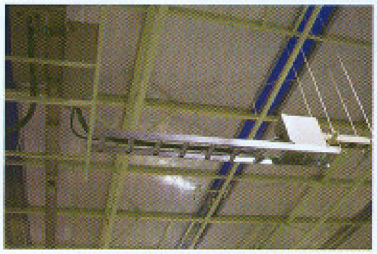








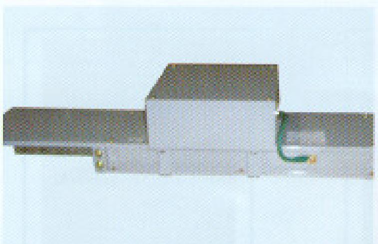
• PLUG-IN SW UNIT



• END FEED-IN UNIT

• PLUG - IN FEEDER

• Plug-in SW Unit
(MINI BUSDUCT)



• CENTER FEED-IN UNIT
(LINE DUCT)

• LINE DUCT

THIS IS
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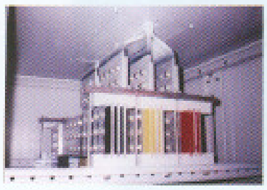
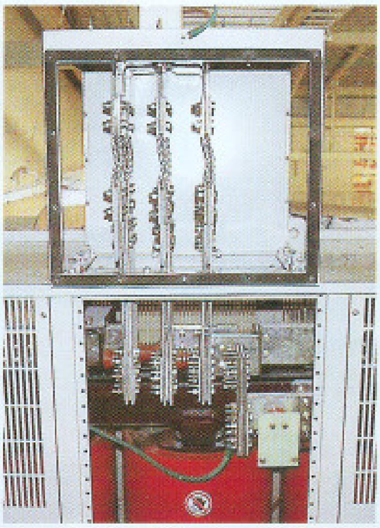
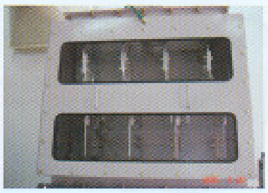
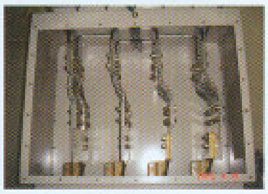
NISSIN ELECTRIC (THAILAND) CO., LTD.

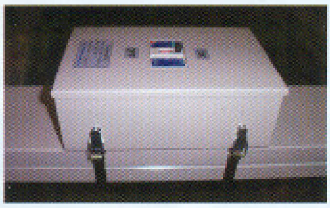




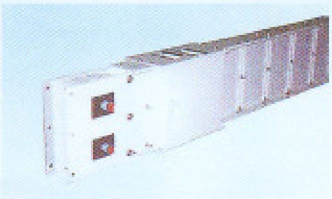
PANEL CONNECTION

TRANSFORMER CONNECTION

• Tap-Off Feeder

• MINI BUSDUCT



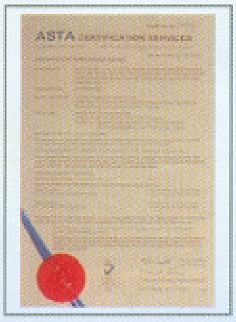
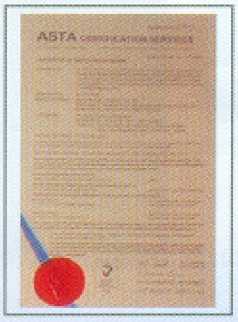
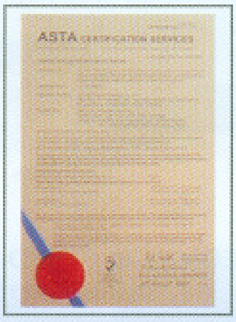
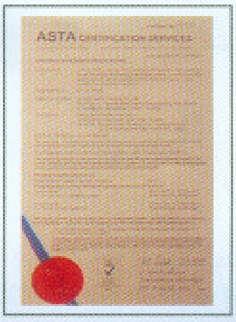


• Plug-in Feeder

• Plug-in SW Unit

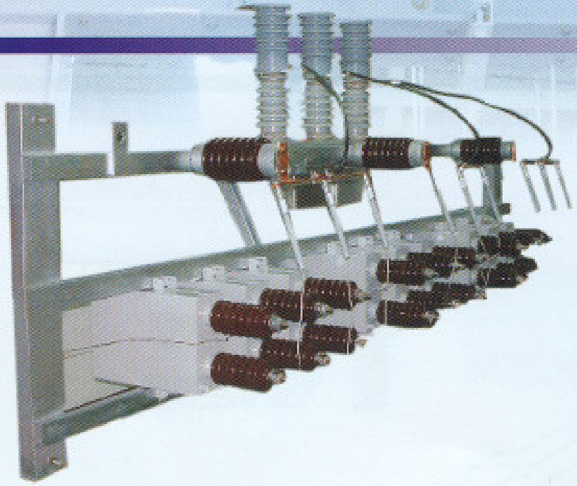
THIS IS
Quality NET

Our busduct was approved certified by ASTA (Association of Short-circuit Testing Authorities), internationnally recognised testing authority.

POWER CAPACITOR
CAPACITOR BANK

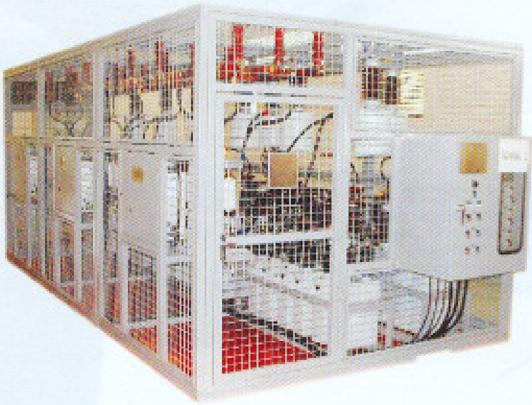
RATED VOLTAGE : 1 kV - 36 kV
CAPACITY : UPON REQUEST



POLE MOUNTED SWITCHING CAPACITOR BANK

MEA

(METROPOLITANCE ELECTRICITY AUTHORITY)
11.9/23.9 kV 3600 kvar
SUBSTATION CAPACITOR BANK
WITH PROTECTION



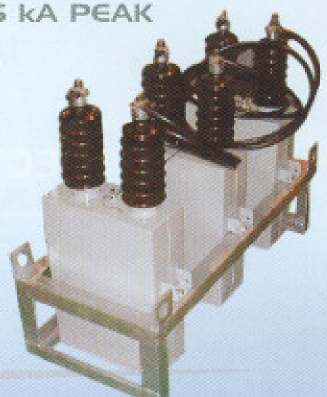
PEA

(PROVINCIAL ELECTRICITY AUTHORITY)
22/33 kV 2.4 Mvar X 3 STEP
SUBSTATION SWITCHING CAPACITOR BANK
WITH PROTECTION

RATED VOLTAGE : 1 kV TO 24 kV
CAPACITY : 50 kvar TO 500 kvar
SINGLE PHASE or THREE PHASE

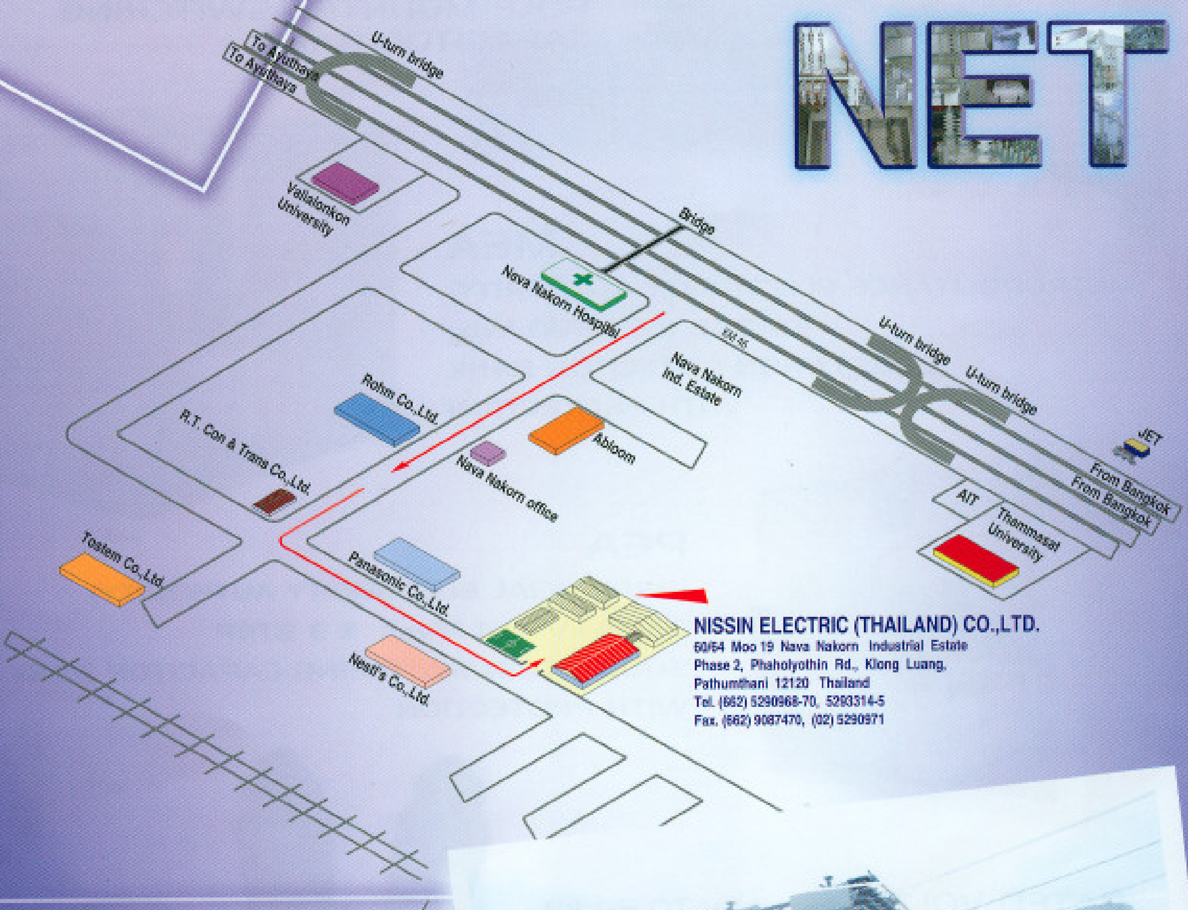
POLE MOUNTH LOAD BREAK SWITCH

RATED 24 kV 600 A
12.5 kA 1 sec
31.5 kA PEAK



24 kV POLE MOUNTED FIXED CAPACITOR BANK

THIS IS NET



NISSIN ELECTRIC (THAILAND) CO., LTD.

60/64 Moo 19 Nava Nakorn Industrial Estate Phase 2,
Phaholyothin Rd. Klong Luang Pathumthani 12120, Thailand
Tel : (+662) 5290968-70 Fax : (+662) 9087470, (02) 5290971
www.nissin-thai.com e-mail:bds@nissin-thai.com

WORK ALL METAL CO.,LTD.
1995 Moo 3 Sukhumvit Road, Tambol Taibanmai,
Muang, Samut prakan 10280 Thailand
Tel: 081 315 3833, 081 694 2521
email: wam@workallmetal.com

Busduct Feature

WORK ALL METAL CO.,LTD.
1995 Moo 3 Sukhumvit Road, Tambol Taibanmai,
Muang, Samut prakan 10280 Thailand
Tel: 081 315 3833, 081 694 2521
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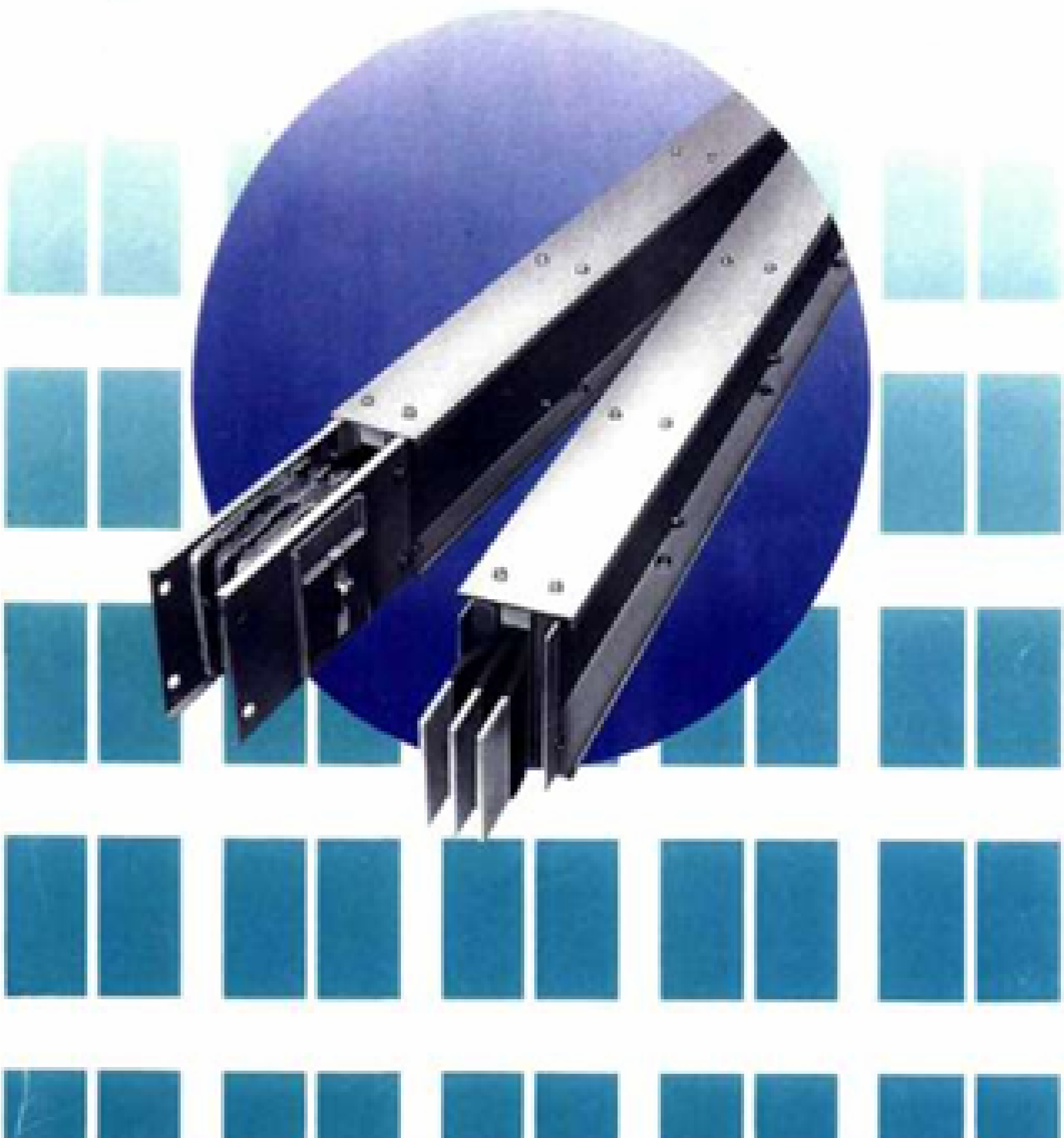
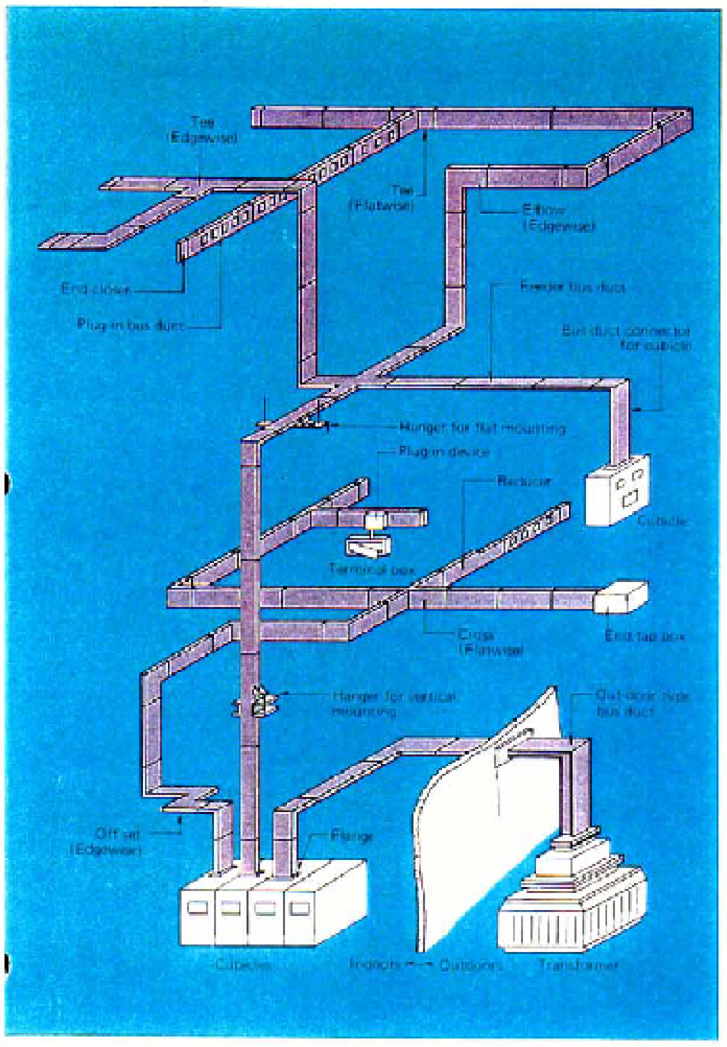
BUS-DUCT



NISSIN ELECTRIC (THAILAND) CO.,LTD.

BUS-DUCT mainly consists of the following component

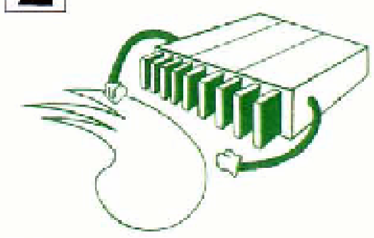


Since bus duct system has a lot of merits, the modern building like ones of cities or hotels are put it to a good use, as the main bus. It is also used regularly from the respect of rationality and good economy in electric power supply for the factories. Asahi Metal manufactures every kind of bus duct system including static and dynamic distribution system. You can find a bus duct system from Asahi's bus duct which is quite suitable for any every installation application. Asahi's bus duct system provides power conveniently wherever it is needed.

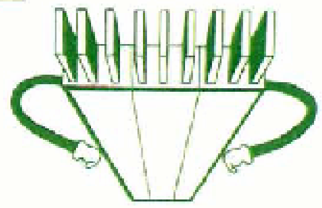
1 Feature

1 Standardized up to 5000A current capacity.

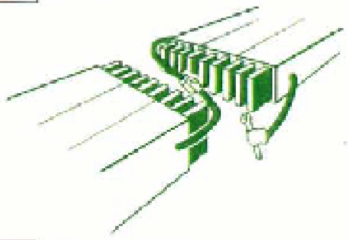
2 Long life and high safety.



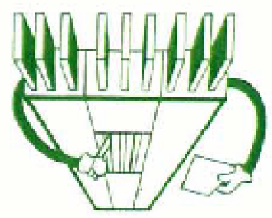
3 Fit into any place neatly.



4 Interchangeable feeders and plug-in sections.



5 Easy installation and maintenance.



2 Construction

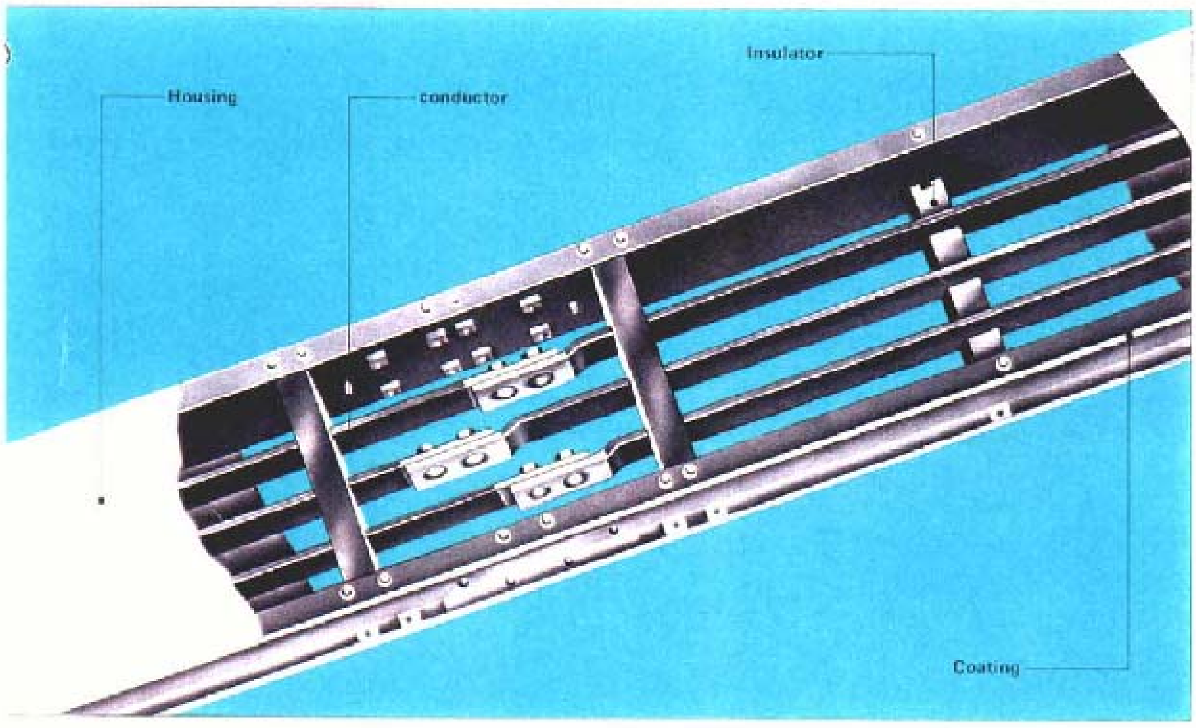
BUS-DUCT using bare conductor

Conductor

Electrical copper having 98% conductivity is used for the copper conductor and electrical aluminium of 60% conductivity for the aluminum conductor. Joints are tin plated. The aluminum conductor costs less and is lighter than the copper conductor.

Housing

The housing is a metal case generally made of galvanized steel or aluminum. It is of non-ventilated type meeting the requirements of the Japanese Industrial Standards



Insulator

The insulator of conductor is provided with of glass-fiber-reinforced polyester having a large mechanical strength and high electrical and heat resistance. Extra attentions have been given to avoid fires due to rising temperatures and mechanical failures.

Coating

The housing is coated with heat resistant paint having strong rustproofness, smooth surface and luster.

The standard color of coating will be greenish blue (7.5 BG6/1.5) for indoor and gray (N7) for outdoor.

Please specify desired colors.

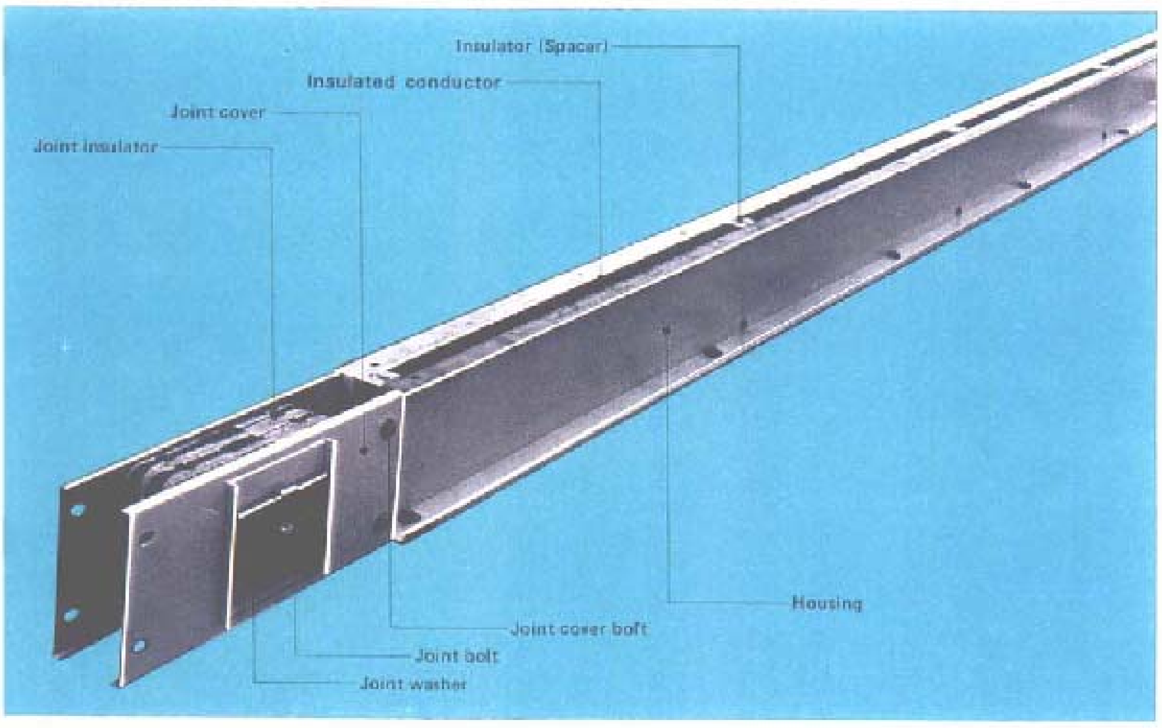
BUS-DUCT using insulated conductor

Insulated conductor

The descriptions of the conductor is the same as bus duct for the bare conductor. The difference is that the conductor is insulated throughout the entire length except the contact areaby extruding tubing.
The insulator is made of Polyester Sheet.

Housing

The housing of the insulated conductor is about the same with that of the bare conductor, its electric loss in the housing is much less than that of the bare conductor.



Jointing(Joint bolt. Joint washer.Joint insulator)

Joints are designed to provide smooth contact surface between the conductors, proper fastening effect, safe electrical insulation and simple installation.

(a) Joint bolt is designed to avoid a "creep" to the bolt as well as to the conductor and large pressures even in the repeated cycles of heating and cooling.

(b) Joint washer is stable against the creep and pressures because it is designed taking into account thermal expansion differentials of the copper conductor or the aluminum conductor to the steel bolt.

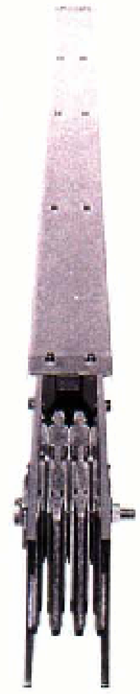
(c) Joint insulator has enough strength to withstand fastening force of the bolt because of a special insulation material containing less humidity.

3 Kind

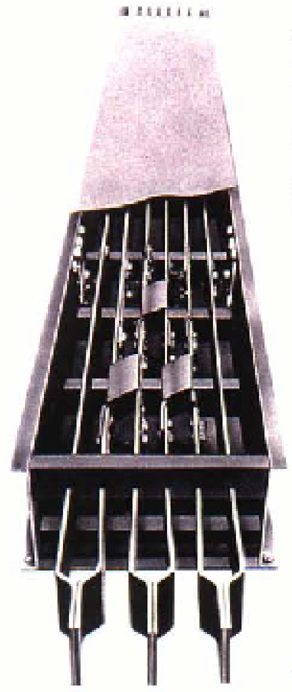
Feeder bus duct

Feeders have no plug-in sections and taps. Sections of straight feeder are 3 meters long measured from the center-line of a joint.

◀Bus duct using bare conductor



▶Bus duct using insulated conductor



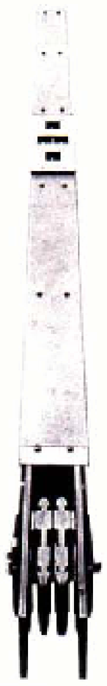
Low impedance bus ducts are arranged in transpositioned Composite conductors.
It is mostly used to prevent the increase in voltage drop of large current or long-range bus ways.

◀Bus duct using bare conductor (low impedance)

Plug-in bus duct

Plug-in bus ducts have holes for plug-in connection with devices. It provides taps where they are desired.

◀Bus duct using bare conductor



▶Bus duct using insulated conductor

Tap bar bus duct

Tap bar bus ducts are suitable for the taps of 600A or more and for direct connecting with tap cables.

◀Bus duct using insulated conductor

Busduct Catalog
(Standard Dimension)

BUSDUCT CATALOG

(Standard Dimension)

Low-voltage Busduct

NET *Nissin Electric (Thailand) Co., Ltd.*

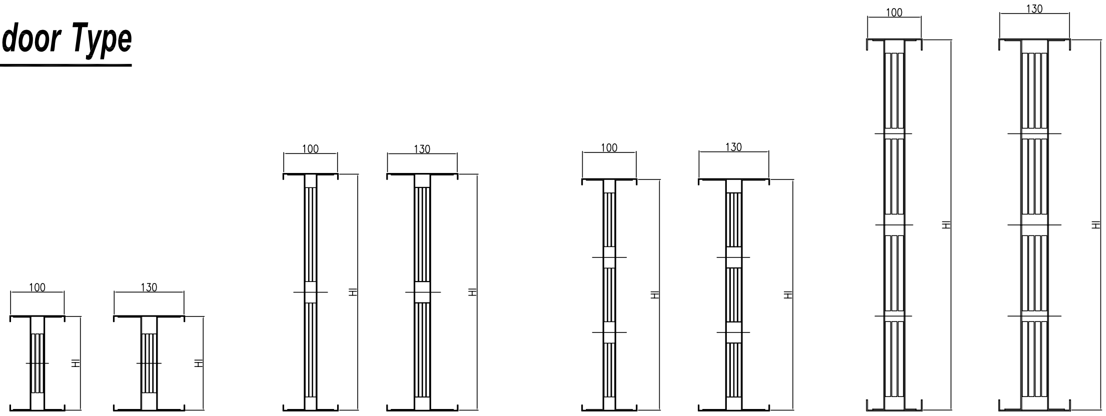
60/64 Moo 19 Navanakorn2 Phaholyothin road, Klongluang, Phathumthani,

12120, Thailand. Tel. (662) 5290968-70, (662) 5293314-5 Fax. (662) 9087470

Website : http://www.nissin-thai.com E-mail : bds@nissin-thai.com

Cross Section of Busduct

Indoor Type

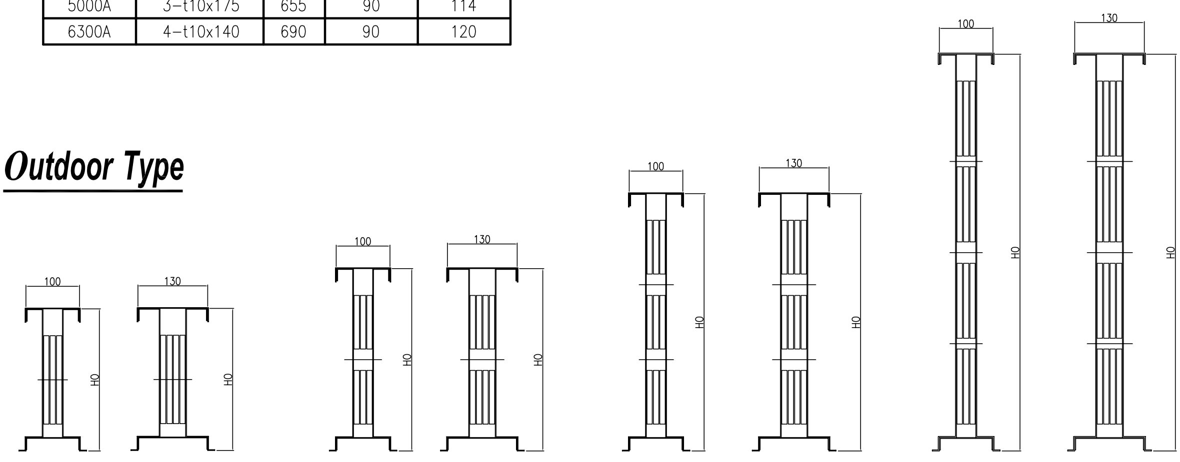


3W (400–2000A) 4W (400–2000A) 3W (2500–4000A) 4W (2500–4000A) 3W (4500–5000A) 4W (4500–5000A) 3W (6300A) 4W (6300A)

ALUMINIUM CONDUCTOR				
AMP. RATING	CONDUCTTOR SIZE (mm)	HI (mm.)	WEIGHT (Kg/m.)	
			3W	4W
400A	1–t6x50	115	11	13
600A	1–t6x50	115	11	13
800A	1–t6x75	125	13	16
1000A	1–t6x100	150	16	20
1200A	1–t6x125	175	18	23
1350A	1–t6x165	215	22	34
1500A	1–t6x165	215	22	34
1600A	1–t10x165	215	28	36
2000A	1–t10x175	225	30	38
2500A	2–t10x125	330	35	45
3000A	2–t10x140	350	40	50
3500A	2–t10x175	440	65	80
4000A	2–t10x200	490	74	89
4500A	3–t10x165	625	84	108
5000A	3–t10x175	655	90	114
6300A	4–t10x140	690	90	120

COPPER CONDUCTOR				
AMP. RATING	CONDUCTTOR SIZE (mm)	HI (mm.)	WEIGHT (Kg/m.)	
			3W	4W
800A	1–t6x50	115	17	21
1000A	1–t6x75	125	21	28
1200A	1–t6x100	150	26	34
1350A	1–t6x125	175	37	41
1500A	1–t6x125	175	37	41
1600A	1–t6x165	215	42	54
2000A	1–t6x175	225	44	57
2500A	2–t6x125	330	50	65
3000A	2–t6x140	350	60	75
3500A	2–t6x175	440	82	98
4000A	2–t6x200	490	94	113
4500A	3–t6x165	625	126	162
5000A	3–t6x175	655	132	171
6300A	4–t6x140	690	140	190

Outdoor Type

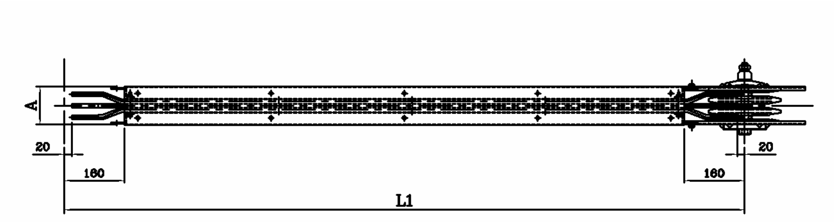


3W (400–2000A) 4W (400–2000A) 3W (2500–4000A) 4W (2500–4000A) 3W (4500–5000A) 4W (4500–5000A) 3W (6300A) 4W (6300A)

ALUMINIUM CONDUCTOR				
AMP. RATING	CONDUCTTOR SIZE (mm)	HO (mm.)	WEIGHT (Kg/m.)	
			3W	4W
400A	1–t6x50	165	23	26
600A	1–t6x50	165	23	26
800A	1–t6x75	175	25	30
1000A	1–t6x100	200	29	34
1200A	1–t6x125	225	32	38
1350A	1–t6x165	265	37	50
1500A	1–t6x165	265	37	50
1600A	1–t10x165	265	44	52
2000A	1–t10x175	275	46	54
2500A	2–t10x125	380	70	90
3000A	2–t10x140	400	80	100
3500A	2–t10x175	490	97	113
4000A	2–t10x200	540	108	124
4500A	3–t10x165	675	132	156
5000A	3–t10x175	705	138	162
6300A	4–t10x140	740	150	200

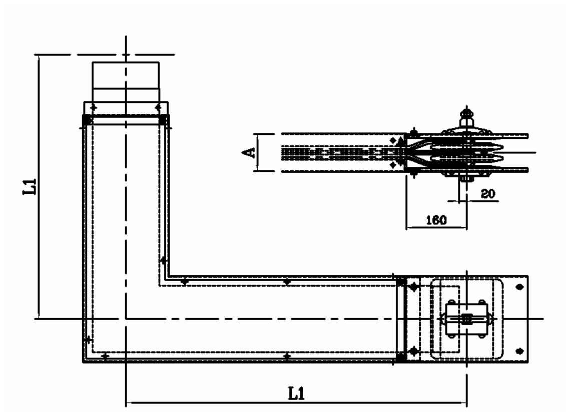
COPPER CONDUCTOR				
AMP. RATING	CONDUCTTOR SIZE (mm)	HO (mm.)	WEIGHT (Kg/m.)	
			3W	4W
800A	1–t6x50	165	29	34
1000A	1–t6x75	175	33	42
1200A	1–t6x100	200	39	48
1350A	1–t6x125	225	51	56
1500A	1–t6x125	225	51	56
1600A	1–t6x165	265	57	70
2000A	1–t6x175	275	60	73
2500A	2–t6x125	380	90	105
3000A	2–t6x140	400	100	115
3500A	2–t6x175	490	114	131
4000A	2–t6x200	540	128	148
4500A	3–t6x165	675	171	210
5000A	3–t6x175	705	180	219
6300A	4–t6x140	740	190	230

Straight (S)



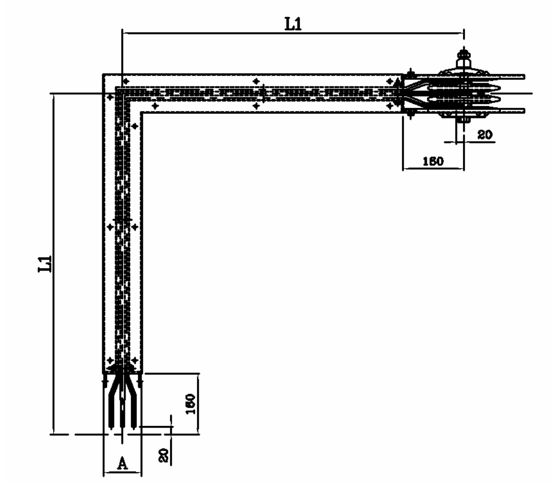
CONDUCTOR	AMP. RATING (A)	A (mm.)		L1 (mm.)	
		3W	4W	STANDARD	MINIMUM
ALUMINIUM	400 - 5000	100	130	3000	500
COPPER	800 - 5000				

Vertical Elbow (EL)



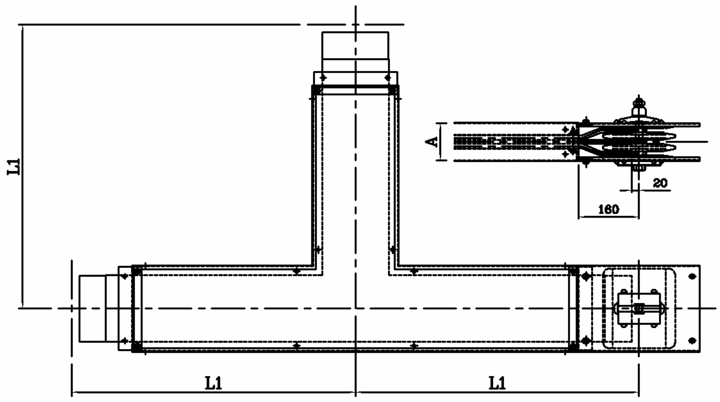
CONDUCTOR	AMP. RATING (A)	A (mm.)		L1 (mm.)	
		3W	4W	STANDARD	MINIMUM
ALUMINIUM	400 - 3000	100	130	500	450
	3500 - 5000			700	650
COPPER	800 - 3000			500	450
	3500 - 5000			700	650

Horizontal Elbow (FL)



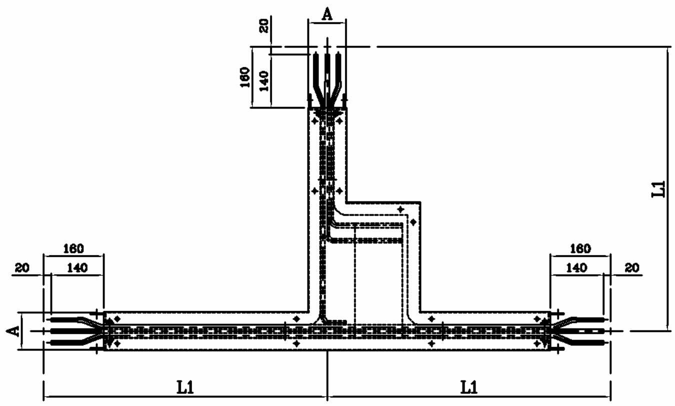
CONDUCTOR	AMP. RATING (A)	A (mm.)		L1 (mm.)	
		3W	4W	STANDARD	MINIMUM
ALUMINIUM	400 - 5000	100	130	500	350
COPPER	800 - 5000				

Vertical Tee (ET)

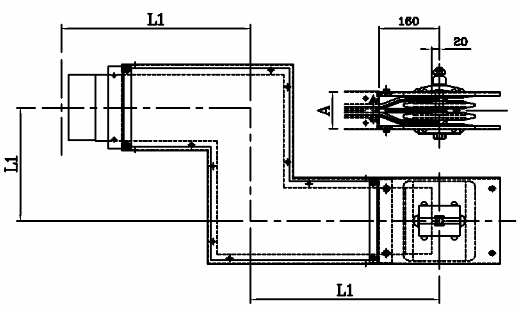


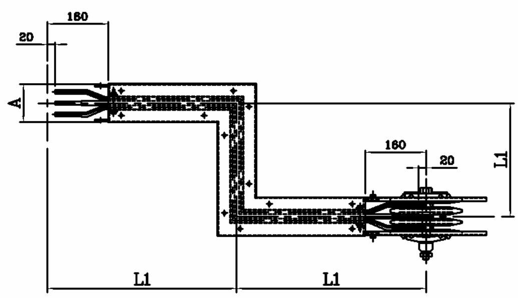
CONDUCTOR	AMP. RATING (A)	A (mm.)		L1 (mm.)
		3W	4W	
ALUMINIUM	400 - 5000	100	130	750
COPPER	800 - 5000			

Horizontal Tee (FT)



CONDUCTOR	AMP. RATING (A)	A (mm.)		L1 (mm.)
		3W	4W	
ALUMINIUM	400 - 5000	100	130	750
COPPER	800 - 5000			





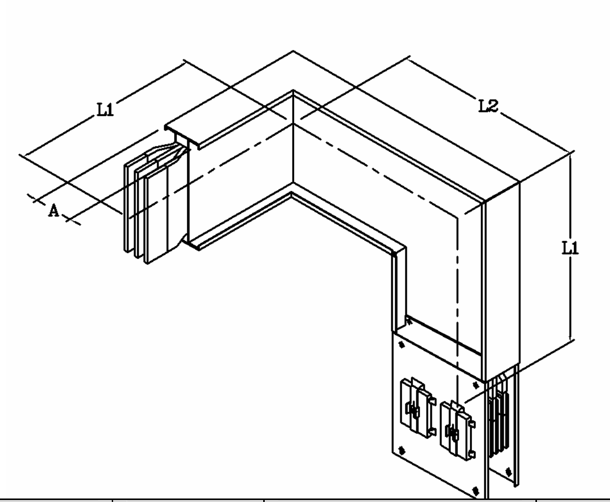
Edgewise Offset Elbow (EZ)

CONDUCTOR	AMP. RATING (A)	A (mm.)		L1 (mm.)	
		3W	4W	STD.	MIN.
ALUMINIUM	400 - 5000	100	130	500	350
COPPER	800 - 5000				

Flatwise Offset Elbow (FZ)

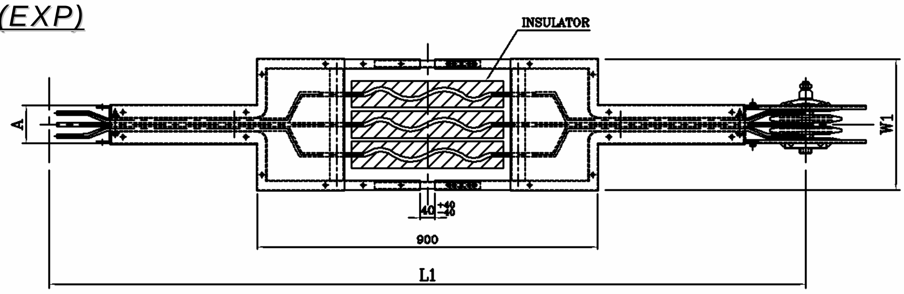
CONDUCTOR	AMP. RATING (A)	A (mm.)		L1 (mm.)	
		3W	4W	STD.	MIN.
ALUMINIUM	400 - 3000	100	130	500	450
	3500 - 5000			700	650
COPPER	800 - 3000			500	450
	3500 - 5000			700	650

Flatwise + Edgewise Elbow (FL+EL)



CONDUCTOR	AMP. RATING (A)	A (mm.)		L1 (mm.)		L2 (mm.)	
		3W	4W	STANDARD	MINIMUM	STANDARD	MINIMUM
ALUMINIUM	400 - 3000	100	130	500	450	500	350
	3500 - 5000			700	650	700	550
COPPER	800 - 3000			500	450	500	350
	3500 - 5000			700	650	700	550

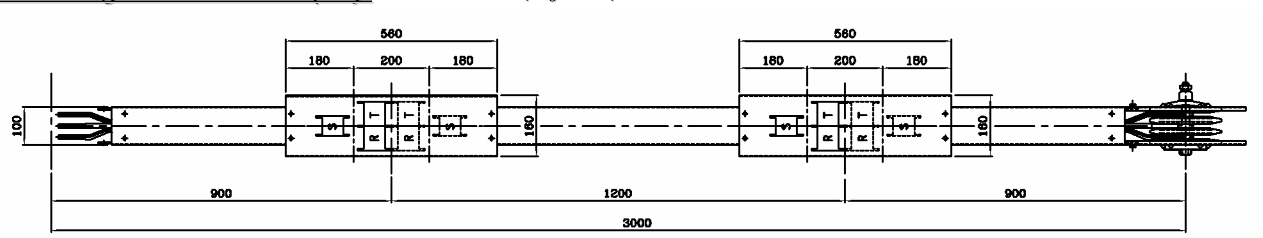
Expansion (EXP)



CONDUCTOR	AMP. RATING (A)	A (mm.)		L1 (mm.)	W1 (mm.)	
		3W	4W		3W	4W
ALUMINIUM	400 - 1500	100	130	2000	245	295
	1600 - 5000				345	425
COPPER	800 - 5000				245	295

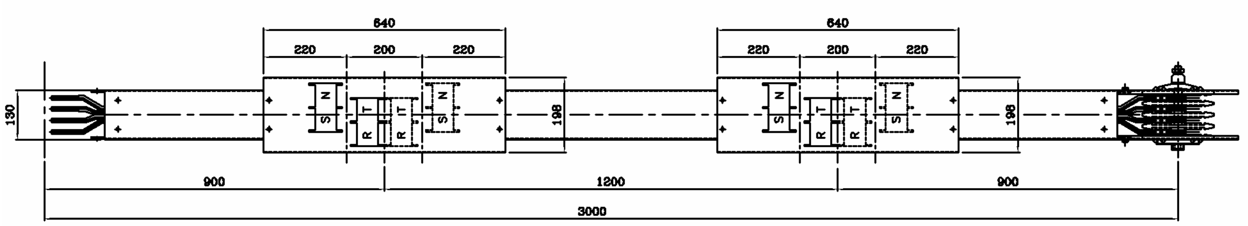
3w Plug-in Busduct (PI)

**** Maximum 6 plug-in unit per Busduct 3 meter.*



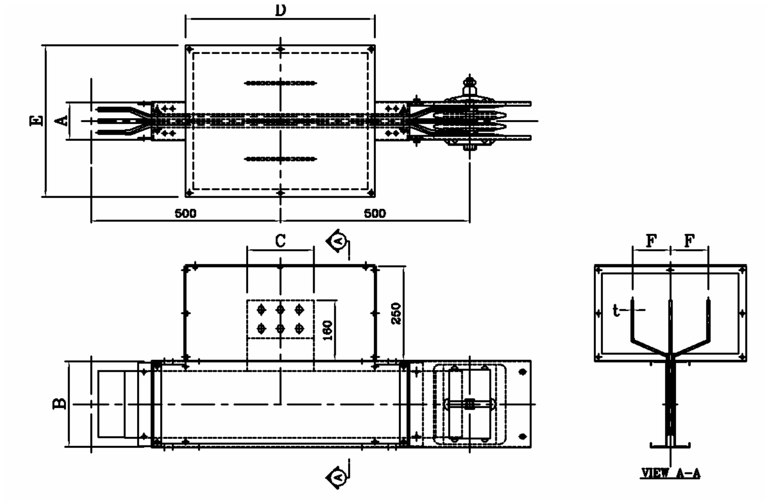
4w Plug-in Busduct (PI)

*** Maximum 6 plug-in unit per Busduct 3 meter.



Center Feed-in

*** See bus bar holing as per page 7.

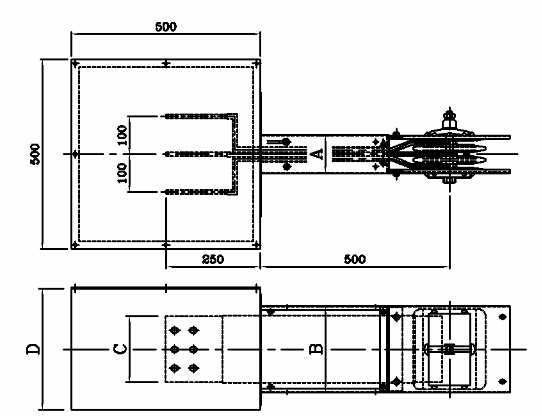


ALUMINIUM CONDUCTOR									
RATING (A)	A 3W	A 4W	B	C	D	E 3W	E 4W	F	t
400			115	50					
600			115	50					
800			125	75	450	350	450	80	
1000			150	100					6
1200	100	130	175	125					
1350			215	165					
1500			215	165	500	400	500	100	
1600			215	165					10
2000			225	175					

COPPER CONDUCTOR									
RATING (A)	A 3W	A 4W	B	C	D	E 3W	E 4W	F	t
800			115	50					
1000			125	75					
1200			150	100	450	350	450	80	
1350	100	130	175	125					6
1500			175	125					
1600			215	165	500	400	500	100	
2000			225	175					

End Feed-in

*** See bus bar holing as per page 7.



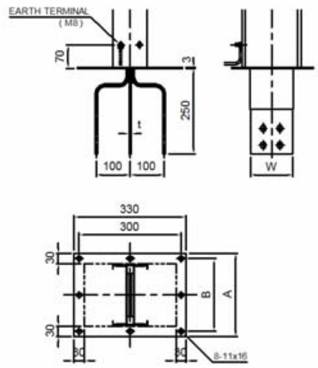
ALUMINIUM CONDUCTOR					
RATING (A)	A 3W	A 4W	B	C	D
400			115	50	
600			115	50	
800			125	75	270
1000			150	100	
1200	100	130	175	125	
1350			215	165	
1500			215	165	320
1600			215	165	
2000			225	175	

COPPER CONDUCTOR					
RATING (A)	A 3W	A 4W	B	C	D
800			115	50	
1000			125	75	
1200			150	100	270
1350	100	130	175	125	
1500			175	125	
1600			215	165	320
2000			225	175	

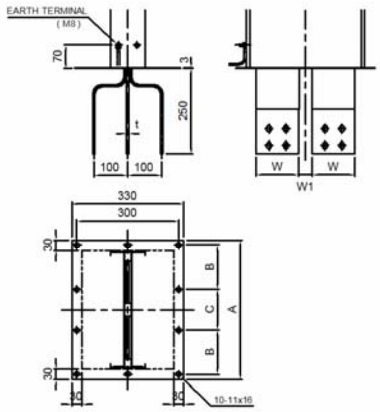
Flanged End

*** See bus bar holing as per page 7.

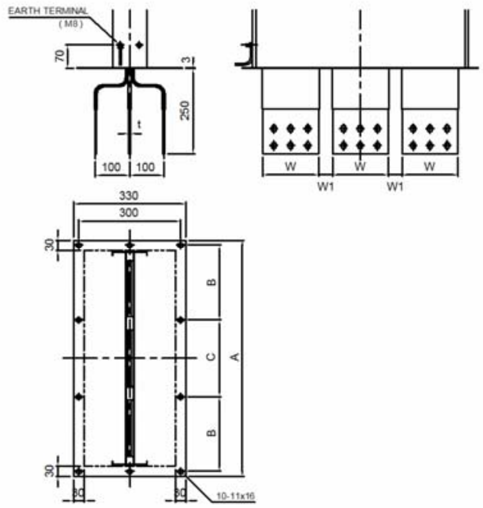
3w 400A~2000A



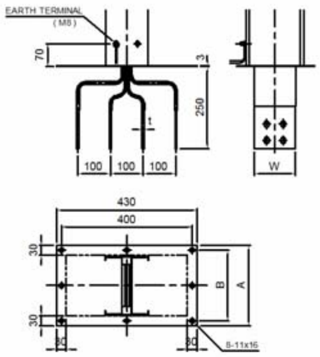
3w 2500A~4000A



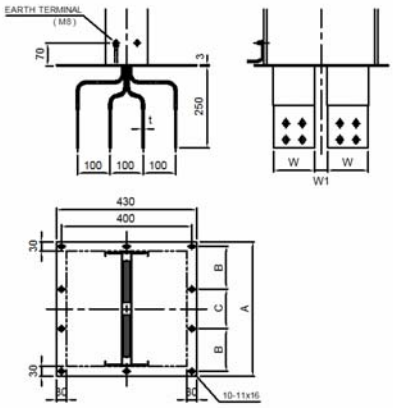
3w 4500A~5000A



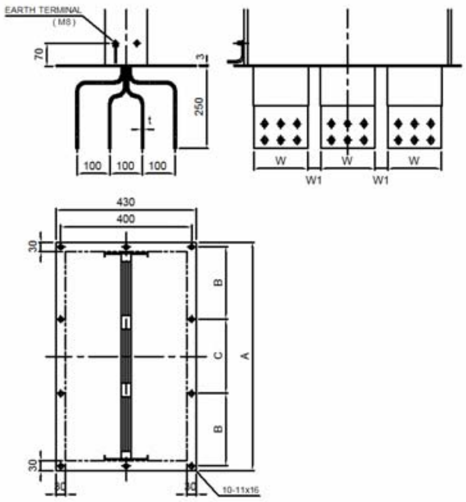
4w 400A~2000A



4w 2500A~4000A



4w 4500A~5000A



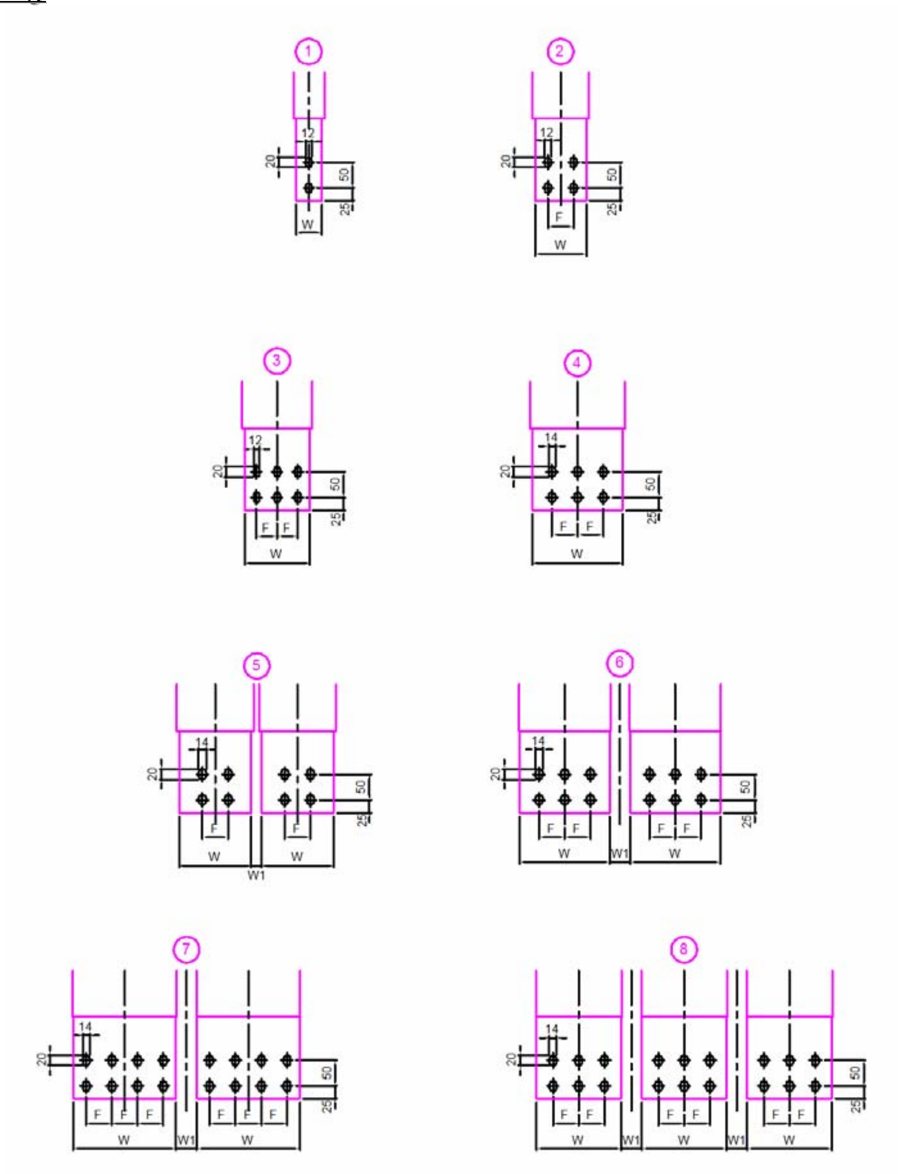
ALUMINIUM CONDUCTOR

AMP. RATING (A)	A	B	C	W	W1	t
400	185	155	-	50	-	6
600	185	155	-	50	-	
800	195	165	-	75	-	
1000	220	190	-	100	-	
1200	245	215	-	125	-	
1350	285	255	-	165	-	
1500	285	255	-	165	-	
1600	285	255	-	165	-	10
2000	295	265	-	175	-	
2500	400	125	120	125	30	
3000	420	130	130	140	20	
3500	510	160	160	175	40	
4000	560	175	180	200	40	
4500	695	220	225	165	40	
5000	725	230	235	175	40	

COPPER CONDUCTOR

AMP. RATING (A)	A	B	C	W	W1	t
800	185	155	-	50	-	6
1000	195	165	-	75	-	
1200	220	190	-	100	-	
1350	245	215	-	125	-	
1500	245	215	-	125	-	
1600	285	255	-	165	-	
2000	295	265	-	175	-	
2500	400	125	120	125	30	
3000	420	130	130	140	20	
3500	510	160	160	175	40	
4000	560	175	180	200	40	
4500	695	220	225	165	40	
5000	725	230	235	175	40	

Bus Bar Holing



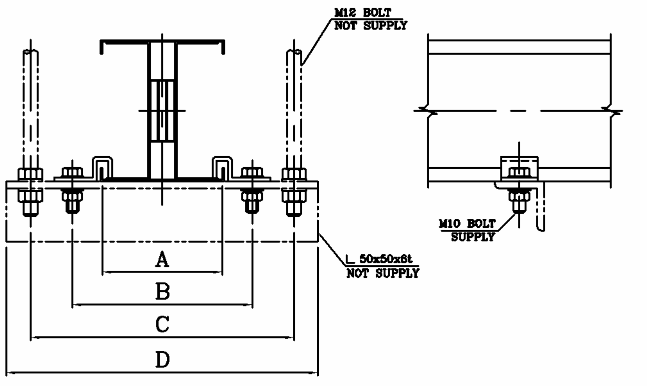
ALUMINIUM CONDUCTOR

AMP. RATING (A)	W	W1	F	PIC TURE
400	50	-	-	1
600	50	-	-	
800	75	-	40	2
1000	100	-	50	
1200	125	-	40	3
1350	165	-	50	4
1500	165	-	50	
1600	165	-	50	
2000	175	-	50	
2500	125	30	50	5
3000	140	20	50	
3500	175	40	50	6
4000	200	40	50	7
4500	165	40	50	8
5000	175	40	50	9

COPPER CONDUCTOR

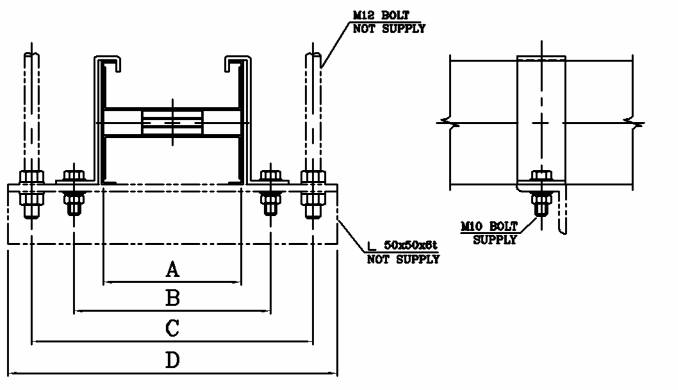
AMP. RATING (A)	W	W1	F	PIC TURE
800	50	-	-	1
1000	75	-	40	2
1200	100	-	50	
1350	125	-	40	3
1500	125	-	40	
1600	165	-	50	4
2000	175	-	50	
2500	125	30	50	5
3000	140	20	50	
3500	175	40	50	6
4000	200	40	50	7
4500	165	40	50	8
5000	175	40	50	9

Hanger (Edgewise)



WIRE	A	B	C	D
3W	100	150	220	260
4W	130	180	250	290

Hanger (Flatwise)



ALUMINIUM CONDUCTOR

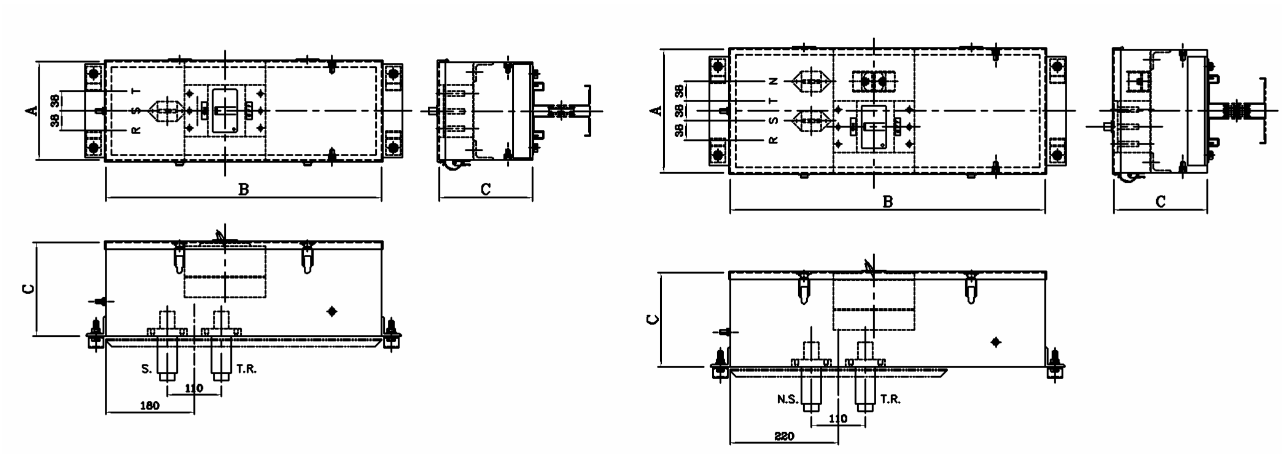
AMP. RATING (A)	A	B	C	D
400	115	164	235	275
600	115	164	235	275
800	125	174	245	285
1000	150	199	270	310
1200	175	224	295	335
1350	215	264	335	375
1500	215	264	335	375
1600	215	264	335	375
2000	225	274	345	385
2500	330	379	450	490
3000	350	399	470	510
3500	440	489	560	600
4000	490	539	610	650
4500	540	589	660	700
5000	650	699	770	810

COPPER CONDUCTER

AMP. RATING (A)	A	B	C	D
800	115	164	235	275
1000	125	174	245	285
1200	150	199	270	310
1350	175	224	295	335
1500	175	224	295	335
1600	215	264	335	375
2000	225	274	345	385
2500	330	379	450	490
3000	350	399	470	510
3500	440	489	560	600
4000	490	539	610	650
4500	540	589	660	700
5000	650	699	770	810

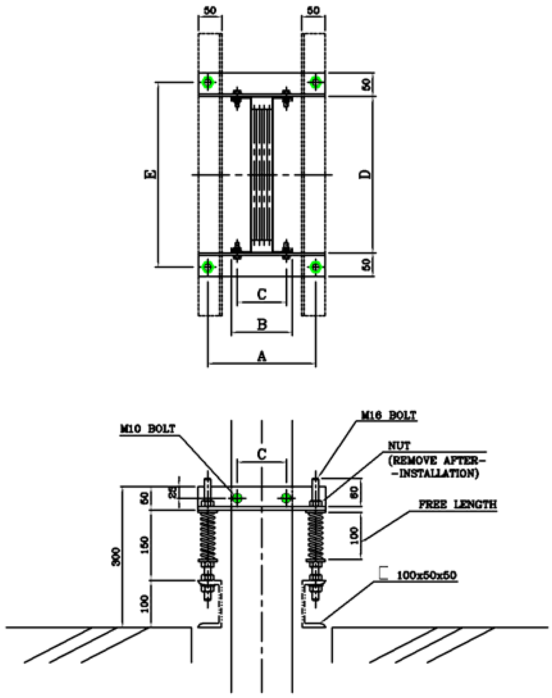
Plug-in Switch Unit

3w   4w



BREAKER FRAME (AF)	3W (mm.)			4W (mm.)		
	A	B	C	A	B	C
50						
100	200	560	190	250	640	190
250						
400	250	680	210	300	700	210
630	320	830	290	370	850	290

Floor Support

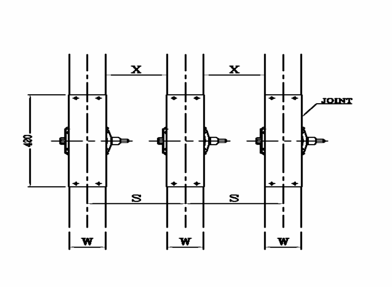


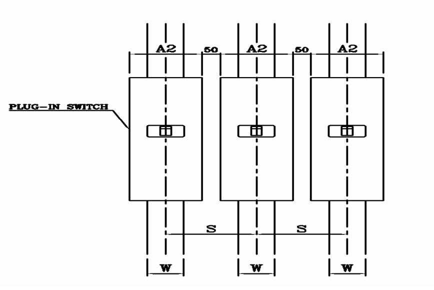
ALUMINIUM CONDUCTOR								
AMP. RATING (A)	3W			4W			D	E
	A	B	C	A	B	C		
400							118	178
600							118	178
800							128	188
1000							153	213
1200							178	238
1350	200	100	74	230	130	104	218	278
1500							218	278
1600							218	278
2000							228	288
2500							334	394
3000							354	414

COPPER CONDUCTOR								
AMP. RATING (A)	3W			4W			D	E
	A	B	C	A	B	C		
800							118	178
1000							128	188
1200							153	213
1350							178	238
1500	200	100	74	230	130	104	178	238
1600							218	278
2000							228	288
2500							334	394
3000							354	414

Minimum Installation Space Between Busduct

Feeder Busduct



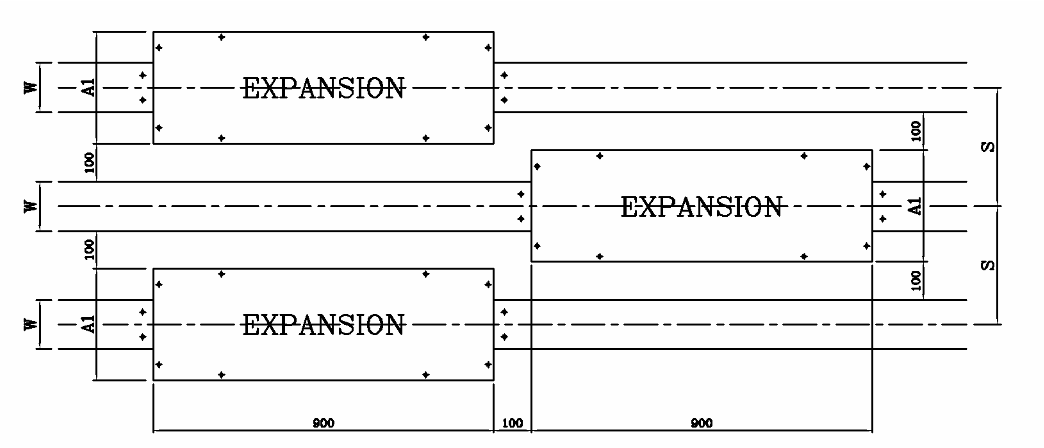


INSTALLATION	X	S
HORIZONTAL RUN	120	W + X
VERTICAL RUN	170	

INSTALLATION	S
HORIZONTAL RUN	A2 + 50
VERTICAL RUN	

Plug-in Busduct

Expansion Busduct



INSTALLATION	S
HORIZONTAL RUN	A1/ 2 + W/2 + 100
VERTICAL RUN	

*** Dimension W: refer to dimension table of ***Cross Section Of Busduct*** (page 1).

*** Dimension A1, A2: refer to drawing of ***Expansion Busduct*** (page 4), ***Plug-in Switch*** (page 9).

ASTA Certificate

Certificate No. 14810

ASTA CERTIFICATION SERVICES

(Incorporated in the year 1938) ASTA House, Chestnut Field, Rugby, CV21 2TL, England

Laboratory Ref. No. 101320AC

CERTIFICATE OF SHORT-CIRCUIT RATING

APPARATUS:	A 415 V / 600 V (U_e/U_i), 50 Hz, busbar trunking system incorporating a flange end feeder, three joints, one straight section, one plug-in straight section and one elbow comprising three-phase and neutral copper busbars in a sheet steel enclosure.
DESIGNATION:	CU 4W 2000A
MANUFACTURER:	Sumiden Asahi (Thailand) Co., Ltd. 900/2 Moo 15 Theparak Road, Tambol Bangsaothong, King Amphur Bangsaothong, Samutprakarn 10542, Thailand.
TESTED BY:	Testing & Certification Australia 18 Mars Road Lane Cove NSW 2066 Australia Tested for : Sumiden Asahi Industries, Ltd. Busduct Division 20-2 Toda Kitagawara, Itami 664 Hyogo Japan
DATE(S) OF TESTS:	16 to 24 May 2001

The apparatus, constructed in accordance with the description, drawings and photographs incorporated in this certificate has been subjected to the series of proving tests in accordance with

IEC Publication 60439-2 : 2000 and BS EN 60439-2 : 2000, Clauses 8.2.2 and 8.2.3

The results are shown in the record of Proving Tests and the oscillograms attached hereto. The values obtained and the general performance are considered to comply with the above Standard(s) and to justify the ratings assigned by the manufacturer as stated below.

Dielectric Properties (Clause 8.2.2)

Rated insulation voltage of the main circuits (U_i) : 600 V

Rated Short-time and Peak Withstand Currents (Clauses 8.2.3.2.3 b and d)

Phase busbars (1 - 175 mm x 6 mm copper per phase)	: 80 kA rms for 1s, 176 kA peak 50 kA rms for 3s, 105 kA peak
Neutral busbar (1 - 175 mm x 6 mm copper bar)	: 80 kA rms for 1s, 176 kA peak 50 kA rms for 3s, 105 kA peak

The record of Proving Tests applies only to the apparatus tested. The responsibility for conformity of any apparatus having the same designations with that tested rests with the Manufacturer.

This Certificate comprises 10 pages, 2 diagrams, 4 oscillograms, 9 photographs, 8 drawings and no other sheets, as detailed on page 1.

Only integral reproduction of this Certificate, or reproductions of this page accompanied by any page(s) on which are stated the assigned rated characteristics of the apparatus tested, are permitted without written permission from ASTA Certification Services, ASTA House, Chestnut Field, Rugby, CV21 2TL England. (see overleaf)

UKAS PRODUCT CERTIFICATION 010

M.A. Carstedt — M. A. Carstedt, ASTA Observer

C. Nick-Evans

ENGINEERING MANAGER

21ST AUGUST 2001 Date

Certificate No 14811

ASTA CERTIFICATION SERVICES

(Incorporated in the year 1938) ASTA House, Chestnut Field, Rugby, CV21 2TL, England

Laboratory Ref. No. 101321AC

CERTIFICATE OF SHORT-CIRCUIT RATING

APPARATUS: A 415 V / 600 V (U_e/U_i), 50 Hz, busbar trunking system incorporating a flange end feeder, two joints, one straight section and one plug-in straight section comprising three-phase and neutral copper busbars in a sheet steel enclosure.

DESIGNATION: CU 4W 2500A

MANUFACTURER: Sumiden Asahi (Thailand) Co., Ltd.
900/2 Moo 15 Theparak Road, Tambol Bangsaothong, King Amphur Bangsaothong, Samutprakarn 10542, Thailand.

TESTED BY: Testing & Certification Australia
18 Mars Road Lane Cove NSW 2066 Australia
Tested for : Sumiden Asahi Industries, Ltd. Busduct Division
20-2 Toda Kitagawara, Itami 664 Hyogo Japan

DATE(S) OF TESTS: 16 to 21 May 2001

The apparatus, constructed in accordance with the description, drawings and photographs incorporated in this certificate has been subjected to the series of proving tests in accordance with

IEC Publication 60439-2 : 2000 and BS EN 60439-2 : 2000, Clauses 8.2.2 and 8.2.3

The results are shown in the record of Proving Tests and the oscillograms attached hereto. The values obtained and the general performance are considered to comply with the above Standard(s) and to justify the ratings assigned by the manufacturer as stated below.

Dielectric properties (Clause 8.2.2)

Rated insulation voltage of the main circuits (U_i) : 600 V

Rated Short-time and Peak Withstand Currents (Clauses 8.2.3.2.3 b and d)

Phase busbars (2 - 125 mm x 6 mm copper per phase)	: 100 kA rms for 1s, 220 kA peak 50 kA rms for 3s, 105 kA peak
Neutral busbar (2 - 125 mm x 6 mm copper bar)	: 80 kA rms for 1s, 176 kA peak 50 kA rms for 3s, 105 kA peak

The record of Proving Tests applies only to the apparatus tested. The responsibility for conformity of any apparatus having the same designations with that tested rests with the Manufacturer.

This Certificate comprises 10 pages, 2 diagrams, 4 oscillograms, 6 photographs, 7 drawings and no other sheets, as detailed on page 1.

Only integral reproduction of this Certificate, or reproductions of this page accompanied by any page(s) on which are stated the assigned rated characteristics of the apparatus tested, are permitted without written permission from ASTA Certification Services, ASTA House, Chestnut Field, Rugby, CV21 2TL England. (see overleaf)

UKAS PRODUCT CERTIFICATION 010

M.A. Carstedt — M. A. Carstedt, ASTA Observer

C. Nick-Evans

ENGINEERING MANAGER

21ST AUGUST 2001 Date

Certificate No. 14812

ASTA CERTIFICATION SERVICES

(Incorporated in the year 1938) ASTA House, Chestnut Field, Rugby, CV21 2TL, England

Laboratory Ref. No. 101322AC

CERTIFICATE OF SHORT-CIRCUIT RATING

APPARATUS:	A 415 V / 600 V (U_e/U_i), 50 Hz, busbar trunking system incorporating a flange end feeder, two joints and two straight sections comprising three-phase and neutral copper busbars in a sheet steel enclosure.
DESIGNATION:	CU 4W 4000A
MANUFACTURER:	Sumiden Asahi (Thailand) Co., Ltd. 900/2 Moo 15 Theparak Road, Tambol Bangsaothong, King Amphur Bangsaothong, Samutprakarn 10542, Thailand.
TESTED BY:	Testing & Certification Australia 18 Mars Road Lane Cove NSW 2066 Australia Tested for : Sumiden Asahi Industries, Ltd. Busduct Division 20-2 Toda Kitagawara, Itami 664 Hyogo Japan
DATE(S) OF TESTS:	16 to 23 May 2001

The apparatus, constructed in accordance with the description, drawings and photographs incorporated in this certificate has been subjected to the series of proving tests in accordance with

IEC Publication 60439-2 : 2000 and BS EN 60439-2 : 2000, Clauses 8.2.2 and 8.2.3

The results are shown in the record of Proving Tests and the oscillograms attached hereto. The values obtained and the general performance are considered to comply with the above Standard(s) and to justify the ratings assigned by the manufacturer as stated below.

Dielectric properties (Clause 8.2.2)

Rated insulation voltage of the main circuits (U_i) : 600 V

Rated Short-time and Peak Withstand Currents (Clause 8.2.3.2.3 b and d)

Phase busbars (2 - 200 mm x 6 mm copper per phase)	: 100 kA rms for 1s, 220 kA peak 65 kA rms for 3s, 143 kA peak
Neutral busbar (2 - 200 mm x 6 mm copper bar)	: 80 kA rms for 1s, 176 kA peak 65 kA rms for 3s, 143 kA peak

The record of Proving Tests applies only to the apparatus tested. The responsibility for conformity of any apparatus having the same designations with that tested rests with the Manufacturer.

This Certificate comprises 10 pages, 1 diagram, 4 oscillograms, 3 photographs, 6 drawings and no other sheets, as detailed on page 1.

Only integral reproduction of this Certificate, or reproductions of this page accompanied by any page(s) on which are stated the assigned rated characteristics of the apparatus tested, are permitted without written permission from ASTA Certification Services, ASTA House, Chestnut Field, Rugby, CV21 2TL England. (see overleaf)

UKAS PRODUCT CERTIFICATION
010

M.A. Carstedt — M. A .Carstedt, ASTA Observer

C. Mick-Evans

ENGINEERING MANAGER

21ST AUGUST 2001 Date

Certificate No 14813

ASTA CERTIFICATION SERVICES

(Incorporated in the year 1938) ASTA House, Chestnut Field, Rugby, CV21 2TL, England

Laboratory Ref. No. 101323AC

CERTIFICATE OF SHORT-CIRCUIT RATING

APPARATUS: A 415 V / 600 V (U_e/U_i), 50 Hz, busbar trunking system incorporating a flange end feeder, two joints, one straight section, one plug-in straight section comprising three-phase and neutral copper busbars in a sheet steel enclosure. The busbar trunking system also incorporated two plug-in MCCB outgoing units.

DESIGNATION: CU 4W 800A

MANUFACTURER: Sumiden Asahi (Thailand) Co., Ltd.
900/2 Moo 15 Theparak Road, Tambol Bangsaothong, King Amphur Bangsaothong, Samutprakarn 10542, Thailand.

TESTED BY: Testing & Certification Australia
18 Mars Road Lane Cove NSW 2066 Australia
Tested for : Sumiden Asahi Industries, Ltd. Busduct Division
20-2 Toda Kitagawara, Itami 664 Hyogo Japan

DATE(S) OF TESTS: 16 to 23 May 2001

The apparatus, constructed in accordance with the description, drawings and photographs incorporated in this certificate has been subjected to the series of proving tests in accordance with

IEC Publication 60439-2 : 2000 and BS EN 60439-2 : 2000, Clauses 8.2.2 and 8.2.3

The results are shown in the record of Proving Tests and the oscillograms attached hereto. The values obtained and the general performance are considered to comply with the above Standard(s) and to justify the ratings assigned by the manufacturer as stated below.

Dielectric Properties (Clause 8.2.2)

Rated insulation voltage of the main circuits (U_i) : 600 V

Rated Conditional Short-circuit Current (Clause 8.2.3.2.3 a)

250 A and 630 A outgoing MCCB units : 40 kA rms at 415 V, pf = 0.25 lag

Rated Short-time and Peak Withstand Currents (Clause 8.2.3.2.3 b and d)

Phase busbars
(1 - 50 mm x 6 mm copper per phase) : 50 kA rms for 0.5s, 105 kA peak
40 kA rms for 1s, 84 kA peak

Neutral busbar
(1 - 50 mm x 6 mm copper bar) : 50 kA rms for 0.5s, 105 kA peak
40 kA rms for 1s, 84 kA peak

The record of Proving Tests applies only to the apparatus tested. The responsibility for conformity of any apparatus having the same designations with that tested rests with the Manufacturer.

This Certificate comprises 14 pages, 1 diagram, 7 oscillograms, 13 photographs, 8 drawings and no other sheets, as detailed on page 1.

Only integral reproduction of this Certificate, or reproductions of this page accompanied by any page(s) on which are stated the assigned rated characteristics of the apparatus tested, are permitted without written permission from ASTA Certification Services, ASTA House, Chestnut Field, Rugby, CV21 2TL England. (see overleaf)

UKAS PRODUCT CERTIFICATION
010

M.A. Carstedt — M. A. Carstedt, ASTA Observer

C. Mick-Evans
ENGINEERING MANAGER

21ST AUGUST 2001 Date

Technical Specification

TECHNICAL SPECIFICATION

OF

NET'S INSULAED BUSDUCT

NET NISSIN ELECTRIC (THAILAND) CO.,LTD

www.nissin-thai.com e-mail: bds@nissin-thai.com

Contents

Note) NET ••• NISSIN ELECTRIC (THAILEND) CO.,LTD.

1. Features of NET's Insulated Bus Duct 1-

1. Generals

1. SS nuts that prevent joints from being left loosely tightened

SS nuts ensure that workers do not forget to tighten the joint bolt completely. This eliminates overheat troubles, which have been experienced often with the conventional nuts, thus raising reliability of the bus duct line.

2. Stable contact surface

Front-and-back contact with a bridge plate secures a twofold contact area as compared with the simple surface lapping method, bringing about a compact and stable joint. The contact surface pressure is designed properly so as to generate no creep.

3. Joint easy to assemble

Since the separator plate and the bridge plate are shaped so as to be coupled smoothly with the duct conductor, assembling the joint can be easily made.

4. Joint compatible to both right and left

Since the joint parts are shaped symmetrical right and left, the joint can be fit without any caution on the parts' directional configuration.

5. No fear of joint parts' displacement

Since the joint is designed so that projections of the separator and the hollows of the side board fit at the correct position, correct fitting of the joint is ensured at any time. The plate spring is also designed so as to be positioned properly.

6. Unified separators and bridge plates

Since the separators and the bridge plates are unified by caulking, not by gluing, they are free from eventual displacement. Caulking causes no degradation different from gluing, which may melt.

7. Ensuring constant contact area

Since the positioning mechanism is provided with the stopper on the bridge plate and the bolt hole of the side board, stable contact area of the joint is ensured at all times.

8- No bonding wire

Since end portion of the duct case and inner surface of the joint side board is left as galvanized without coating application, the complete earthing circuit is secured only by fixing the side board.

9- High tensile strength joint bolts

The joint bolts use high strength steel of a sufficient tensile strength against the large axial force of the bolt that tightens the joint.

10- Superb insulator by wrapping

NET's special high quality, heat resistant polyester film is applied on the conductor by wrapping. This ensures uniform and continuous insulation coating in any cross-section.

11. Compact design

The product uses single conductor per phase up to 3,000A for aluminium and 3,500A for copper. This results in compact form, allowing easy construction works.

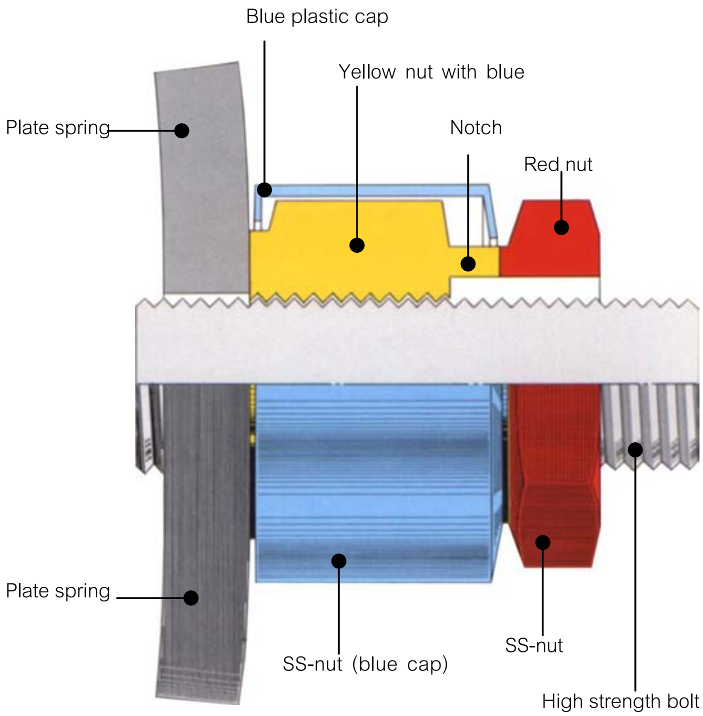
Joint Unit of NET's Insulated Bus Duct

- The unit of single bolt (aluminium conductor; 3W, 600A)

- The unit with double bolts (aluminium conductor; 3W, 2000A)

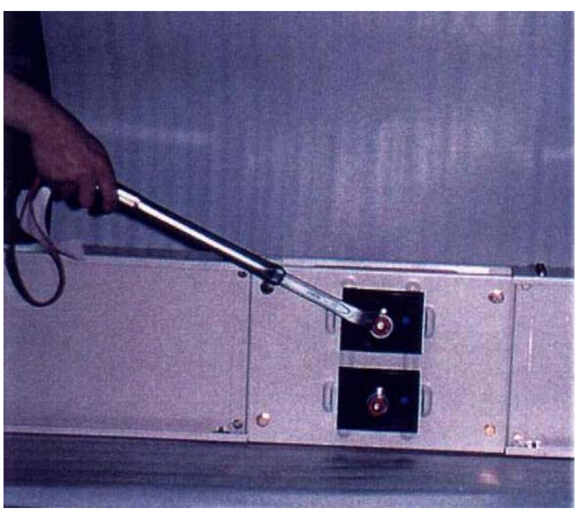
1-2. Features of the joint unit

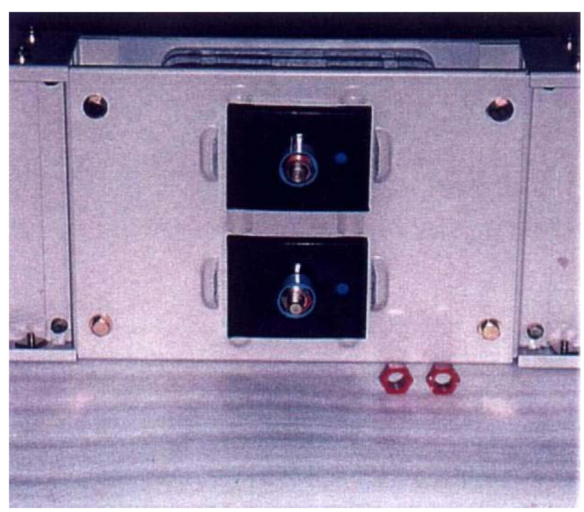
1. SS nuts that prevent the joint from being left loosely tightened



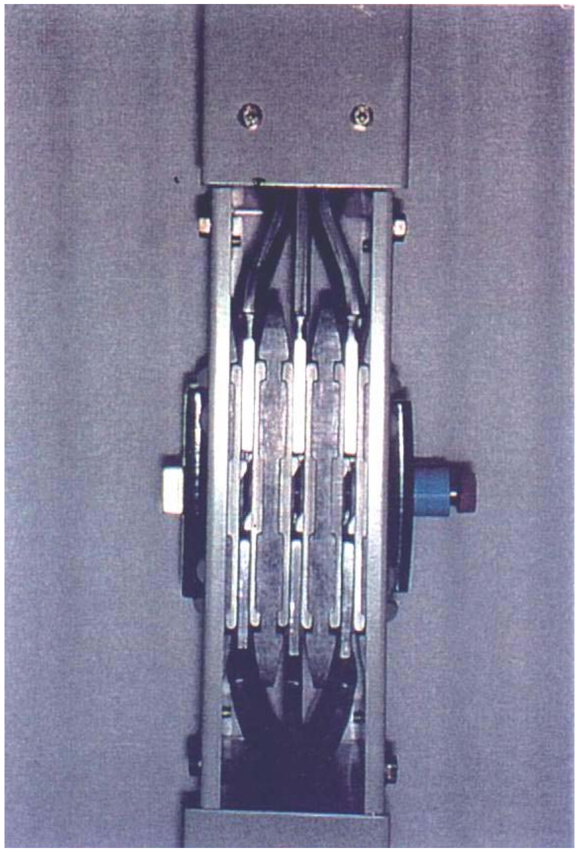
The SS nut, developed and patent right reserved by SEI, is exclusive for tightening the joint unit. It consists of two portions; that coated yellow and covered with a blue plastic cap, and that coated red. A notch is cut between the yellow and the red portions. When the nut is gradually tightened with a ring spanner set on the red part, the notch is broken at a specific torque. The red portion drops off, remaining the yellow in position. This ensures the specific torque tightening the joint. Once the notch is broken, the yellow nut covered with the blue cap watched on the site after assembly ensures perfect installation.

Note) SEI … SUMITOMO ELECTRIC INDUSTRIES, LTD.





2. Reliable contact surface of conductor



Each conductor is jointed with a bridge plate on both sides. This not only secures larger contact area than the method that laps directly the conductors to be joined, but also tends to offer larger true contact between the mated surfaces. Moreover, this joint construction is designed so to exert proper interfacial pressure that prevents creep generation. These features ensure high reliability of the joint, the vital part of the bus duct line.

3. Symmetrically shaped joint portion

Since the joint unit, including its all components, is shaped symmetrical right and left, any unit, whatever of the elbow or the offset it may be, can be inserted into the joint unit either from left or right. This facilitates construction works including configuration alteration or partial modification of the line.

4. Complete joint easily made

Edges of all parts of the joint unit are shaped smoothly like the streamline. Hence, a bus duct unit of any shape can be inserted into the joint unit. And, the stopper on the bridge plate assures a stable length of contact at any instance.

5. The plate spring and washers positioned at the center in any event

A plate spring of special steel and washers are used for construction of the unit joint. These parts are positioned at the center of the unit by the guides provided from the unit's side boards in any event, preventing their gravitational displacement and eccentric exertion of pressure by the bolt(s). Thus, position of the joint unit is stable at any time, and construction work can be easily carried out.

6. Superb electrical and mechanical characteristics of insulator

The insulators in the joint unit are provided with sufficient thickness and rigidity.

1-3. Conductor insulation coating

Conductor insulation is based on NET's insulation technology, which has been established as the basic expertise of the leading electric wire and cable manufacturer. The insulation uses special heat resistant polyester, which is of course strong to moisture and provided with superb electrical and mechanical characteristics.

Table 1-3-1 Properties of the Insulating Material for Insulated Bus Duct

Item	Unit	Typical Value
Breakdown Voltage	KV/mm	min. 60
Thermal Class	-	B(130℃)
Tensile Strength	MPa	min. 147
Elongation	%	min. 60
Insulation Thickness	mm	0.5

2. Voltage Drop

2-1. Calculation of impedance

1) Formula for calculation of the bus duct impedance Z

$Z = R_{ac.t} + jX$

where $R_{ac.t}$: AC resistance at t℃

X : reactance

2) Calculation of $R_{ac.t}$

$$R_{ac.t} = \frac{P_{20}}{S}\{1 + \alpha(t-20)\}\cdot K$$

where P_{20}: resistivity at 20℃ --- Table 2-1-1

S : conductor cross-sectional area

α : temperature coefficient of resistance --- Table 2-1-1

K : skin effect factor --- Fig. 2-1-1

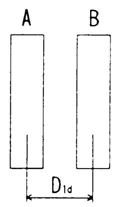
Table 2-1-1 Resistivity and Temperature Coefficient

Material	Resistivity, P_{20} (Ω/m)	Temperature coefficient, α /℃
Aluminium	2.8735×10^{-8}	4.0×10^{-3}
Copper	1.7593×10^{-8}	3.9×10^{-3}

3) Calculation of X

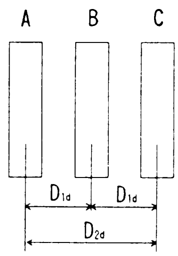
Single phase line

$$X = 4\pi f \times 10^{-7} \ln \frac{D_{1d}}{D_s} \quad (\Omega/m)$$



Three phase line

$$X = 4\pi f \times 10^{-7} \ln \frac{\sqrt[3]{D_{1d}^{2}\cdot D_{2d}}}{D_s} \quad (\Omega/m)$$



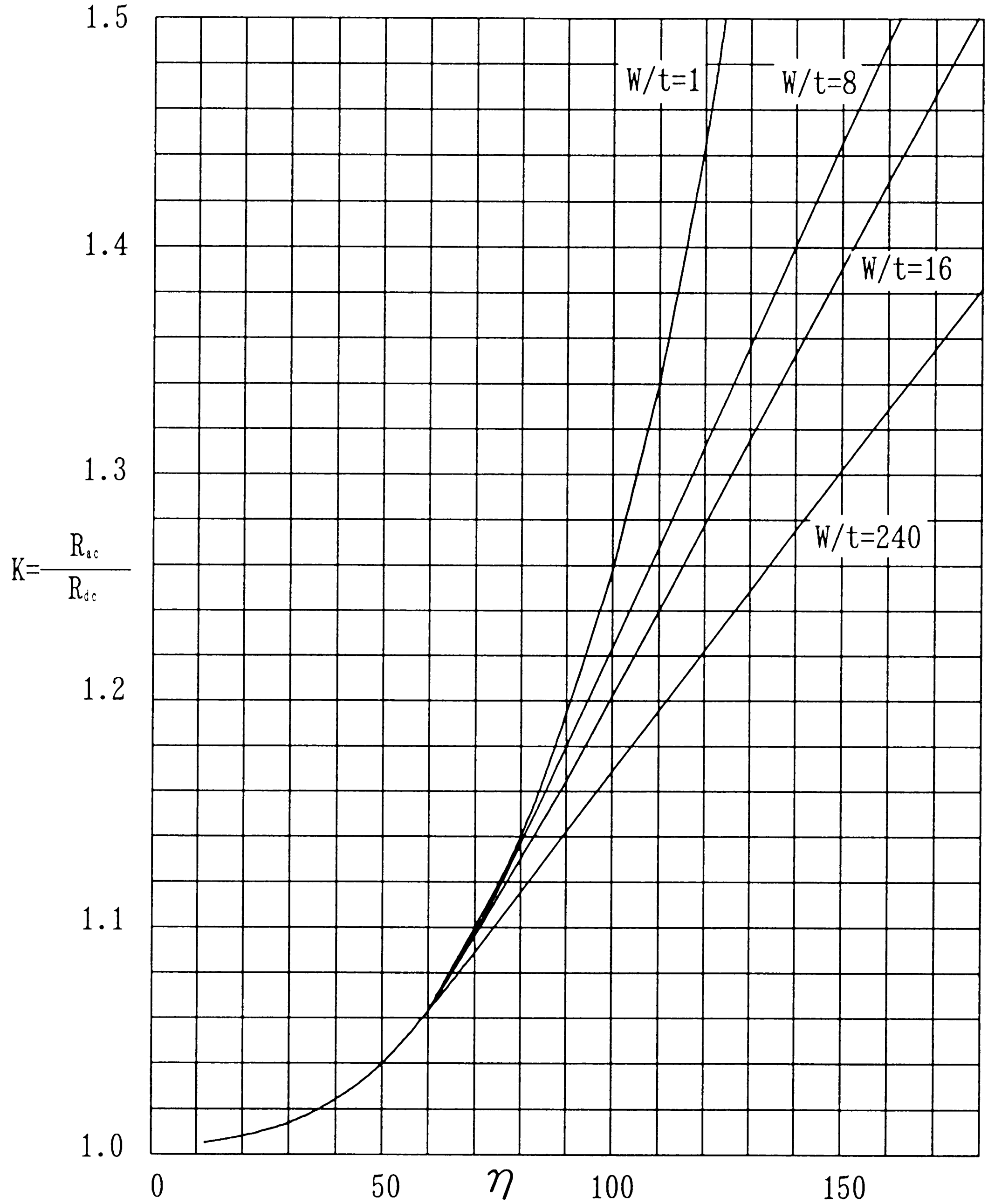
where f : frequency(Hz)

D_s : geographical average diameter of conductor

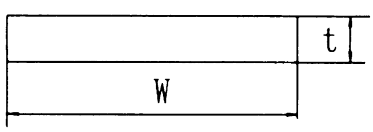
D_{1d} : distance between conductors A and B, and B and C

D_{2d} : distance between conductors A and C

Fig. 2-1-1 Skin Effect Factors



$$\eta = 1.81\sqrt{\frac{f}{R_{dc}}}\ (\Omega/km)$$



f : frequency

R_{dc} : conductor DC resistance (take the value at 95℃ in general) (Ω/km)

$R_{dc} = R_0\{1+\alpha(\theta-\theta_0)\}$

2-2. Table 2-2-1 List of Insulated Bus Duct Impedances

Unit : $10^{-5}\,\Omega/m$

	Amp	Conductor Size	50 Hz		60 Hz		DC
			R_{ac}	X	R_{ac}	X	
Aluminum conductor	600	6 x 50	12.72	2.53	12.76	3.04	12.45
	800	6 x 75	8.56	1.83	8.62	2.20	8.30
	1000	6 x 100	6.49	1.43	6.56	1.72	6.23
	1200	6 x 125	5.26	1.18	5.35	1.42	4.98
	1350	6 x 165	4.09	0.92	4.18	1.10	3.77
	1500	6 x 165	4.09	0.92	4.18	1.10	3.77
	1600	10 x 165	2.61	1.28	2.68	1.54	2.26
	2000	10 x 175	2.48	1.22	2.55	1.46	2.13
	2500	2 - 10 x 125	1.67	0.83	1.71	1.00	1.49
	3000	2 - 10 x 140	1.51	0.76	1.55	0.91	1.33
	3500	2 - 10 x 175	1.24	0.62	1.27	0.74	1.07
	4000	2 - 10 x 200	1.11	0.55	1.14	0.66	0.93
	4500	3 - 10 x 165	0.92	0.45	0.95	0.54	0.75
	5000	3 - 10 x 175	0.88	0.43	0.90	0.51	0.71
	6300	4 - 10 x 140	0.83	0.40	0.86	0.48	0.67
Copper conductor	800	6 x 50	7.84	2.53	7.90	3.04	7.58
	1000	6 x 75	5.34	1.83	5.42	2.20	5.05
	1200	6 x 100	4.11	1.43	4.20	1.72	3.79
	1350	6 x 125	3.37	1.18	3.45	1.42	3.03
	1500	6 x 125	3.37	1.18	3.45	1.42	3.03
	1600	6 x 165	2.64	0.92	2.71	1.10	2.30
	2000	6 x 175	2.51	0.87	2.58	1.05	2.17
	2500	2 - 6 x 125	1.69	0.60	1.73	0.72	1.52
	3000	2 - 6 x 140	1.53	0.54	1.56	0.65	1.35
	3500	2 - 6 x 175	1.26	0.44	1.29	0.53	1.08
	4000	2 - 6 x 200	1.12	0.39	1.15	0.47	0.95
	4500	3 - 6 x 165	0.93	0.32	0.96	0.38	0.77
	5000	3 - 6 x 175	0.89	0.30	0.91	0.36	0.72
	6300	4 - 6 x 140	0.84	0.28	0.86	0.34	0.68

Note) R_{ac} : AC resistance at 95°C

2-3. Calculation of voltage drop

Formulas of voltage drop calculation for typical electrical systems:

Single phase two line system $\Delta V = 2\,(R\cos\psi + X\sin\psi)\, I \cdot L$

Single phase three line system $\Delta V = (R\cos\psi + X\sin\psi)\, I \cdot L$

Three phase three line system $\Delta V = \sqrt{3}\,(R\cos\psi + X\sin\psi)\, I \cdot L$

Three phase four line system $\Delta V = (R\cos\psi + X\sin\psi)\, I \cdot L$

Where
- ΔV : voltage drop (V)
- I : line current (A)
- R : AC resistance (Ω / m)
- X : reactance (Ω / m)
- $\cos\psi$: load power factor
- $\sin\psi$: $\sqrt{1-\cos^2\psi}$
- L : bus duct line length (m)

2-4. Current vs. voltage drop of insulated bus duct lines

Fig. 2-4-1

3-aluminium conductor type

3φ, 50Hz, pf=0.85

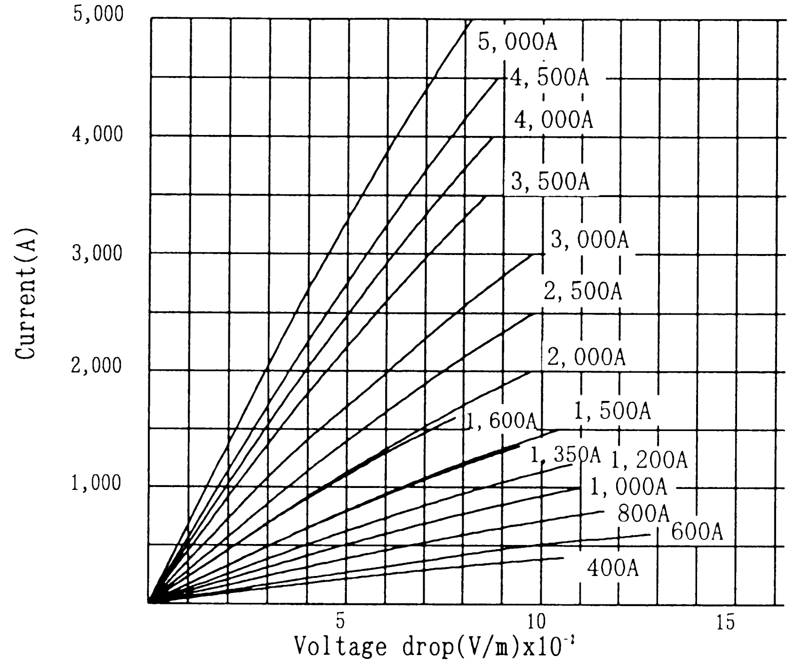
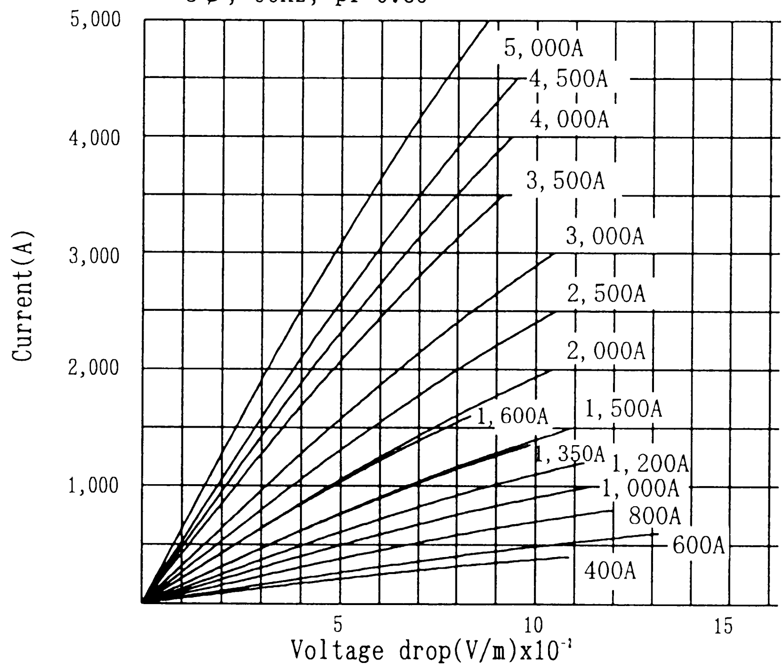


Fig. 2-4-2

3-aluminium conductor type

3φ, 60Hz, pf=0.85



Notes) 1) The voltage drop in these curves assumes an ambient temperature of 40℃, and is corrected with the AC resistance when the current is smaller than the rated value.

2) The values represent aluminium conductor and steel board housing.

Fig. 2-4-3

3-copper conductor type

3ϕ, 50Hz, pf=0.85

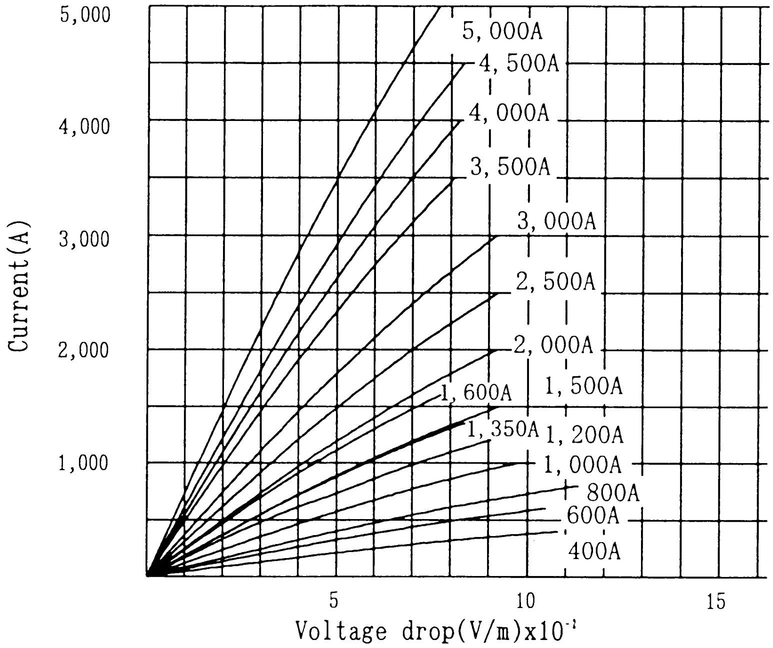
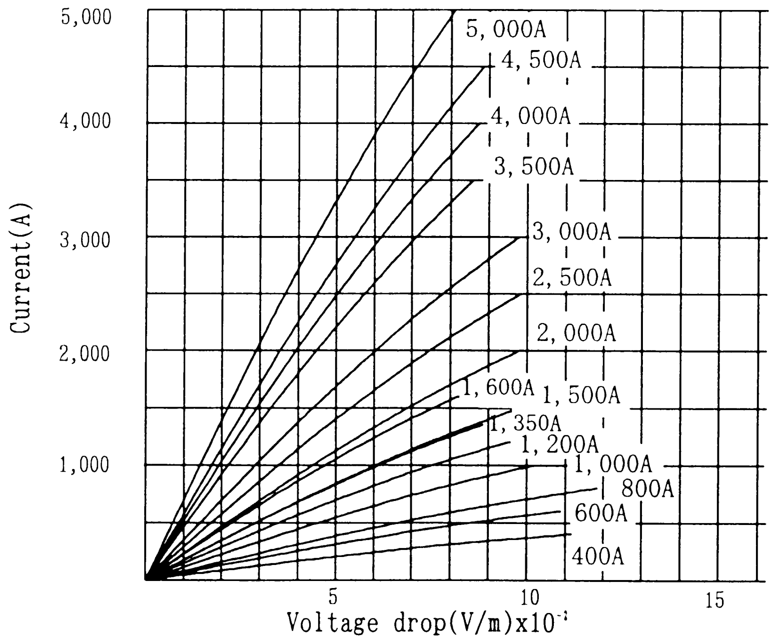


Fig. 2-4-4

3-copper conductor type

3ϕ, 60Hz, pf=0.85



Notes) 1) The voltage drop in these curves assumes an ambient temperature of 40℃, and is corrected with the AC resistance when the current is smaller than the rated value.
2) The values represent copper conductor and steel board housing.

2-5. Voltage drop by rated current

This section shows the calculated voltage drop with the rated current for each three phase three conductor bus duct. The conductor temperature of 95 deg.C is assumed; the ambient temperature of 40 deg.C plus the maximum permissible temperature rise of 55 deg.C. The results are summarized in Tables 2-5-1 and -2, and Figs. 2-5-1 to -4.

Table 2-5-1 Voltage Drops by Rated Currents
aluminium conductors in steel housing at 95 deg.C

Conductor material	Frequency (Hz)	Rated current (A)	Voltage drop(V/m)							
			Power factor							
			100%	98%	95%	90%	85%	80%	75%	70%
Aluminium	50	400	0.110	0.112	0.112	0.109	0.106	0.102	0.098	0.094
		600	0.132	0.136	0.135	0.132	0.128	0.124	0.119	0.114
		800	0.119	0.122	0.122	0.119	0.116	0.112	0.108	0.104
		1,000	0.112	0.116	0.116	0.114	0.110	0.107	0.103	0.099
		1,200	0.109	0.113	0.113	0.111	0.108	0.104	0.101	0.097
		1,350	0.096	0.099	0.099	0.097	0.094	0.091	0.088	0.084
		1,500	0.106	0.110	0.110	0.108	0.105	0.101	0.098	0.094
		1,600	0.069	0.075	0.077	0.078	0.078	0.077	0.076	0.074
		2,000	0.086	0.093	0.096	0.097	0.097	0.096	0.095	0.093
		2,500	0.087	0.094	0.097	0.098	0.098	0.097	0.096	0.094
		3,000	0.086	0.094	0.096	0.098	0.097	0.096	0.095	0.093
		3,500	0.075	0.082	0.084	0.086	0.086	0.085	0.084	0.082
		4,000	0.077	0.084	0.086	0.087	0.087	0.086	0.085	0.084
		4,500	0.078	0.085	0.087	0.088	0.084	0.086	0.086	0.085
		5,000	0.072	0.078	0.080	0.082	0.082	0.081	0.080	0.078
	60	400	0.110	0.113	0.113	0.111	0.108	0.105	0.101	0.097
		600	0.133	0.137	0.137	0.135	0.132	0.128	0.123	0.118
		800	0.119	0.124	0.124	0.123	0.120	0.116	0.112	0.108
		1,000	0.114	0.118	0.119	0.117	0.115	0.111	0.108	0.104
		1,200	0.111	0.116	0.116	0.115	0.112	0.109	0.106	0.102
		1,350	0.098	0.102	0.102	0.101	0.099	0.096	0.093	0.089
		1,500	0.109	0.113	0.113	0.112	0.110	0.107	0.103	0.099
		1,600	0.071	0.078	0.081	0.083	0.083	0.083	0.082	0.081
		2,000	0.088	0.098	0.101	0.104	0.104	0.104	0.103	0.101
		2,500	0.089	0.098	0.102	0.104	0.105	0.105	0.104	0.102
		3,000	0.089	0.098	0.102	0.104	0.105	0.104	0.103	0.102
		3,500	0.077	0.085	0.089	0.091	0.092	0.091	0.091	0.089
		4,000	0.079	0.087	0.091	0.093	0.094	0.094	0.093	0.091
		4,500	0.080	0.089	0.092	0.094	0.095	0.095	0.094	0.092
		5,000	0.074	0.082	0.085	0.087	0.087	0.087	0.086	0.085

Table 2-5-2 Voltage Drops by Rated Currents
copper conductors in steel housing at 95 deg.C

Conductor material	Frequency (Hz)	Rated current (A)	Voltage drop(V/m)							
			Power factor							
			100%	98%	95%	90%	85%	80%	75%	70%
Copper	50	400	0.107	0.111	0.112	0.110	0.108	0.105	0.102	0.098
		600	0.101	0.106	0.107	0.106	0.105	0.102	0.099	0.096
		800	0.109	0.114	0.116	0.115	0.113	0.111	0.108	0.104
		1,000	0.092	0.098	0.099	0.099	0.098	0.096	0.093	0.090
		1,200	0.085	0.090	0.092	0.092	0.090	0.089	0.086	0.084
		1,350	0.079	0.084	0.085	0.085	0.084	0.082	0.080	0.078
		1,500	0.088	0.093	0.094	0.094	0.093	0.091	0.089	0.086
		1,600	0.073	0.077	0.079	0.079	0.078	0.076	0.074	0.072
		2,000	0.087	0.092	0.093	0.093	0.092	0.090	0.088	0.086
		2,500	0.087	0.093	0.094	0.094	0.092	0.091	0.088	0.086
		3,000	0.087	0.092	0.093	0.093	0.092	0.090	0.088	0.085
		3,500	0.076	0.081	0.082	0.082	0.081	0.079	0.077	0.075
		4,000	0.078	0.082	0.083	0.083	0.082	0.081	0.079	0.077
		4,500	0.079	0.083	0.085	0.084	0.083	0.082	0.080	0.077
		5,000	0.073	0.077	0.078	0.078	0.077	0.075	0.073	0.071
	60	400	0.107	0.113	0.114	0.113	0.112	0.109	0.106	0.103
		600	0.102	0.108	0.110	0.110	0.109	0.107	0.104	0.101
		800	0.110	0.117	0.119	0.119	0.118	0.116	0.114	0.111
		1,000	0.094	0.101	0.103	0.103	0.103	0.101	0.099	0.097
		1,200	0.087	0.094	0.096	0.096	0.096	0.094	0.092	0.090
		1,350	0.081	0.086	0.088	0.089	0.089	0.087	0.086	0.084
		1,500	0.090	0.096	0.098	0.099	0.098	0.097	0.095	0.093
		1,600	0.075	0.081	0.082	0.083	0.082	0.081	0.079	0.078
		2,000	0.089	0.096	0.098	0.099	0.098	0.096	0.095	0.092
		2,500	0.090	0.096	0.098	0.099	0.098	0.097	0.095	0.092
		3,000	0.090	0.096	0.098	0.099	0.098	0.096	0.094	0.092
		3,500	0.078	0.084	0.086	0.086	0.086	0.085	0.083	0.081
		4,000	0.080	0.086	0.087	0.088	0.087	0.086	0.085	0.082
		4,500	0.081	0.087	0.089	0.089	0.089	0.087	0.086	0.083
		5,000	0.074	0.080	0.081	0.082	0.081	0.080	0.078	0.076

Fig. 2-5-1 Voltage Drops by Rated Currents(95 deg.C)

aluminium conductors in steel housing
three phase three conductor system
frequency: 50Hz

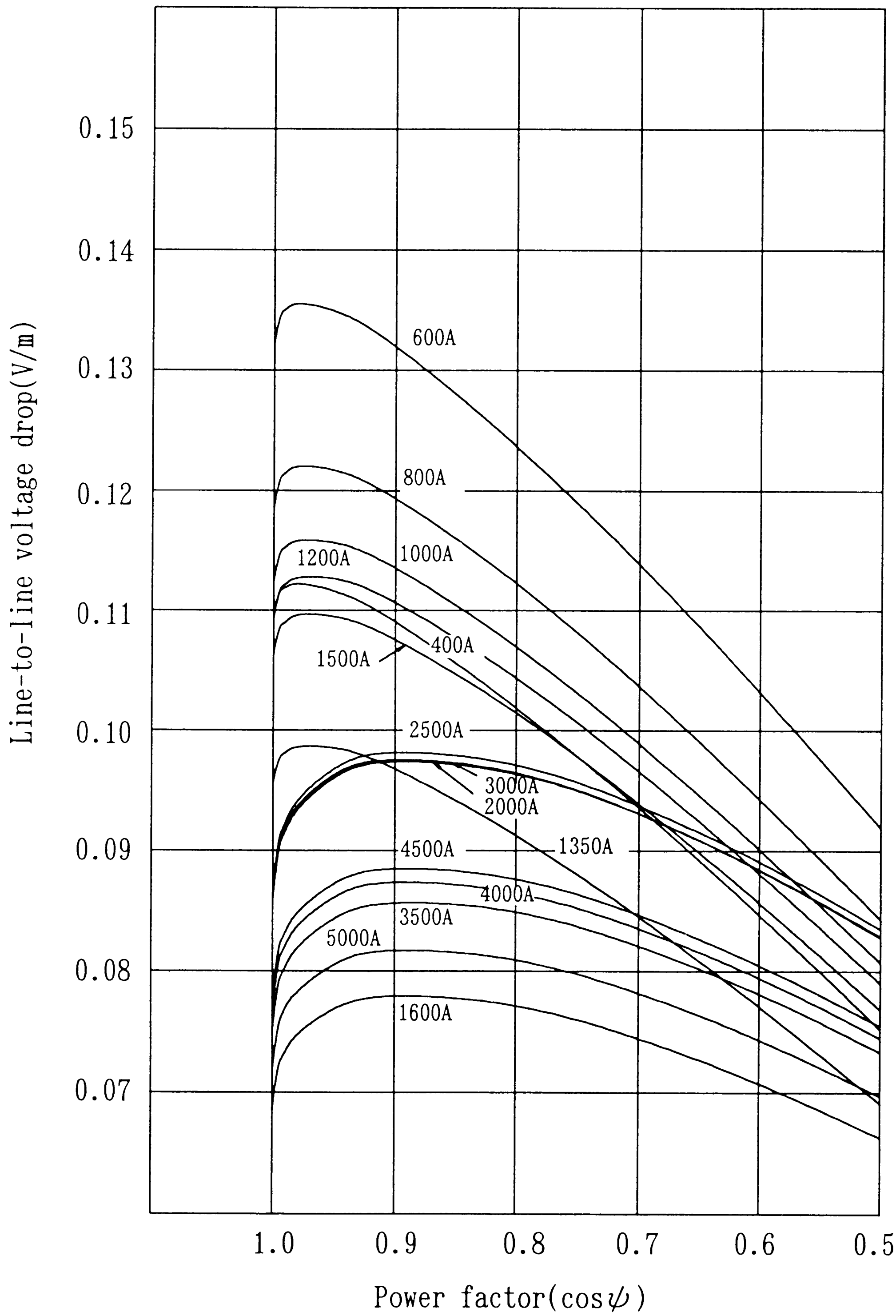


Fig. 2-5-2 Voltage Drops by Rated Currents(95 deg.C)

aluminium conductors in steel housing
three phase three conductor system
frequency: 60Hz

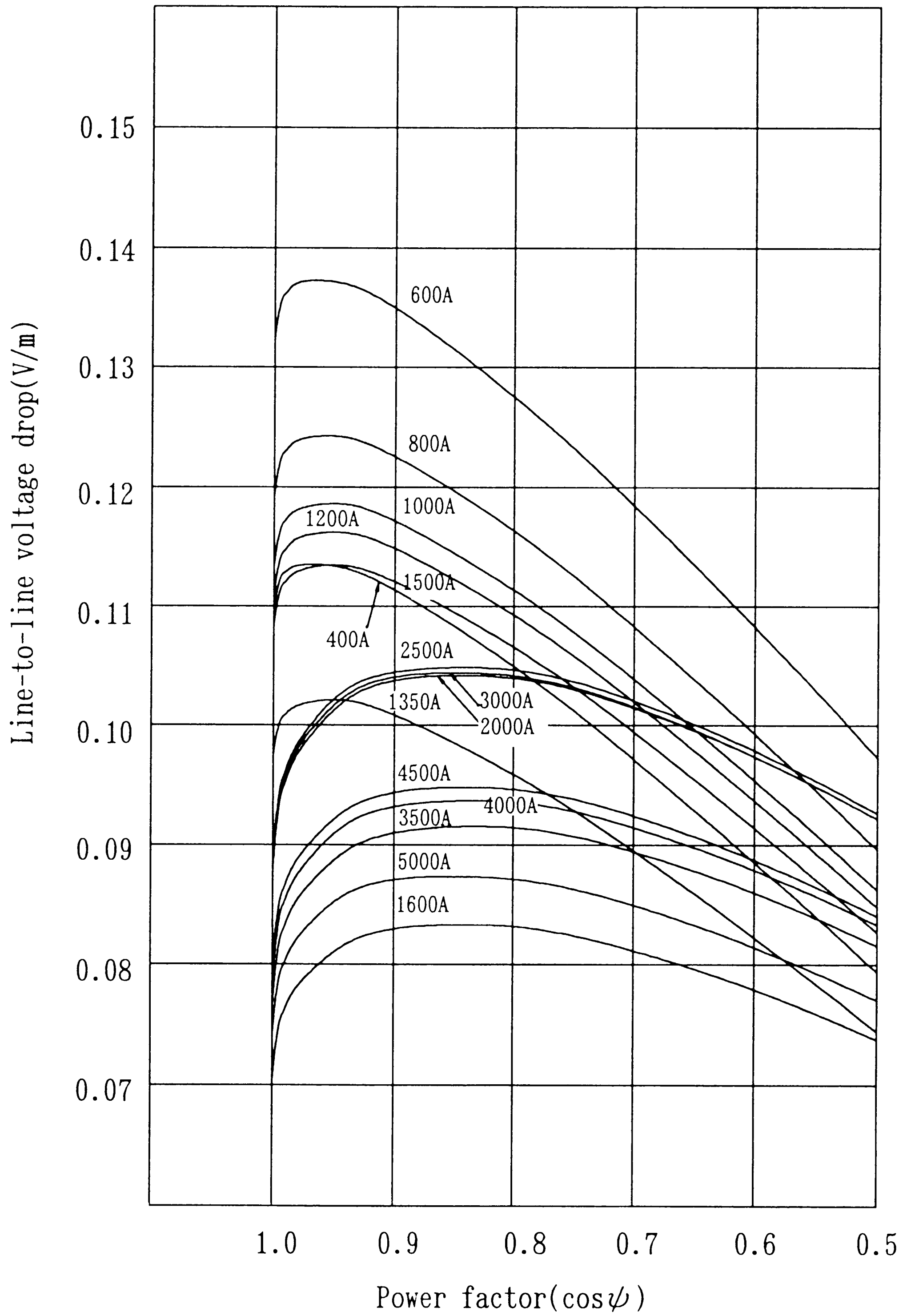


Fig. 2-5-3 Voltage Drops by Rated Currents(95 deg.C)

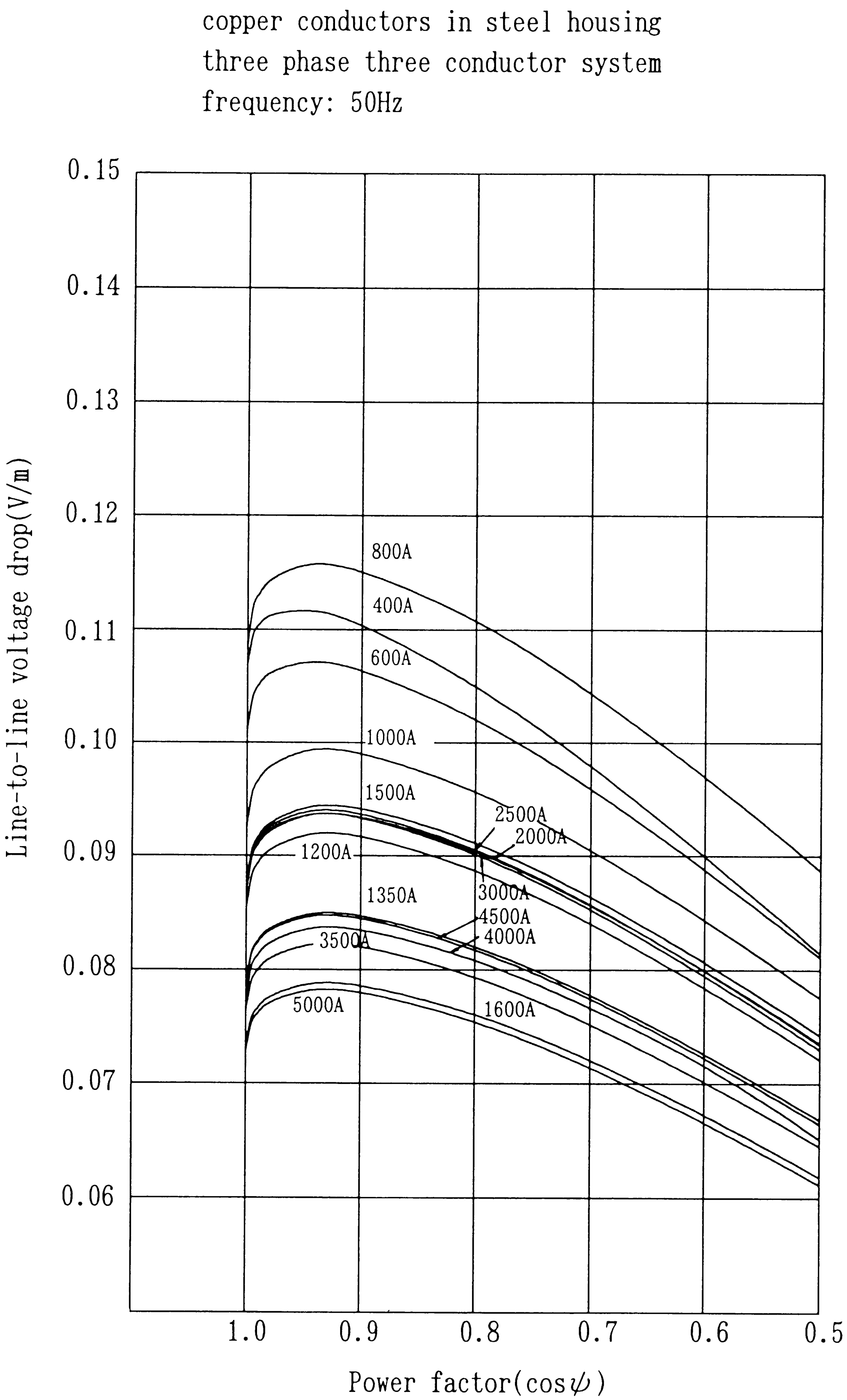
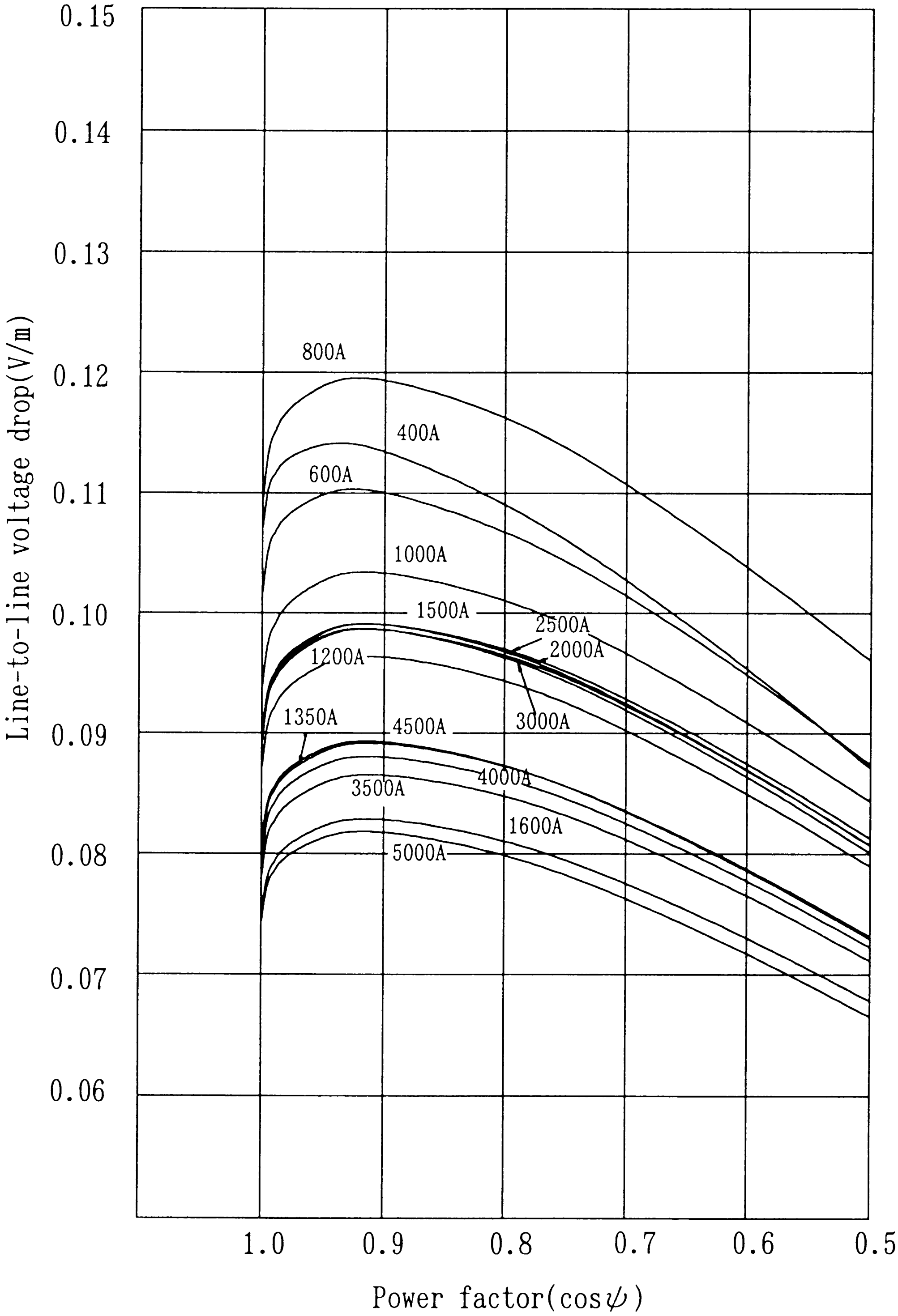


Fig. 2-5-4 Voltage Drops by Rated Currents(95 deg.C)

copper conductors in steel housing
three phase three conductor system
frequency: 60Hz



3. Short-circuit Strength

3-1. Calculation of electromagnetic force at short-circuit

Electromagnetic force F at short-circuit generated in the bus duct conductor is given with the following formula:

$$F = K_1 \cdot K_2 \frac{2.05\ I^2 \times 10^{-8}}{S} \quad (kg/m)$$

where I : peak value of short-circuit current wave(A)

S : equivalent distance between conductors(m)

K_1 : coefficient representing circuit condition

for single phase short-circuit: 1.0

for three phase short-circuit : 0.866

K_2 : coefficient of correction for shape

for rectangular conductors --- Fig.3-2-1

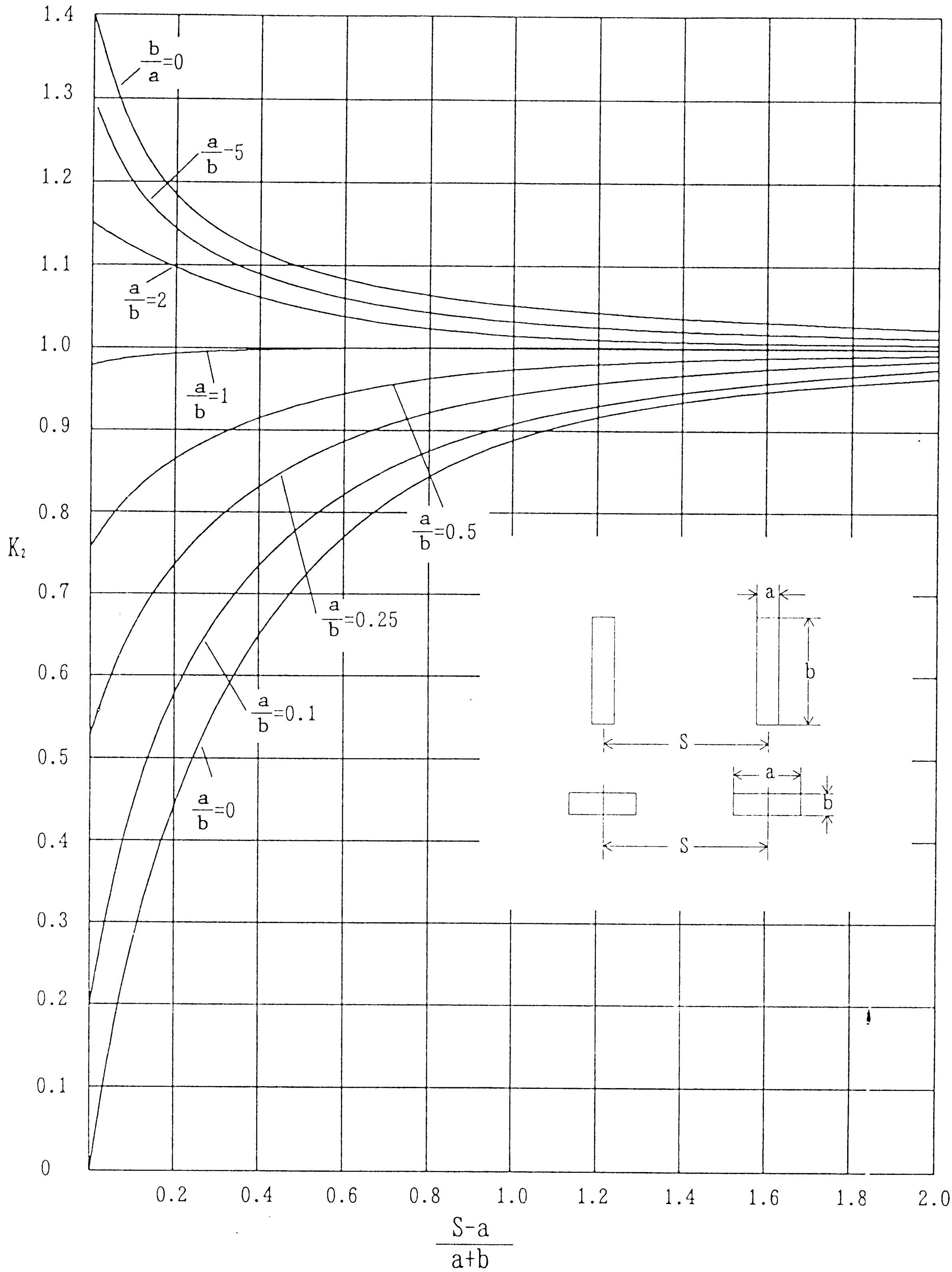
3-2. Table 3-2-1 Short-circuit Strength of Bus Duct, NET's Products vs. JIS Standard

Rated current (A)	Permissible short-circuit currents(A)	
	SAT standard	JIS standard
400	40,000	22,000
600	40,000	22,000
800	40,000	22,000
1,000	60,000	22,000
1,200	60,000	42,000
1,350	80,000	42,000
1,500	80,000	42,000
1,600	80,000	60,000
2,000	80,000	60,000
2,500	100,000	60,000
3,000	100,000	60,000
3,500	120,000	60,000
4,000	120,000	90,000
4,500	120,000	90,000
5,000	120,000	90,000

NET's bus duct has sufficient mechanical strength to short-circuit that meets JIS standard.

(Note) JIS standard prescribes short-circuit test current as the effective value defined by drawing the envelop of the peaks of AC current waves, and multiplying the envelop value a half cycle after short-circuit occurrence by $1/2\sqrt{2}$.

Fig.3-2-1 Coefficient of Correction(K_2)



(cf.) COPPER for BUSBARS

C.D.A. Publication No.22 First issued 1936 Seventh revised impression,1956

P.65 Fig13 --- Shape factor for rectangular copper conductors.

3-3. Calculation of short-circuit current

(Reference: Data 65-6 of Japan Electric Contractors' Assoc.)

In the building power consumers' systems, the single phase short-circuit current in the three phase circuit will be approx. 87% of the three phase short-circuit current, and the one phase grounding current ranges from approx. 65 to 125%; but in the indoor circuits like those in buildings, the one phase grounding current will never be larger than the three phase short-circuit current.

Hence, calculation should be made with the three phase short-circuit current.

a. Calculation of the three phase short-circuit current

The short-circuit is calculated after determining the %-Z from the power supply point to the short-circuit point.

Symmetric value of short-circuit current(A)

$$= \frac{\text{reference KVA}}{\frac{\%Z}{100} \times \sqrt{3} \times (\text{KV})} \quad \text{-------- (eq. 1)}$$

Asymmetric value of short-circuit current(A)

$= K_1$ x symmetric value of short-circuit current(A) -- (eq. 2)

where $\%Z = \sqrt{\%R^2 + \%X^2}$ --- % impedance from the power supply point to the short-circuit point

(KV) ------- reference line-to-line voltage(KV)

K_1 ------- asymmetry coefficient

Because most of the breakers in the circuits of a voltage of 600KV or lower have the open pole time or the fusing time of approx. 1/2 cycle, the asymmetric value, including DC component, at approx. 1/2 cycle after short-circuit occurrence should be taken for product strength evaluation. And, because resistance is much larger than reactance in the circuits of a voltage of 600V or lower, the value of K_1 of 1.1 to 1.25, generally 1.25 as the typical, is taken for calculation.

But, K_1(average of the three phases) should be determined from Fig.3-3-1 after calculating X/R on the low voltage side if the ratio can be known there.

Fig.3-3-1 Asymmetry Coefficient 1/2 Cycle After

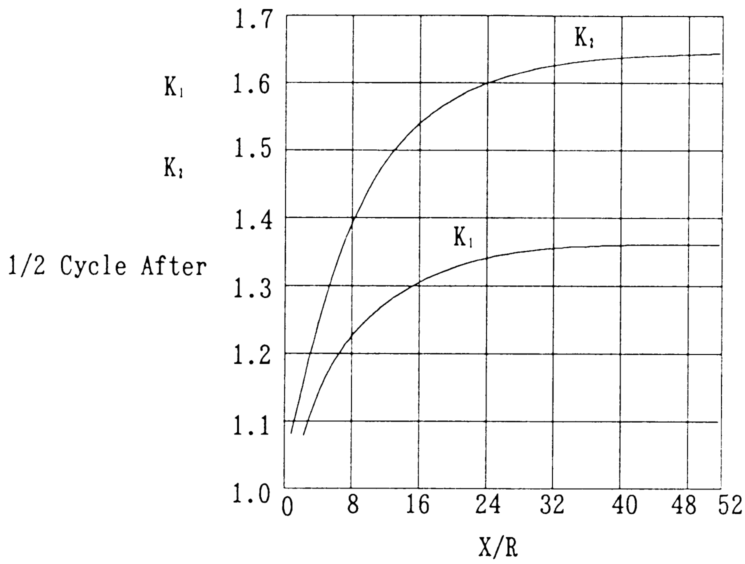


Fig.3-3-1 shows the ratio of DC component to the symmetric value of short-circuit current for each value of X/R of the circuit.

K_1 represents the three phase average of the asymmetry coefficients of the peak value. But, K_2 should be used for the bus strength design.

The breaking capacity of the low voltage breaker, however, is given with the three phase average of the total current effective value, including the DC component 1/2 cycle after short-circuit occurrence. Hence, asymmetry coefficient of K_1 must be employed when referring to the breaking capacity indication of the low voltage breaker. But, in case when using separate breaking devices(e.g. power fuses) on the three phases, K_2 should be employed because each phase is independently broken.

a-1. Calculation of %R and %X

Resistance value and reactance value of the bus duct line should be converted to %R and %X to the reference KVA and reference line-to-line voltage(kV):

$$\%R = \frac{R(\Omega) \text{ x reference KVA}}{1{,}000 \text{ x } (kV)^2} \text{ x } 100 \quad \text{------} \quad \text{(eq. 3)}$$

$$\%X = \frac{X(\Omega) \text{ x reference KVA}}{1{,}000 \text{ x } (kV)^2} \text{ x } 100 \quad \text{------} \quad \text{(eq. 4)}$$

where R(Ω): resistance component per phase
X(Ω): reactance component per phase

As for the impedance on the power supply side, only the reactance component should be taken because the resistance component is very small.

The %X on the power supply side when the short-circuit capacity is given:

$$\%X = \frac{\text{reference KVA for calculation}}{\text{system short-circuit capacity(KVA)}} \times 100 \quad \text{---} \quad \text{(eq. 5)}$$

The %X on the power supply side when the symmetric value of the short-circuit current is given:

$$\%X = \frac{\text{reference KVA for calculation}}{\text{(short-circuit current)}(\sqrt{3})\text{(kV)}} \times 100 \quad \text{-----} \quad \text{(eq. 6)}$$

The motors connected to the circuit should be taken as the short-circuit current source because they perform generation with revolution brought about by their inertia after the fault occurrence.

Reference KVA and %X of motors:
Equivalent KVA = 3·E·I
where E: rated voltage
I: total load current
When motors' power factor and efficiency are not clear,
Induction motors' equivalent KVA = 1.5 x (KW output) -- (eq. 7)

Table 3-3-1-1 % Reactance of Induction Motors(per equivalent KVA)

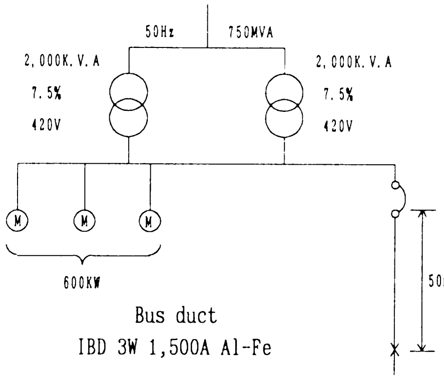
Induction motor capacity	% X_d		
	2 poles	4-6 poles	8-12 poles
over 600V	15	18	19
600V or lower	20	20	20

%X of transformers, generators and motors should be converted to the reference KVA, since it is indicated based on their own KVAs.
Conversion of reference KVA:
%X on reference KVA after conversion

$$= \frac{\text{reference KVA after conversion}}{\text{base KVA before conversion}} \times (\%X \text{ before conversion})$$

--- (eq. 8)

b. Example of calculation



Taking 2,000KVA as reference, from eq.5:

Power supply point %X

= (2,000/750,000)x100 =0.267

Motors' %X, from eq.7 and Table 3-3-1-1:

Equivalent KVA = 1.5x600

= 900KVA

%X on the reference KVA

= (2,000/900)x20 =44.4

Bus duct line's %R and %X, from Table 3-4-2, on the reference KVA of 1,000:

%R = 2.32 x 10^{-1} %/m

%X = 0.595 x 10^{-1} %/m

Converting this to the reference KVA of 2,000, from eq.8:

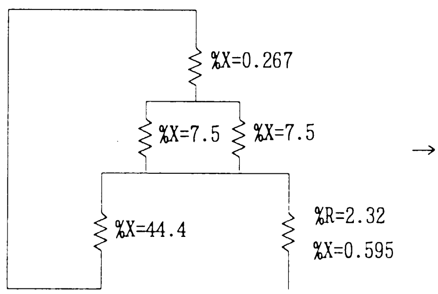
%R = (2,000/1,000) x 2.32 x 10^{-1} = 4.64 x 10^{-1} %/m

%X = (2,000/1,000) x 0.595 x 10^{-1} = 1.19 x 10^{-1} %/m

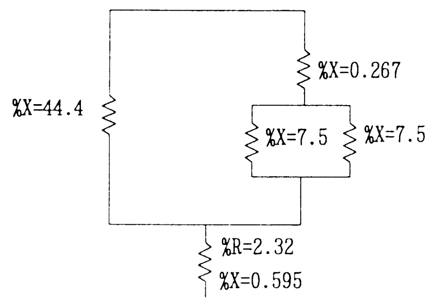
%R and %X of the bus duct line of a length of 50 m:

%R50= 4.64 x 10^{-1} x 50 m = 2.32

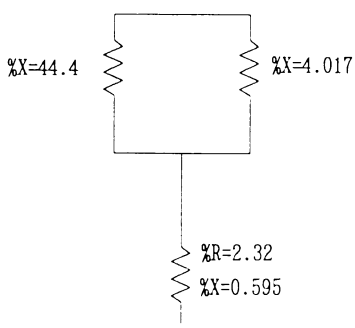
%X50= 1.19 x 10^{-1} x 50 m = 0.595



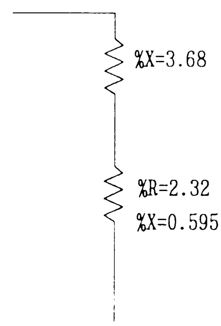
(1)



(2)



(3)



(4)

$$\%Z = \sqrt{2.32^2 + (3.68 + 0.595)^2}$$

$$= 4.86$$

Thus, the impedance map can be obtained as shown below:
Short-circuit current, from eqs. 1 and 2:

$$\text{Short-circuit symmetric current} = \frac{2,000}{(4.86/100) \times \sqrt{3} \times 0.42}$$

$$\fallingdotseq 56,600 \text{ A}$$

$X/R = 4.275/2.32 \fallingdotseq 1.84$

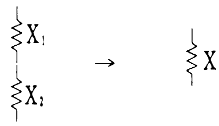
Taking the asymmetry coefficient 1.1 from Fig.3-3-1,
Asymmetric short-circuit current = 1.1 x 56,600 $\fallingdotseq$ 62,300 A

c. Conversion of impedances

To summarize multiple impedances to one, parallel ones are often converted to a series form. When they are combined in Δ or Y, ΔY conversion or YΔ conversion is performed according to necessity. Fig.3-3-2 shows the methods.

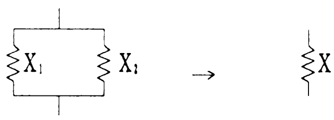
Fig.3-3-2 Methods of Impedance Conversion

(a) Series



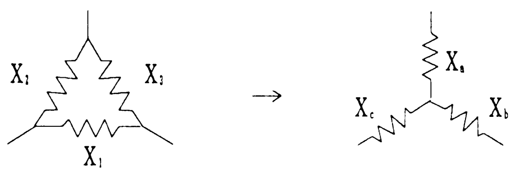
$$X = X_1 + X_2$$

(b) Parallel



$$X = \frac{1}{\frac{1}{X_1} + \frac{1}{X_2}} = \frac{X_1 \cdot X_2}{X_1 + X_2}$$

(c) ΔY conversion

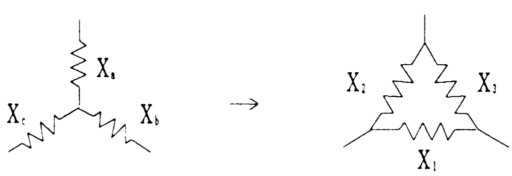


$$X_a = \frac{X_2 \cdot X_3}{X_1 + X_2 + X_3}$$

$$X_b = \frac{X_1 \cdot X_3}{X_1 + X_2 + X_3}$$

$$X_c = \frac{X_1 \cdot X_2}{X_1 + X_2 + X_3}$$

(d) YΔ conversion



$$X_1 = \frac{X_a \cdot X_b + X_b \cdot X_c + X_c \cdot X_a}{X_a}$$

$$X_2 = \frac{X_a \cdot X_b + X_b \cdot X_c + X_c \cdot X_a}{X_b}$$

$$X_3 = \frac{X_a \cdot X_b + X_b \cdot X_c + X_c \cdot X_a}{X_c}$$

3-4. % impedance of insulated bus duct

(a) Table 3-4-1 Copper conductor(on 1,000KVA, at 95 deg.C)

Type	Rating (A)	50 Hz				60 Hz			
		×10^{-2} %/m				×10^{-2} %/m			
		Voltage (V)	%R	%X	%Z	Voltage (V)	%R	%X	%Z
Single conductor	400	210	35.0	10.5	36.5	210	35.1	12.7	37.3
		420	8.75	2.64	9.14	420	8.78	3.16	9.33
	600	210	22.1	7.66	23.4	210	22.2	9.21	24.0
		420	5.52	1.92	5.84	420	5.55	2.3	6.01
	800	210	17.8	6.49	18.9	210	17.9	7.80	19.5
		420	4.44	1.62	4.73	420	4.48	1.95	4.89
	1,000	210	12.1	4.72	13.0	210	12.3	5.65	13.5
		420	3.03	1.18	3.25	420	3.07	1.41	3.38
	1,200	210	9.32	3.70	10.0	210	9.52	4.44	10.5
		420	2.33	0.924	2.51	420	2.38	1.11	2.63
	1,350	210	7.64	3.06	8.23	210	7.82	3.67	8.64
		420	1.91	7.65	2.06	420	1.96	0.918	2.16
	1,500	210	7.64	3.06	8.23	210	7.82	3.67	8.64
		420	1.91	0.765	2.06	420	1.96	0.918	2.16
	1,600	210	5.99	2.38	6.44	210	6.15	2.86	6.78
		420	1.50	5.95	1.61	420	1.54	0.714	1.69
	2,000	210	5.69	2.27	6.13	210	5.85	2.72	6.45
		420	1.42	0.567	1.53	420	1.46	0.680	1.61
	2,500	210	4.58	1.79	4.92	210	4.72	2.15	5.19
		420	1.14	0.448	1.23	420	1.18	0.539	1.30
	3,000	210	3.81	1.47	4.09	210	3.92	1.77	4.30
		420	0.952	0.369	1.02	420	0.981	0.442	1.08
Double conductor	3,500	210	2.86	1.13	3.07	210	2.92	1.38	3.24
		420	0.714	0.283	0.769	420	0.731	0.346	0.809
	4,000	210	2.54	1.02	2.74	210	2.61	1.22	2.88
		420	0.635	0.255	0.684	420	0.652	0.306	0.720
	4,500	210	2.29	0.907	2.46	210	2.36	1.09	2.59
		420	0.573	0.227	0.616	420	0.590	0.272	0.649
	5,000	210	1.90	0.748	2.05	210	1.95	0.884	2.14
		420	0.476	0.187	0.512	420	0.488	0.221	0.535

(b) Table 3-4-2 Aluminium conductor(on 1,000KVA, at 95 deg.C)

Type	Rating (A)	50 Hz ×10^{-2} %/m Voltage (V)	%R	%X	%Z	60 Hz ×10^{-2} %/m Voltage (V)	%R	%X	%Z
Single conductor	400	210	35.9	7.66	36.7	210	36.0	9.21	37.2
		420	8.98	1.92	9.18	420	9.00	2.30	9.29
	600	210	28.8	6.49	29.6	210	28.9	7.80	30.0
		420	7.21	1.62	7.39	420	7.23	1.95	7.49
	800	210	19.4	4.72	20.0	210	19.5	5.65	20.3
		420	4.85	1.18	4.99	420	4.89	1.41	5.09
	1,000	210	14.7	3.70	15.2	210	14.9	4.44	15.5
		420	3.68	0.924	3.79	420	3.72	1.11	3.88
	1,200	210	11.9	3.06	12.3	210	12.1	3.67	12.7
		420	2.98	0.765	3.08	420	3.03	0.918	3.17
	1,350	210	9.27	2.38	9.58	210	9.48	2.86	9.90
		420	2.32	0.595	2.39	420	2.37	0.714	2.48
	1,500	210	9.27	2.38	9.58	210	9.48	2.86	9.90
		420	2.32	0.595	2.39	420	2.37	0.714	2.48
	1,600	210	5.62	3.02	6.38	210	5.78	3.63	6.83
		420	1.41	0.754	1.60	420	1.45	0.907	1.71
	2,000	210	5.62	3.02	6.38	210	5.78	3.63	6.83
		420	1.41	0.754	1.60	420	1.45	0.907	1.71
	2,500	210	4.54	2.43	5.14	210	4.67	2.90	5.50
		420	1.13	0.607	1.29	420	1.17	0.726	1.38
	3,000	210	3.76	2.00	4.26	210	3.88	2.40	4.56
		420	0.941	0.499	1.07	420	0.969	0.601	1.14
Double conductor	3,500	210	2.81	1.54	3.21	210	2.88	1.86	3.43
		420	0.703	0.386	0.802	420	0.720	0.465	0.857
	4,000	210	2.52	1.36	2.86	210	2.59	1.66	3.07
		420	0.629	0.340	0.715	420	0.646	0.414	0.767
	4,500	210	2.27	1.22	2.58	210	2.34	1.47	2.76
		420	0.567	0.306	0.644	420	0.584	0.369	0.690
	5,000	210	1.88	1.02	2.14	210	1.95	1.20	2.29
		420	0.471	0.255	0.535	420	0.488	0.300	0.573

4 Temperature Characteristics

4-1. Temperature rise by rated current

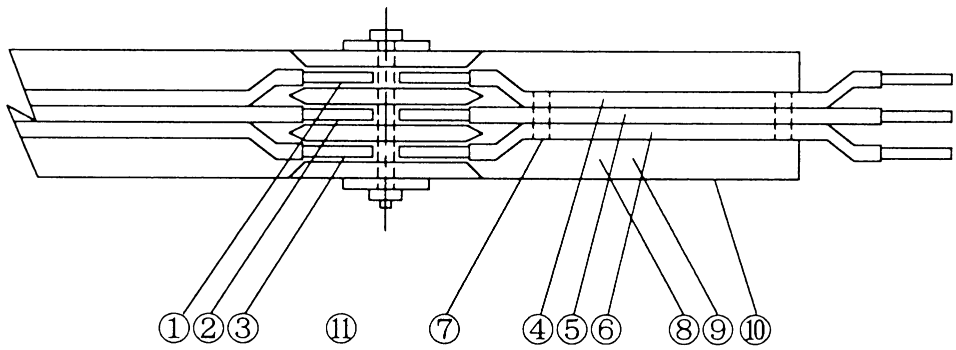
JIS stipulates that the saturated temperature rise of the bus duct by the rated current shall be not higher than 55 deg.C above the ambient temperature, bringing about the maximum temperature of 95 deg.C assuming the ambient of 40 deg.C.

SAT's insulated bus ducts yield a temperature rise lower than 55 deg.C for each rated current. An example of test result is given in Fig.4-1-2.

Temperature rise test

Sample: insulated bus duct, 3W, 1,000A, aluminium conductors in steel housing

Fig.4-1-1 Points of Temperature Measurement



① ② ③	conductor joint temperature
⑪	room temperature
⑦	spacer temperature
④ ⑤ ⑥	conductor insulation coating temperature
⑧	air temperature inside the housing
⑨	housing top cover temperature
⑩	housing side board temperature

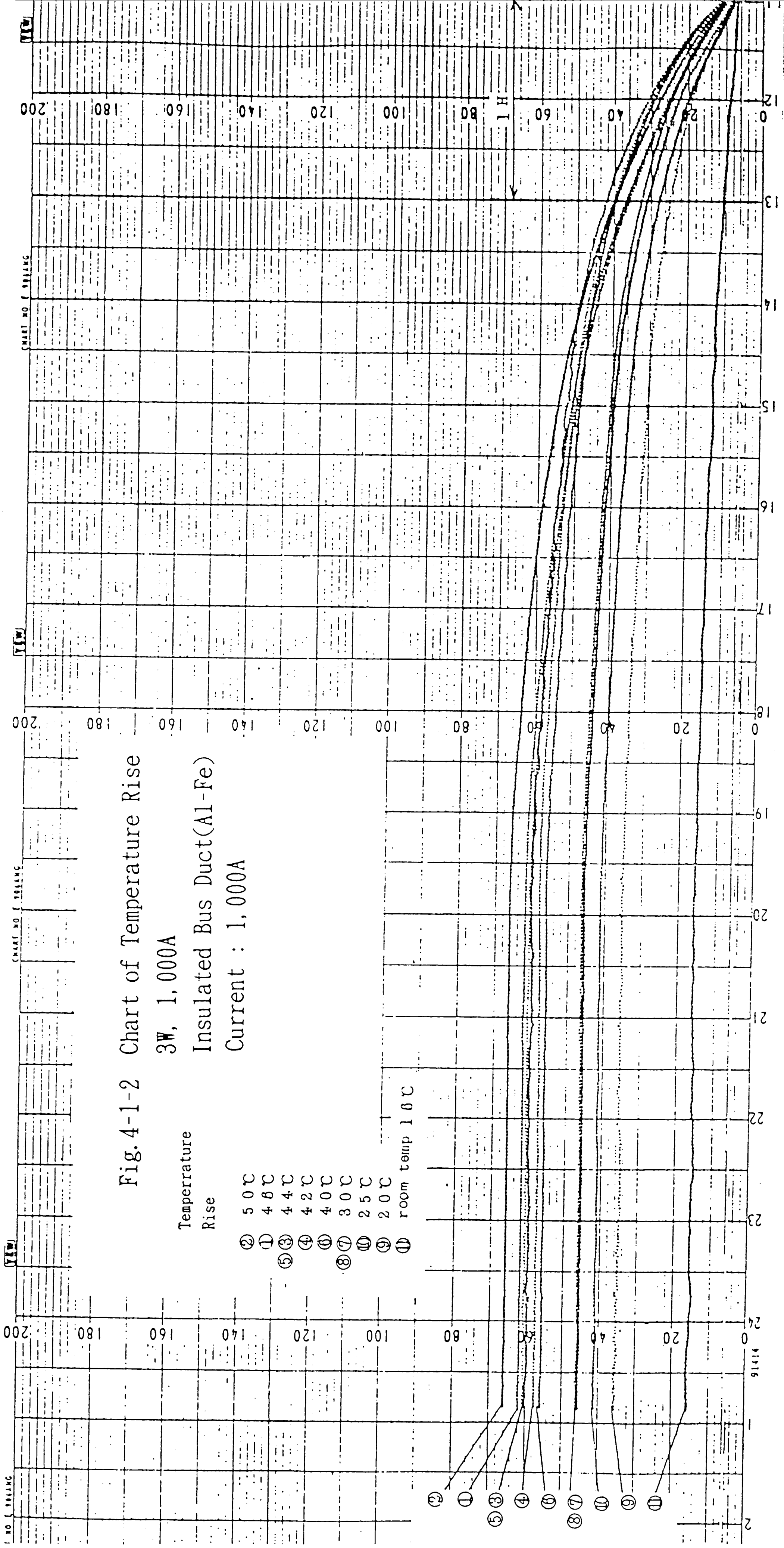


Fig.4-1-2 Chart of Temperature Rise
3W, 1,000A
Insulated Bus Duct(Al-Fe)
Current : 1,000A

4-2. Temperature rise by short-circuit current

Since short-circuit current duration is generally very short, it is assumed that the heat generated in the conductors is stored inside the duct, and consumed totally to raise temperature of the components. Consequently, the equation below gives the relation between magnitude of short-circuit current and temperature rise:

$$I^2 = \frac{J \cdot Q \cdot S}{\alpha \cdot r_1 \cdot t} \ln \frac{(1/\alpha)-20+T_2}{(1/\alpha)-20+T_1}$$

where J : mechanical equivalent of heat = 4.2

Q : conductor's specific heat capacity(cal/deg.C·cm^3)

aluminium : 0.59

copper : 0.81

S : conductor's cross-sectional area(cm^2)

α : conductor's temperature coefficient of resistance at 20 deg.C(/deg.C)

aluminium : 0.004

copper : 0.0039

r_1 : conductor's resistance at 20 deg.C(Ω/cm)

T_1 : conductor temperature before short-circuit(deg.C)

T_2 : maximum conductor temperature in short-circuit(deg.C)

t : duration of short-circuit current(sec)

SAT insulated bus ducts' short-circuit capacities are given in Figs.4-3-1 and -2 as determined from the aspect of mechanical strength to short-circuit. The products have marginal safety in mechanical strength exceeding the JIS standards stipulated for performance time of the breaking device.

4-3. Graphs showing short duration permissible currents

Fig.4-3-1 Short Duration Permissible Current of Insulated Bus Duct
a) 3-copper conductor type, initial temp.: 95 deg.C

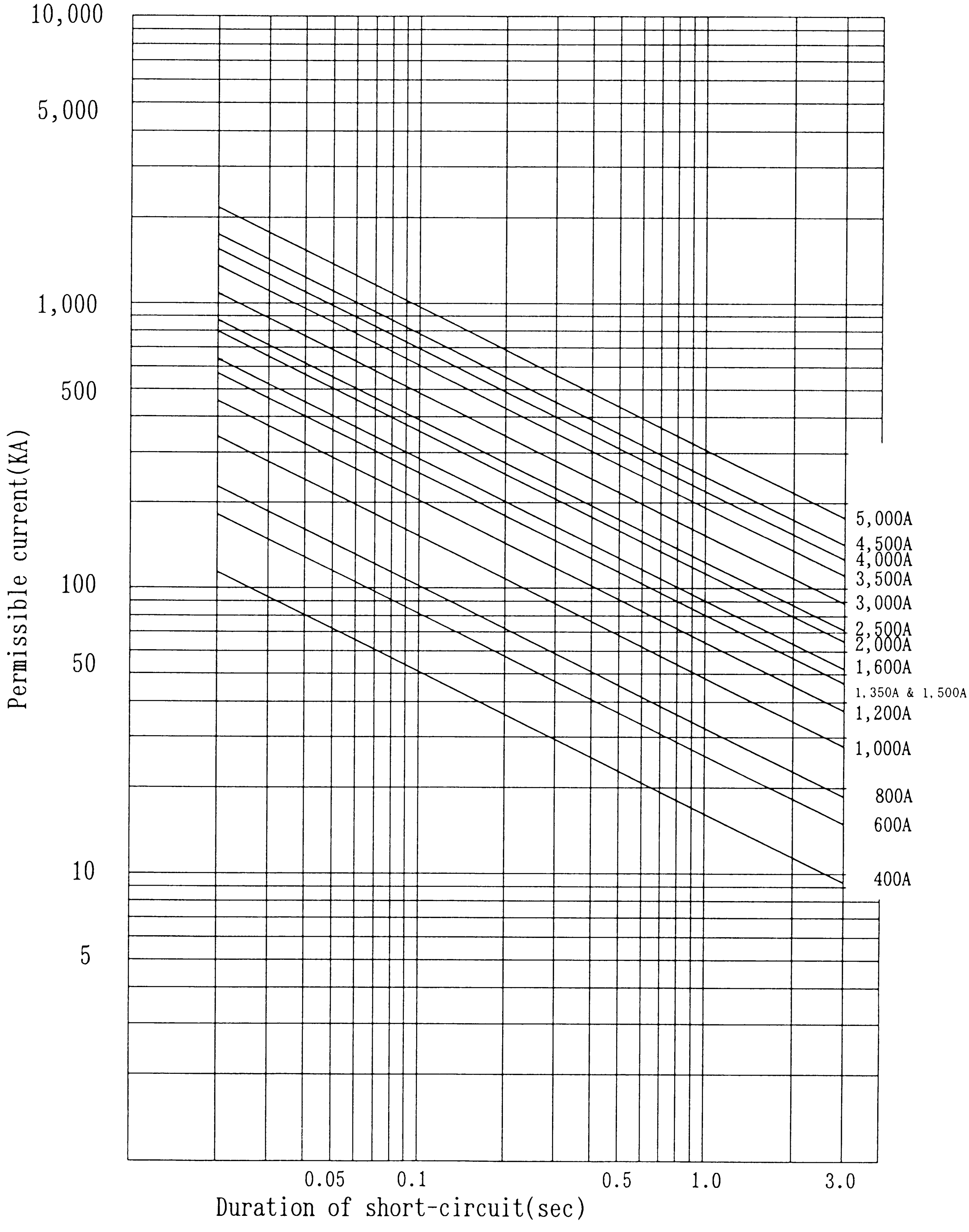
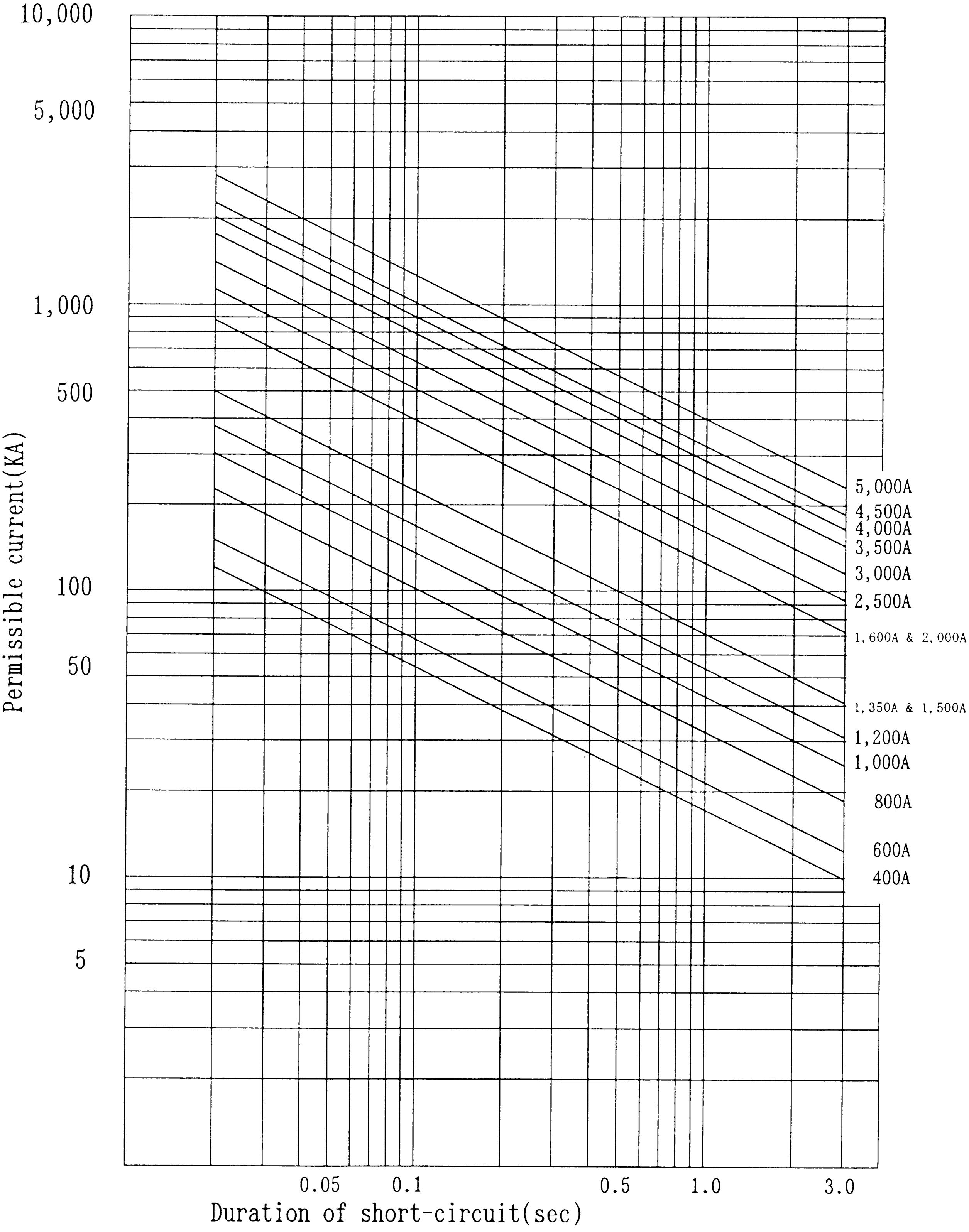


Fig.4-3-2 Short Duration Permissible Current of Insulated Bus Duct

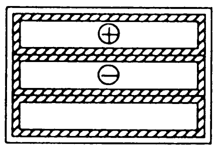
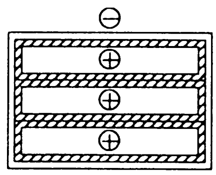
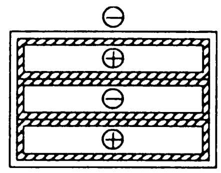
a) 3-aluminium conductor type, initial temp.: 95 deg.C



5. Capacitance

5-1. Capacitances of insulated bus ducts

Table 5-1-1 Capacitances of Insulated Bus Ducts

Rated current (A)	Capacitance($x10^{-2}$ $\mu F/m$)					
						
	aluminium conductor	copper conductor	aluminium conductor	copper conductor	aluminium conductor	copper conductor
400	0.071	0.044	0.283	0.177	0.425	0.266
600	0.089	0.071	0.354	0.283	0.531	0.425
800	0.133	0.089	0.531	0.354	0.797	0.531
1,000	0.177	0.133	0.708	0.531	1.062	0.797
1,200	0.221	0.177	0.885	0.708	1.328	1.062
1,350	0.292	0.221	1.168	0.885	1.752	1.328
1,500	0.292	0.221	1.168	0.885	1.752	1.328
1,600	0.310	0.292	1.239	1.168	1.859	1.752
2,000	0.310	0.310	1.239	1.239	1.859	1.859
2,500	0.398	0.398	1.593	1.593	2.390	2.390
3,000	0.496	0.496	1.982	1.982	2.974	2.974
3,500	0.620	0.620	2.478	2.478	3.717	3.717
4,000	0.708	0.708	2.832	2.832	4.248	4.248
4,500	0.797	0.797	3.186	3.186	4.779	4.779
5,000	0.991	0.991	3.965	3.965	5.947	5.947

For readers' reference, charging current can be calculated by

$$I = 2\pi f \cdot C \cdot V$$

where I: charging current(A)

f: frequency(Hz)

C: capacitance(F)

V: voltage(V)

6. Expansion Unit

6-1. Necessity of expansion units

When laying the bus duct for a long distance, forming a line very rigid different from wire and cable, it is necessary to place the expansion units at appropriate positions to prevent harmful strain or deformation like snaking from occurring due to thermal expansion and contraction of the bus duct line.

The positions where to place those units cannot be determined by general rules because they depend on laying conditions. "The Guideline for Bus Duct Line Construction," prepared by Technical Committee of the Japan Electric Contractors' Association, estimates the straight length of the line which cannot absorb thermal expansion and contraction as approx. 30m, although the corner portions such as elbow and offset units work like expansion units. We recommend this length as a good estimation.

In cases, however, when to lay bus ducts vertically, load given to the support on the floor is largely affected by the interval between expansion units. This may make it necessary to place expansion units at a shorter interval in the vertical line than in the horizontal line.

6-2. Verification by long term heat cycle test

We made a long term heat cycle test to verify the effects given to insulated bus ducts by repeated cycles of thermal expansion and contraction due to temperature changes.

1) Method of the test

Sample layout: a horizontal straight line of 10.1m with both ends fixed including four expansion units

Sample bus duct: 3W, 2,000A, aluminium conductors in steel housing

Heat cycle: raise temperature with the rated current up to the equilibrium point, cut the current, and re-start the current after the temperature has cooled down to the room temperature; Number of the cycles: 116

2) Result of test

Vertical snaking: 10mm at the maximum
Horizontal snaking: 3mm at the maximum
Observation of the joints: slight trace of sliding on the contact surface, no damages whatever left thereon
Insulation resistance and strength: no abnormalities
Construction and permanent deformation: no abnormalities

3) Conclusion

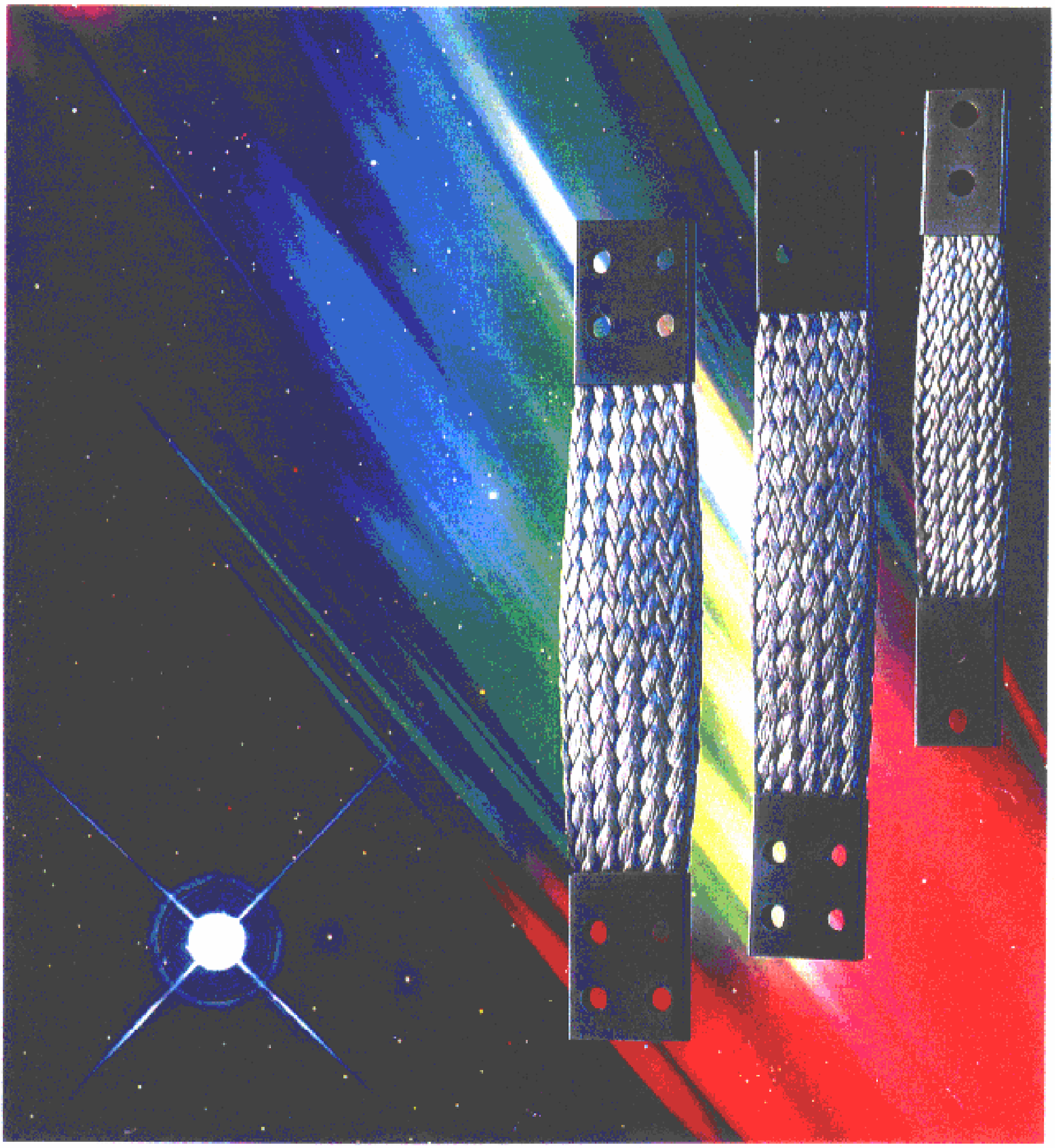
Small snaking occurs even on the line of 10m with both ends fixed and the internal portion ready to absorb thermal expansion and contraction.

It has been assured that no performance abnormalities occur after a long term repetition of heat cycles. But, when the straight section is so long that the thermal expansion and contraction therein cannot be absorbed by the corner units at both ends, harmful effects such as snaking abnormal in appearance and scratches on the contact surface are feared. Hence, we recommend to place an expansion unit at an interval of 30m, as stated before.

Flexible Conductor

NET's Flexible Conductor

A Product of Bus Ducts Manufacturing Technologies



NISSIN ELECTRIC (THAILAND) CO.,LTD.

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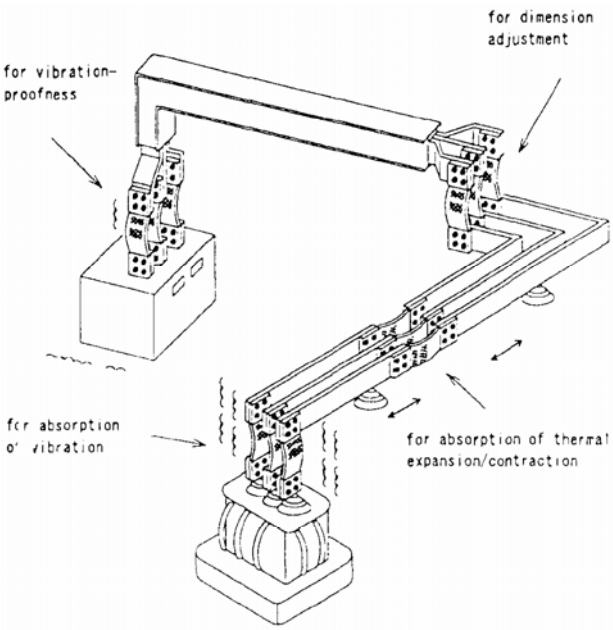
Application of Flexible Conductors



Using high quality of flat braided conductors, NET's Flexible Conductors are very flexible.

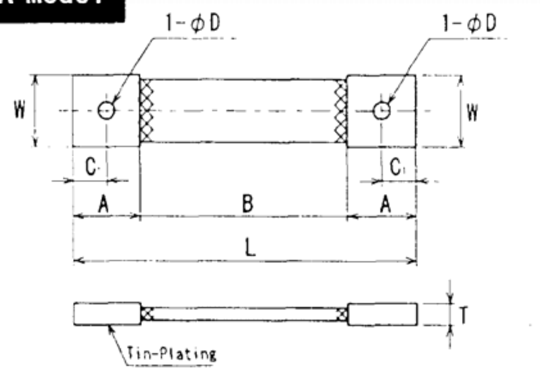
From their capability of buffering vibration forces, they are effective to prevent loosening of affixing bolts-and-nuts and screws due to power supplying transformers' vibration as well as to absorb or moderate shocks due to mechanical causes including earthquakes.

Hence, NET's Flexible Conductors prevent or reduce damages of bus bars and other electric units as a consequence of electrical or mechanical vibrations or shocks.

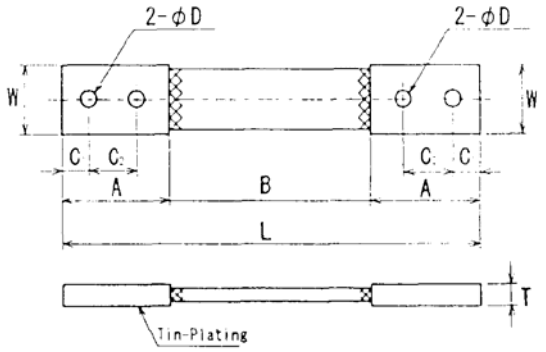
Moreover, they facilitate dimension adjustment, direction change and twisting in assembling bus bar connections between units in electrical construction works.

Standard Dimensions of NET's Flexible Conductors

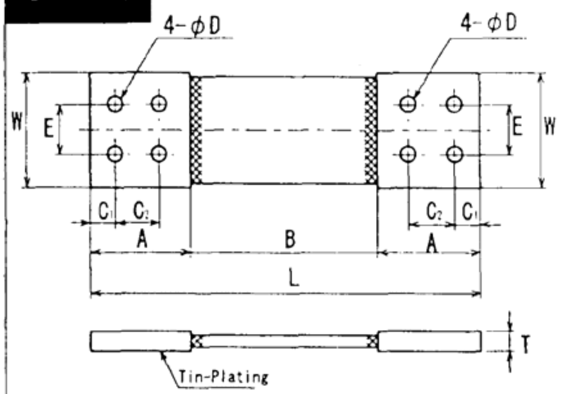
A Model



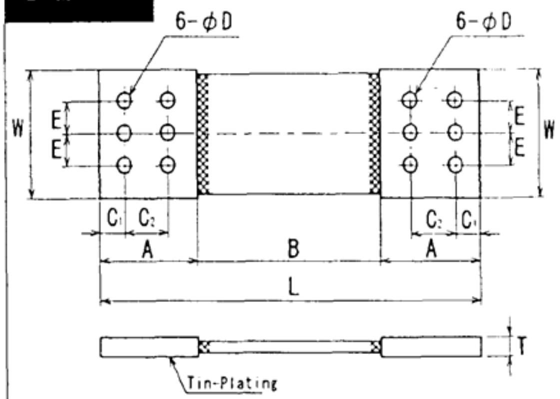
B Model



C Model



D Model



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Type No.	Nominal cross-sectional area (mm²)	Permissible current (A)	Model	Terminal width W	Lengthwise dimensions L	A	B	Hole diameter and pitches C_1	C_2	E	ϕD	Bolt diameter	Thickness T
FS－ 501	38	200	A	25	200	45	110	20	－	－	12	M10	6.0
FS－ 502	76	300											8.0
FS－ 503	114	380											10.0
FS－ 504	152	450											12.0
FS－ 801	50	290	B	40	300	85	130	20	40	－	12	M10	5.6
FS－ 802	100	410											7.2
FS－ 803	150	520											8.9
FS－ 804	200	580											10.5
FS－ 805	250	690											12.1
FS－ 806	300	770											13.8
FS－1001	100	450	B	50	330	95	140	25	40	－	14	M12	6.5
FS－1002	200	650											9.1
FS－1003	300	820											11.6
FS－1004	400	970											14.2
FS－1005	500	1,100											16.7
FS－1006	600	1,220											19.3
FS－1501	150	680	C	75	350	95	160	25	40	40	14	M12	8.5
FS－1502	200	760											9.4
FS－1503	250	860											10.2
FS－1504	300	940											11.1
FS－1505	400	1,100											12.8
FS－1506	500	1,240											14.5
FS－1507	600	1,380											16.2
FS－1508	800	1,630											19.6
FS－1509	1,000	1,860											23.0
FS－1510	1,200	2,070											26.4
FS－2001	200	860	C	100	400	105	190	25	50	50	14	M12	8.5
FS－2002	250	970											9.1
FS－2003	300	1,060											9.7
FS－2004	400	1,240											11.0
FS－2005	500	1,380											12.2
FS－2006	600	1,530											13.5
FS－2007	800	1,800											16.0
FS－2008	1,000	2,000											18.5
FS－2009	1,250	2,200											21.6
FS－2010	1,500	2,500											24.7
FS－3001	400	1,460	D	150	500	150	200	25	100	50	18	M16	9.5
FS－3002	500	1,640											10.3
FS－3003	600	1,800											11.2
FS－3004	800	2,100											12.9
FS－3005	1,000	2,350											14.6
FS－3006	1,200	2,600											16.4
FS－3007	1,600	3,000											19.8
FS－3008	2,000	3,400											23.4
FS－4001	500	1,850	D	200	550	165	220	30	100	60	18	M16	9.2
FS－4002	800	2,360											11.1
FS－4003	1,000	2,640											12.4
FS－4004	1,200	2,900											13.7
FS－4005	1,500	3,260											15.6
FS－4006	2,000	3,800											18.8
FS－4007	2,500	4,200											22.1

The permissible currents in this table represent the values in open space assuming a temperature rise of 50℃.

For our information on the product price;

◎ When you request our information on the product price, please designate the Type No. shown in the dimension table on the previous page. You can specify arbitrary dimensions except for the terminal width(which should be selected among 25, 40, 50, 75, 100, 150 and 200 mm), together with the specifications listed below:

① Current carrying capacity or nominal cross-sectional area
② Terminal width
③ Dimensions of various portions
④ Quantity and delivery date

◎ The terminal portion is tin-plated if not otherwise specified. (If you want silver-plating, please specify it without fail.)

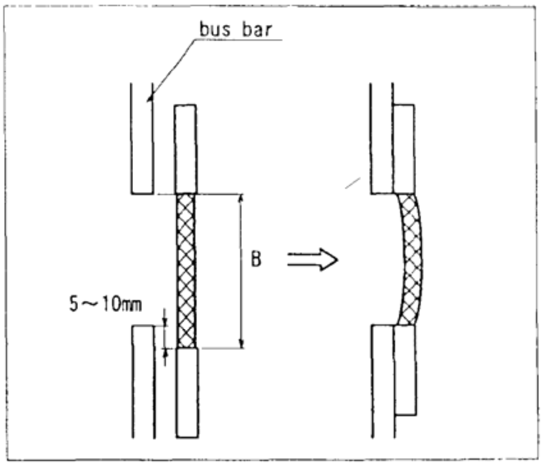
◎ If you want insulator coating, please inform us. (The insulator shall be polyvinyl chloride.)

For selection of flexible conductor type;

In selecting the type or design of flexible conductor, please be noted on the following:

① Determine the braided wire length(B) longer by 5 to 10 mm than that required from bus bar layout so as to secure an allowance in installation. (for prevention of insufficient flexibility occurrence in use)
(Refer to the figure on the right.)

② Select diameters of the terminal holes among $\phi 10$, $\phi 12$, $\phi 14$, $\phi 15$, $\phi 16$, $\phi 18$ and $\phi 20.5$.



SS-Nut

NET NISSIN ELECTRIC (THAILAND) CO., LTD.

The SS Nut for Insulation Bus Duct

The SS nut prevents " forgetting to tighten a bolt" in a work of installing the insulation bus duct.

The SS nut prevents forgetting to tighten a bolt" in a work of installing the insulation bus duct.

With the conventional nut, troubles of overheat used to be a problem that could not be eliminated completely due to forgetting to completely tighten bolt-and-nut assemblies.

As a novel invention of the Company, the SS nut eliminates such a trouble and improves reliability of insulation bus duct wiring.

Features of the SS nut

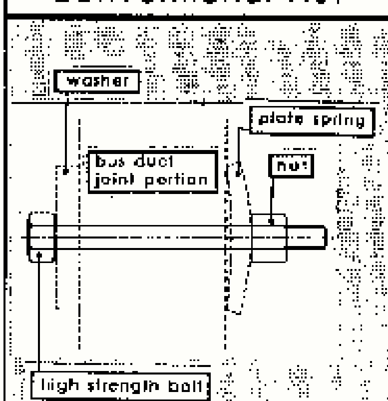
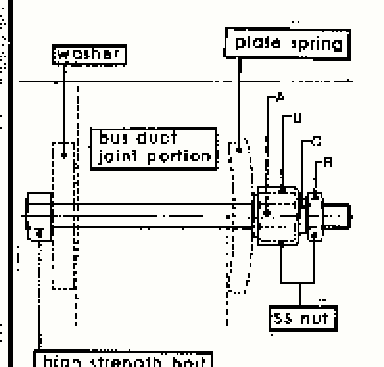
*The SS nut does requires no torque wrenches in installation works. Commonly marketed ring wrenches or spanners are sufficing.

*When the torque proper to the bolt size is applied, the red nut part of the SS nut breakes apart, thus assuring good tightening naturally.

*When you use SS nuts, state of tightening can be assured only by visually checking the nut. (When the red remains, tightening is insufficient; when the blue is seen, tightening is complete; and when the yellow is seen, state of tightening is susceptible.)

*Once the SS nut is completely tightened, the yellow nut with the blue round cap remains. Hence, artificial loosening the nut becomes impossible because the round cap prevents for a wrench or a spanner to catch the nut(yellow part).

The conventional nut vs. the SS nut

Conventional Nut	SS Nut
	
*The conventional nut needs a torque wrench to be tightened completely. It should be tightened using a torque wrench until it clicks. *Assuring state of tightening is impossible visually, requiring a torque wrench for assurance.	*The SS nut incorporates the parts A, B, C and D as a unit. *Tightening the part B to the specified torque with a ring wrench or a spanner breaks the part C apart, separating the parts A and B. *Separation of the part B ensures the torque specific to the bolt-and-nut size; i.e., complete tightening. *After tightening completely, the round cap, the part D, remains. Hence, no ring wrench nor spanner can catch the remaining nut, inhibiting to loosen it. *State of tightening the nut can be judged only by looking at it.

Cautions for Handling SS-Nuts

Watch out the blue plastic cover(cap) of the SS nut.

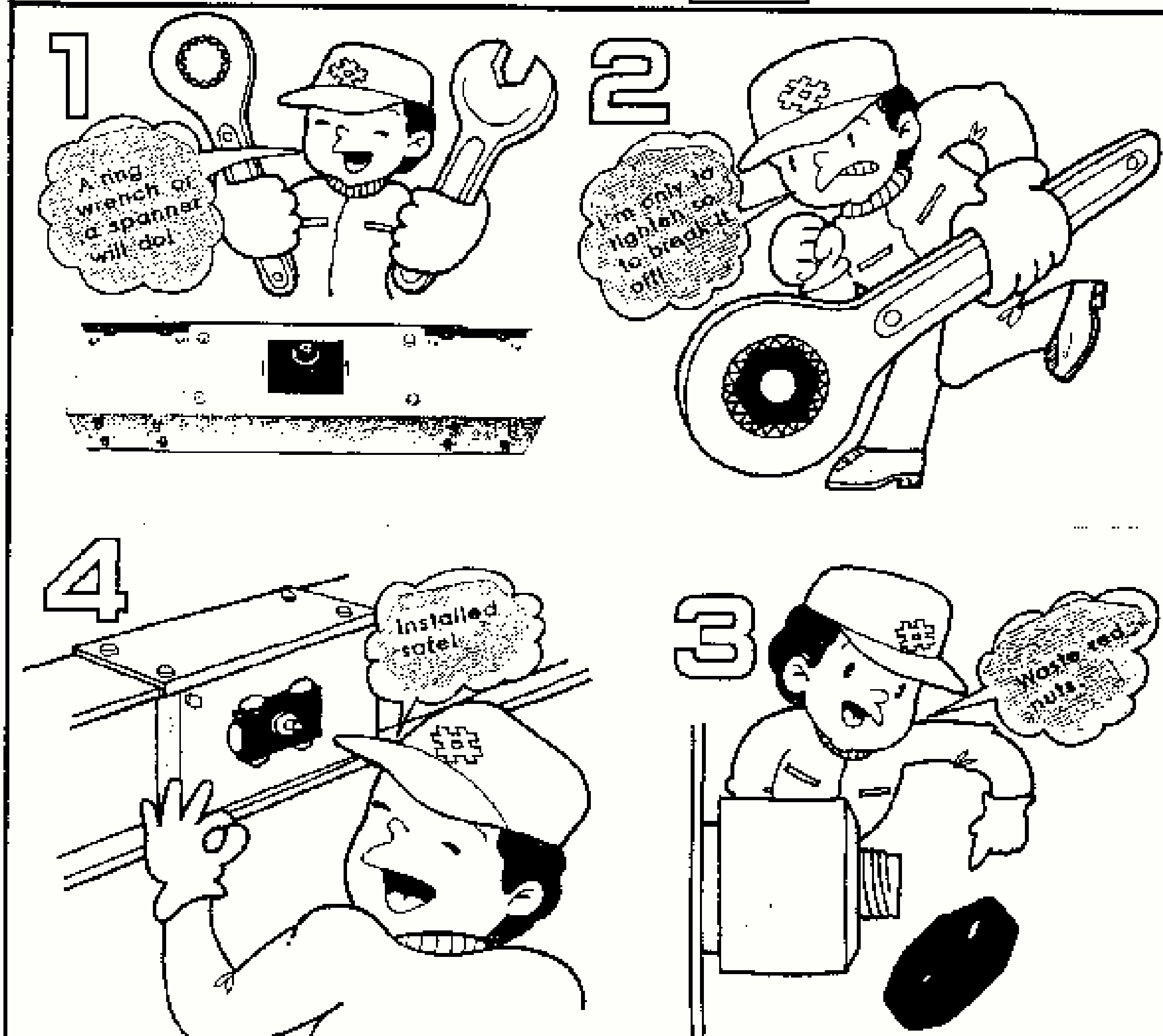
After you have tightened an SS nut completely, the yellow nut with the blue cap remains. Do not give any damage to the blue cap since it serves as the indication of tightening finished. Should it be broken or lost, replace it with a new one. When you have to loosen a bolt-and-nut assembly for a reason such as extension of the bus duct, break the blue plastic cover off with a pair of plyers to loosen the yellow nut.

Take care against dropping the red nut in tightening works.

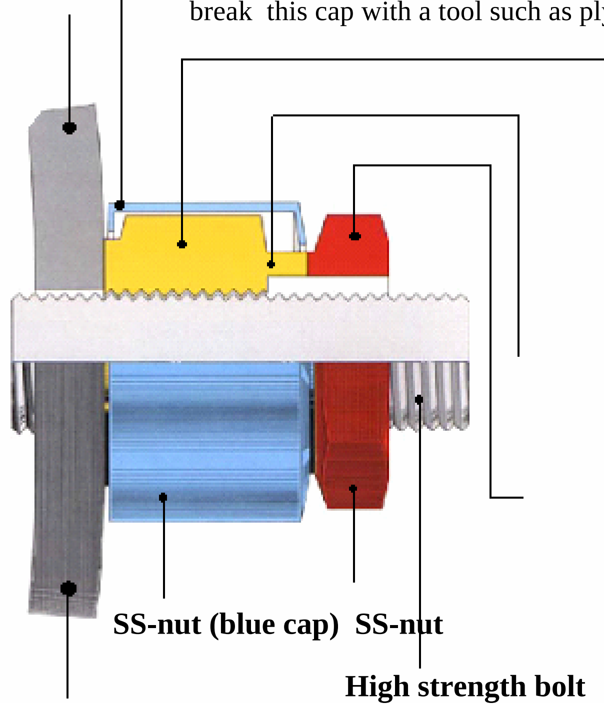
Take care not to drop the red nut cut off in the process of tightening SS nuts. If the dropping is a problem because of working conditions, use ring wrenches with a mechanism preventing dropping developed by the Company.

Procedures of Tightening the SS Nut

Check the three colors: the red shows danger, the blue ensures safety, and the yellow calls for caution.



ovel Invention Produced by Technology Oriented SEI



When it is necessary to loosen the bolt and nut assembly for a reason such as extending the busduct line, break this cap with a tool such as plyers, and loosen the nut with a wrench or a spanner.

Yellow nut with the blue cap

This nut is the key part for the insulation busduct joint. In the state after breaking apart of the red nut, the yellow nut with the blue cap holds the specific tightening torque. Since the yellow nut portion is enclosed with the blue plastic cap, this construction prevents the yellow, key nut from being tightened, loosened or re-tightened.

Breaking portion (breaking at the specific torque)

This portion breaks apart at a torque of approx. 1000 kg-cm for the M12 nut and approx. 1600 kg-cm for M16 nut.

Red nut

– Tighten this part with a ring wrench. When the torque reaches the value specific for the size, this part breakers off from the main portion.

Bolt Sizesb forb Joint and Proper Tighteng Torque

Rated current	Al-Fe 3 wire type insulation busduct					Cu-Fe 3 wire type insulation busduct			
	Conductor Dimensions (mm)	Bolt size	Num ber of bolte	Tightening torque* (kg-cm)		Conductor Dimensions (mm)	Bolt size	Number of bolte	Tightening torque* (kg-cm)
600A	6 x 50	M12	1	1000		6 x 40	M12	1	1000
800A	6 x 75	M12	1	1000		6 x 50	M12	1	1000
1000A	6 x 100	M16	1	1600		6 x 75	M12	1	1000
1200A	6 x 125	M16	1	1600		6 x 100	M16	1	1600
1350A	6 x 165	M16	1	1600		6 x 125	M16	1	1600
1500A	6 x 165	M16	1	1600		6 x 125	M16	1	1600
1600A	10 x 175	M16	1	1600		6 x 165	M16	1	1600
2000A	10 x 175	M12	2	1000		6 x 175	M12	2	1000
2500A	10 x 225	M16	2	1600		6 x 225	M16	2	1600
3000A	10 x 280	M16	2	1600		6 x 280	M16	2	1600
3500A	10 x 175 x 2	M12	4	1000		6 x 175 x 2	M12	4	1000
4000A	10 x 200 x 2	M12	4	1000		6 x 200 x 2	M12	4	1000
4500A	10 x 225 x 2	M16	4	1600		6 x 225 x 2	M16	4	1600
5000A	10 x 280 x 2	M16	4	1600		6 x 280 x 2	M16	4	1600

(Note) The tightening torque given here is the representative value.

Installaion Procedure

.Engineering Data No.____________

Date____________

INSTALLATION PROCEDURE

OF

LV. BUSDUCT

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CONTENTS

1 PREPARATION FOR INSTALLATION

1.1 Acceptance

1.1.1 Handing

Preservation of quality on the bus bar end is vitally important. Never give any harm to this portion in handing. Because of its weight, the product will be easily given with a damage when it hits something. Take a sufficient care

1.1.2 Number of parts

Check numbers of the parts against the invoice when they are delivered to the site. Inform about shortages, if any, without delay.

1.1.3 Construction and appearance

Check constructions and appearances of parts on their arrival at the site. Inform about troubles during transportation and deviations from the specification, if any, without delay.

1.2 Storage

1.2.1 Place for Storage

(1) Store the product indoors without fail.

(2) Place the product on a flat floor such as a concrete floor.

(3) Do not put the product direct on the floor. Use something like timbers to support it.

(4) Insert wooden lagging between products when they are stacked for storage. (Or, use pallets.)

(5) Put sheets over the whole storage to protect against casual water poured on.

(6) Provide warning or off-limit signboards so that no people get on the product.

1.2.2 Period of Storage

(1) Erect the product as early as possible after acceptance to minimize the period of storage.

(2) If the period of storage would inevitably be long, store the product in a warehouse, not on the site of installation.

1.3 Transportation

(1) Do not give any harm to the product. Take special cares about the joint and the bar edge.

(2) Do not take the vinyl packing off until erection.

(3) Carry the product carefully with hand, carts, forklifts or hoists.

6.2 Re-Assurance of Finished Joint

Re-assure the four conditions depicted the following.

The four conditions:

(1) The level of conductors to fit left and right.

(2) The positions of the plate springs and the flat washers normal.

(3) The sideboard of the joint to be set normally, showing no swelling-out deformation.

(4) The joint outside and inside clean without any dust.

6.3 Other Inspections

(1) Are all cases aligned neat? If rather zigzag, check whether there is any joint where conductors were inserted in a forcing manner.

(2) Is there no joint cover for gotten to be put on? Are there no screws for gotten to be set or tightened?

6.4 Tests

(1) Insulation resistance test Conduct this test on the bus duct line isolate from the switchboard, the transformer, etc., as measured with a 500V megger.

7 INSPECTION AFTER STARTING OPERATION

Implement periodical inspections of abnormal appearance including discoloration, coating flaking-off and rust generation, and state of hanging including loosening and deformation of hanging bolts. And, make repair as soon as possible when some abnormalities are found. Although depending on the site conditions, frequency of the periodical will generally be enough with approximately once a year.

2 ERECTION

2.1 Unpacking

2.1.1 .Set the bus duct cases at the proper place with the vinyl packing put on, and take the packing off after setting them in position. (To prevent mortar sticking and water poured on)

2.1.2 .If the packing on the bar edge must inevitably be taken off in order to carry the product case in, take special cares so as to give no damage to the conductor.

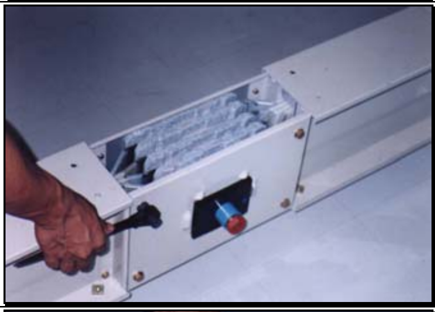
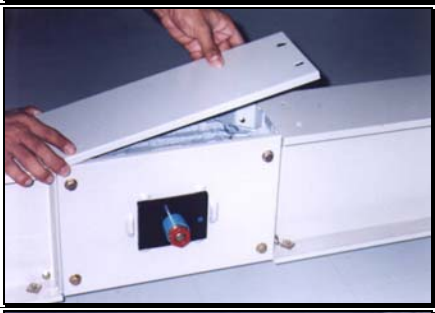
2.2 Pulling Up

2.2.1. When you pull the product up with ropes, hook the rope at two or more points on the product to make it horizontal as lifted. Hold one end of the product by hand or via rope to adjust its position so that it hits nothing.

2.2.2 If you pull the product up in a vertical position, take care so that the bottom end of the product in not dragged on the floor.

2.3 Making the joint

2.3.1 Assembling the joint (see table in next page).

ASSEMBLING THE JOINT	
1. Wipe the bar edges clean and match the level and the center of the bars to be mated.	
2. Insert the bars to be jointed to the position where they hit the stoppers provided on the joint pads. Temporarily tighten the SS nuts for the joint bolts with the spanner.	
3. Tighten the sideboard fastening bolts with the spanner. (The sideboard works also for grounding.)	
4. Assure that no bolts, nuts or washers are left inside the joint. Then, put the cover on.	
5. After finishing the entire line alignment, tighten the nuts until their red portions are broken off. The remaining blue cap indicates that the nut is tightened properly. No torque wrench is necessary for this tightening.	
6. Make sure that there is no red nuts remaining in the whole lines. Tightening of bolts is complete if only the blue-capped nuts remain. No check with the torque wrench is necessary. *** (Only outdoor type busduct) Fix the waterproof cover for outdoor joint.	

2.3.2 Tightening of the SS-Nut

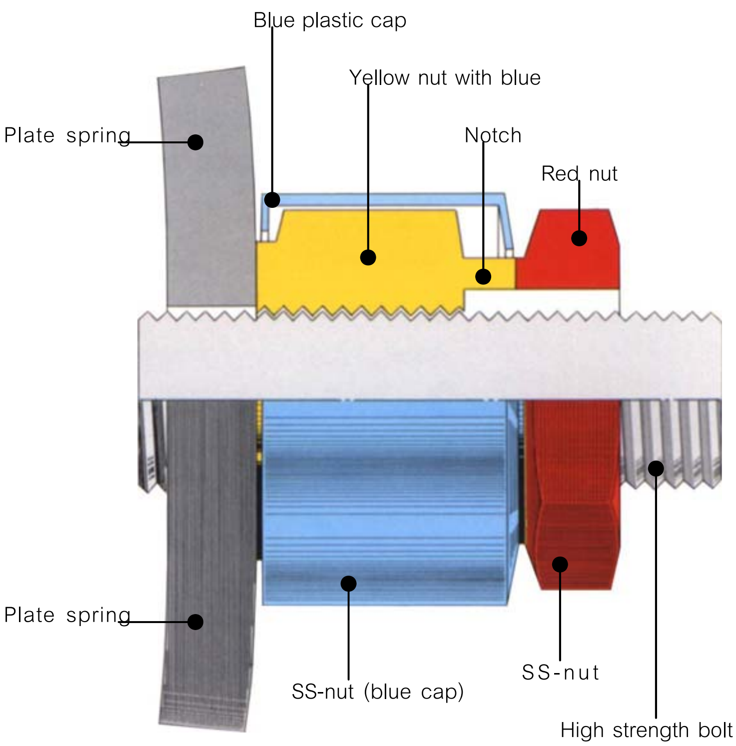
The SS-Nut can be tightened properly with ring or ordinary spanners generally marketed. Different from the conventional nut, it does not require any torque wrench to be tightened at the specific torque.

(1) Put the wrench on the red portion of the SS nut, and tighten it until the red portion is broken off by twist. Be careful not to put the wrench obliquely on the nut or give an unnatural shock for breaking off. (A wrench with a long handle is easy to use.)

(2) At the specific torque, the red portion of the nut is broken off. Scrap the red nuts taken off. This completed tightening.

(3) The nut with only the blue cap remains after completing tightening. Only visual check that no red nuts remain but only nuts with the blue cap do ensures complete tightening of the bolts. If there are any nuts with the blue cap taken off and the yellow one exposed, replace them with new SS nuts.

Note: Do not disassemble into individual pieces, during the joint assembling work, the sets of plate springs and the bolt provided in the joint as delivered.



3 SUPPORTS

3.1 Horizontal Support

3.1.1 Set the support interval not more than 2.5M.

3.1.2 Construct supports so as to allow future inspection of joints.

(1) Avoid a hanger angle at the joint position.

(2) Secure a peripheral space for workers' approach.

3.2 Riser Support

(1) The support of the first floor of riser busduct does fixed support and other floor do support which uses the spring.

(2) Confirm bus duct support drawing NET-SP97003 (spring type) and NET-SP97004 (fix type) to the support of riser busduct.

(3) Please adjust the nut so as not to enter the state, which the spring completely compressed at the spring support.

(4) In the middle, you should fix the bus duct from the wall side in the place where the height of the floor exceeds 5M.

4 GROUDING

(1) Grounding is connected between bus ducts by affixing the joint sideboards. Surely fix them firm.

(2) Grounding connections in parts mating to the panel and the transformer are formed using grounding terminals provided at the end of the bus duct line. Connect the grounding wire to the terminals.

5 WATERPROOFING

Water gives a vital damage to the indoor type bus duct. Once getting on the bus duct, it enters inside through spaces between the external cases, screw holes, spaces in joints, etc. to give harms to long term performances. Be careful never to wet bus ducts with water during installation and operation.

6 INSPECTION AFTER INSTALLATION

6.1 Inspection of Bolt Tightening

After finishing to connect bus ducts, make sure once more that the red nuts are all broken off? It is all right if only the nuts with the blue cap remain. It is not required to check tightening torque with the torque wrench like the practice implemented in the past.