

## Application Note DK9222-0411-0050

### Control cabinet

#### Keywords

reverse switching  
relay replacement  
solid state relay  
fieldbus  
Bus Terminal  
HD Bus Terminal  
KL2284  
KL2784  
KL2794  
16 channel  
wear-free  
switching

# How to reduce control cabinet space using High Density I/O and DC motor terminals

**The size of a control cabinet is naturally a major driver of cost in industrial system design. The more comprehensive the system functions, the more electronic components are required. The modular Bus Terminal system from Beckhoff offers plenty of scope for control cabinet optimization. This application example focuses on three separate aspects: increasing channel density per terminal with the HD Bus Terminal, DC motor control with the KL2284 reverse switching terminal, and replacement of relays with wear-free, short-circuit-proof semiconductor circuits through a digital KL2784 output terminal.**

## HD Bus Terminal

The Beckhoff HD Bus Terminal is a new Bus Terminal generation with much higher channel density. These 'High Density' (HD) Bus Terminals feature 16 digital channels in the compact housing of a 12 mm terminal block. It has the same external dimensions as most standard Bus Terminals and is compatible with them. The HD Bus Terminals reduce the space requirements in control cabinets, resulting in a significant reduction of the price per channel. HD Bus Terminals are available in different versions both for EtherCAT Terminals and for Bus Terminals. For example, 16-channel terminals are available for digital inputs or outputs, 8-channel terminals for digital inputs or outputs with 2-wire connection or combination terminals with eight digital inputs and eight digital outputs, which offer users a particularly high degree of flexibility.

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Fig. 1 Exceptionally compact control: Ethernet Controller with integrated IEC 61131-3 PLC functionality combined with 64 digital I/Os including end terminal in a mere 104 mm mounting space.

### Reduction of control cabinet space

The Beckhoff I/O system is based on 12 mm terminal blocks with an internal system bus: the K-bus for Bus Terminals and the E-bus for EtherCAT Terminals. In most machines and systems, the acquisition and output of 24 V digital inputs and outputs form the main part of the controller. The compact 16-channel HD Bus Terminals offer new possibilities for project planning here: doubling the channel density leads to a 50% reduction of the required control cabinet space, the price per channel is reduced and assembly is simplified. With these compact I/O modules, the user can save valuable mounting space, helping reduce control cabinet space requirements and machine footprints. For example, eight control switches with integrated LEDs for signalling the switching states can be fully wired on a 12-mm Bus Terminal. On the input side, eight end positions or door contacts can be connected to one HD Bus Terminal using the 2-wire technique. Again, a further advantage is the simplification of the assembly: despite the high channel density, the general format of the connection points is retained.

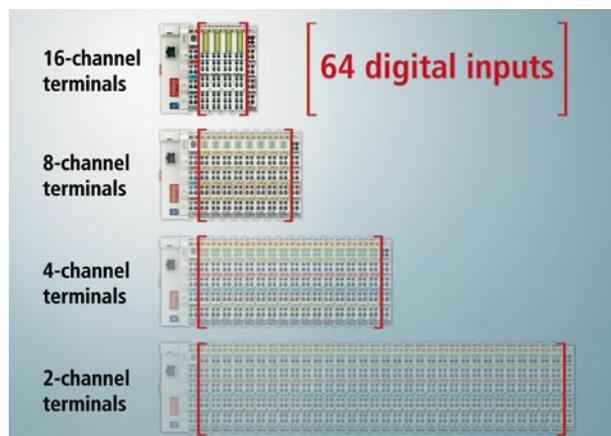


Fig. 2 Compact I/O modules save valuable cabinet space

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### DC motor control with the KL2284 for reverse switchings

The KL2284 output terminal offers connection options for four DC motors and switches loads in terms of selectable polarity, so that 24 V DC motors can be used in both directions of rotation. Integrated locking prevents simultaneous switching of both directions. The outputs of the KL2284 can accommodate a maximum load of 2 A per channel. The high switch-on and short-circuit currents of the KL2284 are comparable with a robust relay. In contrast to a relay-based four-quadrant actuator (H bridge), semiconductor technology offers a virtually unlimited number of switching cycles. Advanced power semiconductors enable safe and wear-free switching with minimized dimensions.

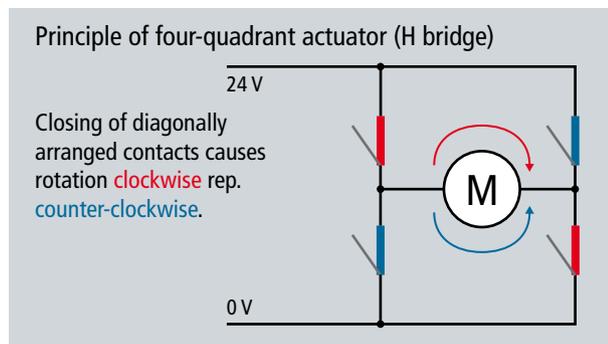


Fig. 3 Four-quadrant actuator

### KL2784 and KL2794 | Semiconductor switch replaces relay

Relays are electromagnetic switches that are designed for low switching capacity, usually in the DC range, without spark blow-out chambers. In contrast to contactors, their switching contacts are single-interrupting. Relays are widely used, despite their poor EMC characteristics (separating arc leads to back-scatter into the grid). The service life of a contactor is limited by a maximum number of switching cycles, since frequent actuation leads to burning of contact and wear of movable components etc. Replacing relays with semi-switches minimizes actuation and release times, increases equipment availability and reduces the required mounting space in the control cabinet.

For this purpose the modular Beckhoff Bus Terminal system includes digital output terminals for the voltage range 0 to 24 V AC/DC. The 4-channel KL2784 and KL2794 digital output terminals each provide four independent switches that can be used like a relay contact. The electronic switch in the Bus Terminal is implemented by efficient Mosfet transistors with a low switch-on resistance. The electronics are virtually wear-free. The switch itself is not short-circuit-proof, but can conduct a high current with its high pulse current capability long enough, until the circuit-breaker switches off. It behaves like a robust relay contact.

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### Special features

- Both terminals are suitable for the application in the lower DC and AC range up to 24 V.
- Inductive loads can be connected directly without additional safety measures, since the circuitry switches comparatively slowly and prevents high peak voltages. No break sparks are created in the terminal and no electromagnetic interference pulses occur.
- In contrast to the KL2784 (power contact as common potential), the KL2794 switches the power contacts without connection to the circuit, so that loads can be connected potential-free.

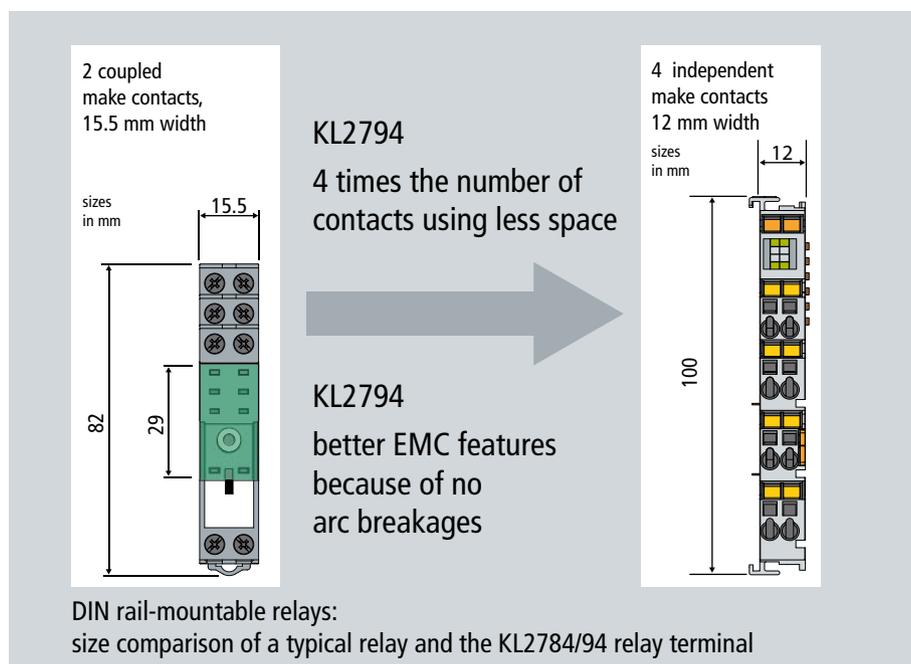


Fig. 4 DIN rail-mountable relays: size comparison of a typical relay and the KL2784/94 relay terminals

- 4-channel digital output terminal 24 V AC/DC, 2 A, short-circuit-proof [www.beckhoff.com/KL2784](http://www.beckhoff.com/KL2784)
- 4-channel digital output terminal 24 V AC/DC, 2 A, potential-free, short-circuit-proof [www.beckhoff.com/KL2794](http://www.beckhoff.com/KL2794)
- 4-channel digital output terminal 24 V DC, 2 A, reverse switching [www.beckhoff.com/KL2284](http://www.beckhoff.com/KL2284)
- HD Bus Terminal [www.beckhoff.com/HD-Busterminal](http://www.beckhoff.com/HD-Busterminal)

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