DISSERTATION REPORT

Manufacturing of Prototype Sample 1600 Amps Sandwich Bus duct

Submitted in partial fulfillment of the requirements for the award of the degree of

Master of Engineering

In

Power Systems

Submitted By

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CERTIFICATE 1

This is to certify that Manish Kumar has Done project work on "**Manufacturing of Prototype Sample 1600 Amps Sandwich Bus duct**" and submitted the report in partial fulfilment of the requirements for the award of a Master of Engineering Degree in Power Systems at the Thapar Institute of Engineering and Technology, is a genuine work done under our supervision. To the best of my knowledge and belief, no one has not submitted the content of the report to any other university/institute to receive a degree/diploma.

(Signature)
Dr. Surya Parkash
Associate Professor, EIED
Thapar Institute of Engineering and Technology

CERTIFICATE 2

This is to certify that Manish Kumar has done Research work on, **Manufacturing of Prototype Sample 1600 Amps Sandwich Bus duct**,' and submitted the report in partial fulfilment of the requirements for the award of a Master of Engineering Degree in Power Systems at the Thapar Institute of Engineering and Technology, is a genuine work done under my supervision. To the best of my knowledge and belief, no one have not submitted the content of the report to any other university/institute for the purpose of receiving a degree/diploma.

(signature)
Dr. Amrita Sinha
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CERTIFICATE 3

TO WHOME IT MAY CONCERN

This is to certify That Mr. Manish Kumar, Student of Masters in Engineering (Power Systems) at Thapar institute PATIALA has done his research work on **EXECUTION OF SANDWHICH BUSBAR TRUNKING SYSTEM PROJECT,** under My Supervision is a genuine work done to the best of my knowledge and belief.

(signature)
Mr. Amit Agarwal
General Manager (BBT Sales & OEG)
L&T Electrical and Automation
A Schneider Electric Group Company

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ABBREVIATIONS

AFFL: Above Finish Floor Level
BBT: Busbar Trunking System
C.T.: Current Transformer
V.T.: Voltage Transformer
D.P.: Double-Pole
E/F: Earth Fault
I.D.: Inner Diameter
MCB: Miniature Circuit Breaker
MCCB: Moulded Case Circuit Breaker
Max.: Maximum
Min.: Minimum
M.S.: Mild Steel
O/C: Overcurrent
O.D.: Outer Diameter
RCD: Residual Current Device
REC: Registered Electrical Contractor
REW: Registered Electrical Worker
RM: Room
S/S: Substation
SW: Switch
Tx: Transformer
TP: Three-Pole
4P: Four-Pole
TPN: Three-Pole & Neutral
WCC: Work Completion Certificate
1-Ø : Single-Phase
3-Ø : Three-Phase

ABSTRACT

Busbar Trunking system is Most popular alternatives to cable in electrical power distribution, it has extremely flexible in its design, requires less time for installation on-site, and is the most effective, secure, and optimal system for supplying electricity to high-rise buildings and industrial sites. Electrical power distribution for low voltage and high current systems is required by Busbar trunking systems. Due to a variety of factors, the fundamental design of the Busbar trunking System and the impact of electrical parameters on its design and operation must be researched and analyzed. BBT is currently being designed and tested by Larsen & Toubro for low or medium voltage and greater current ratings.

IEC 61439 was utilized as a guideline for the design of the Busbar trunking system. As a result, they are conducting a significant amount of study into the construction, functionality, and influences of Busbar. This project was started in order to fully comprehend the impact of various phenomena, such as proximity effect, skin effect, inductance, magnetic fields, electrodynamic forces, contact resistance, and permittivity of insulation material, on the functionality of Busbar trunking systems and the importance of their design in practical situations. Another investigation was made to determine how a bus-running system would respond to a temperature rise under typical operating conditions. The method used to complete these tasks involves extensive research, the use of mathematical tools for any established mathematical models' implementation and verification, and in some cases, the use of software like FEMM to comprehend specific processes impacting Busbars.

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CHAPTER 1: INTRODUCTION

1.1 An Introduction to Bus Bar Trunking Systems

One of the most fundamental components of a power system, bus bars connect various components, including generators, transmission lines, and loads. Bus bars exist. Utilized usually in switchgear and control gear assemblies as well as for establishing electricity distribution. The bus bar offers a vast range of connecting techniques and advancements qualities of the heat.

The temperature of the bus bar rising system is a crucial element that negatively impacts its performance. the size of the cross-section, the amperage. The bus bar's design and conductivity are the criteria that calculate the bus bar's heat generation rate. a flaw loss in the bus bar as a result of the temperature rise of all the devices that are attached to it. Bus bar protection should be quick, dependable, and solid. The current carrying capacity (or ampacity), which is constrained by the maximum working temperature, needs to be precisely evaluated to construct power equipment like the bus bar.

Temperature rise and contact resistance between copper conductors were measured. It was discovered that the temperature rises at the measuring places in the same phase did not differ very much. With increasing insulation material thickness, the bus bar temperature rises linearly resource-intensive procedure.

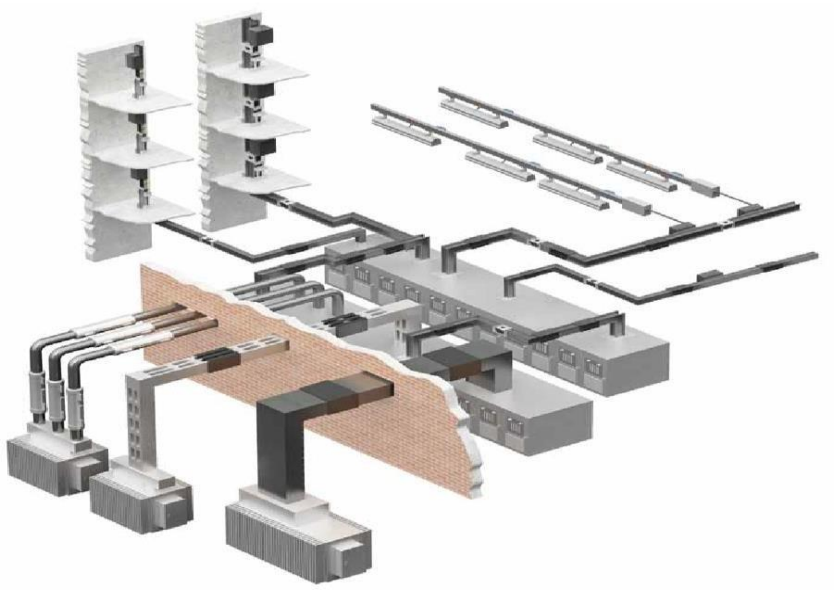

Figure 1: -A power Distribution System using Busbar Trunking Systems

A Busbar Trunking Or bus duct is a sheet metal or casts resin duct with copper or aluminum busbars to conduct a sizable amount of electrical current. It provides power lines with a different method of conducting electricity. Its carries out the task of moving current from one place to another. Historically, cables were employed for this purpose. BBT goes further than what cables can. By tapping boxes, BBT can cut power to switchgear for later distribution. BBT can therefore be used as distribution panels at various levels as opposed to cables (on floors of a building). BBT continues to be used as a single system (commercial or industrial) to replace cables and distribution boards at the floor level for buildings.

Due to their convenience and safety, Busbars are now irreplaceable. Compared to Busbars, traditional cables have substantially greater cabling and trunking costs and longer installation times.

Figure 2 - Conductors

Figure 3 - Insulations

The system has been specifically created for projects and installations where a power source needs to be made readily available. These are best suited for uses when the precise position and amount of power consumed are uncertain and where potential changes to the physical distribution of loads are contemplated. The BBT is enclosed, has a non-ventilated design, and is completely insulated with epoxy insulation made without halogens to retard fire. Through this compact and scalable range of systems, the BBT system offers a superior alternative to cables and other bus trunking choices, giving an improved solution for power transmission and distribution in buildings as well as industries.

The system has been created explicitly for projects and installations where a power source must be readily available. These are best suited for uses when the precise position and amount of power consumed are uncertain and where potential changes to the physical distribution of loads are contemplated.

1.2 Classification of bus duct-

At LT voltages, i.e., up to 1000 Volts, there are two types of Bus-ducts Biased on their Technology and Construction

Figure 4 Sandwich Bus-duct

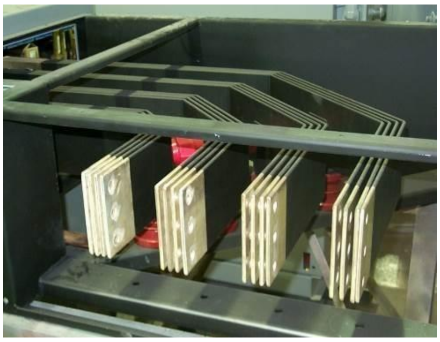

Figure 5 Air Insulated Bus-duct

Further Biased on the application, these are categorized into two types

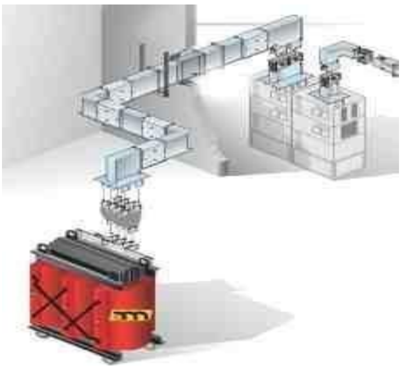

Figure 6 Feeder Bus duct

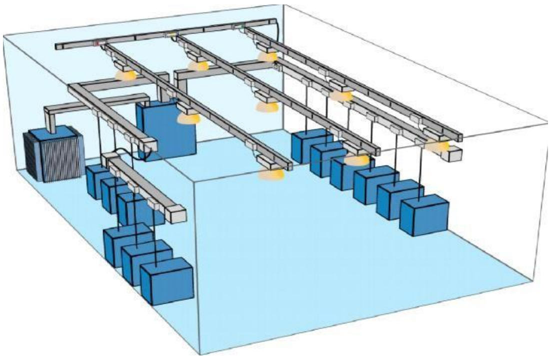

Figure 7 Plug in Bus-duct.

Both sandwich and air-insulated bus ducts can be used in either application. L&T Electrical and automation only manufacture Sandwich Bus-duct as it is the latest technology and has very advantages over other.

Sandwich Bus Bar trunking Systems offer a superior alternative to cables and other conventional type bus trunking options through this compact and scalable range of systems thus providing an enhanced solution to power transmission and distribution in buildings as well as industry; BBTS can tap off power to switchgear for further distribution using the tap of boxes. Compared to cables, BBTS can thus serve as distribution panels at different stages (on floors of a building). BBTS thus continues as a single system to replace cables and distribution boards at floor level for the building.

Bus Bar trunking Systems are used for the distribution of Low voltage electrical Power. These are available in both Low and High Current ratings as per requirements. Operating voltage is up to 1000 volts, and operating currents can be 100 Amps to 6300 Amps. Bus Bar material used is of high conductivity grade Aluminum or copper. Short Circuit Breaking Capacity of up to 100kA for 1 Sec. The metal-clad enclosure has an IP rating ranging between IP20 to IP65.

The products are designed and manufactured as per industrial standards accepted worldwide. These products can also be specifically designed to operate in different environmental conditions considering ambient temperature, moisture, elevation from sea level etc. and as per the requirement of the end-user. It is compatible with operating without fault in a seismic zone" V".

1.3 Benefits of Sandwich Bus Bar Trunking Systems

Here are many benefits to installing Busbars rather than traditional cabling, some of which are listed below: -

1. Design- Busbars are constructed with a small footprint that allows compressed flat conductors to pass through the enclosure. Busbars are more space-efficient than typical cabling systems because of their small designs, significantly benefiting when thousands of amperes of energy need to be transported.
2. Heat Absorption- Busbars can absorb heat generated during transmission and distribution of electricity in the enclosure walls because the design is compact and has a metal casing with a clearly defined surface. The cooling system is far superior to the standard cabling system.
3. Flexibility- Busbars can be utilized in any type of construction with any arrangement, making them more flexible than cables. Because they are simple to modify, adding a second room or structure is simple. Busbars can also be moved without incurring a significant capital expense.
4. Cost Savings- Busbars are more accessible to attach than cables and require less installation money than conventional cables. They can be mounted more quickly than conventional cables.
5. Better Resistance- Busbars are more resistant than cables because of their rigid design elements, particularly in cases of short circuits. Busbars have conductor spacing that is kept to a minimum, which lowers resistance induction. Busbars also have a thin, flat tire that aids in distributing current density optimally, lowering resistance. Voltage loss is significantly lower than cables for the same length because of lower density levels.
6. Reduced Loss of Energy- Busbar resistance is lower than cable resistance. As a result, Busbars experience less energy loss during transmission and distribution. In comparison to cable systems, Busbars require less reactive power to operate.
7. Lower Electromagnetic Field- Busbars produce a lower electromagnetic field than cables because

of their compact design and steel construction. As a result, high loads of 4000 amperes to 5000 amperes free of electromagnetic interference can be simply established near the data cables.

8. No Dependency on Length- Traditional cables have different lengths depending on location and connection when connecting a phase with high amperage. Busbars, however, contain active and inductive resistance specifications to ensure that the load on each phase is equal. Therefore, the length difference is avoided.
9. Ease of Distribution- Busbars help in easy, efficient and safe distribution of lines with the junction boxes in places where they are required. Moreover, the location data junction boxes can be changed whenever and wherever in the future. The junction boxes can be easily increased in the future with Busbars.
10. Standard Cells- Fully certified standard cells are an integral part of Busbars which are meant to eliminate human error. Examples of such standard cells include junction boxes and plugs. These are certified parts of Busbars which meet all kinds of safety standards.
11. Safe and Secured- Unlike cables, Busbars have a steel casing that prevents damage from rodents.

In addition to the benefits, Busbars have several other advantages over wires. Busbars will continue to grow in relevance as traditional cables become obsolete due to the increasing network and distribution requirements

The BBT is enclosed, has a non-ventilated design, and is completely insulated with epoxy insulation made without halogens to retard fire. Through this compact and scalable range of systems, the Meg duct BBT system offers a superior alternative to cables and other bus trunking choices, giving an improved solution for power transmission and distribution in buildings as well as industries

The system has been created explicitly for projects and installations where a power source must be readily available. These are best suited for uses when the precise position and amount of power consumed are uncertain and where potential changes to the physical distribution of loads are contemplated.

1.4 Various components of Sandwich Busduct

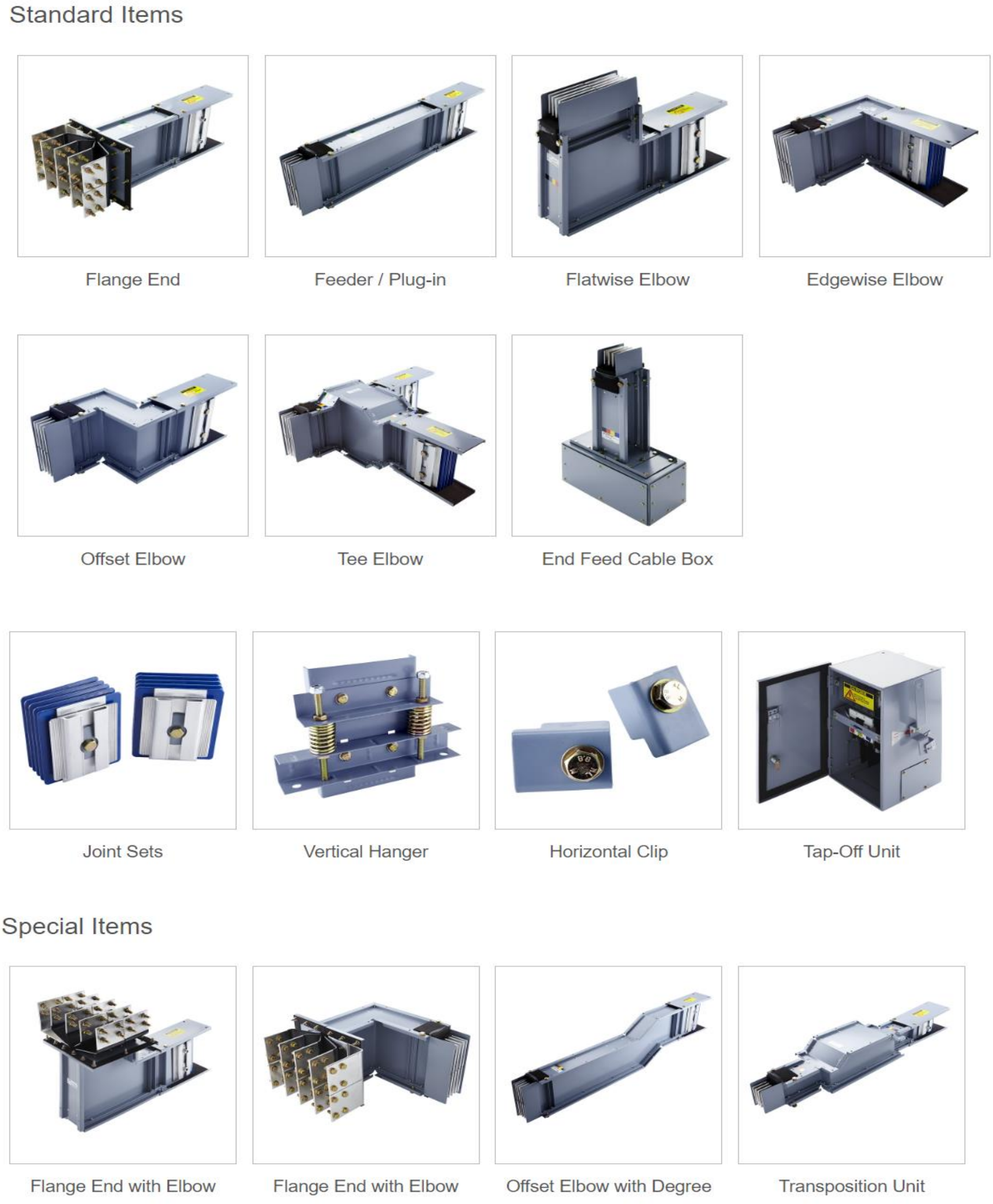

Figure 8 Components of Busduct system

CHAPTER 2 LITERATIVE REVIEW

ERDA, Journal Volume 1'Study on feasibility of upgrading the operating temperature of Al Busbars without plating' [1] This paper discusses measurement of temperature on busbar connection based on contact resistance and plating cloth in relation to the value of touch resistance. This study is meant to save you failure when busbar connection is connected. The failure of the electric connection can arise because of horrific touch so that the contact resistance is accelerated, excessive losses, overheating, and it can even cause a fireplace chance. Thereare three test samples of modeled: copper busbar connection with out plating, copper busbar reference to nickel plating and copper busbar connection with silver plating. The contact resistance of every sample become measured at contact strain of 12 MPa. eventually the samples loaded with the modern-day of 350 A and temperature at the connection become measured and simulated till constant kingdom situation reached. The consequences display that the temperature at the contact place is better than that of busbar appears because of the touch resistance. both size and simulation consequences display that busbar reference to silver plating having lower touch resistance and lower maximum temperature, accompanied by the connection with the nickel plating and busbar connection without plating.

IEC 61439[2] Part 1: Low-voltage switchgear and control gear assemblies, And Part 6: Busbar trunking systems (busways) Are documents for international standards which are referred worldwide by national electrotechnical committees (IEC National Committees), this document is a work and publication of The International Electrotechnical Commission (IEC) which is a worldwide organization. The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

AS/NZS 3439.1:2002[3] Low-voltage switchgear and control gear assemblies - Type-tested and partially type-tested assemblies AS/NZS 3439.1:2002 (AS 3439) is an Australian Standard whose objective 'is to lay down the definitions and to state the service conditions, construction requirements, technical characteristics and tests for low-voltage switchgear and control gear Assemblies' (AS/NZS 3439.1:2002, p1). AS 3439 states in its Preface that 'Information regarding the current carrying capacity for copper busbars can be found in AS 4388:1996' (AS/NZS 3439.1:2002, pii), which reiterates the statement made by AS 3000. As stated in Section 2.2.1 of this project, AS 4388:1996 was superseded by AS 60890:2009 of the same title in 2009. Clause 7.8.2 of AS 3439 also reiterates the statement made by AS 3000 that the responsibility for the calculation of current carrying capacities of busbars lies with the manufacturer. Clause 7.8.2 Dimensions and rating of busbars and insulated conductors. The choice of the cross-sections of conductors inside the Assembly is the responsibility of the manufacturer. (AS/NZS 3439.1:2002, p48) Clause 7.3 of AS 3439 defines the temperature rise limits in Table 2 of AS3439, the maximum copper busbar operational temperature under normal service conditions is 105°C. The Temperature-rise limits apply for mean ambient air temperatures less than or equal to 35°C and shall not be exceeded for Assemblies when verified in accordance with (AS/NZS 3439.1:2002, p27)

Clause 7.3 states that the temperature rise needs to be verified in accordance with Clause 8.2.1. Sub-clause 8.2.1.1 (below) states that verification of temperature rise limits shall be made either by test or by extrapolation. Clause 8.2.1.1 Verification of temperature rise. The Temperature-rise test is designed to verify that the temperature-rise limits specified in 7.3 for the different parts of the Assembly are not exceeded… … The verification of temperature-rise limits for PTTA shall be made – By test in accordance with 8.2.1, or – By extrapolation, for example in accordance with IEC 60890. (AS/NZS 3439.1:2002, p27) AS 60890:2009 is a reproduction of the IEC 60890 standard, and is therefore the equivalent when referred to in AS 3439. Summarizing AS 3439, it states that the responsibility for the calculation of current carrying capacities of busbars lies with the manufacturer, and AS 60890:2009 can be used as a guide. Additionally, the maximum copper busbar operational temperature, under normal service conditions, is 105°C

CHAPTER 3: PROJECT

3.1 Project Objective- The objective of this project is to manufacture a live working sample of 1600 amps bus duct in the plug-in configuration.

3.2 Finalizing Specifications: -

Service conditions

The performance of a bus system can be affected by the following service conditions: -

1. Ambient temperature
2. Altitude
3. Atmospheric conditions
4. Excessive vibrations and seismic effects

We are designing a product which can be used worldwide, however, for sample manufacturing, we are focusing on products designed as per Indian service conditions. As per Geographic conditions, India has

In India CPWD look after all technical standards of public sector work hence we will match the technical requirements of CPWD. As per CPWD required technical parameter for bus duct shall match as below-

Table-1 Standards

IS standard:	IEC 61439-part 6
Supply system three-phase four-wire	415 V ± 10%,
Maximum permissible temperature Rise	55*C
Maximum operating Voltage	1000 V
Insulation Voltage	1000 V
Frequency	50 Hz ± 3%
Ambient temperature	40*C

Bus Bar Sizing Calculation: -

We should consider the following points while doing: -

- Adequate minimum required clearance between Phases and Phase to Earth.
- Selection of Adequate Busbar Insulator Standoffs.
- Bolting Arrangements for Continuous Busbar Connections.

- Thermal Effects on Busbar and Insulator Standoffs under normal and Fault conditions.
- Electrodynamic Forces applied to Busbars and Insulator Standoffs under Fault Conditions.
- Avoidance of mechanical resonance under normal operating and Fault Conditions.
- temperature rise:
- Conductivity of Conductor
- Skin and proximity effects on a current carrying conductor
- Heat dissipation factor
- Voltage drops

Instead of doing long calculations, we shall use the size as per industry standards and then verify the size. We will select Aluminums as a conductor as it is very economical compared with copper, and processing Aluminum is very easy compared with copper. For Aluminum, conductor conductivity is 1 Amp per sq MM, and due to good heat dissipation, the current can be taken at 1.8 Amps per sq MM. Here, for the sandwich bus duct width of the Busbar is selected as 6 mm by default as per the market availability of the Busbar.

Now total cross section will be 150 MM x 6 MM = 900 Sq MM Amps Rating will be as below - Calculation for 1600A: 1 x 6 x 150 Aluminum Bus duct

Table-2 Technical Parameters		
Project	-	
Customer	-	
No. of bars per phase		1
Bus bar width	mm	150
Bus bar thickness	mm	6
Bus bar Material		Aluminum
Temperature rise allowed	°C	85
Ambient	°C	40
Frequency	Hz	50
Height of enclosure	mm	135
Width of enclosure	mm	190
Location of bus duct		Indoor

The d.c. rating for single bar

$$I = \frac{1.02 * A^{0.5} * P^{0.39} * \Theta^{0.61}}{((1 + \alpha_{20} * (T - 20)) * \rho)^{0.5}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Equation no 1 is taken from the reference books Thomas and Rata [4] and copper for busbar [5]

Here,
I = d.c. current rating is still air (A)
A = cross-sectional area of Busbar (mm^2) P = perimeter of Busbar (mm) θ = temperature rise allowed in ^{0}C

α = resistance temperature co-efficient of the conductor (per^{0}C) ρ = resistivity of conductor at ambient temperature (μΩ cm) T = maximum temperature allowed on bus bar °C

Thus,
Skin Effect Ratio =1.05A
Thus, open-air AC rating of bus bar

$$I_{ac} = \frac{I_{dc}}{\text{Skin Effect Ratio}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Thus,
De-rating factor for enclosure = 0.8
Maximum current rating with the enclosure I = 1627 A

Open air ac rating Iac =	2034 A

Short Circuit Capacity Calculation for 1600A Aluminium Bus-duct

- We use Electrically Conductive grade Aluminium as conductor in our bus-duct to ensure best quality of electrical distribution.
- The bar size that we use for 1600A Aluminium Busbars are 1 x 6 x 150 mm
- we are designing 1600AAluminium bus-duct has been designed according to IEC- 61439 Part 1 & 6.
- Theoretical calculation of current carrying capacity of Busbar according to IEC- 61439-1

$$\mathbf{A = \frac{\sqrt{(I^2 x t)}}{K}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

where ,

I = r.m.s. value of fault current in Amp
A = cross-sectional area,sqmm = 900
t = duration of fault in Sec t = 1Sec
k = is the factor dependent on the material of the conductor, insulation initial and final temperature.
k = 116 for Aluminum

Initial temperature of the conductor assumed to be 30 Deg C
By using above formula to arrive the factor of aluminum Busbar

I = (k x A) / (√ t) …………………. (4)
i.e., 116 x 900/ 1 = 104400A
Hence, I = 104.4 kA

1.2 WATT LOSS CALCULATION

We use A1060 grade Aluminum as conductor in our bus-duct to ensure best quality of electrical distribution.
Theoretical calculation of watt loss is as per below,

P(Loss) = 3 x I^2 x Rac …………………. (5)

were,

I = Rated Current in Amp

R = 42.29 μΩ/m (Resistance at 80 Deg C in μΩ/m)

By using above formula to calculate the Watt Loss or Heat Loss of Aluminum Bus- bar.

P(Loss) = 3 x I^2 x Rac

i.e., 7680000.0 x 42.29 = 324.79 W

P (Watt Loss) = 0.3248 kW/Hr

1.3 Enclosure (Material Selection and Size)-

Selection of enclosure material depends upon various factors such as: -

1. Thermal conductivity
2. Tensile strength
3. Cost of material

4. Resistance to corrosion

Looking above factors we can choose between aluminum and sheet Steel Cost of fabrication in aluminum is very high as compared to Sheet steel, among sheet steel, we can choose between CRCA (Cold Rolled and Close Annealed) And GI sheets, we will use TATA make GI sheets.

The size of the enclosure shall be such that it can accommodate 4 nos Busbar of 150 MM x 6 MM also the enclosure shall be such that it can provide Minimum Clearances and Creepage distances at joint Ares the shape of the enclosure shall be such that it can dissipate maximum heat through it. And it shall be self-supported.

Table 3 – Clearances for enclosed, indoor air-insulated busbars		
Rated Voltage kV	Minimum clearance to ground in air mm	Minimum clearance between phases in air mm
Up to 0.415	16	19
0.6	19	19
3.3	51	51
6.6	64	89
11	75	127
15	102	165
22	140	241
33	222	356

Selection of Insulation is done as per the properties described below: -

- Electric insulator
- Transparent
- High tensile strength
- Chemical stability
- Reflective
- Gas barrier
- Odor barrier

While selecting insulation we will use class “F” insulation as the maximum operating temperature of our bus duct is 95 * C.

Table-4 Insulation class	
Insulation Classes	Maximum permissible temperature
Y	90
A	105
E	120
B	130
F	155
H	180
C	>180

We can use Multilayer Bo PET (biaxially oriented polyethene terephthalate) film as insulation. Final Specification of the Sample Project is now finalized which can be summarized as per the table.

Table-5 Atmospheric conditions	
Longitude:	78.96288
Latitude:	20.593684
Elevation:	248m / 814feet
Relative humidity	up to 85%
Barometric Pressure:	98KPa
Normal ambient temperature	40*C
Seismic Zone up to	Zone-V
Atmospheric condition	marine (near the sea), dusty and extreme (in Thar desert),

	Table-6 Design Condition		
S. No.	Application Condition		
1	Design ambient temperature		40^0c
2	Elevation above sea level		below 1000m
3	Relative humidity		95% or below
4	Atmosphere		marine dusty and corrosive
5	Seismic zone		up to zone-v

Table 7 Bus Bar Specification

S.	Description	Units	Specification	Detail
A	**General Particulars**			
3	Type Of Busway			Sandwich Busway System
4	Busbar Material			Aluminum
5	Ampere Rating	A		1600 A
6	Ingress Protection	IP		IP 54
8	Configuration			3 Phase 4 Wire
B	**Electrical Particulars**			
1	Reference Standard			IEC 61439 PART1 & 6
2	Rated Operational Voltage	V	Ue	1000 V
3	Rated Insulation Voltage	V	Ui	1000 V
4	Rated Impulse Withstand Voltage	V	U imp	8 KV
5	Rated Frequency	Hz		50 HZ
6	Rated Short-circuit Current/ Peak Withstand Capacity	KA		80 kA
7	Power Frequency Withstand Voltage	kV		2.5kV for 5 sec
C	**MECHNICAL PARTICULARS**			
1	Size Of Phase Busbar (R, Y, B)	mm		150 Mm WidthX 6

				Mm Thickness
2	Size Of Neutral Busbar	mm		150 Mm WidthX 6 Mm Thickness
3	Size Of Earth Busbar	Mm		75 MM X 3 MM
4	Conductor Purity	%		99%
5	Conductor Conductivity	%		60%
6	Class Of Insulation			Class-F (155 Deg C)
7	Insulation Material			N-Aramid APA

8	Thickness Of Insulation Material Used		Micro n	4 Layer Of 5mil Each, 1 Mil=25.4 Micron,
9	Dielectric Strength of Insulation		KV/m m	2.8 kV / mil
10	Halogen Gas Emission		%	Halogen Free
D	**ENCLOSURE**			
1	Enclosure Material			Tata Galvanized Plain Steel Sheets
2	Enclosure Thickness	mm		1.6 MM
3	Height (Mm)	mm		205 MM
4	Width (Mm)	mm		150 MM
5	Painting Shade (Internal/External)			Epoxy Powder Coated (RAL 7032)
6	Paint Thickness	µm		50 Micron
7	Standard Straight Length	mm		3000 MM

8	Maximum Straight Length	mm		3500 MM
9	Minimum Straight Length	mm		400 MM
10	Gross Weight	Kg		**23.3568 KG**
B	**Application Condition**			
1	Design Ambient Temperature	^0C		40^0C
2	Elevation Above Sea Level			Below 1000m
3	Relative Humidity			95% Or below
4	Atmosphere			Marine Dusty and Corrosive
5	Seismic Zone			Up To Zone-V

3.3 (Designing and CAD Modelling of Prototype)- Now we will make CAD designing of our prototype

Basic Design-

1. Cross section of bus duct can be drawn as

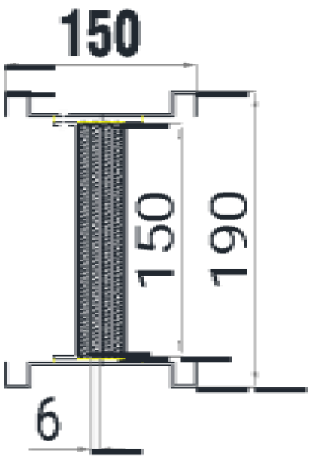

Figure 9 Cross section of busduct

2. Isometric view of a vertical length can be shown as:

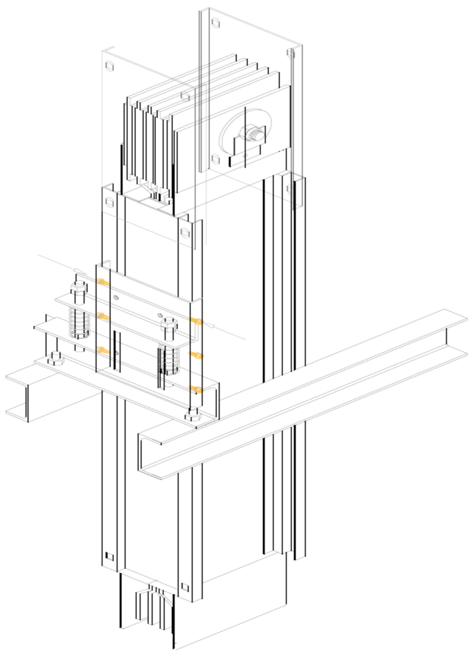

Figure 10 isometric view of busduct

3. Flange end drawing

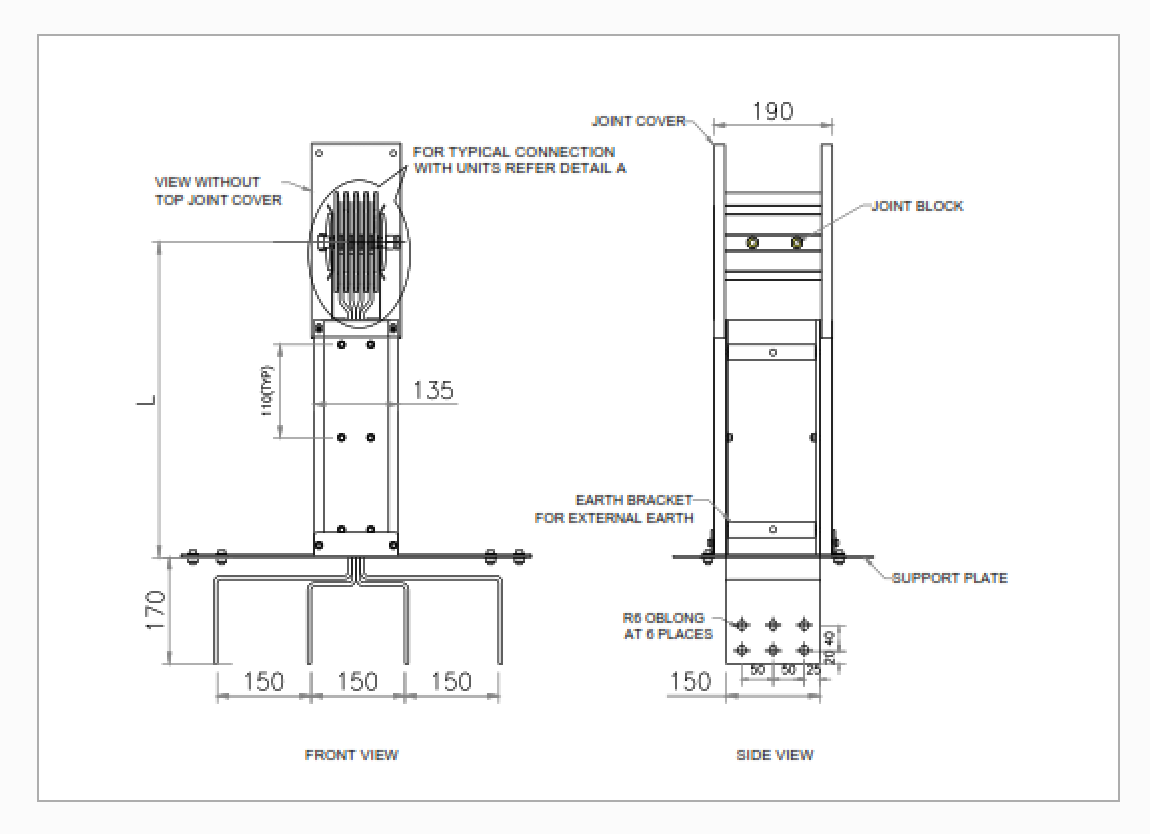

Figure 11 flange end Drawings of busduct

Assembled drawing of complete prototype

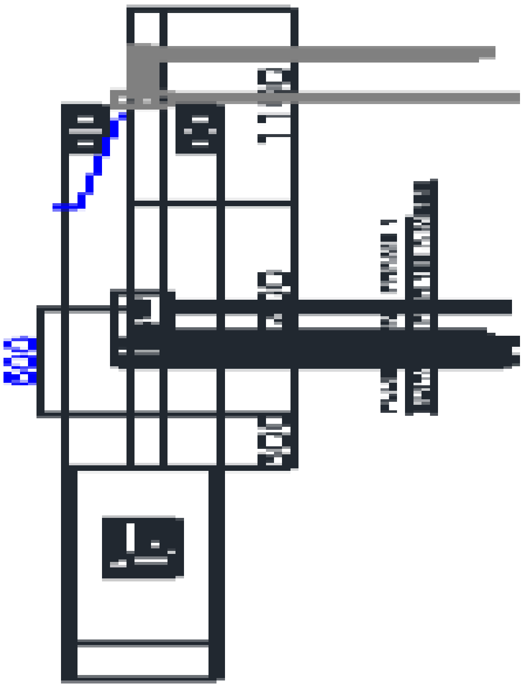

Figure 12 complete assembly of busduct

3.4 Manufacturing Procedure

Manufacturing of Busbar trunking system is divided into these parts

- Enclosure Manufacturing
- Busbar Manufacturing
- Busbar Insulation
- Assembly of Prototype.

Enclosure Manufacturing

We have manufactured and Assembled the Prototype at Vishtech Engineering Corporation Patiala Workshop.

We have manufactured Enclosure of TATA make Gi sheets, the process used to make Enclosure is as below: -

Figure 13 sheet bending at power press

Figure 14 welding process by MIG welder

Figure Source (https://www.datametal.com/blog/)

Figure Source https://rooengineering.co.uk/fabrication/)

Table-8 Steel Fabrication Machines	
Sheet Sheering:	100 Ton Techpro Make Sheering Machine
Sheet Pressing/ Punching / Bending Process	150-ton Techpro Make Bench-press
Welding Process	400- amps weld nation makes MIG machine
Finishing	Bosch make Grinders
Power coating process	7 tank power coating done at vendor place

Busbar Manufacturing-

Busbar is manufactured by using Global Make -Hyderabad Busbar of grade AL 1060 (Purity 99.6% Conductivity 61%) manufacturing of Bus- bar involve process as below: -

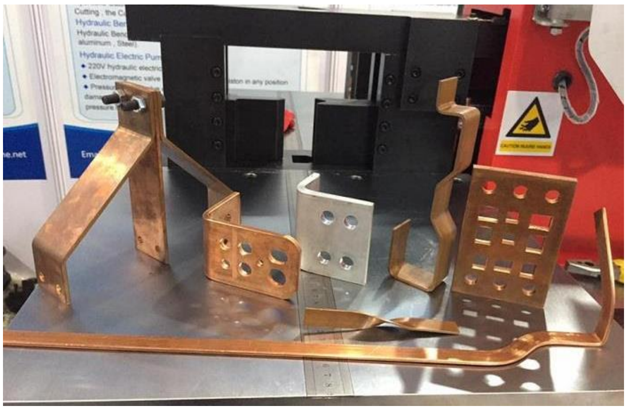

Figure 15, 16 Busbar sharing Bending and Punching Operation

Figure Source (https://www.jpbusbarmachine.com/)

Figure Source (https://www.boschertusa.com/)

Table-9 Bus Bar Process Machines	
Busbar Sheering:	50 Ton Self Make Sheering Machine
Busbar Pressing/ Punching / Bending Process	50-ton self-Make Bench-press
Welding Process	400- amps Electra makes TIG machine
Finishing	Bosch make Grinders
Busbar Insulation:	After Busbar Manufacturing it is warped in 4 layer of PET insulation film

Assembly of Prototype- All the components as shown in the drawings are assembled manually and each element is installed as per the final drawings.

Figure 17- 22 Same type of sample products manufactured and assembled by our team

CHAPTER 4: PROTOTYPE TESTING

As the sample is manufactured as per the plans, we need the sample to be tested as per reference standards IEC 61439 Part 6

Type tests are as below-

1. Short Circuit
2. Temperature Rise.
3. Routine tests
4. Verification of Dimensions
5. Continuity tests
6. Insulation Resistance.
7. Dielectric Test
8. Checking Paint Thickness
9. Labels, Name Plate Danger Plate
10. Field Tests
11. Insulation Resistance before Charging
12. Torque and Alignment check of the Installed Busduct

we shall not be able to carry out type tests on our Prototype as it is not possible to do so as we are not going to do a Commercial manufacturing these types of tests are done on a sample of lot and the sample product on which test are carried out shall not be used due to change of getting damaged in case of test fails, However, we have chosen sizes as per industries standard hence these tests are not required on our Prototype.

We have done all the Routine test as Mentioned above and found that our sample passes all the test mentioned.

Table-10 Routine Tests	
Continuity tests	Pass
Insulation Resistance.	Pass above 500 Mega Ohm (Min 200 Mega Ohm Required)
Checking Paint Thickness	Pass
Labels, Name Plate Danger Plate	Pass
Verification of Dimensions	Pass

It is done after installation of bus duct before charging the System hence we will do it on Later stage before charging the System.

4.1 SAMPLE INSTALLATION

Following Item have been installed

Table-11 Installation of the Sample prototype has been Done.	
1	End Feed Unit without SWITCHGEAR
2	Flange Unit (Above End feed Unit)
3	Plug in Length
4	End Cap
5	Wall Mounted Support for Rising Mains
6	Spring Support for Rising Mains.
7	Mechanical Interlocking Type Plugin Box with 100 Amps MCCB.

The photograph of sample installation is attached from both sides.

Figure 23- 24 Final Prototype Assembled and Charged

CHAPTER 5: CONCLUSION

Interlocking systems speed up inspections and prevent mounting mistakes. Without exposure to live connections, work is done safely. Tap-off units are inaccessible to live parts. The trunking can be activated to add or delete tap-off units. Devices that interlock eliminate connection mistakes. To improve protection, the PE conductor is wired up ahead of the phase and neutral conductors.

Workflow is made easy by prefabricated design. The adjustable and upgradeable nature of this technology allows for exact planning of installation schedules as well as quick and efficient response to changes in plans. Increased productivity is the end outcome. It is simple and quick to shift electrical equipment or install a machine. The kind of service that clients value is that. The same adjustment can require cables.

5.1 Future Work

The Bus trunking is more reliable from power cable its and it is flexible to use. Moreover, its uses copper or aluminum Busbar and appropriate enclosures and adequate protection, the Busbar trunking system distributes electricity while preventing damage to the cables from foreign objects. Due to their convenience and safety, Busbars are now considered to be irreplaceable. Busbar is used in various fields of applications that require current distribution of high and low voltage, including factories, workshops, assembly lines, warehouses, stations, rack servers, data center, supermarkets, etc.

References

[1.] ERDA, Journal Volume 1'Study on feasibility of upgrading the operating temperature of Al Busbars without plating'.

[2.] IEC 61439 Low Voltage Switchgear and Control gear Assemblies: Part II: Particular Requirements for Busbar Trunking Systems (Busways)

[3.] AS/NZS 3439.1:2002 Low-voltage switchgear and control gear assemblies - Type-tested and partially type-tested assemblies AS/NZS 3439.1:2002 (AS 3439)

[4.] Thomas, A.G. and Rata, P.J.H., Book for Aluminum Busbar. Hutchinson

[5.] Book by Bus bar, Copper Development Association.

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