

# 104 - Busbar Specification

## Technical Specifications

### Performance under Short-circuit Conditions

Busbar trunking systems to BS EN 60439-2 are designed to withstand the effects of short-circuit currents resulting from a fault at any load point in the system, e.g. at a tap off point or at the end of a feeder run.

### Rating under Short-circuit Conditions

The withstand ability will be expressed in one or more of the following ways:

- short-time withstand rating (current and time)
- peak current withstand rating
- conditional short-circuit rating when protected by a short-circuit protective device (s.c.p.d.)

These ratings are explained in more detail:

#### a) Short-time Withstand Rating

This is an expression of the value of rms current that the system can withstand for a specified period of time without being adversely affected such as to prevent further service. Typically the period of time associated with a short-circuit fault current will be 1 second, however, other time periods may be applicable.

The rated value of current may be anywhere from about 10kA up to 50kA or more according to the construction and thermal rating of the system.

#### b) Peak Current Withstand Rating

This defines the peak current, occurring virtually instantaneously, that the system can withstand, this being the value that exerts the maximum stress on the supporting insulation.

In an A.C. system rated in terms of short-time withstand current the peak current rating must be at least equal to the peak current produced by the natural asymmetry occurring at the initiation of a fault current in an inductive circuit. This peak is dependent on the power-factor of the circuit under fault conditions and can exceed the value of the steady state fault current by a factor of up to 2.2 times.

#### c) Conditional Short-circuit Rating

Short-circuit protective devices (s.c.p.ds) are commonly current-limiting devices; that is they are able to respond to a fault current within the first few milliseconds and prevent the current rising to its prospective peak value. This applies to HRC fuses and many circuit breakers in the instantaneous tripping mode. Advantage is taken of these current limiting properties in the rating of busbar trunking for high prospective fault levels. The condition is that the specified s.c.p.d. (fuse or circuit breaker) is installed up stream of the trunking. Each of the ratings above takes into account the two major effects of a fault current, these being heat and electromagnetic force. The heating effect needs to be limited to avoid damage to supporting insulation. The electromagnetic effect produces forces between the busbars which stress the supporting mechanical structure, including vibrational forces on A.C. The only way to verify the quoted ratings satisfactorily is by means of type tests to the British Standard.

## Type Testing

Busbar trunking systems are tested in accordance with BS EN 60439-2 to establish one or more of the short circuit withstand ratings defined above. In the case of short-time rating the specified current is applied for the quoted time. A separate test may be required to establish the peak withstand current if the quoted value is not obtained during the short-time test. In the case of a conditional rating with a specified s.c.p.d. the test is conducted with the full prospective current value at the trunking feeder unit and not less than 105% rated voltage, since the s.c.p.d. (fuse or circuit breaker) will be voltage dependent in terms of let through energy.

## Application

It is necessary for the system designer to determine the prospective fault current at every relevant point in the installation by calculation, measurement or based on information provided e.g. by the supply authority. The method for this is well established, in general terms being the source voltage divided by the circuit impedance to each point. The designer will then select protective devices at each point where a circuit change occurs e.g. between a feeder and a distribution run of a lower current rating. The device selected must operate within the limits of the busbar trunking short-circuit withstand. The time delay settings of any circuit breaker must be within the specified short time quoted for the prospective fault current.

Any s.c.p.d. used against a conditional short-circuit rating must have energy limitation not exceeding that of the quoted s.c.p.d. For preference the s.c.p.d. recommended by the trunking manufacturer should be used.

## Voltage Drop

The requirements for voltage-drop are given in BS 7671: Regulation 525-01-02. For busbar trunking systems the method of calculating voltage drop is given in BS EN 60439-2 from which the following guidance notes have been prepared.

### Voltage Drop

Figures for voltage drop for busbar trunking systems are given in the manufacturer's literature.

The figures are expressed in volts or milli-volts per metre or 100 metres, allowing a simple calculation for a given length of run.

The figures are usually given as line-to-line voltage drop for a 3 phase balanced load.

The figures take into account resistance to joints and temperature of conductors and assume the system is fully loaded.

### Standard Data

BS EN 60439-2 requires the manufacturer to provide the following data for the purposes of calculation, where necessary:

$R_{20}$  the mean ohmic resistance of the system, unloaded, at 20°C per metre per phase

X the mean reactance of the system, per metre per phase

For systems rated over 630A:

$R_T$  the mean ohmic resistance when loaded at rated current per metre per phase

### Application

In general the voltage drop figures provided by the manufacturer are used directly to establish the total voltage drop on a given system; however this will give a pessimistic result in the majority of cases.

Where a more precise calculation is required (e.g. for a very long run or where the voltage level is more critical) advantage may be taken of the basic data to obtain a more exact figure.

**i) Resistance** - the actual current is usually lower than the rated current and hence the resistance of the conductors will be lower due to the reduced operating temperature.

$R_x = R_{20} [1 + 0.004(T_c - 20)]$  ohms/metre and  $T_c$  is approximately  $T_a + T_r$

where  $R_x$  is the actual conductor resistance

$T_a$  is the ambient temperature

$T_r$  is the full load temperature rise in °C (assume say 55°C)

**ii) Power factor** - the load power factor will influence the voltage drop according to the resistance and reactance of the busbar trunking itself.

The voltage drop line-to-line ( $\Delta v$ ) is calculated as follows:

$$\Delta v = \sqrt{3} I (R \cos \phi + X \sin \phi) \text{ volts/metre}$$

where I is the load current

$R_x$  is the actual conductor resistance ( $\Omega/m$ )

X is the conductor reactance ( $\Omega/m$ )

$\cos \phi$  is the load power factor

$\sin \phi = \sin(\cos^{-1} \phi)$

**iii) Distributed Load** - where the load is tapped off the busbar trunking along its length this may also be taken into account by calculating the voltage drop for each section. As a rule of thumb the full load voltage drop may be divided by 2 to give the approximate voltage drop at the end of a system with distributed load.

**iv) Frequency** - the manufacturers data will generally give reactance (X) at 50Hz for mains supply in the UK. At any other frequency the reactance should be re-calculated.

$$X_f = X \frac{F}{50}$$

where  $X_f$  is the reactance at frequency F in Hz

**Note : Information taken from EIEMA (The Electrical Installation Equipment Manufacturers' Association)**