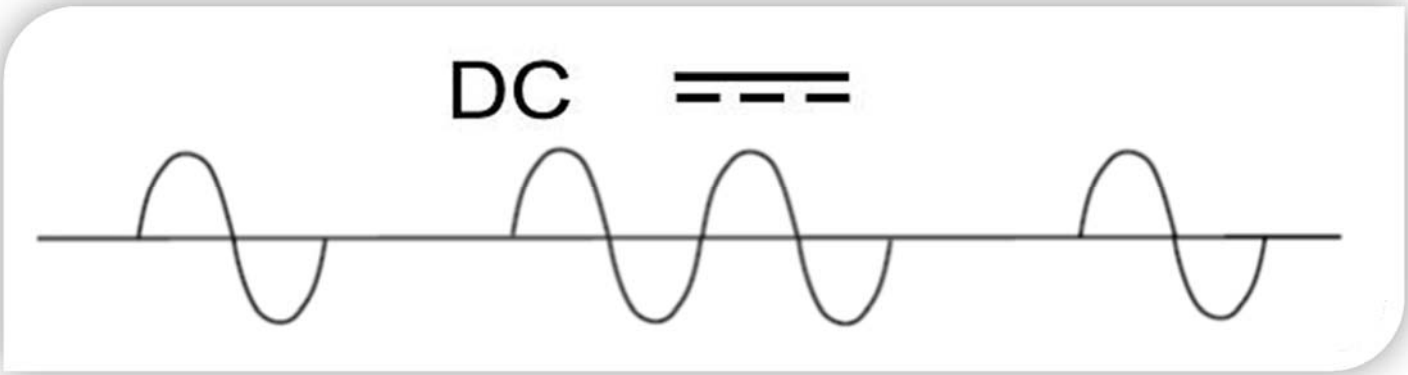
SWITCHPOINT HEATING

DC-Systems



Switchpoint Värmekabelteknik Heating

INDEX

(A) Conductor 2 x 1.3mm^2
(B) Semi-conductive material with self-limiting characteristics (the resistance increases with rising temperature)
(C) Insulation and outer shath of fluoropolymer (PFA)

Range of application:

Switchpoint heating and power rail heating.

Technical data:

Basic type..... Class II

Manufactured according to .....VDE, IEC800

Cable class..... double insulated*

Colour:..... Grey outer sheath

Test voltage.....1500 V DC

Supply voltage..... DC. Nominal 750 V

Operating temperature..... max. +150°C

Exposure temperature.....max. +250°C

Installation temperature..... min – 20°C

Output/m..... at 10°C ~ 100/130W – 750V

Bending radius ..... min 40 mm

Dimension .....11.5 x 6.5 mm

Weight.....0.15 kg/m

Part.no.:.....VX502

Denomination.....Velox ORIGO30-DC

Customs/Tariff-code 84195090

Velox ORIGO30-DCis manufactured with a sheath of PFA.

Table 1:

Part.no	Type of cable	Length max* (m)
VX502	VELOX ORIGO30-DC	125

** at 10% power loss.*

* Double insulated cable with each insulation layer thickness according to IEC:1995. R.M.S. 450/750 V. Min. requirement 0.60mm.

(A) Resistance wire
(B) High-temperature Silicone
(C) High-temperature PFA

Range of application:

Switchpoint heating and power rail heating.

Velox SIP is a double insulated series resistive heating cable for connections up to 1000 VDC.

Technical data:

Manufacturing std../Basic type

Basic type,
Manufactured according to.....VDE/IEC 800

Colour: .....White outer sheath

Test voltage 3000V

Supply voltage 750v/max 1000V

Output .....Ohms law

Max. ambient temperature ..... 20°C

Max Exposure temperature .....130°C

Installation temperature.....-10

Bending radius..... 6 x Ø

Diameter..... 4.5 / 5.0 mm
.....depending on resistance

Weight ..... ca 80-90 kg/1000m

Part.no. .....SIP/PFA.....(+ Ω-värde)

Denomination: .....Velox SIP + resistance value

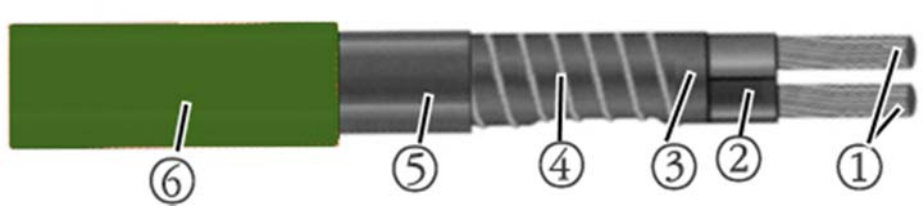
Customs/Tariff-code.....84195090

SIP/PFA is manufactured with a sheath of PFA.

Table 1:

Part.no	Type of cable	Power (W/m)	Length max* (m)
SIP/PFA + Ohm-value	VELOX SIP/PFA	80	Ohm's Law

** at 10% power loss.*



① Conductor, tin-coated Cu, 1,5mm²
② Conductor insulation Fluor-plastic
③ Bed for heating conductor
④ Heating conductor Ni-Cr
⑤ Sheath 1 Fluorplast
⑥ Sheath 2 Fluorplast

Range of application:

Switch heating at railways, subways, tramways.

PH-750 have a double sheath of corrosion hard-ened material (teflon) and manages aggressive environmentals.

PH-750 is double insulated without earth.

Technical data:

Basic type..... VDE 253 /EEC800

Approved, tested by ..... CE

Colour:..... Green outer sheath

Test voltage ..... 3000 VDC

Supply voltage..... 750 VDC

Output..... 90W / m

Distance between contact points..... 2 meter

Max Operating temperature..... 180°C

Max Exposure temperature..... 230°C

Installation temperature..... min -30◦C

Bending radius ..... min 50 mm

Diameter ..... 7,8 x 5,6 mm

Weight..... 75 kg/1000m

Part.no.:..... VX504

Denomination:..... Velox PH-750 VDC

Note: PH-750 VDC is installed on 750 V with a channel (datasheet channel see page 15-16) of Glas fiber plastic.

Table 1:

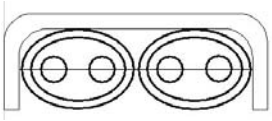
Part.no	Reference	Power (W/m)	Length max* (m)
VX504	Velox PH-750VDC	90	160

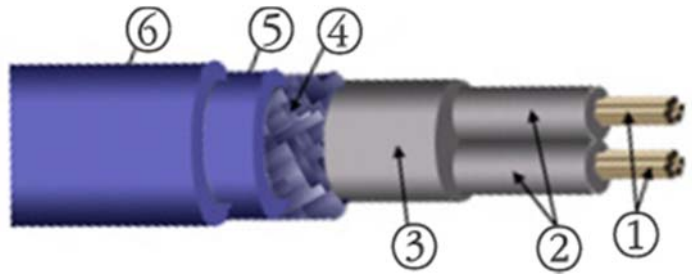
** at 10% power loss*

Insulation

If two cables are installed parallel under same channel, standard channel you will have a con-stant wattage parallel resistance cable with output up to 180 W/m.

2 cables installed parallel under channel ref.no 6-18-9.





① Resistance wire
② PFA
③ Silicone
④ Armouring
⑤ Sheath PFA
⑥ Sheath PFA

Range of application:

Power switch heater.

Velox PH-750 is a series resistive, teflon insulated heating cable with two resistance wires.

Velox PH-750 have three insulated jacets.

Cable data:

Manufacturing std./Basic type..VDE 253 / EEC800

Approved, tested by .....CE

Color: .....Yellow or blue outer sheath

Test voltage.....3000 VDC

Rated voltage..... 750V DC

Power.....max 90 W/m

Max Operating temperature..... 160°C

Max Exposure temperature.....230°C

Lowest installation temperature..... min -30°C

Lowest bending radius .....min 50 mm

Dimension ..... max. 7,8 x 5,6 mm

Weight.....75 kg/1000m

Part.no..... VX PH-0.04
.....VX PH-0.025

Denomination:..... Velox PH-750

Velox PH-750 is manufactured with a sheath of PFA.

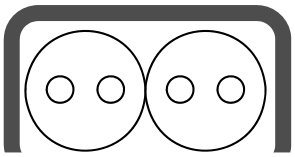
Table 1:

Part.no	Type of cable	Power (W/m)	
VXPH-0.04	Velox PH-750 / 0.04	2 x 0.04 Ohm/m	Per single core Yellow sheath
VXPH-0.025	Velox PH-750/0.025	2 x 0.025 Ohm/m	Per single core Blue sheath

** at 10% power loss.*

Insulation

Up to two cables can be installed parallel in the same channel.



General considerations

Heating elements for rails are usually in the form of tapes or cables clipped to the rail. There are a number of different ways of taking and controlling power from the third rail to heat a section of rail or a the rails of a switch point. There are two basic possibilities. Heating elements can be rated at the live to running rail potential, or they can be rated at some other potential.

Low voltage elements .

If heating elements designed for any voltage other than the live-rail-to-running-rail potential some form of switch mode converter must be operated directly from the rails. It may be that low voltage elements are cheaper than live-to-running rated elements, but an inverter that is reliable under all conditions and does not pass any electrical interference back to the rail system will be expensive.

Live-rail-to-running-rail rated elements .

Essentially all that is needed is a switch controlled by a temperature sensor on the heated rail. As usual it is not quite so simple as that, but it is much simpler than the use of a switching inverter.

Choice of basic system:

Any reasonably efficient device which can convert power at a direct pressure of 750 volts to, say, 110 volts has to use a fast switching process. The obvious configuration uses a semiconductor switch to connect an inductor between the source and the load until a certain current is reached. The switch then disconnects and a flywheel diode allows the inductor to continue to force current into the load until its magnetic field collapses. After a delay the process starts again. Output voltage (and therefore heat delivery) is varied by controlling the delay.

Whatever the configuration, the switching device is only separated from the power source by whatever filtering is necessary to control the flow of unwanted energy in either direction. Switching device rating, depending on the type of converter, will need to be at least double the load current or at least double the worst case source voltage.

Suppression of unwanted energy is much easier. Switching events happen at times measured in seconds rather than microseconds. There is therefore far less energy to absorb, and it can be absorbed easily without disrupting system action.

Since live-rail-to-running-rail rated elements are readily available without significant cost penalty, the choice of basic system has to be the straightforward switch.

Switching Devices .

Since heating elements rated at the live rail to running rail potential are readily available the system choice is to use them with a temperature controlled ON/OFF switch.

Historically speaking, many devices have been used to switch DC power. Currently the realistic choice of device to perform the actual switching operation rests between an IGBT (Isolated Gate Bipolar Transistor) and a contactor.

Superficially, a contactor is easier to use. It needs less protection from incoming noise and surges. However, frequent cycling, breaking 50A DC (note that there is no zero crossing to extinguish the arc) with a source voltage of up to 1KV suggests serious life problems or much expense.

A suitably rated IGBT has no problems with repeated cycling. It must be driven correctly, and it must be protected from incoming interference.

In practice the devices needed to give a contactor some sort of life expectancy and those needed to protect an IGBT are very similar. The devices needed to stop outgoing (to the rails) interference are probably also very similar, although the contactor's arcing must be expected to get worse as its contacts burn and distort.

One further consideration is that the temperature sensing and switch control electronics need some power. This low voltage power has its tedious side.

For example, a 30mA at 24 volt supply can be derived using a 24 volt zener and a 22K ohm resistor. The problem with the resistor is that it has to specified to dissipate 37 watts continuously.

In practice, some current is needed for ancillary devices such as telephone diallers. Control package current is therefore at a premium. The IGBT control circuits take almost zero average current.

Specifications for relays capable of repeatedly switching 50A with a source pressure of up to 1KV DC are not available but the solenoid current requirements will certainly not be insignificant.

The conclusion is clear. Provided, of course, that incoming noise can be controlled the only realistic choice is an IGBT.

Figure 1: General Schematic

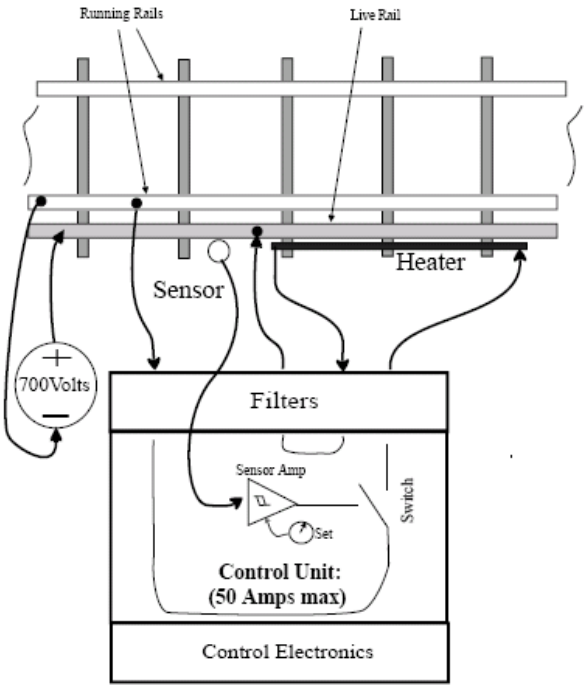
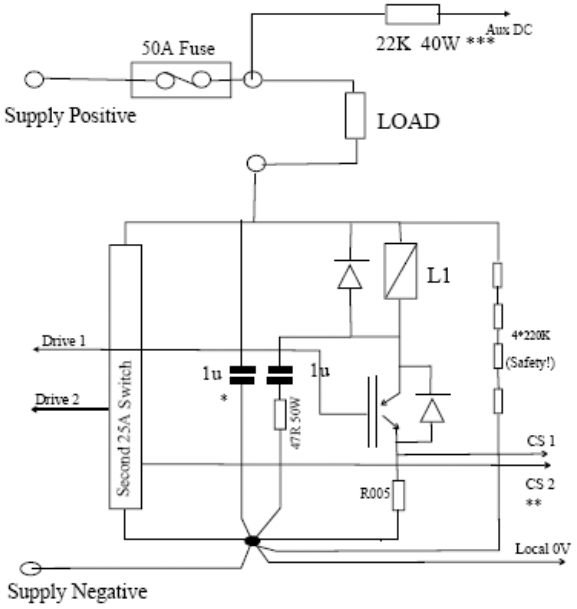


Figure 2: Main Switching Circuit Elements



Twin 25Amp Switches Provide 50A Capability

Notes:
* Not implemented on the prototype

** Over Current Protection: Not implemented on the prototype

*** The prototype has a 33K 40 watt resistor here.

Some practicalities

No figures have been found for the noise (interference) levels that can be expected on the power source.

The following assumptions were made:

1) High voltage spikes (possibly some KV high either way) have to be expected.
2) The metals in supply transformers and motors are conventional transformer standard. The rates of rise will be commensurate with this.
3) Sustained (more than a few milliseconds) voltage surges will be less than 1KV.

Implementation:

It is important to use tried and tested devices. An IGBT rated at 33A continuous current and 1200V sustained voltage is a standard part. Two of these in parallel can give us control of 50Amps with a source potential of 750 volts and some margin for safety.

Some inductance is needed between the switching device and the supply to reduce unwanted energy transfer either way. Without figures to work to the calculation became one of what we could reasonably achieve.

It was soon found that a 50A inductor was seriously unwieldy. Splitting it into two made it much more manageable and incidentally provided a very small resistance that would ensure current sharing between switches.

Inductance was eventually chosen on the basis that it resulted in the largest assembly that was easily handled by one person! The inductor cores could have been made of high grade metal, but since fast events are not expected a substantial cost saving was made by using standard material.

Flywheel diodes were added and anti-parallel diodes to cope with reverse voltage spikes. Such spikes will be of short duration, at least individually, and current will be limited by the resistance of the heating element

Snubbers (R/C networks) were added to reduce the dv/dt at the moment of switching.

Final Comment:

Provision for transient energy (either way) absorption has been the subject of some guesswork. At this stage of any project it is a perfectly normal situation. It is believed that the estimates made are realistic, but only testing in real conditions can confirm this.

Increasing the ability to absorb transient energy is not a problem, but it is a cost.

NOTES

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