HOW TO SELECT A CABLEBUS SYSTEM

What are the specifics of cablebus construction and application?

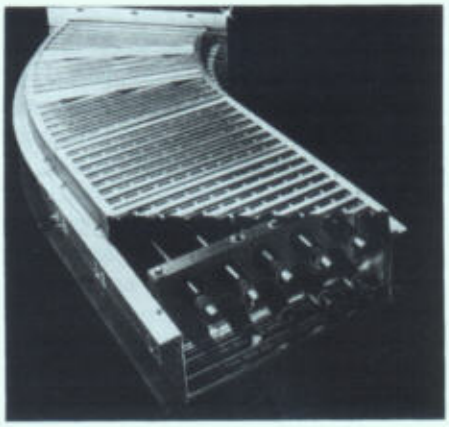
CABLEBUS is an increasingly used alternative to traditional wiring methods such as cable in conduit or tray; armored cable in tray; and nonsegregated phase bar bus (bus duct). (Cablebus is also considered nonsegregated phase busway.) Depending on the application, this method may be less expensive, more efficient, and more flexible, particularly in the current range of 800 to 8000A.

What is cablebus?

According to Art. 365 of the National Electrical Code, cablebus is described as follows:

> Cablebus is an approved assembly of insulated conductors with fittings and conductor terminations in a completely enclosed, ventilated protective metal housing.

A cablebus system is a field assembled system of distributing power consisting of a metallic housing, 600V or medium voltage (MV) conductors, and cable support blocks. These blocks, which are usually made of wood or fiberglass, maintain the correct cable spacing and phasing arrangement and provide bracing so that the cablebus can withstand momentary short circuit forces. Manufacturers typically supply drawings for approval prior to custom fabricating a system to a particular job requirement.



Selection criteria

Each of the following issues should be addressed during the design stages of a cablebus system.

Conductor sizing. Due to the amount of ventilation in the top and bottom of a cablebus housing, many systems use a "free air rating" when sizing conductors. However, depending on the specific application, some manufacturers suggest a more conservative approach. For example, a solar derating factor may need to be applied to installations in hot, outdoor areas where prolonged exposure to sunlight is the norm.

An ampacity calculation should be required of the supplier and reviewed in accordance with NEC Table 310-17 or 310-19, and the standards of the Institute of Electrical and Electronic Engineers (IEEE) and the Insulated Cable Engineers Association (ICEA). Regardless, the NEC stipulates that the minimum size conductor shall be 1/0 AWG.

Even though 90°C-rated cable is often used, 75°C overcurrent protection equipment connections will force you to apply the ampacity tables for 45°C temperature rise in a 30°C ambient environment.

To verify correct conductor sizing, temperature rise calculations can be performed in accordance with the IEEE Neher-McGrath method (IEEE Transaction Paper No. 57-660, "The Calculation of the Temperature Rise and Load Capability of Cable Systems"). Or, an actual temperature rise test can be performed by the cablebus manufacturer.

During the temperature rise test, temperature probes embedded in the conductors measure the actual temperature rise above ambient at the rated current. This allows experimentation with housing design. For example, the difference between solid and ventilated top covers can be investigated.

Conductor insulation. Type TC cable need not necessarily be used in a cablebus system. For 600V cablebus systems, type XHHW conductors are typically used.

For MV applications, a variety of insulation and jacket types can be used. Cablebus manufacturers typically suggest a cross-linked polyethylene (XLP) insulation/polyvinyl chloride (PVC) jacket construction. An ethylene-propylene-rubber (EPR) insulation/Hypalon jacket construction is suggested where emissions from burning insulation and jacketing material must meet low toxicity emission levels.

Phasing arrangements. The use of continuous, parallel conductors provides the opportunity for the cablebus supplier to optimize conductor phasing arrangements. For lower losses, the inductive reactance is calculated and the most efficient phasing arrangement is specified. The results of the calculations are used to provide a cablebus system where the voltage drop is minimized and the phase currents are balanced.

Cablebus systems typically have lower volt-

5kV System Ampacity Profile

Copper conductor	Cablebus	3-conductor cable (in tray)	Three single conductor cables in conduit (in air)
500kcmil	695A	485A	425A
750kcmil	900A	615A	525A
1000kcmil	1075A	705A	590A

Table 1. A comparison of the current carrying capacities of 5kV cablebus, 3-conductor 5kV in tray, and single conductor 5kV cable in conduit (in free air), with all conductors rated at 90°C.

MPHusky Corp.,
Greenville, SC.

age drop than bus duct systems as the cablebus conductors are continuous while bus bars are often bolted together every 6 to 8 ft. Bus duct splices have the potential of becoming a problem if loosened due to thermal cycling.

Due to today's sophisticated inductive reactance calculations, transposing of conductors is seldom needed. This old method of criss-crossing or interleaving conductors to balance phase currents has largely been replaced by calculating the correct cable arrangement during the cablebus design process.

Short-circuit bracing. Cablebus systems offer bracing of conductors to withstand large momentary short circuit forces. Certified test reports usually can be provided that verify the cablebus system's ability to withstand certain fault current levels, for example, bracing for 100,000A rms symmetrical. To ensure this level of bracing, support blocks are normally spaced every 36 in. for horizontal runs and every 18 in. for vertical runs of cablebus. NEC Article 365 specifies these as maximum conductor support spacing dimensions. To obtain even higher short circuit bracing ratings, the distance between conductor support blocks is reduced. To maintain consistent strength, the rungs that hold the cable support blocks are welded to the outside of the housing side rail.

System design. Prior to initiating any design, you'll need to specify if the cablebus is a 3-phase, 3-wire or a 3-phase, 4-wire system. Another consideration is whether or not an equipment grounding conductor will be needed. If required, it will typically be run along the outside of the housing flange and supported every 6 to 8 ft. The total cablebus installation must be grounded per NEC Secs. 250-32 and 250-33.

Other considerations include whether a full or half neutral is required, the minimum bending radii as it applies to the installation, the basic impulse level (BIL) required, and the need for any termination or adapter bars.

Engineered drawings. Cablebus systems are supplied with cable, connectors, firestops, termination kits, and other accessories for a complete warranted system. Manufacturers will normally supply layout drawings for approval, final construction drawings, and installation manuals as a matter of standard practice. To assist with the preparation of engineered drawings, the following information will be needed.

- General layout drawings or sketches of intended installation.
- Elevation views of intended installation.
- Equipment (switchgear, transformer, etc.) details.

So that the correct amount of space to transpose and terminate cablebus conductors is available, top hats may have to be furnished with switchgear and termination boxes with transformers. Where outdoor terminations are involved, they should be environmentally sealed. If required, firestops can be added where the cablebus penetrates fire-rated walls and floors. At floor penetrations in dry areas and where firestops are *not* required, cablebus must be totally enclosed at the point where it passes through the floor for a distance of 6 ft above the floor. In wet locations and where firestops are again not required, curbs must be installed around the floor opening to prevent water flow and the cablebus must be totally enclosed for a distance of 6 ft above the floor.

Typically, 3 to 5 ft of cablebus conductor are left at each end of the bus run. In instances where there are minor mislocations of equipment, the cablebus housing can be field-modified for the required adjustment. Unlike solid bus bars, variances of a few inches can be readily accommodated.

Environmental concerns. NEC Art. 365 specifies that cablebus is suitable for both indoor and outdoor use in that its conductors are well ventilated yet fully insulated. Typically, cablebus conductors run cooler than bus bars as they operate at 75°C or 90°C versus 115°C and are well ventilated.

Cablebus housings are available in HDGAF (hot-dipped galvanized after fabrication) steel, stainless steel and aluminum. Most applications are well-served by an aluminum housing with top and bottom covers corrugated for strength and slotted for ventilation. If needed, solid top covers with louvered sides can be provided. However, the benefits of shedding water are outweighed by the long-term benefits of cooler operating conductors in a well-ventilated housing. Moisture is not accumulated and simply flows around and beyond the fully insulated conductors.

A note of caution: if a HDGAF steel housing is used, you must be aware of the potential for circulating currents. These can be eliminated, however, by providing an insulating strip under the cablebus cover.

Installation pointers. Cablebus housings are supplied in precut lengths, with the bottom segments of the support blocks (for bracing and spacing) already in place. Starting at one end, the housing is bolted together in the field before any conductors are installed. Once the housing is in place and supported (Per NEMA VE-1), the conductors are then installed from a predetermined reel length. Each conductor is pulled with standard cable tray pulling tools and placed into the cable support blocks.

For particularly long or complex cablebus runs, you should make a pulling tension and an induced shield voltage calculation (in medium voltage applications). The results of the pulling tension calculation will decide whether or not a splice box is required. The results of the induced shield voltage calculation will decide whether it's necessary to ground the conductor's insulation shield at both ends.

Cablebus applications need not be limited to short runs. Many installations of well over 1000 ft have been operating for years throughout North America.

To support a cablebus system indoors, trapeze-type hangers are typically used and are fabricated from strut and threaded rod. For outdoor installations, T-type pipe supports and H-frames or towers are often used if an existing pipe rack is not available. The cablebus supplier can supply a complete support system and incorporate this into the final system design. Per Sec. 365-6(a), cable-bus should be supported at intervals not exceeding 12 ft. ■