Control Technology for Mobile Machines
Product Catalogue
Table of contents

1. Introduction
   - General 5
   - New products 9
   - Innovations 11
   - CAN bus systems 13
   - Circuit structures 20
   - Specification of inputs and outputs 24
   - Functional safety 28
   - Programming options 36

2. Control Equipment for General Applications 39
   - Universal mobile controller HY-TTC 50 43
   - Universal mobile controller HY-TTC 60 47
   - Universal mobile controller HY-TTC 90 51
   - Universal mobile controller HY-TTC 94 55
   - Universal mobile controller HY-TTC 77 59
   - Universal mobile controller HY-TTC 200 63
   - Universal mobile controller HY-TTC 540 69
   - Universal mobile controller HY-TTC 580 73
   - Universal mobile controller HY-TTC 30-H 77
   - Universal mobile controller HY-TTC 30S-H 81

3. I/O Expansion Modules 85
   - HY-TTC 30X-H 89
   - HY-TTC 30X-O 93
   - HY-TTC 30X-I 97
   - HY-TTC 30XS-H 101
   - HY-TTC 30XS-I 105
   - HY-TTC 36X 109
   - HY-TTC 48X 113
   - HY-TTC 48XS 117

4. Displays with Integrated Controller 121
   - HY-eVision² 7.0 123
   - HY-eVision² 10.4 127

5. Accessories 131
   5.1 Cable harnesses, cabling and connection technology 133
   5.2 Accessories for training, development, testing and service purposes 141
   5.3 Sensors for increased functional safety, diagnostics and standard applications 175
   5.4 Operating elements, pilot control units and radio controls 183

6. Service 185
   - Services 185
   - Training courses 186
Introduction

HYDAC – Your partner for expertise in mobile machines

With over 7,500 employees worldwide, HYDAC is one of the leading suppliers of fluid technology, hydraulic and electronic equipment. Our broad range of products, combined with our expertise in development, manufacturing, sales and service enables the wide range of requirements for mobile machinery to be met worldwide.

Our quality and environment certification to ISO 9001/2000 and ISO 14001 denote first class quality and responsible management of our resources.

Global and yet local.

With over 50 overseas companies, and more than 500 sales and service partners, HYDAC is your reliable partner worldwide.

HYDAC ELECTRONIC

HYDAC stands for hydraulics, systems and fluid engineering.

For over 50 years, HYDAC has been developing and manufacturing components and systems for specific applications in these fields. Over 30 years ago, inspired by its industry and application experience, HYDAC expanded its portfolio to include sensors, measuring instruments and electronic controls. Almost all these products are developed, manufactured and marketed by HYDAC ELECTRONIC. Suitability for the application is tested on the many HYDAC test rigs.

As a Tier 1 automotive supplier, HYDAC ELECTRONIC is certified in accordance with the rigorous quality standard ISO/TS 16949 and therefore meets the very high requirements regarding product quality, production processes and continuous improvement processes.

Within the framework of continuous technical change towards mechatronic systems, particularly on mobile machines, HYDAC has expanded its product range accordingly. In the area of control technology and visualization, it established a joint venture with the company TTTech Computertechnik AG. The collaboration is the perfect fusion of expertise in both companies in different industries and applications with the aim of providing application-specific system solutions of maximum benefit to the customer.

The target markets are mobile machines and special vehicles such as construction machines, agricultural machines, municipal vehicles, cranes, material handling machines and snow groomers.

TTTech Computertechnik AG has many years’ experience in developing robust hard and software solutions which must sometimes meet very rigorous safety standards. The main areas of application here are in the aerospace and automotive sectors. HYDAC has comprehensive industry know-how in stationary and mobile hydraulics, with a broad product range "from the component right through to the system" which also includes sensors and measuring technology. By virtue of its international sales network, HYDAC also has the ideal global marketing platform, providing professional advice, support, supply and a broad range of services.

Functional safety

The technical requirements with regard to functional safety are derived from the standards IEC 61508 and EN 13849. For this HYDAC provides controllers certified to IEC 61508, SIL 2 / 3 and EN 13849, PL d.

HYDAC offers other components for applications with increased functional safety, namely sensors and valves.

In addition, HYDAC provides support throughout, from risk analysis to certified machine function.

HYDAC can provide support and advice to the customer, as required, through the entire product development cycle – from design and simulation, right through to the application software, commissioning and series production.
HYDAC measurement and control technology – for a wide variety of industries and applications

There is almost no hydraulic or pneumatic medium or system which could not be monitored and controlled by HYDAC measurement technology – quickly, precisely and safely.

It is no surprise, therefore, that individually designed HYDAC measurement technology is employed by well-known manufacturers and operators in all industries.

These applications range from analysis and diagnostics of operating fluids in the laboratory and on site, to controlling complex industrial systems and to miniaturised systems in construction and road vehicles.

**Telescopic cranes**
- Sensors and system electronics to generate modern control concepts or whole concepts for easy integration.
  - Load torque limiting
  - Load spectra
  - Load sensing
  - Max. load regulation
  - Energy management
  - Condition monitoring

**Municipal machines**
- Sensors, system electronics and condition monitoring.
  - Working hydraulics
  - Axle suspension systems
  - Cab suspension systems
  - Levelling systems

**Excavators**
- Electronic controls and sensors to complement the system electronics.
  - Max. load regulation
  - Electro-hydraulic load sensing
  - Integrated operational data logging
  - Controls of special equipment
  - Shutdown devices
  - Safety shutdown devices

**Tractors**
- Sensors, system electronics and condition monitoring.
  - Cab suspension
  - Central hydraulics
  - Front axle suspension
  - Transmission shift control
  - Level control
  - Active roll stabilisation

**Wheel loaders**
- Electronic controls and sensors to complement the system electronics.
  - Max. load regulation
  - Electro-hydraulic load sensing
  - Integrated operational data logging
  - Controls of special equipment
  - Shutdown devices
  - Safety shutdown devices

**Special vehicles**
- Electronic controls and sensors to complement the system electronics.
  - Cab suspension
  - Central hydraulics
  - Transmission shift control
  - Level control
  - Active roll stabilisation

**Road construction machinery**
- Sensors and system electronics to generate modern control concepts or whole concepts for easy integration.
  - Load spectra
  - Condition monitoring
  - Safety systems
  - Load limiting
  - Function controllers
  - Energy management

**Special sport / recreational vehicles**
- Electronic controls and sensors to complement the system electronics.
  - Load spectra
  - Condition monitoring
  - Safety systems
  - Load limiting
  - Function controllers
  - Energy management
Agricultural technology
Electronic controls and sensors to complement the system electronics.
- Max. load regulation
- Electro-hydraulic load sensing
- Integrated operational data logging
- Controls of special equipment
- Shutdown devices
- Safety shutdown devices

Forklifts
Sensors, system electronics and condition monitoring.
- Load sensing
- Max. load regulation
- Central hydraulics
- Energy management
- Condition monitoring

Telescopic loaders
Sensors, system electronics and condition monitoring.
- Max. load regulation
- Load sensing
- Safety systems
- Load limiting
- Function controllers
- Safety shutdown devices

Condition monitoring
Data collection and interpretation of condition information on machines, systems and their components.
New products

HY-TTC 500 series
- Controller series for complex tasks with increased functional safety PL d / SIL 2
- Up to 3 shutdown groups for differentiated safety levels
- 96 configurable inputs and outputs gives great flexibility
- Up to 7 CAN bus and Ethernet interfaces
→ For further information see page 69

HY-TTC 30S
- Compact controllers for applications with increased functional safety, safety PL c according to EN ISO 13849
- 30 inputs and outputs
→ For further information see page 77

HY-TTC 30XS – Safety versions
- Compact I/O extensions for distributed applications with increased functional safety, safety PL c according to EN ISO 13849
- Flexible configurations for additional:
  - Hydraulic functions HY-TTC 30XS-H
  - Inputs HY-TTC 30XS-I
- 30 inputs and outputs
→ For further information see page 101

HY-eVision² 7.0
- Display can be landscape or portrait depending on installation position
- 4 CAN-interfaces
- Sleep mode
→ For further information see page 123

HY-eVision² 10.4
- New camera function: 2 pictures can be displayed simultaneously
- New polarised touchscreen (optional) for maximum readability in direct sunlight
- Display can be landscape or portrait depending on installation position
- Sleep mode
→ For further information see page 127
New products

Controller test rigs

- MTB – Manual Controller Test Rig
- RTB – Remote Controlled Controller Test Rig

Functions:
- Can be used for all HY-TTC controllers and I/O extensions
- Controlling the controller inputs and outputs
- RTB with configuration software
- Excellent scalability due to modular construction
- High current load rating

⇒ For further information see page 149

RTB software

- Configuration of the test rig
Innovations

MATCH – “Mobile Application Tool Chain”

The modern market imposes ever greater demands on all machine builders. There are more stringent regulations for the safety of machines, the health of the driver and amongst others, significantly stricter emission standards. These enormous challenges must be tackled in increasingly short development cycles. At the same time, the development and production process requirements themselves are increasing, and this is reflected in the necessary expenditure for documentation, traceability, change processes and particularly in the enormous number of function and safety tests. This added expenditure which is a necessity from the legal standpoint cannot normally be passed on to the end customer via the eventual machine price to compensate. New ways therefore have to be found within the machine development process.

In response to the new market challenges outlined, HYDAC is currently developing an integrated tool chain intended as a comprehensive approach to system software development of mobile machines. This method of embedded software development is hardware-neutral and has multi-controller capability. It is based on a standardized basic software and a library concept specifically tailored to mobile machines. It includes other fields of activity, such as documentation, software testing, commissioning and optimisation on the vehicle as well as diagnostics in the field and service workshop.

Since the system has been precisely co-ordinated using tools optimized for the individual tasks, interface losses and multiple inputs are almost completely avoided. All system parts have interfaces to enable documentation to be generated automatically. The enormous expense for documentation can be significantly reduced in this way. The close interaction between individual system parts can drastically reduce the development times required. A reduction of up to 50 % is quite feasible.
Scheduled certification of the relevant system parts by an independent third-party organisation corresponding to the following safety standards:

- “SIL2” to IEC 61508
- “PL d” to EN ISO 13849
- “AgPL d” to ISO 25119 or EN 16590

provides you with the certainty that the application software developed for your machine is based on a professional basic software which can be deployed for safety-related applications.
Continuous advances in technology and the desire for ever greater safety and convenience have led to a rapid expansion in technical systems in the automotive industry.

By implication the concept of modularity which emerged means that large systems are split up into smaller, manageable and usually independent subsystems with their own control electronics.

The exchange of ever increasing quantities of data between the individual subsystems via simple cable harnesses quickly became cumbersome, and resulted in noticeably heavier machines.

This became one of the motivating factors for developing a reliable, robust and simple data transfer system. In the 80s, together with other automotive manufacturers, BOSCH developed the CAN bus (Controller Area Network). This is an asynchronous serial bus system, created to link the control electronics, sensors and actuators of a complex system with maximum efficiency.

Today’s widespread success of the CAN bus is due in large part to the standardization in ISO 11898. It defined a communication language which can be received and processed by a number of devices from different manufacturers. Its robustness and reliability make the CAN bus the first choice for data communication in vehicles and mobile machines.

As a basis on which communication logs in networked systems are designed, the so-called OSI (Open Systems Interconnection) reference model has proved successful.

The model consists of 7 layers where the level of abstraction increases with each successive layer. So in Layer 1 (bit-transfer layer) it is just the physical type of data transmission that is controlled. This would include the type of cable, the connectors, the electrical signal conventions and other physical aspects of data transfer.

The second layer is called the Data Link Layer. The role definition for this layer is to implement largely error-free and reliable data transmission as well as controlling access to the transmission layer (Layer 1). To achieve this, the bit data stream is packed into individual blocks, referred to as frames. Checksums are added to these frames to enable the receiver to recognize a transmission error.

Layers 3, 4, 5 and 6 are not used by the CAN bus.

Layer 7 (only used by CANopen), the Application Layer, serves as an interface between the application and the communication medium. Put simply, the application transfers the data to this layer and in the lower layers 2 and 1, the data is then packed and sent.
The application of the OSI reference model in the CAN

In the case of the CAN bus, in Layer 1 we refer to a 3-wire technique consisting of the signal lines CAN-high, CAN-low and CAN-GND. If necessary the bus cable can also be shielded.

Physical signal transmission in the CAN network is based on differential signal transmission. The evaluation of the differential voltage (see Fig. 2) varies according to the type of bus coupler (high-speed or low-speed).

<table>
<thead>
<tr>
<th>Differential voltage CAN-high – CAN-low</th>
<th>CAN-High-Speed</th>
<th>CAN-Low-Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logical “1”</td>
<td>0 V</td>
<td>5 V</td>
</tr>
<tr>
<td>Logical “0”</td>
<td>2 V</td>
<td>2.2 V</td>
</tr>
</tbody>
</table>

At low speed the maximum data transmission rate is limited to 125 kBit/s and at high speed to 1 MBit/s.

The differential evaluation also determines the high interference resistance of the CAN bus. If there is interference on the bus line from an external cause, this interference affects both lines (CAN-high and CAN-low) equally.

The differential voltage however remains unchanged.

The CAN topology

The network topology of the CAN bus provided is linear in design. On a continuous line structure, the individual subscribers are connected via stubs which are as short as possible.

Both ends of the bus line are terminated with a 120 Ohm load resistance (bus termination). These prevent reflected waves on the cable which can seriously disrupt communication, even leading to total failure.

In some cases, for design reasons, it is necessary to use longer stub lengths. However, these should be kept to a minimum because otherwise the termination effect is weakened or completely lost.
A communication process can be explained using the following example and schematics:

The subscriber wishing to communicate via CAN transmits the data concerned and a message ID to the Application Layer. This transfers the data in an appropriate form to the Data Link Layer. Here the data is packed into a standardised frame, in other words it is translated into the generally understood “language”. This frame is then transferred to the Physical (bit-transfer) Layer and is transmitted as a signal onto the bus line.

Each subscriber connected to the BUS listens to what is “said” on the BUS.

If a “keyword” (Message-ID), arouses the interest of the relevant subscriber, i.e. the receiver filter for the message is open, the data is forwarded to the application of this subscriber and further processed there.

Of course, several subscribers can react to one message. It is critical that the subscriber has a relevant filter to determine what is of interest to it.
Packing of the CAN messages

A clearer understanding of the structure of a CAN message, as it appears on the CAN bus line, can be gained from a more detailed examination of the frames defined in the protocol. Firstly we must distinguish between:

- **Data Frame**
- **Remote Frame**
- **Error Frame**

The different types of frame each perform a special function in the data traffic. Actual information is sent in the **Data Frame**. When a **Remote Frame** is sent, subscribers are prompted to prepare data. The **Error Frame** is then used when a subscriber has detected an error in the communication, precisely to communicate this to all subscribers.

To explain what is packed into a frame, firstly a data frame is decoded below.

---

**Base Data Frame**

<table>
<thead>
<tr>
<th>Arbitration Field</th>
<th>Control Field</th>
<th>CRC Field</th>
<th>ACK Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOF</td>
<td>Identifier</td>
<td>RTR</td>
<td>IDE</td>
</tr>
<tr>
<td>ID</td>
<td>DLC</td>
<td>Data Field</td>
<td>CRC</td>
</tr>
<tr>
<td>Sequence</td>
<td>DEL</td>
<td>ACK</td>
<td>DEL</td>
</tr>
<tr>
<td>EOF</td>
<td>ITM</td>
<td>Bus Idle</td>
<td></td>
</tr>
</tbody>
</table>

**Arbitration field:**

In the Arbitration Field first the ID of the message (11 bit on Base Frames, 29 bit on Extended Frames) is transmitted, by which the priority of the message is also determined. The type of frame (Data Frame or Remote Frame) is differentiated via the RTR bit (Remote Transmission Request).

**Control field:**

In the following Control Field, the IDE-Bit indicates whether the Standard-ID (11 bit) or the Extended-ID (29 bit) is being used. If the Standard-ID format is used, a reserved bit follows and then the details of data length – indicated in bytes – 4 bits wide. A maximum of 8 bytes of data can be packed in a frame.

**Data field:**

The data field contains the useful data which is to be transmitted. A maximum of 8 bytes, that is 64 bits, can be transmitted in a frame.

**CRC field:**

The contents of the CRC field is a checksum inserted by the Data Security Layer by which the receiver can check the correct transmission of the message.

**Acknowledgement field:**

The receiver which on the basis of the checksum detects that the message has arrived properly, acknowledges receipt in the Acknowledgement field. If an error is detected, this acknowledgement fails to appear and an Error Frame is immediately sent by the subscriber.

---

**Extended Data Frame**

<table>
<thead>
<tr>
<th>Arbitration Field</th>
<th>Control Field</th>
<th>CRC Field</th>
<th>ACK Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus Idle</td>
<td>SOF</td>
<td>Base-</td>
<td>S R I D E</td>
</tr>
<tr>
<td>Identifier</td>
<td>S R I D E</td>
<td>Extended-</td>
<td>R T R r1 r0</td>
</tr>
<tr>
<td>Identifier</td>
<td>R T R DLC</td>
<td>Data Field</td>
<td>CRC</td>
</tr>
<tr>
<td>Sequence</td>
<td>DEL</td>
<td>ACK</td>
<td>DEL</td>
</tr>
<tr>
<td>EOF</td>
<td>ITM</td>
<td>Bus Idle</td>
<td></td>
</tr>
</tbody>
</table>

**SOF, EOF:**

The SOF bit (Start Of Frame) and an EOF field (End Of Frame) establish the start and end of a frame. Whilst the SOF is composed of one bit, the EOF consists of 7 sequential bits with logical 1. The SOF bit is also used in the whole bus system to synchronize the timing of individual subscribers.

---

In order to send a Data Frame with extended ID, the IDE bit is set. Once this bit is disclosed the frame is extended, as shown in the diagram below.
The RTR bit of the Base frame is replaced by an SRR bit (Substitute Remote Request) (still logical 1). The 18 Extension bits of the identifier follow the IDE bit. Next comes the familiar RTR bit again. The extended ID allows considerably more messages (536870912) to be differentiated than when using the Standard ID (2048). On the other hand, the frames are also increased in length by 20 bits which can reduce the speed.

If data from one or several subscribers is to be sent “on demand”, then the requester sets the RTR bit to create a Remote message. These Remote frames contain no data field. The subscribers affected react to this frame by sending the required data.

At the end of the particular frame, three ITM bits (Intermission) are inserted, which guarantee a gap between two sent frames.

The so-called Error frames have a slightly different form. They are sent by a subscriber which has detected an error in the communication. They have an overlay of Error-Flags of the various subscribers.

---

**Fig. 11: Format of a CAN Remote frame**

**Fig. 12: Format of a CAN Error frame**
The battle for transmission channels

Whilst we have explained how the messages are received, the transmission process still needs clarification. A priority-based system of arbitration decides which bus subscriber may actually transmit in the event that several devices attempt to transmit simultaneously. This is determined by the message ID. The lower the ID, the more important the message. This can be explained by the following example:

Three subscribers try simultaneously to send their message via the bus. Subscriber no. 1 transmits its message using “ID 10”, subscriber 2 using “ID 8” and subscriber 3 using “ID 9”.

Represented in bits, these messages start as shown in Fig. 13.

The ID is compared bit by bit during transmission. As long as there are no differences, the senders with the higher bit value will switch into listen-only. Gradually the lowest ID is identified. In the end, just one subscriber is still in transmit mode and can then transmit its data. If the bus is free again (EOF or ITM transmitted), the other subscribers can try once again to place their message on the bus.

The disadvantage of this process is that messages with a higher ID have to wait a long time on a transmit channel, if need be.

The process described here is known in specialist literature as the “CSMA/CA” process (Carrier Sense Multiple Access with Collision Avoidance) and is illustrated in the following flow diagram (Fig. 14).
Speed and line length

The possible data transmission rates in CAN networks is currently 1 Mbits/s max. (also 1 MBit/s). The speed is known as the Baud rate. The speed technically possible is primarily dependent on the total line length used in the bus system. This correlation is shown in the following table. All values are also dependent on the quality of the line and the quality of the design of the bus cabling.

<table>
<thead>
<tr>
<th>Bit rate</th>
<th>Cable length</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 kbits/s</td>
<td>6.7 km</td>
</tr>
<tr>
<td>20 kbits/s</td>
<td>3.3 km</td>
</tr>
<tr>
<td>50 kbits/s</td>
<td>1.3 km</td>
</tr>
<tr>
<td>125 kbits/s</td>
<td>530 m</td>
</tr>
<tr>
<td>250 kbits/s</td>
<td>270 m</td>
</tr>
<tr>
<td>500 kbits/s</td>
<td>130 m</td>
</tr>
<tr>
<td>1 Mbits/s</td>
<td>40 m</td>
</tr>
</tbody>
</table>

Higher layer protocols

Based on the CAN protocol, some additional communication protocols have been developed, known as “higher level protocols”. They represent a further level of abstraction of the CAN protocol. The most important representatives for the mobile industry are CANopen and CAN J1939.

CANopen

The CANopen protocol is a tool for linking devices which support this protocol simply by means of “plug and play”. Having the protocol means that the machine developer does not need to worry about the bits and bytes which are to be transmitted via the bus. All this happens in the background. Only the parameters and data required for the particular device are visible, and editable, if necessary. This concept operates according to the master-slave process. The master must be seen as the central control unit of the CANopen network, but it does not affect the linear bus topology.

A node number (node ID) is allocated to each device and during data transmission this is always incorporated in the message ID which means that the bus subscribers always know where the data has come from. A targeted response of certain nodes is also possible.

An electronic data sheet (EDS file) also always belongs to a CANopen capable device. It describes the interface which is visible to the operator of the device and is provided by the manufacturer of the CANopen capable device. Basically this means: connect device → parameterize → exchange data.

J1939

The J1939 protocol was developed for data communication in commercial vehicles. This transmits diagnostic data such as engine speed, temperature and also control data and commands. The information which is sent via the bus is grouped in parameter groups with dedicated numbers (PGN). The J1939 protocol uses the extended identifier to pack numerous pieces of information into the 29 bit ID. The data transfer rate is 250 kBit/s.

 Prioritisation in this case is in the top 3 bits. Then the parameter group numbers follow in 18 bits and finally the address of the sender. In the J1939 protocol too, each device is assigned its own node-ID.
Circuit structures and electronic networking in mobile machines

The complexity of mobile machines and the electronics used in them is increasing with the development of every new generation. Traditional control modules, such as hydraulic valve blocks and mechanical levers, for example, are steadily being replaced by modern, flexible electronic modules.

Multifunctional joysticks, electronic accelerator pedals, electro-hydraulic valves and a variety of sensors which monitor the machines and work processes have long been a part of the standard equipment in modern vehicles and machines.

Every manufacturer tries to outdo their competitors by implementing special functions which are only possible using highly sophisticated electronics.

When a new mobile machine is being developed, the process usually starts with an outline of the system and a more or less detailed specification in which the individual functions of the machine are listed and described – but mostly without any specific instruction with regard to implementation.

Given the constantly increasing demands for efficacy, profitability and flexibility, electronic control is the tool of choice for designers.

Designing the appropriate control architecture plays an important role here. Selecting the “right” architecture is crucial for the future viability of a machine. Basically, there are two kinds of control architecture: centralized and decentralized.

One control for all – Stand-Alone option

In the centralized control architecture, a single centralized and high-powered controller controls the whole machine.

This architecture is normally found in simpler machines. The requirement for sensors and actuators in this case is usually limited and they are connected directly to the central controller which controls and monitors all machine functions (traction and work functions) from the centre.

The advantages of this architecture are that it is possible to design a compact machine using a few individual functions in a smaller space. However, there is only limited scope to add to the sensors / actuators or to extend functionality.

Typical examples:
Simple construction machines, compact municipal machines ...
Information exchange and networking

The key advantage of a decentralized control architecture is having the flexibility to modify or expand the functions at a later date without completely re-designing the machine controls. This is made possible by networking individual controllers with defined interfaces and bus protocols. The CAN bus is currently by far the most commonly-used system of communication for mobile machines.

In addition, simpler serial interfaces such as RS232, RS485 and LIN are used in cost-sensitive applications. The use of these robust methods of communication reduces on the one hand the cabling and on the other considerably enhances and stabilizes the data transmission rate in the entire system.

Typical examples:
Complex construction and agricultural machines, mobile cranes, pavers, turntable ladder and fire-fighting vehicles ...

The decision for or against an architecture always rests with the machine manufacturer. Every architecture has its specific advantages and disadvantages which must be weighed up in every case. The decision in favour of an architecture can have a huge impact on the future viability of a machine and should only be taken after thorough consideration.

Distribution of control tasks – the Team Player

As the complexity and flexibility demanded of a machine advances, so must the design of the control electronics be correspondingly complex. This creates numerous challenges. Thermal problems caused by high load currents and bulky cable harnesses which have to run through the machine are two such examples. For this reason in large and complex vehicles and machines with numerous equipment options, a modular, “decentralized” control architecture is preferred.

Smaller functional groups are controlled by a separate autonomous controller. These can be placed to the best advantage throughout the machine, thus dramatically reducing the complexity of cabling. A further advantage of this is the possibility of installing only those electronics required for a specific model in an extensive series. Additional electronics can be integrated in existing systems with ease during any subsequent retrofit.

A clear interface definition and the standardized CAN bus communication provide for independent development, simple combination of individual functions as well as periodic communication between them all.

Fig. 17: Decentralized control architecture using the example of a combine harvester

Fig. 18: Organization of a machine into functional levels
**Architecture examples “Centralized control system”**

A central controller with directly connected sensors and actuators, operation via display, joystick and keypad.

Additional requirements for input and outputs can be provided by I/O expansion modules which are linked via CAN.

**Fig. 19:** Centralized structure using a controller

**Fig. 20:** Centralized structure using a controller and an I/O expansion module
Architecture examples
“Decentralized control system”

Two controllers each with their own separate application software, input and output expansion with an I/O expansion module, operated via display, joystick and keypad, network communication via CAN.

Entire networks of controllers, displays, operating elements and expansion modules can easily be created.
The “classic” switch as input signal

Switches are found in most machines because many functions can only be switched on or off. Electrically, there are two possibilities of producing a switching signal: switching the voltage supply (high-side) or switching the earth wire (low-side). When a switch is open, an internally defined signal level is required to prevent unpredictable behaviour resulting from a floating input. This level must oppose the switching signal; in other words, when switching the supply voltage, the input must be referenced to ground when the switch is opened. This function is implemented on the digital inputs of our controllers via a switchable resistance.

Here you can clearly see the toggle switch installed after the \( \text{R}_{\text{pd}} \). This can either be switched to ground or to an internal signal voltage via the software. The switch position shown here produces a ground referenced signal when in the open position.

This diagram shows the configuration for ground signal switches, in this case the simple switch has been replaced by an “open collector” transistor switch, as is often found in speed sensors or initiators. It is important to note here that the recorded signal levels are inverse to the switching conditions. When this kind of sensor (or switch) is operated, the input is pulled down to ground and in the software you receive a digital FALSE or 0 signal, in the de-energized condition, you receive a digital TRUE or 1 signal because the input is pulled up to the internal signal voltage (5 V) via the \( \text{R}_{\text{pd}} \).

To adjust the inputs to the switching elements, on many of our controllers, the resistance value of \( \text{R}_{\text{pd}} \) can be changed (1 kOhm or 10 kOhm). It is always important to note the maximum input voltage, the limits of which can be found in the relevant “User Manual” of the controller. In some cases, 5 V inputs can also be configured as digital inputs – however they will be unable to receive 24 V signals.
**When “black” and “white” is not enough: analogue signal acquisition**

For controls and status reports, it is absolutely essential to record a differentiated signal value. The signal assumes the task of converting the physical measured value into an electrical signal. As far as electrical signals are concerned, the differentiation is basically between voltage and current signals. Voltage signals are simpler to produce and measure, but have the disadvantage that they react more sensitively to interference. For this reason, when recording signal values for functions with increased safety requirements, current signals are usually used: very often 4 – 20 mA.

Another difference with analogue sensors is whether they have integrated electronics or are simply passive components, for example, potentiometers or resistance temperature sensors like PT100 or PT 1000. For passive sensors, our controllers supply a stable 5 V from internal sensor supply voltages.

In the example shown here, a passive analogue transmitter (in this case a potentiometer) is shown connected to an analogue voltage input. An internal supply voltage of 5 V drops across the potentiometer. By changing the slider position, values between 0 V and 5 V can be produced and measured at the input. To reduce interference (e.g. voltage peaks caused by insecure slider contact) a capacitor is installed in the inputs – precise parameters can be found in the “User Manual”.

The voltage divider (highlighted here in green) serves to retrieve the actual sensor supply voltage. This value is used as the basis for the “ratiometric” measurement. In this case, the measured input voltage is always converted to the nominal value (in this case 5 V) of the sensor supply i.e. the input voltage is evaluated relative to the sensor supply. So, for example, when the slider is in the mid position, exactly 2.5 V is indicated on the input irrespective of whether the sensor supply is actually 4.992 V or 5.027 V. The additional errors originating from an unstable sensor supply can thus be automatically compensated and the measurement accuracy is increased. This type of operation is therefore recommended for passive sensors.

Passive resistance sensors are connected in a similar way. However an internal resistance is used as a reference for the voltage divider ($R_{pu}$ to $R_{sensor}$). The measured input voltage is calculated from the ratio of the reference resistance $R_{pu}$ to the actual sensor resistance value. The input voltage is not evaluated directly but is instead converted by the controller’s driver software directly into a resistance value. The device measuring range is documented in the relevant “User Manual”.

---

**Diagram:**

- **Sensor**
- **Analogue input** (0 .. 5 V)
- **ECU**
- **CPU**
- **A/D**
- **$R_{pu}$**
- **$R_{sensor}$**
- **+5 V**
As previously stated, current signals can also be measured. Some analogue inputs from our controllers provide a connectible low resistance shunt. The sensor supply is therefore dependent on the parameters of your sensor. In the example shown here, the ECU’s internal sensor supply is used. When connecting several sensors to a single sensor supply, be sure to take into account the maximum output load current. It is also possible to use an external power supply. For this, the reference ground of the controller and the external supply must be connected. The sensor output is then connected to the input of the controller. Note also that only sensors which function as a current source can be used. This is the case in the circuit shown here. The electronics integrated into the sensor regulates the output current depending on the measured physical variables. This current flows through the measuring resistance Rpd. The voltage drop measured by the ECU’s input is converted back into a current value by the driver software.

With current measurement signals, the value range 4 – 20 mA is the most common. The signal deliberately only starts at 4 mA in order that invalid signals such as a cable break (0 mA) can be clearly identified. Some of our functionally safe sensors use this characteristic and produce an invalid measurement signal (less than 4 mA) in order to indicate a possible sensor fault to the controller. This is comparable to sensors using voltage outputs which cover a value range from 0.5 to 4.5 V. With these signals, cable faults can also be detected.

**Interacting with the outside world: Digital switching outputs**

If you wish to manipulate the system, then the outputs come into play. The simplest is the digital output. Our outputs are designed to be capable of controlling common solenoid actuators such as valve coils. This does not usually require any additional circuitry. The example shown here is a very common type of control. One side of the actuator is connected directly to the reference ground and switched via the controller output.

The maximum current which an output of this kind can drive is dependent on the particular controller. Usually, solenoids up to 2 A (sometimes up to 4 A) can be connected directly. When designing the system, you must also take into account the total current. This is indicated on our controllers. It is the maximum current load when simultaneously driving several outputs of the controller. This value applies to the entire permitted temperature range.

Most of our controllers have the circuit shown here which consists of two switch mode output stages connected in series. The top switch mode output stage is the general enable for all or one group of outputs. On functionally safe controllers, this is additionally controlled by the “watchdog”, the monitoring CPU, which in the event of a fault, can achieve a redundant disconnection. The actual switch mode output stage can be controlled as a PWM (pulse width modulated) or simple switch depending on the output type. At the output there is usually a pull-up resistance for the cable break detection. This resistance is very high (usually approx. 10 kOhm) and a connected solenoid coil pulls the output to ground when in non-driven operating condition. Via the internal feedback, the controller can detect a cable break or a short circuit to ground or to the supply voltage, independently of the switching condition. These faults can be imported via the software and processed.

The diode shown here serves as a freewheeling diode and reduces the voltage peaks produced by the inductivity when shut down. Please check whether the integrated diode is sufficient for the power outputs produced by the inductivity in your application. For standard applications, the power consumption of this diode is quite sufficient.
One problem when operating proportional valves with solenoid coils is that the solenoid coil increases its resistance as it heats up. This increase in internal resistance has the effect of reducing the coil current for the same supply voltage. Since the coil current is in turn proportional to the positioning force of the solenoid, the spool position of the valve also changes. To counteract this shift in the hydraulic operating point, the coil current can be measured and thereby also controlled.

On this point, our 16 Bit controllers differ from those of the new generation. All controllers in the HY-TTC xx series (HY-TTC 60, HY-TTC 90 etc.) have specific current measuring inputs to measure the coil currents. They are only suitable for measuring coil currents and not sensor signals. For this the output of the solenoid coil is connected to a current measurement input. A further advantage of this circuit is that all poles of the solenoid coil can be disconnected. This is important if there should be a short circuit to the supply voltage in the cable harness. If the output of the solenoid coil is directly connected to ground, the valve cannot be switched off. In the circuit shown here, you can disconnect the solenoid coil from ground via the integrated “low side switch” and therefore prevent leakage current. This circuit should be used to control work functions with increased functional safety (PL d).

**The PWM signal; control of proportional actuators**

Many work functions require variable control. Our controllers have digital outputs with PWM (pulse width modulation) for this. This is a special characteristic of a digital switching signal. A PWM output switches at an adjustable frequency between ground (approx. 0 V) and supply voltage. The duty cycle (pulse width or duty) can be altered via the software. The longer the output is switched, the longer the current flows through the solenoid and hence the power can be varied (\(P = U \times I\)). It is characteristic of a solenoid coil that it always wants to maintain a current once it is flowing. This effect, over several periods of the PWM signal, produces a smoothing of the current average value. Using the current measurement inputs, this arithmetical average value of the current can be measured. By means of a control algorithm the measured current value can then be used to match the pulse width and therefore to control the current.
Functional safety in mobile machines

Basic terms and definitions

More and more safety-critical functions are being incorporated today in machine building, automation, electrical engineering and process technology. Programmable systems are being used increasingly in this field. It therefore makes more sense to talk about “functional safety” than safety and risk in the classic sense.

Firstly, an overview of what the different terms actually mean:

Risk:
Combination of probability of damage occurring and the degree of damage. This damage could affect persons, the environment, production facilities, company image etc.

Safety:
Safety is the freedom from intolerable risks.

Functional safety:
Functional safety is the portion of total system safety which depends on the correct function of safety-critical systems for minimising risk. This includes electrical, electronic and programmable electronic systems (E/E/PES). These systems must carry out their intended functions (safety functions) within defined error conditions and with defined high probability. The aim is to achieve and maintain a safe system condition. Functional safety is met when each specific safety function is implemented and the required level of fulfilment for each safety function is achieved.

In order to bring greater clarity to products with functional safety, the following pictogram is used:

Legal principles of product and manufacturer’s liability

Manufacturer’s organization and duty of care:
Operation must be organized such that errors are prevented or detected through monitoring. This also applies to the development process. As it is almost impossible to eliminate failures in complex mechatronic systems, the manufacturer must satisfy special requirements of due diligence when developing and manufacturing so that a claim of negligence cannot be asserted.

Reverse burden of proof:
In contrast to the normal regulations governing the burden of proof, in the case of product and manufacturer’s liability, a relief or a reversal of the burden of proof can apply to the injured party. It is sufficient for the injured party to be able to demonstrate impartially a safety defect – circumstantial evidence is quite sufficient here. Then the manufacturer is obliged to prove that his product corresponds to all applicable safety requirements, taking into account all due diligence, also in respect of organization and documentation.

Various relevant regulations and standards

Generally speaking, there are three different types of standard. The so-called basic standards cover the basic issues and general concerns.

As basic safety standards (type A standards), they contain the design principles and general aspects for machines which include the whole life cycle. Examples of these are IEC 61508 (“Functional Safety of Electrical / Electronic / Programmable Electronic Systems”) or EN 12100-1 (risk analysis). These specify that measures for preventing risks shall be performed and documented in the following order:

1. Safe design
2. Technical safeguards
3. User information

Secondly, there are the safety group standards (Type B standards). These relate to specific sectors of industry, such as machine building or process technology. They describe safety aspects and safety-critical equipment to be used for a range of machines. Examples of these are EN 954-1 and EN ISO 13849-1 (Safety-related parts of control systems). Both these standards cover all technologies (mechanics, pneumatics, hydraulics, electrics). They do not therefore apply solely to electrical and electronic systems. At the end of December 2011 EN ISO 13849-1 will finally replace EN 954-1. There is currently a transitional period. EN ISO 13849 is already the successor to EN 954.

Thirdly, there are the so-called safety product standards (Type C standards). They include concrete requirements and safeguards against the risks caused by a machine and all types of machine group, taking these basic and group standards into account. Examples of these Type C standards are EN 13000 (for mobile cranes) and ISO 25119 (standard for agricultural and forestry machinery).

Essentially it is the deterministic elements such as control architectures and processes, e.g. risk graph and classification into safety categories which have been adopted from current EN 954-1. These safety categories or risk classes will in future be known as “Performance Levels”. The classification or evaluation of the function or control task into these classes / levels is achieved with the help of a risk graph.
The current and future situation in respect of these standards is illustrated in the following schematic. In addition, the diagram shows how much influence the basic standard IEC 61508 has on EN 13849-1.

IEC 61508 – The basic standard
The standard consists of 7 sections and is called “Functional Safety of Electrical / Electronic / Programmable Electronic Safety-Related Systems”. The standard was adopted in 2001 as EN 61508, as it is identical in content, by the European Committee for Standardization (CEN). In Germany it is in force as the German version under the name DIN EN 61508 and VDE 0803.

An essential element is determining the Safety Integrity Levels (SIL 1 to SIL 4). When analyzing the safety functions of E/E/PE, the SIL is used to estimate the tolerable risk of the system causing the danger so that the intolerable risk is not exceeded.

EN 13849-1 – The group standard and the future standard
EN 954-1 was always controversial; amongst the criticisms were, for example, that this standard follows a relatively simple deterministic approach without considering aspects like reliability and failure probability of components (i.e. the probabilistic or statistical viewpoint). It neglected an essential aspect which can affect the availability in practice of machines and systems – and therefore also the acceptance of the safety equipment.

This criticism has been taken on board by the standardization bodies. As standards are not intended to be in force for a long period (unlike laws) but have to take into account relevant technical progress, it was decided to give greater emphasis to this aspect in the upcoming revision of EN 954-1. The decision was also made specifically to replace the familiar control categories with a categorization which includes these factors. The basic procedure however remains the same. The risk parameters of the well-known “risk graphs” also remain practically unchanged and there continues to be 5 control categories / architectures.

The fundamental change is that “Performance Levels” (PL A to E) are now assigned to these categories.

When identifying the “Performance Level”, the following factors are used, among others: “Mean Time to Dangerous Failure” (reliability, average time between safety-critical failures or breakdowns; MTTFd), failure coverage rate / diagnostic coverage (DC, Diagnostic Coverage), and measures to combat failures of common cause (CCF; Common Cause Failure). It is therefore quite clear that besides the structural and deterministic approach, the probabilistic (i.e. statistical) approach is also in evidence.

The following diagram again shows how the standards EN 954-1 and IEC 61508 have influenced the new safety group standard EN 13849-1.

**Fig. 23: Current standards situation**

**IEC 62061**
**EN 13849-1**
**IEC 61508**
**IEC 61115**

**Deterministic**
**Probabilistic**

**New standard**

**Fig. 24: Affect of existing standards on EN 13849-1**
The use of electronics in commercial vehicles and in machines has increased rapidly in the last few decades. In modern vehicles and machines many systems are no longer controlled purely hydraulically but electronically. This is partly for economic reasons and partly to enhance convenience and work-station ergonomics. A fault occurring in such an electronic system can lead to a sudden and uncontrolled movement of the vehicle, working equipment or its attachments. As a consequence there is a greater or lesser risk of damage occurring to the machine, the environment or more importantly to personnel.

Product safety and product reliability are therefore becoming increasingly important for OEMs and suppliers in the commercial vehicle industry.

Whilst mechanical and hydraulic components are generally considered safe (providing they are sized correctly), electronic components can fail without previous sign of defectiveness or wear.

Comprehensive self-diagnostics and / or redundancy must be included in the electronic control equipment in order to detect and pinpoint both random and systematic errors in the electronics and then immediately activate a pre-defined safe condition. A safety management process must be defined and maintained throughout the entire product lifecycle. As a result, the probability of a dangerous failure caused by hardware or software failure is reduced to an acceptable level.

Implementing such a process requires specific expertise and knowledge and normally implies a significant investment of time and money. The use of components which are already certified (such as the controllers HY-TTC 90, HY-TTC 94 or HY-TTC 200 and appropriately certified sensors) significantly reduces these investment costs as well as the development expenditure for the machine builder.

Legal situation and product liability

Although the current safety standards (like the basic standard IEC 61508 or group standard EN ISO 13849 in the commercial vehicle and machine building sector mentioned in the previous chapter) are not yet legally binding, compliance in relation to the new machinery directive (2006/42/EC) and the resulting product liability claims are now taken into account by most manufacturers. The safety standards currently affecting the machine builder are again illustrated in the following graphic.

According to the EU Product Liability Directive 85/374/EEC the manufacturer is solely responsible for damage caused by product defects. Product liability can however be excluded if it can be demonstrated that the product was developed and built according to the latest technological best practice. IEC 61508 is currently considered to be state-of-the-art worldwide. Therefore the manufacturer is not liable for possible product liability claims if it can be proved that his product was developed according to IEC 61508.
On the other hand, courts can find manufacturers negligent if persons have been hurt or killed as a result of a failure and the product has not been developed according to IEC 61508. Accordingly, the machine builder is obliged to carry out a risk and hazard analysis in advance for each new product (see graphic 'Risk analysis and risk assessment'). All possible causes of a failure are used as the basis for this analysis. For every potential hazard arising from the machine, possible causes are identified and their frequency estimated. After this, all the risks and hazards associated with the machine and its components are analysed, evaluated and classified accordingly. In addition to the practical aspects of machine operation and use, service and maintenance work are also taken into account. The machine is subsequently developed, designed, produced and commissioned in the light of the results of the risk analysis. In the following pages, the different regulations (safety standards) are considered in detail and the specific approaches are explained.

**IEC 61508**

The IEC 61508 is a global standard independent of industry which was published in 1998. This standard defines guidelines concerning functional safety of electrical, electronic and programmable electronic systems. Various other industry and product-specific standards have developed from the IEC 61508 standard to date. IEC 61508 defines a comprehensive safety life cycle as its basis. During the entire product life cycle the functional safety of the complete system must be reliably maintained. In addition, all activities which take place during the different stages of the product life cycle must be adequately documented.

**Safety functions and safety integrity**

For potentially hazardous incidents identified in the hazard and risk analysis, safety functions must be defined and implemented. The aim is to prevent hazards or to neutralize their effects (reducing risks by reducing their effect).

By using a risk graph the required safety integrity of a safety-relevant system can be determined with regard to the risk factor. The higher the level of safety integrity, the higher the probability that the system is implementing the safety functions correctly.

---

**Fig. 26: Risk analysis and risk score**

---

**Fig. 27: Risk appraisal according to IEC 61508**

---

**Extent of losses**
- S1 Minor injury of a person, insignificant environmental damage
- S2 Severe, irreversible injury of one or more persons or death of one person; severe or temporary environmental damage
- S3 Death of several persons, severe, permanent environmental damage
- S4 Catastrophic effects; death of large number of persons

**Presence of persons in hazardous area**
- A1 Seldom to often
- A2 Frequently to continuously

**Avoidance of danger**
- G1 Possible under certain circumstances
- G2 Practically impossible

**Probability of an undesired situation arising**
- W1 Very slight
- W2 Slight
- W3 Relatively high

---

* PCT protective device alone not sufficient
### Classification of the levels of risk: Safety Integrity Level (SIL)

For every safety critical function a **Safety Integrity Level (SIL)** is determined. Levels 1 to 4 are specified and defined by the **Probability of dangerous Failures per Hour (PFH)**. SIL 1 is the lowest and SIL 4 the highest level.

<table>
<thead>
<tr>
<th>SIL</th>
<th>Probability of dangerous failures per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>$\geq 10^9 \ldots &lt; 10^6$</td>
</tr>
<tr>
<td>3</td>
<td>$\geq 10^6 \ldots &lt; 10^7$</td>
</tr>
<tr>
<td>2</td>
<td>$\geq 10^7 \ldots &lt; 10^8$</td>
</tr>
<tr>
<td>1</td>
<td>$\geq 10^8 \ldots &lt; 10^9$</td>
</tr>
</tbody>
</table>

Safety Integrity Level with the particular failure limits PFH

**Example:**

SIL 4 designates safety functions with catastrophic effects in case of a failure (for example: the death of several persons).

In commercial vehicles the so called “by-wire functions” represent safety critical applications. For example a “steer-by-wire system” requires the SIL 3 classification. For this reason safety requirements in commercial vehicles rarely exceed SIL 3.

By reason of its status as a basic standard and its worldwide validity the IEC also has ground-breaking influence in Europe. However, for the European Single Market within the framework of the machinery directive, there is EN ISO 13849 which acts as a safety group standard for the entire machinery industry. This standard applies to all industrial machine building and all mobile machines.

---

### EN ISO 13849

In 2006 at European level, a revision of the standard EN ISO 13849 was published and ratified by the relevant European and national standards organizations.

EN ISO 13849 contains safety requirements and principles for the development and integration of safety-related parts in control systems.

The standard is based on the same parameters which are described in the older EN 954. The deterministic\(^1\) concept of EN 954 has however been extended to include probabilistic\(^2\), quantitative methods to deal with modern electronic systems. In order words, statistical errors such as spontaneous failure of components have been taken into account.

### Safety functions and safety performance

Similar to the IEC 61508, safety functions are defined and implemented according to the new EN ISO 13849 for potentially dangerous incidents, which are identified in the hazard and risk analyses.

In this case however, the required performance level of a safety related system is determined by means of a risk graph with reference to the risk factor.

The higher the Performance Level, the higher the probability that the system is implementing the safety functions correctly.

---

**Fig. 28: Risk appraisal according to EN ISO 13849**

Starting point for the risk appraisal

- **S1**: Minor, reversible injury
- **S2**: Severe, irreversible injury, including death

Frequency / duration of exposure to the hazard

- **F1**: Seldom or short exposure to hazard
- **F2**: Frequent to continuous exposure to hazard

Possibility of avoiding the hazard or limiting the damage

- **P1**: Possible under certain circumstances
- **P2**: Practically impossible

---

1) Deterministic = future events are clearly defined by pre-conditions
2) Probabilistic = circumstances which exist with a defined probability
Classification of the levels of risk: Performance Level (PL)

Based on hazard and risk analyses, a so called performance level (PL) is determined for a safety critical function. There are five performance levels, PL a to PL e. They are defined according to the probability of dangerous failure per hour. PL a is the lowest and PL e the highest level. Therefore a work function or part of a machine which is rated as PL d is potentially more dangerous than one classified as PL a.

This relationship and the different performance levels with their related failure probabilities are shown in the table below.

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Average probability of failure per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>&gt; 10⁻⁴ .. &lt; 10⁻³</td>
</tr>
<tr>
<td>b</td>
<td>&gt; 3x10⁻⁶ .. &lt; 10⁻⁵</td>
</tr>
<tr>
<td>c</td>
<td>&gt; 10⁻⁶ .. &lt; 3x10⁻⁴</td>
</tr>
<tr>
<td>d</td>
<td>&gt; 10⁻⁷ .. &lt; 10⁻⁶</td>
</tr>
<tr>
<td>e</td>
<td>&gt; 10⁻⁸ .. &lt; 10⁻⁷</td>
</tr>
</tbody>
</table>

Performance Level with the relevant failure limits per hour

Furthermore, in EN ISO 13849 and IEC 61508 there is a group of predefined architectures and design concepts concerning the control and processing structure of each work function.

The so-called “designated architectures” are divided into five categories (B, 1, 2, 3 and 4). These categories describe which diagnostic and redundancy systems must be available in a system. For example: Category B describes a simple single-channel architecture without specific test or diagnostic mechanisms. Category 2 contains test or diagnostic mechanisms and Category 3 represents a dual-channel system (see figure 29).

The achievable performance level is therefore determined by selecting the system architecture category, the diagnostic coverage (DCavg) achieved and the mean time to dangerous failure (MTTFd). The MTTFd value is directly related to the previously mentioned PFH value (Probability of Failure per Hour) for the failure rate per hour. Both indicators are reciprocal.

In contrast to the technical requirements of the old standard EN 954-1, the new standard EN ISO 13849 allows for alternative ways of achieving the required performance level.

The machine manufacturer can thus combine the most suitable measures to serve his purpose. This means that the role of both technical parameters and cost factors can be more or less important. However, defined safety structures must still be respected.

1) designated architectures = predetermined structures of the safety-related parts of controls which are known from the application of EN 954-1
2) The diagnostic coverage indicates the probability of detecting failures by means of a test
3) MTTFd = Mean time to dangerous failure
The competing standards
IEC 61508, EN ISO 13849 and IEC 62061

The EN ISO 13849 at European level and the IEC 61508 at
worldwide level are based on similar principles.

The general (worldwide) standard IEC 61508 is based on
probabilistic (statistical) approaches to achieve certain safety
levels and it contains procedures and methods to estimate
component reliability and to test quality.
To calculate whole-system reliability, models from the calculation
of probability (Markov model)6) are used.

The industry-specific (European) standard EN ISO 13849
attempts to combine deterministic and probabilistic methods and,
in so doing, to simplify system development and design.
This simplification is achieved by defining the previously
mentioned “designated architectures” and categories,
as well as by pre-defining the performance level that can be
achieved within each category. This also reduces the complexity
when applying the standard.

In contrast to Standard IEC 61508, EN ISO 13849 is harmonised
within the new Machinery Directive (2006/42/EC). Therefore
compliance with EN ISO 13849 also implies conformity with the
Machinery Directive. In 2005, the sector-specific standard IEC
62061 was derived from the broader IEC 61508. This standard
also continues to apply to machine systems and it is also
harmonised within the Machinery Directive.

While the IEC standard (IEC 61508 and IEC 62061) deals
exclusively with electronic systems and software, EN ISO 13849
also covers non-electronic parts, like hydraulics, mechanics
and pneumatics. On the other hand, because of its extensive
requirements in relation to software and development processes,
the IEC standard caters for higher safety levels for complex and
programmable electronics and therefore covers higher risks and
hazard levels.

6) Markov model = Mathematical model based on states and transition probabilities

In order that machine controls work safely, they must comply with
certain requirements. Particular emphasis is given to 4 important
parameters which are independent of standards, and which play a
key role in evaluating electrical and electronic safety systems:

- Architecture and structure of the system
  (e.g. single channel, dual channel, with diagnostics, without
diagnostics, ...)

- Diagnostic coverage
  (probability of error detection by means of tests)

- Failure rate (PFH) or mean time to dangerous failure
  (MTTF_d) (Number of failures per time unit and/or time to first
dangerous failure)

- Common cause failure (CCF)
  (Cause variables which affect several systems simultaneously)

The interaction of 3 of these 4 cause variables or cause
parameters is shown in the so called PL bar-chart (Fig. 30)
(see also BGIA report 2/2008, Functional Safety of Machine
Controls – Application of DIN EN ISO 13849).

The parameter for the CCF, or its value, only comes into play in
the case of multi-channel structures. (Note: For multi-channel
control structures, Category 2 and above, the CCF must be
analysed. This relates to measures to prevent the failure of both
channels of a safety device due to a common cause.)

![Fig. 30: Determining the PL using the bar chart](image-url)
Important points and conclusion

The question is: how should the designer of a machine, the application engineer of a work function or the sales staff of a component supplier deal with these factors? It would be expecting too much of them to have to determine the “Mean Time to Dangerous Failure” for a safety relay for example. It is not their job, after all, but rather the job of the development department at the component manufacturers or of other suppliers, whose components and subsystems are to be installed in safety-related systems. You, the manufacturer, must declare the values required to determine the Performance Level and at the same time take into account the requirements of EN 13849-1 or IEC 61508. Both standards IEC 61508 and EN 13849 complement each other: the safety components manufacturer complies with the requirements of IEC 61508 whereas the machine builder manufactures according to EN 13849-1. This may generate some additional expenditure in practice but this should not be a fundamental problem because the Performance Level of EN 13849 is directly related to the Safety Integrity Level of IEC 61508 – even though the designations are different (For example: SIL 2 corresponds to Performance Level D, see Figure 31).

The Performance Levels which apply to the particular overall solution will be an important issue in the cooperation between machine builder and manufacturers of safety components – from sensor to actuator. Manufacturers of safety components must familiarize themselves with the new standards to provide the machine manufacturers with the essential parameters for determining the Performance Level.

Compliance with the standard at the earliest possible stage in the development process of a new machine indicates to the customer that the manufacturer can react swiftly to a new situation and can ensure the future sustainability of components and machines or systems.

HYDAC has already reacted to the new situation and offers both control units and sensors for SIL 2/SIL 3-applications. This corresponds to Performance Level e (PL e) in EN 13849-1 (under the "old" EN 954-1, if used with the appropriate controllers, they would comply with the requirements of control category 4 – i.e. the highest category).

Although the new standards seem complicated at first sight, one should concentrate on the positive aspects of EN 13849-1 and IEC 61508, which are undeniable. It is good company practice that when selecting safety relevant components, factors like failure safety and operational stability are also taken into consideration, because the safest control or the safest system is no use if it fails or has limited service life.

Equally, the integrated approach is without doubt a great improvement over the standards which applied previously. It is not individual components which are evaluated, but a Performance Level is determined for the entire safety chain for the particular function concerned. HYDAC supports their customers with this in the usual way, starting with advice in selecting the best electronic and hydraulic components right through to integrated system design within the context of functional safety.
Flexible programming of control electronics

Selection of control system hardware is based on the inputs and outputs, interfaces, processing performance and safety level required.

The decision for or against a particular programming system depends on several different factors. The decisive criteria here are: type of industry, application, available development knowledge, cost of development tools and type of usage.

Programming of controllers

There are various mainstream options for programming HYDAC ELECTRONIC controllers, – irrespective of the industry and application.

CODESYS® (IEC 61131-3)

CODESYS® (Controller Development System) has been freely available since 1994 and is an integrated development environment for programming control units according to IEC 61131-3. This standard originated in the automation sector and defines 3 graphical languages (function block diagram, ladder diagram and sequential function chart) and 2 text-based languages (structured text and instruction list) for programming the programmable logic controller.

CODESYS® stands out primarily for its simplicity and ease of use. The 5 different languages which are available within the system derive from different industries. They allow even non-specialist developers to create their own programs quickly.

Furthermore, CODESYS® offers a standardized system model for representing hardware resources and unified access functionalities for various control units. This system model includes functions for transferring and monitoring the application as well as support during interactive debugging. If no hardware is connected to the development computer, a simple simulation mode is also available.

In contrast to other programming systems, the main advantage of CODESYS® is that within an integrated development environment, all the functions required for programming control units are already available. In addition to the CODESYS® basic system, all that is required is a so-called target system package for the controller. Normally, this target system is provided directly by the hardware manufacturer.

The development environment can be obtained free-of-charge from the Service Division.

C/C++

C (developed in 1972) and C++ (developed in 1979) are among the oldest of the classic programming languages in IT, but they are still widely used today and act as the benchmark with regard to achievable performance and flexibility. Because of their very high speed of execution and low memory requirements, hardware-oriented programs, in particular – e.g. device firmware or device drivers – are still programmed in C/C++ today. C/C++ is also used for applications with high performance requirements or systems with limited resources, like cost-optimised volume production devices.

As a multipurpose programming language C/C++ was not designed for specific applications, and therefore relies heavily on external libraries.

On the one hand, it is more complex to use than special languages which are used to program control units (like those in compliance with IEC 61131-3). On the other hand, C/C++ offers completely flexible programming and free access to all hardware resources of the control unit.

To be able to program electronic systems using C/C++, a C-compilers compatible with the target platform (the main processor) is required as well as appropriate software and hardware to transfer the generated binary files to the target device (for example via a hardware debugger or CAN downloader).

For de-bugging during the development stage, we also recommend purchasing a hardware debugger.

Overview of compilers used:

| C-Compiler | HW-Debugger
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HY-TTC 50/60/90/94</td>
<td>Lauterbach Base Station: Power Debug USB2 LA-7708</td>
</tr>
<tr>
<td>HY-TTC 200</td>
<td>Lauterbach-Base Cable: OCDS-C166S-V2 LA-7759 ICD for XC2000</td>
</tr>
<tr>
<td>HY-TTC 500</td>
<td>Lauterbach Base Station: Power Debug USB2 LA-7708</td>
</tr>
<tr>
<td>HY-TTC 30</td>
<td>Lauterbach-Base Cable: BDM-MPC500/800 LA-7722</td>
</tr>
<tr>
<td>HY-TTC 77</td>
<td>Lauterbach Base Station: Power Debug Interface USB 3 LA-77843</td>
</tr>
<tr>
<td>HY-TTC 30</td>
<td>Lauterbach Base Station: Power Debug Interface USB 3</td>
</tr>
<tr>
<td>HY-TTC 77</td>
<td>Lauterbach Base Station: Power Debug Interface / USB 2 LA-7708</td>
</tr>
</tbody>
</table>

1) A compiler is a computer program that translates a program written in a source language into a semantically equivalent program of a target language.

2) For efficient working, a HW-Debugger is very useful; using an adapter cable from our accessories range, it can be connected to the JTAG interface of a controller which is programmable using C.
Programming of displays

The visualisation equipment HY-eVision\(^2\) from HYDAC Electronic is provided with integrated programmable electronics.

The significant increase in performance, as well as the desire to take full advantage of all possible device functions and features, has necessitated a change to the new CODESYS\(^\circledR\) version 3.5. This version enables visualization packages, specially developed for displays, to be integrated. Ready-to-use installations of the CODESYS\(^\circledR\) environment including packages with extensive and efficient graphic libraries for 3D models, vector graphics, transparency effects etc., can be downloaded free of charge from the HYDAC website.

System update via USB Stick

Another special function is made possible by the new display generation HY-e Vision\(^2\). The display project created in CODESYS\(^\circledR\) v3.5 using the visualization package, can be transferred to a standard USB stick at the click of a button.

The whole translated project is now at your disposal and can be transferred to the display. You just have to plug in the USB stick, turn on the display and follow the on-screen instructions.

But this function has even more to offer. All HYDAC control units which are networked to the display can now be provided with application software. Updating the software for an entire machine is therefore very easy, regardless of location and without the often costly services of an on-site programmer.
Control Equipment for General Applications

The use of electronic, programmable controls in mobile machines is becoming more and more important due to the ever increasing demands for functionality, efficiency and reliability of machines.

No manufacturer can afford any longer to ignore the crucial advantages, such as extremely short reaction times, simple networking, excellent versatility, small dimensions or weight saving.

In particular, the area of safe function monitoring and minimization of risk presents new opportunities for the manufacturer which would be impossible without electronic controls.

With the HY-TTC series of controllers, HYDAC ELECTRONIC offers the right platform for a wide variety of requirements and applications – always efficient, safe, reliable and flexible.

Reliable in every situation

The programmable controllers from HYDAC ELECTRONIC are subjected to rigorous testing to guarantee that the instrument, and by extension also the machine, function reliably even under the harshest conditions.

The use of modern technology and high-quality materials ensures that all control units can withstand mechanical, environmental and electromagnetic impacts.

High level of efficiency in a small space

The increasing demand for more efficient and more compact machines means that all components used must be designed and configured to save space because the installation space for individual components is shrinking.

This is not a problem for the compact controllers from HYDAC ELECTRONIC. They can be installed and connected in even the tightest space in a machine without any loss in performance. The well-established automotive-industry enclosure with the space-saving male connection is key to this.

A safe business

Dynamic new developments have been triggered in the area of functional safety of machines. This has been prompted by the stricter legal requirements for the minimization of risk by the machine builder, especially the new Machinery Directive 2006/42/EC which is legally binding from 2012.

In the future, the responsibility for risk assessment, the manufacture of safe machines and with that the liability in the event of an accident lies solely with the manufacturer. If the worst happens, the manufacturer must prove that he fulfilled all legal requirements and that he has reduced the possibility of risk according to the latest technical standards.

The basic requirement for the minimization of risk and the implementation of safety critical functions is the use of “safe controls”.

HYDAC ELECTRONIC offers electronic, programmable controllers, which are suitable for control tasks with high level safety requirements up to SIL 2 (Safety Integrity Level 2) and PL d (Performance Level d), due to their internal diagnostic and monitoring functions. These controllers are certified through an independent test procedure by TÜV-Nord.
The range of controls

The HYDAC ELECTRONIC controllers can be divided into two series based on two powerful platforms: a 16 bit and a 32 bit processor.

The 16 bit series includes the basic model HY-TTC 50, the HY-TTC 60 (an enhanced version with different inputs), as well as the safety-certified, high-performance versions HY-TTC 90 and HY-TTC 94. The HY-TTC 94 has 4 CAN bus interfaces and the same input/output range as the HY-TTC 90.

In the 32 bit series, the safety-certified HY-TTC 200, HY-TTC 540 and HY-TTC 580 are available. Our controllers were designed to comply with the IEC 61508 and ISO/EN 13849 international standards.

<table>
<thead>
<tr>
<th>Type</th>
<th>HY-TTC 30-H</th>
<th>HY-TTC 30S-H</th>
<th>HY-TTC 50</th>
<th>HY-TTC 60</th>
<th>HY-TTC 90</th>
<th>HY-TTC 94</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>Infineon XC 22xx microcontroller 80 MHz</td>
<td>Infineon XC 22xx microcontroller 80 MHz Watchdog</td>
<td>16-bit Infineon XC 2287 80 MHz</td>
<td>16-bit Infineon XC 2287 M 80 MHz Watchdog-CPU</td>
<td>16-bit Infineon XC 2287 M 80 MHz Watchdog-CPU</td>
<td></td>
</tr>
<tr>
<td>Memory</td>
<td>768 kB Flash</td>
<td>768 kB Flash</td>
<td>768 kB Flash</td>
<td>832 kB Flash</td>
<td>832 kB Flash</td>
<td>832 kB Flash</td>
</tr>
<tr>
<td></td>
<td>82 kByte RAM</td>
<td>82 kByte RAM</td>
<td>82 kByte RAM 512 kB ext. RAM</td>
<td>58 kByte RAM 512 kB ext. RAM</td>
<td>58 kByte RAM 512 kB ext. RAM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 kByte EEPROM</td>
<td>64 kBit EEprom</td>
<td>64 kBit EEprom</td>
<td>64 kBit EEprom</td>
<td>64 kBit EEprom</td>
<td></td>
</tr>
<tr>
<td>Interfaces</td>
<td>1 x CAN</td>
<td>2 x CAN 1 x RS232 1 x LIN</td>
<td>4 x CAN 1 x RS232 1 x LIN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inputs and</td>
<td>30 total 8 PWM (6 with current meas.) 10 Analogue-IN 4 Timer-IN 6 Analog-OUT (ratiometric) 2 Digital-OUT</td>
<td>40 total 8 PWM 4 current meas. 8 Analogue-IN 4 Timer-IN 8 Digital-IN 8 Digital-OUT</td>
<td>48 total 8 PWM 4 current meas. 16 Analogue-IN 4 Timer-IN 8 Digital-IN 8 Digital-OUT</td>
<td>48 total 8 PWM 4 current measurement 16 Analogue-IN 4 Timer-IN 8 Digital-IN 8 Digital-OUT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Functional Safety</td>
<td>EN 13849 PL c</td>
<td>EN 13849 PL c</td>
<td>IEC 61508 SIL 2 EN 13849 PL d</td>
<td>EN 13849 PL d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programming</td>
<td>C / C++</td>
<td>CODESYS® V2.3 C / C++</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) The configuration of the inputs and outputs can be altered via a control configuration. The configuration shown is intended as an example.

2) In appropriate system architecture
<table>
<thead>
<tr>
<th>Type</th>
<th>Processor</th>
<th>Memory</th>
<th>Interfaces</th>
<th>Inputs and outputs[^1]</th>
<th>Functional Safety (certified by TÜV Nord)</th>
<th>Programming</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 bit controllers</td>
<td>16-bit Infineon XC 2288 H 80 MHz Watchdog-CPU</td>
<td>1.6 MB int. Flash 138 kB RAM 8 kB EEPROM</td>
<td>2 x CAN 2 CAN 1 x RS232 1 x LIN</td>
<td>65 total 18 PWM 30 Analogue-IN 2 Timer-IN 7 Digital-IN 8 Digital-OUT</td>
<td>EN 13849 PL d</td>
<td>C</td>
</tr>
<tr>
<td>32 bit controller</td>
<td>32 bit freescale MPC 555 40 MHz Watchdog-CPU</td>
<td>448 kB Flash 26 kB RAM 512 kB ext.RAM (optional 1 MB) 16 kBit EEprom</td>
<td>2 x CAN 2 CAN 1 x RS232 1 x LIN</td>
<td>69 total 12 PWM (8 with current meas.) 8 Analogue-IN 8 Timer-IN 17 Digital-IN 22 Digital-OUT 2 analogue-OUT</td>
<td>IEC 61508 SIL 2 EN 13849 PL d</td>
<td>CODESYS®, CODESYS® Safety SIL 2 C / C++</td>
</tr>
<tr>
<td>32-bit microcontroller platform</td>
<td>32 bit TI TMS 570 Dual-core lockstep CPU 180 MHz Companion CPU</td>
<td>3 MB Flash 256 kB RAM 64 kB EEPROM</td>
<td>4 x CAN</td>
<td>96 total 28 PWM (28 with current meas.) 32 Analogue-IN 20 Timer-IN 16 Digital-OUT</td>
<td></td>
<td>CODESYS®, CODESYS® Safety SIL 2 C / C++</td>
</tr>
</tbody>
</table>

[^1]: (Example configuration)
Universal Mobile Controller
HY-TTC 50

Description
The HY-TTC 50 is the basic model in the 16 bit controller series.

It is a powerful device which can be used both as a stand-alone solution and as a part of a networked system in modern machines. It meets all the technical requirements of modern automotive electronics in the off-highway sector.

For serial communication the following interfaces are available: two CAN, one RS-232 and one LIN interface.

The HY-TTC 50 is part of a complete and compatible product series. It is protected by a robust and extremely compact housing which was specially designed for the off-highway vehicle industry.

Special features

- Programming in CODESYS® 2.3 or C/C++
- 82 kB RAM
- 40 inputs and outputs, including 16 power outputs, 4 current measuring inputs, 8 analogue inputs
- All inputs and outputs are configurable and are protected against overvoltage and short circuits
- Stabilized, adjustable sensor voltage supply with internal monitoring
- No reset caused by dip in voltage when engine is started
- Robust aluminium die cast housing with a waterproof 80-pole male connection and pressure equalization via a waterproof Gore-Tex® membrane
- e12 type approval

Technical data

<table>
<thead>
<tr>
<th>Ambient conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature</td>
</tr>
<tr>
<td>Operating altitude</td>
</tr>
<tr>
<td>Supply voltage</td>
</tr>
<tr>
<td>Permitted voltage drop</td>
</tr>
<tr>
<td>Peak voltage</td>
</tr>
<tr>
<td>Idle current</td>
</tr>
<tr>
<td>Standby current</td>
</tr>
<tr>
<td>Current consumption</td>
</tr>
</tbody>
</table>

Fulfils the following standards

- Compliant with 2004/108/EC
- E-mark 2009/19/EC
- EMC ISO 13766 (up to 200 V/m, 20 MHz .. 1 GHz)
- ESD IEC 61000-4-2
- Load dump ISO 7637-2

<table>
<thead>
<tr>
<th>Dimensions and weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing dimensions</td>
</tr>
<tr>
<td>Minimum clearance for connection</td>
</tr>
<tr>
<td>Weight</td>
</tr>
</tbody>
</table>

Features

- 16 bit Infineon XC 2287 microcontroller, 80 MHz, 768 kB int. Flash, 82 kB int. RAM
- 8 KByte EEPROM
- 1 x RS-232 and 1 x LIN serial interfaces
- 2 x CAN, up to 1 Mbit/s
- 128 individually configurable CAN message buffers
- 8 x Analogue-IN 0 .. 5 V or 4 .. 20 mA (0 .. 22.7 mA) / 10 bit, configurable via software
- 4 x current measurement, configurable as 4 x digital-OUT / low-side 2 A
- 4 x Timer-IN (timer input 0.1 Hz .. 10 kHz)
- 8 x Digital-IN
- 8 x PWM-OUT 2 A high-side, configurable as 8 x Timer inputs
- 8 x Digital-OUT 4 A high-side, configurable as 8 x Analogue-IN
- Internal monitoring of board temperature, sensor supply and battery voltage
- Connector types: 52-pole Tyco PN 1393450-5 / 28-pole Tyco PN 1393436-4
- 1 x sensor supply 8.5 V / 10.0 V (30 mA) or 14.5 V (40 mA) configurable
- 2 x sensor supply 5 V (30 mA)
- Programming: CODESYS® 2.3; C/C++

Note: All I/Os and interfaces are protected against short circuit to GND and BAT+.
**HY-TTC 50**

**XC 2287**
- 768 kB Flash
- 82 kB RAM
- 80 MHz int. clock
- 16 bit bus

**CAN controller** up to 1 Mbit/s

**UART controller**

**EEPROM** 8 KByte

**BDM**

**Emulator interface**

**Internal monitoring:**
- Board temperature
- Battery voltage
- Sensor supply

**K 15**
- Sensor supply
  - 1 x 8.5 / 10.0 V (30 mA) or 14.5 V (40 mA) (configurable)
  - 2 x 5 V, (30 mA)

**8 x Analogue-IN**
- 0 .. 5 V or 4 .. 20 mA (0 .. 22.7 mA) / 10 bit configurable via software

**4 x current measurement**
- configurable as 4 x Digital-OUT
- 2 A low-side

**4 x Timer-IN**
- (4 timer inputs 0.1 Hz .. 10 kHz)
- high / low active

**8 x Digital-IN**
- high / low active

**8 x Signal-OUT**
- 2 A high-side configurable as 8 x Analogue-IN

**8 x PWM-OUT**
- 2 A high-side configurable as 8 x timer inputs

**8 x Digital-OUT**
- 4 A high-side configurable as 8 x Analogue-IN

**Serial communication**
- CAN driver
- CAN driver
- LIN
- RS 232

**Block circuit diagram**
Model code

HY-TTC 50 – XX – 082K – 768K – 00 XX – 000

Firmware

CD = CODESYS® run-time system
for CODESYS® development environment
CP = for “C/C++” programming without CODESYS®

RAM memory
082K = 82 kByte

Flash memory
768K = 768 kByte

Functional safety
00 = not provided

Equipment options
00 = none
01 = fast current filter

Modification number
000 = standard

Note:
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

Accessories
Appropriate accessories, such as cables and connectors, service tools, software etc. can be found in the Accessories section.

Dimensions

52-pole Tyco PN 1393450-5 / 28-pole Tyco PN 1393436-4

Note
The information in this brochure relates to the operating conditions and applications described.
For applications and operating conditions not described, please contact the relevant technical department.
Subject to technical modifications.
**Description**

The HY-TTC 60 is the enhanced model in the 16 bit controller series and compared to the basic version, offers additional input functions.

It is a powerful device which can be used both as a stand-alone solution and as a part of a networked system in modern machines. It meets all the technical requirements of modern automotive electronics in the off-highway sector.

For serial communication the following interfaces are available: two CAN, one RS-232 and one LIN interface.

The HY-TTC 60 is part of a complete and compatible product series. It is protected by a robust and extremely compact housing which was specially designed for the off-highway vehicle industry.

**Special features**

- Programming in CODESYS® 2.3 or C/C++
- 594 kB RAM
- 48 inputs and outputs, including
  - 16 power outputs
  - 4 current measuring inputs
  - 8 analogue inputs (voltage / current)
  - 8 analogue inputs (voltage, configurable)
- All inputs and outputs are configurable and are protected against overvoltage and short circuits
- Stabilized, adjustable sensor voltage supply with internal monitoring
- No reset caused by dip in voltage when engine is started
- Robust aluminium die cast housing with a waterproof 80-pole male connection and pressure equalization via a waterproof Gore-Tex® membrane
- E12 type approval

**Technical data**

**Ambient conditions**

- Operating temperature: -40 .. +85 °C (with full load) to EN 60068-2
- Operating altitude: 0 .. 4,000 m
- Supply voltage: 8 .. 32 V
- Permitted voltage drop: up to 3.4 V (U_{in}) without reset to ISO 7637-1 (for engine start in 12 V systems)
- Peak voltage: 45 V max. (1 ms)
- Idle current: 0.15 A max. at 9 V
- Standby current: 0.5 mA max.
- Current consumption: 25 A max. (complete voltage and temperature range)

**Fulfils the following standards**

- mark: Compliant with 2004/108/EC
- E-mark: ECE-R10 Rev.3
- EMC: ISO 13766 (up to 200 V/m, 20 MHz .. 1 GHz)
- ESD: IEC 61000-4-2
- Load dump: ISO 7637-2
- Protection class: EN 60529 IP 65 / IP 67
- Temperature: EN 60068-2-1; -14Nb; -2; -78; -30
- Vibration, shock, bump: IEC 60068-2-29; -64; -27; -32

**Dimensions and weight**

- Housing dimensions: 148 x 181 x 40 mm
- Minimum clearance for connection: 198 x 203 x 40 mm
- Weight: 675 g

**Features**

- 16-Bit Infineon XC 2287 microcontroller, 80 MHz, 768 kB int. Flash, 82 kB int. RAM, 512 kB ext. RAM
- 8 KByte EEPROM
- 1 x RS-232 and 1 x LIN serial interfaces
- 2 x CAN, up to 1 Mbit/s
- 128 individually configurable CAN message buffers
- 8 x Analogue-IN 0 .. 5 V or 4 .. 20 mA (0 .. 22.7 mA) / 10 bit, configurable via software
- 8 x Analogue-IN 0 .. 32 V / 10 bit, range configurable via software
- 4 x current measurement, configurable as 4 x Digital-OUT / low-side 2 A
- 4 x Timer-IN (timer input 0.1 Hz .. 10 kHz)
- 8 x PWM-OUT 2 A high-side, configurable as 8 x Timer inputs
- 8 x Digital-OUT 4 A high-side, configurable as 8 x Analogue-IN
- Internal monitoring of board temperature, sensor supply and battery voltage
- Connector types: 52-pole Tyco PN 1393450-5 / 28-pole Tyco PN 1393436-4
- 1 x sensor supply 8.5 V / 10.0 V (30 mA) or 14.5 V (40 mA) configurable
- 2 x sensor supply 5 V (30 mA)
- Programming: CODESYS® 2.3; C/C++

Note: All I/Os and interfaces are protected against short circuit to GND and BAT+.
Block circuit diagram

HY-TTC 60

**XC 2287**
- 768 kB Flash
- 82 kB RAM
- 80 MHz int. clock
- 16 bit bus

**EEPROM**
- 8 KByte

**512 kB ext. RAM**

**BDM**

**Emulator interface**

**Serial communication**
- CAN driver
- CAN driver
- LIN
- RS 232

**Internal monitoring:**
- Board temperature
- Battery voltage
- Sensor supply

**CAN controller**
up to 1 Mbit/s

** UART controller**

**K 15**
Sensor supply
1 x 8.5 / 10.0 V (30 mA) or 14.5 V (40 mA) (configurable)
2 x 5 V, (30 mA)

**8 x Analogue-IN**
- 0 .. 5 V or 4 .. 20 mA (0 .. 22.7 mA) / 10 bit configurable via software

**8 x Analogue-IN**
- 0 .. 32 V / 10 bit
  Range configurable via software

**4 x current measurement**
configurable as 4 x Digital-OUT
- 2 A low-side

**4 x Timer-IN**
- (4 timer inputs 0.1 Hz .. 10 kHz)
  high / low active

**8 x Digital-IN**
high / low active

**8 x PWM-OUT**
- 2 A high-side
  configurable as 8 x Timer inputs

**8 x Digital-OUT**
- 4 A high-side
  configurable as 8 x Analogue-IN
**Model code**

**Firmware**
- CD = CODESYS® run-time system for CODESYS® development environment
- CP = for "C/C++" programming without CODESYS®

**RAM memory (internal and external)**
- 594K = 594 kByte

**Flash memory (internal and external)**
- 768 K = 768 kByte

**Functional safety**
- 00 = not provided

**Equipment options**
- 00 = none
- 01 = fast current filter

**Modification number**
- 000 = standard

**Note:**
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

**Accessories**
Appropriate accessories, such as cables and connectors, service tools, software etc. can be found in the Accessories section.

**Dimensions**

52-pole Tyco PN 1393450-5 / 28-pole Tyco PN 1393436-4

**Note**
The information in this brochure relates to the operating conditions and applications described.
For applications and operating conditions not described, please contact the relevant technical department.
Subject to technical modifications.
Universal Mobile Controller
HY-TTC 90

Description
The HY-TTC 90 and the HY-TTC 94 are safety-certified and are the most powerful controllers in the 16 bit controller series. They meet all the technical requirements of modern vehicle electronics in the off-highway sector. The HY-TTC 90 was developed in accordance with the international standards IEC 61508 and ISO/EN 13849 and is certified by TÜV Nord. It thus meets the requirements of the safety levels SIL 2 (Safety Integrity Level 2) and PL d (Performance Level d).

For the CPU, it uses the safety CPU XC2287M which was specially developed by Infineon for safety applications. This offers enhanced safety features for the protection of the internal RAM and Flash memories.

Special features
- SIL 2 / PL d certified
- Additional watchdog CPU
- Programming in CODESYS® 2.3 or C/C++
- 570 kB RAM
- 48 inputs and outputs, including
  - 16 power outputs
  - 4 current measuring inputs
  - 8 analogue inputs:
    - voltage / current
  - 8 analogue inputs:
    - voltage, configurable
- All inputs and outputs are configurable and are protected against overvoltage and short circuits
- Stabilized, adjustable sensor voltage supply with internal monitoring
- No reset caused by dip in voltage when engine is started
- Robust aluminium die cast housing with a waterproof 80-pole male connection and pressure equalization via a waterproof Gore-Tex® membrane
- e12 type approval

Technical data

<table>
<thead>
<tr>
<th>Ambient conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature</td>
</tr>
<tr>
<td>Operating altitude</td>
</tr>
<tr>
<td>Supply voltage</td>
</tr>
<tr>
<td>Permitted voltage drop</td>
</tr>
<tr>
<td>(for engine start in 12 V systems)</td>
</tr>
<tr>
<td>Peak voltage</td>
</tr>
<tr>
<td>Idle current</td>
</tr>
<tr>
<td>Standby current</td>
</tr>
<tr>
<td>Current consumption</td>
</tr>
</tbody>
</table>

Fulfills the following standards
- IEC 61508 - SIL 2
- EN ISO 13849 - PL d
- ISO 13766 (up to 200 V/m, 20 MHz .. 1 GHz)
- IEC 61000-4-2
- ISO 7637-2
- EN 60529
- DIN 40050
- Protection class
  - IP 65 / IP 67
  - DIN 40050
- Temperature
  - EN 60068-2-1; -14Nb; -2; -78; -30
- Vibration, shock, bump
  - IEC 60068-2-29; -64; -27; -32

Dimensions and weight
- Housing dimensions
  - 148 x 181 x 40 mm
- Minimum clearance for connection
  - 198 x 203 x 40 mm
- Weight
  - 656 g

Features
- 16-Bit Infineon XC2287M microcontroller, 80 MHz, 832 kB Int. Flash, 58 kB Int. RAM, 512 kB ext. RAM
- 8 KByte EEPROM
- watchdog CPU freescale HC 908, including monitoring software
- 1 x RS-232 and 1 x LIN serial interfaces
- 2 x CAN, up to 1 Mbit/s
- 128 individually configurable CAN message buffers
- 8 x Analogue-IN 0 .. 5 V or 4 .. 20 mA (0 .. 22.7 mA) / 10 bit, configurable via software
- 8 x Analogue-IN 0 .. 32 V / 10 bit, range configurable via software
- 4 x current measurement, configurable as 4 x Digital-OUT / low-side 2 A
- 4 x Timer-IN (timer input 0.1 Hz .. 10 kHz)
- 8 x Digital-IN
- 8 x PWM-OUT 2 A high-side, configurable as 8 x Timer inputs
- 8x Digital-OUT 4 A high-side, configurable as 8 x Analogue-IN
- Optional mini module (8 pins for customized system extension)
- Internal monitoring of board temperature, sensor supply and battery voltage
- Connector types: 52-pole Tyco PN 1393450-5 / 28-pole Tyco PN 1393436-4
- 1 x sensor supply 8.5 V / 10.0 V (30 mA) or 14.5 V (40 mA) configurable
- 2 x sensor supply 5 V (30 mA)
- Programming: CODESYS® 2.3; C/C++

Note: All I/Os and interfaces are protected against short circuit to GND and BAT+.
Block circuit diagram
HY-TTC 90

**XC 2287M**
- 832 kB Flash
- 58 kB RAM
- 80 MHz int. clock
- 16 bit bus

**Serial communication**
- CAN driver
- CAN driver
- LIN
- RS 232

**Internal monitoring:**
- Board temperature
- Battery voltage
- Sensor supply

**EEPROM**
- 8 KByte

**512 kB ext. RAM**

**BDM**

**Emulator interface**

**K 15**
- Sensor supply
  - 1 x 8.5 / 10.0 V (30 mA) or 14.5 V (40 mA) (configurable)
  - 2 x 5 V, (30 mA)

**8 x Analogue-IN**
- 0 .. 5 V or 4 .. 20 mA (0 .. 22.7 mA) / 10 bit configurable via software

**8 x Analogue-IN**
- 0 .. 32 V / 10 bit
  - Range configurable via software

**4 x current measurement**
- Configurable as 4 x Digital-OUT
  - 2 A low-side

**4 x Timer-IN**
- (4 timer inputs 0.1 Hz .. 10 kHz)
  - High / low active

**8 x Digital-IN**
- High / low active

**8 x PWM-OUT**
- 2 A high-side configurable as 8 x Timer inputs

**8 x Digital-OUT**
- 4 A high-side configurable as 8 x Analogue-IN

**8 x Analogue-IN**
- 0 .. 5 V or 4 .. 20 mA (0 .. 22.7 mA) / 10 bit configurable via software

**4 x current measurement**
- Configurable as 4 x Digital-OUT
  - 2 A low-side

**4 x Digital-IN**
- High / low active

**Watchdog CPU**
- 68HC908

**Mini module**
- (optional)
  - Up to 8 pins for customized system extensions;
  - 4 pins shared with block:
    - 8 x Analogue-IN 0 .. 32 V / 10 bit
**Note**

The information in this brochure relates to the operating conditions and applications described. For applications and operating conditions not described, please contact the relevant technical department. Subject to technical modifications.

---

**Model code**

**HY-TTC 90 – XX – 570K – 832K – WD XX – 000**

**Firmware**

CD = CODESYS® run-time system for CODESYS® development environment
CP = for “C/C++” programming without CODESYS®

**RAM memory (internal and external)**

570K = 570 kByte

**Flash memory (internal and external)**

832 K = 832 kByte

**Functional safety**

WD = watchdog with standard software

**Equipment options**

- 00 = none
- 01 = fast current filter
- 02 = 4x additional current measurements
- 03 = 4x additional current measurements with current filters

**Modification number**

- 000 = standard

---

**Note:**

On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

**Accessories**

Appropriate accessories, such as cables and connectors, service tools, software etc. can be found in the Accessories section.

---

**Dimensions**

52-pole Tyco PN 1393450-5 / 28-pole Tyco PN 1393436-4

---

HYDAC ELECTRONIC GmbH
Hauptstraße 27
66128 Saarbrücken, Germany
Tel. +49 6897 509-01
Fax +49 6897 509-1726
E-mail: electronic@hydac.com
Internet: www.hydac.com
Description

Alongside the HY-TTC 90, the HY-TTC 94 is safety-certified and is the most powerful controller in the 16 bit controller series. It meets all the technical requirements of modern vehicle electronics in the off-highway sector.

The HY-TTC 90/94 was developed in accordance with the international standards IEC 61508 and ISO/EN 13849 and is certified by TÜV NORD. Therefore, it meets the requirements of safety levels PL d (Performance Level d).

For the CPU, it uses the safety CPU XC2287M which was specially developed by Infineon for safety applications. This offers enhanced safety features for the protection of the internal RAM and Flash memories.

Technical data

Ambient conditions

- Operating temperature: -40 ... +85 °C (with full load) to EN 60068-2
- Operating altitude: 0 ... 4,000 m
- Supply voltage: 8 ... 32 V
- Permitted voltage drop: up to ±4 V (U㎜) without reset to ISO 7637-1 (for engine start in 12 V systems)
- Peak voltage: 45 V max. (1 ms)
- Idle current: 0.15 A max. at 9 V
- Standby current: 0.5 mA max.
- Current consumption: 25 A max. (complete voltage and temperature range)

Fulfils the following standards

- E-mark: Compliant with 2004/108/EC
- ECE-R10 Rev.3
- PL d certified

Functional Safety

- EN ISO 13849-PL d
- EMV: ISO 13766 (up to 200 V/m, 20 MHz .. 1 GHz)
- ESD: IEC 61000-4-2
- Load dump: ISO 7637-2
- Protection class: EN 60529 IP 65 / IP 67
- Temperature: EN 60068-2, 2.1-14NB, 2,-2, -78, -30
- Vibration, shock, bump: IEC 60068-2-29, -64, -27, -32

Dimensions and weight

- Housing dimensions: 148 x 181 x 40 mm
- Minimum clearance for connection: 198 x 203 x 40 mm
- Weight: 664 g

Features

- 16-Bit Infineon XC2287M microcontroller, 80 MHz, 832 kB int. Flash, 58 kB int. RAM, 512 kB ext. RAM
- 8 KB EEPROM
- Watchdog CPU freescale HC 908, including monitoring software
- 1 x RS-232 and 1 x LIN serial interfaces
- 4 x CAN, up to 1 Mbit/s
- 128 individually configurable CAN message buffers
- 8 x Analogue-IN 0 ... 5 V or 4 ... 20 mA (0 ... 22.7 mA) / 10 bit, configurable via software
- 8 x Analogue-IN 0 ... 32 V / 10 bit, range configurable via software
- 4 x current measurement, configurable as 4 x Digital-OUT / low-side 2 A
- 4 x Timer-1 (timer input 0.1 Hz ... 10 kHz)
- 8 x Digital-IN
- 8 x PWM-OUT 2 A high-side, configurable as 8 x Timer inputs
- 8 x Digital-OUT 4 A high-side, configurable as 8 x Analogue-IN
- Internal monitoring of board temperature, sensor supply and battery voltage
- Connector types: 52-pole Tyco PN 1393450-5 / 28-pole Tyco PN 1393436-4
- 1 x sensor supply 8.5 V / 10.0 V (30 mA) or 14.5 V (40 mA) configurable
- 2 x sensor supply 5 V (30 mA)
- Programming: CODESYS® 2.3, C/C++

Note: All I/Os and interfaces are protected against short circuit to GND and BAT+.

Special features

- PL d certified
- Additional watchdog CPU
- Programming in CODESYS® 2.3 or C/C++
- 570 kB RAM
- 48 inputs and outputs, including - 16 power outputs
- 4 current measuring inputs
- 8 analogue inputs: voltage / current
- 8 analogue inputs: voltage, configurable
- All inputs and outputs are configurable and are protected against overvoltage and short circuits
- Stabilized, adjustable sensor voltage supply with internal monitoring
- No reset caused by dip in voltage when engine is started
- Robust aluminium die cast housing with a waterproof 80-pole male connection and pressure equalization via a waterproof Gore-Tex® membrane
- E12 type approval
Block circuit diagram

HY-TTC 94

**XC 2287M**
- 832 kB Flash
- 58 kB RAM
- 80 MHz int. clock
- 16 bit bus
- CAN controller up to 1 Mbit/s

**EEPROM**
- 8 KByte

**512 kB ext. RAM**

**BDM**

**Emulator interface**

**Internal monitoring:**
- Board temperature
- Battery voltage
- Sensor supply

**8 x Analogue-IN**
- 0 .. 5 V or 4 .. 20 mA (0 .. 22.7 mA) / 10 bit configurable via software

**8 x Analogue-IN**
- 0 .. 32 V / 10 bit
  - Range configurable via software

**4 x current measurement**
- configurable as 4 x Digital-OUT
  - 2 A low-side

**4 x Timer-IN**
- (4 timer inputs 0.1 Hz .. 10 kHz)
  - high / low active

**8 x Digital-IN**
- high / low active

**8 x Digital-OUT**
- 4 A high-side configurable as 8 x Analogue-IN

**8 x PWM-OUT**
- 2 A high-side configurable as 8 x timer inputs

**Watchdog CPU**
- 68HC908

**CAN driver**

**LIN**

**RS 232**

**Serial communication**
### Model code

| HY-TTC 94 – XX – 570K – 832K – WD XX – 000 |

### Firmware
- **CD** = CODESYS® run-time system
  - for CODESYS® development environment
- **CP** = for “C/C++” programming without CODESYS®

### RAM memory (internal and external)
- 570K = 570 kByte

### Flash memory (internal and external)
- 832 K = 832 kByte

### Functional safety
- **WD** = watchdog with standard software

### Unit options
- 00 = none

### Modification number
- 000 = standard

### Note:
- On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

### Accessories
- Appropriate accessories, such as cables and connectors, service tools, software etc. can be found in the Accessories section.

### Dimensions

- 52-pole Tyco PN 1393450-5 / 28-pole Tyco PN 1393436-4

- 216.00
- 80.00
- 44.78
- 200.00
- 2.71
- 7.00

---

**HYDAC ELECTRONIC GmbH**

Hauptstraße 27
66128 Saarbrücken, Germany
Tel. +49 6897 509-01
Fax +49 6897 509-1726
E-mail: electronic@hydac.com
Internet: www.hydac.com

---

**Note**

The information in this brochure relates to the operating conditions and applications described.

For applications and operating conditions not described, please contact the relevant technical department.

Subject to technical modifications.
Description

The HY-TTC 77 is a powerful controller for mobile off-highway applications with 12 V voltage supply.

The design of the HY-TTC 77 meets the requirements for PL d (Performance Level) of the international standard EN ISO 13879.

The CPU XC 2288 H from Infineon used in the controller has enhanced safety features for protecting the internal RAM and Flash memory.

The HY-TTC 77 is part of a complete and compatible product series. It is protected by a robust and extremely compact housing which was specially designed for the off-highway vehicle industry.

Special features

- Programming in C
- 138 kB RAM
- 65 inputs and outputs
  - 26 power outputs
  - 30 analogue inputs
  - 7 digital inputs
  - 6 PWM current measurement
  - 2 timer-IN optional
- All inputs and outputs are configurable and are protected against overvoltage and short circuits
- Stabilized sensor voltage supply with internal monitoring
- No reset caused by dip in voltage when engine is started
- Robust aluminium die-cast housing with a waterproof 80-pole male connection and pressure equalization via a waterproof Gore-Tex® membrane
- e12 type approval

Technical data

**Ambient conditions**
- Operating temperature: -40 °C to +85 °C (with full load) to EN 60068-2
- Operating altitude: 0 .. 4,000 m
- Supply voltage: 8 .. 16 V
- Permitted voltage drop: up to 24 V (U\(_{\text{BAT}}\)) without reset to ISO 7637-1 (for engine start in 12 V systems)
- Peak voltage: 45 V max. (1 ms)
- Idle current: 0.15 A max. at 9 V
- Standby current: 0.5 mA max.
- Current consumption: 40 A max. (complete voltage and temperature range)

**Fulfils the following standards**
- E-mark: Compliant with 2004/108/EC
- E-mark: ECE-R10 Rev.3
- EMC: ISO 13766 (up to 100 V/m, 20 MHz .. 1 GHz)
- ESD: IEC 61000-4-2
- Protection class: EN 60529 IP 65 / IP 67
- Temperature: EN 60068-2-1; -14Nb; -2; -78; -30
- Vibration, shock, bump: IEC 60068-2-29; -64; -27; -32

**Dimensions and weight**
- Housing dimensions: 148 x 181 x 40 mm
- Minimum clearance for connection: 198 x 203 x 40 mm
- Weight: 640 g

**Features**
- 16 bit Infineon XC 2288 microcontroller, 80 MHz, 1.6 MB int. Flash, 138 kB int. RAM
- 32 KByte EEPROM
- 2 x CAN, 125 kbit/s up to 1 Mbit/s
- CPU internal safety features:
  - Hardware CRC testing of the Flash memory
  - Integral memory protection (MPU)
  - RAM protected by means of Error-Correcting-Code (ECC)
- Watchdog CPU Freescale HC 908, including monitoring software
- 12 x PWM-OUT 2.5 A high-side with frequency measurement, of which 6 with current measurement; PL d classified; configurable as Timer-IN; 3 output groups can be shut down independently in the case of malfunction for emergency operation
- 6 x PWM-OUT 2.5 A high-side with voltage measurement; up to 4 A for individual outputs (4 PWM-OUT PL c classified)
- 8 x Digital-OUT 2.5 A high-side; up to 4 A for individual outputs
- 4 x Analogue-IN 0 to 5 V / 0 – 24 mA / resistive / Digital-IN low-side; 10 bit; configurable via software; PL d classified
- 8 x Analogue-IN 0 to 15 V / Digital-IN; 10 bit; PL d classified
- 8 x Analogue-IN 0 to 5 V / 10 bit; PL d classified
- 8 x Analogue-IN 0 to 10 V or Digital-IN; high-side / low-side; 9 bit; PL d classified
- 2 x Analogue-IN 0 to 15 V; 10 bit; PL d classified
- 2 x Digital-Timer-IN (0.1 Hz to 10 kHz); PL d classified, not populated
- 7 x Analogue-IN high-side
- Internal monitoring of board temperature, sensor supply and battery
- 3 x Analogue sensor ground, 1 x Digital ground
- 2 x sensor supply 5 V, each 100 mA
- Programming: C

Note: All I/Os and interfaces are protected against short circuit to GND and BAT+.
Block circuit diagram

HY-TTC 77

CAN driver

Serial communication

CAN controller up to 1 Mbit/s

XC 2288 H
- 1,600 kB Flash
- 138 kB RAM
- 80 MHz int. clock
- 16 bit bus

EEPROM
- 8 KByte

BDM

Emulator interface

K 15
- Sensor supply (configurable), 2 x 5 V (each 100 mA)

Internal monitoring:
- Board temperature
- Battery voltage
- Sensor supply

4 x Analogue-IN
- 0 .. 5 V / 0 .. 24 mA / 0 .. 65 kOhm / 10 bit
- configurable, PL d classified

8 x Analogue-IN
- 0 .. 5 V / 10 bit
- PL d classified

8 x Analogue-IN
- 0 .. 10 V / 9 bit
- Digital-IN high-side / low-side
- PL d classified

2 x Analogue-IN
- 0 .. 15 V / 10 bit
- PL d classified

8 x Analogue-IN
- 0 .. 15 V / 10 bit
- Digital-IN high-side / low-side
- PL d classified

2 x Digital-Timer-IN
- (0.1 - 10,000 Hz)
- (optional)
- high-side
- with voltage measurement

2 x Digital-IN
- high-side

Watchdog CPU
- 68 HC 908

12 x PWM-OUT 2.5 A
- high-side
- with frequency measurement, 6 with current measurement
- PL d classified

4 x PWM-OUT 2.5 A
- high-side
- with voltage measurement
- PL C classified

2 x PWM-OUT 2.5 A
- high-side
- with voltage measurement

8 x Digital-OUT 2.5 A
- high-side

12 x PWM-OUT 2.5 A
- high-side
- with frequency measurement, 6 with current measurement
- PL d classified
Model code:

- **HY-TTC 77 – XX – 138K – 1.6M – 00 XX – 000**

Firmware:
- CP = for “C/C++” programming without CODESYS®

RAM memory:
- 138K = 138 kByte

Flash memory:
- 1608K = 1608 kByte / 1.6 MByte

Functional safety:
- WD = watchdog with standard software

Equipment options:
- 05 = full configuration

Modification number:
- 000 = standard

Note:
- On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

Accessories:
- Appropriate accessories, such as cables and connectors, service tools, software etc. can be found in the Accessories section.

Dimensions:

- 52-pole Tyco PN 1393450-5 / 28-pole Tyco PN 1393436-4
- 216.00
- 80.00
- 147.12
- 200.00
- 44.78

Note:
- The information in this brochure relates to the operating conditions and applications described.
- For applications and operating conditions not described, please contact the relevant technical department.
- Subject to technical modifications.
**Description**

The HY-TTC 200 is safety-certified and is one of the most powerful controllers in the 32 bit controller series. Configurable inputs and outputs ensure that it can be used with almost all types of sensor and actuator.

The control unit was developed to ensure the reliability and performance of mobile machinery, even under the most extreme conditions.

The HY-TTC 200 was developed in accordance with the international standard EN ISO 13849 and certified by TÜV NORD. It meets the safety requirements up to **PL d** (Performance Level d) as a stand-alone device.

**Special features**

- **PL d certified**
- Additional watchdog CPU
- Programming in CODESYS® 2.3 or C/C++
- Up to 1 MB RAM
- 69 inputs and outputs, including
  - 12 PWM outputs
  - 8 with integrated current measurement
  - 22 power outputs
  - 8 analogue inputs (voltage/current)
  - 12 analogue/Digital inputs with diagnostic function
- All inputs and outputs are configurable and are protected against overvoltage and short circuits
- Stabilized sensor voltage supply with internal monitoring
- Robust aluminium die cast housing with a waterproof 154-pole male connection and pressure equalization via a waterproof Gore-Tex® membrane
- Housing fins for optimum heat dissipation
- e12 type approval

**Technical data**

**Ambient conditions**

- Operating temperature: -40 .. +85 °C (with full load) to EN 60068-2
- Operating altitude: 0 .. 4,000 m
- Supply voltage: 9 .. 32 V
- Peak voltage: 45 V max. (1 ms)
- Idle current: 1 A max. at 9 V
- Standby current: 1 mA max.
- Current consumption: 50 A max. (complete voltage and temperature range)

**Fulfills the following standards**

- **EC mark**: Compliant with 2004/108/EC
- **E-mark**: Compliant with 2006/28/EC
- **PL d**

**EMC**

- ISO 13766 (up to 300 V/m, 20 MHz .. 1 GHz)
- ESD IEC 61000-4-2
- Load dump ISO 7637-2, 173 V, 2 Ohm

**Dimensions and weight**

- Dimensions with mounting bracket: 204.8 x 211 x 42.1 mm
- Minimum clearance for connection: 265 x 233 x 45 mm
- Weight: 784 g

**Features**

- 32 bit MPC 555 processor, 40 MHz, 448 kB int. Flash, 26 kB int. RAM, 512 kB ext. RAM (opt. 1 MB ext. RAM), 2 MB ext. Flash
- 2 KByte EEPROM
- Watchdog CPU freescale HC 908, including monitoring software
- 1 x RS-232 and 1 x LIN serial interfaces
- 2 x CAN, up to 1 Mbit/s
- 8 x Analogue-IN 0 .. 5 V or 4 .. 20 mA (0 .. 22.7 mA) / 10 bit, configurable via software
- 12 x Analogue/Digital-IN with diagnostic function 0 .. 10 V / 10 bit
- 8 x Timer-IN (timer input 10 Hz .. 10 kHz)
- 5 x Digital-IN optional can be used as instrument ID
- 8 x PWM-OUT 2.35 A high-side with current measurement, short-circuit and load detection (open load), configurable as 4 x Timer input or Digital-IN
- 4 x PWM-OUT 4 A high-side, short-circuit and load detection (open load), configurable as 4 x Timer input or Digital-IN
- 16 x Digital-OUT 4 A high-side, short-circuit and load detection (open load), configurable as 16 x Digital-IN
- 3 x Digital-OUT 15 A high-side, open load detection, (1 x with screen wiper option), configurable as 3 x timer input or Digital-IN
- 3 x Digital-OUT high-side for external relays to switch off output for safety applications (fail-safe)
- 2 x Analogue-OUT, 0.2 .. 0.8 V~
- Internal monitoring of board temperature, sensor supply and battery voltage
- Connector types: 60-pole Tyco PN 284742-1 / 94-pole Tyco PN 284743-1
- 1 x sensor supply 10.5 V (50 mA for 12 V systems, 20 mA for 24 V system)
- 2 x sensor supply 5 V (100 mA)

**Note:** All I/Os and interfaces are protected against short circuit to GND and BAT+.
HY-TTC 200

Block circuit diagram

**MPC 555 (32 bit)**
- 448 kB Flash
- 26 kB RAM
- 40 MHz int. clock
- 16 bit bus

**CAN controller**
up to 1 Mbit/s

**UART controller**

---

**Internal monitoring:**
- Board temperature
- Battery voltage
- Sensor supply

---

**Ext. RAM 512 kB**

**Ext. Flash 2 MB**

**EEPROM 2 KByte**

**BDM**

**Emulator interface**

**Sensor supply**
1 x 10.5 V (50 mA for 12 V systems, 20 mA for 24 V systems),
2 x 5 V (100 mA)

---

**CAN driver**

**LIN**

**RS 232**

---

**8 x Analogue-IN**
- 0 .. 5 V or
- 4 .. 20 mA (0 .. 22.7 mA) / 10 bit
configurable via software

---

**12 x Analogue-IN**
or Digital-IN
- 0 .. 10 V / 10 bit
with diagnostic function

---

**8 x Timer-IN**
- (8 timer inputs
- 10 Hz .. 10 kHz)

---

**5 x Digital-IN**

---

**Watchdog CPU**
- 68HC908

---

**2 x Analogue-OUT**
- 0.2 .. 0.8 V

---

**3 x Digital-OUT 15 A**
configurable as 3 x Digital-IN
or 3 x Timer inputs

---

**8 x PWM-OUT 2.35 A high-side**
with current measurement
configurable as 8 x Digital-IN
or 8 x timer inputs

---

**4 x PWM-OUT 4 A high-side**
configurable as 4 x Digital-IN
or 4 x Timer inputs

---

**16 x Digital-OUT**
- 4 A high-side
configurable as
16 x Digital-IN

---

**3 x Digital-OUT**
for external relays
### Model code

**HY-TTC 200 – XX – XXXX – 2.4M – WD 00 – 000**

### Firmware
- **CD** = CODESYS® run-time system for CODESYS® development environment
- **CP** = for “C/C++” programming without CODESYS®

### RAM memory (internal and external)
- 538K = 538 kByte
- 001M = 1 MByte

### Flash memory (internal and external)
- 2.4M = 2.4 MByte

### Functional safety
- **WD** = watchdog with standard software

### Equipment options
- 00 = none
- 10 = with mounting bracket, fitted

### Modification number
- 000 = standard

### Note:
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

### Accessories
Appropriate accessories, such as cables and connectors, service tools, software etc. can be found in the Accessories section.

### Dimensions

![Dimensions Diagram](image-url)

- **26.3**
- **92**
- **178.5**
- **97.5**
- **78**
- **54**
- **Ø 7.0**
- **204.8**
- **31.5**
- **42.1**
- **3.6**
- **180**
- **197**
- **211**

**HYDAC ELECTRONIC GmbH**
Hauptstraße 27
66128 Saarbrücken, Germany
Tel. +49 6897 509-01
Fax +49 6897 509-1726
E-mail: electronic@hydac.com
Internet: www.hydac.com
Controller Units
Series HY-TTC 500

The new controller series from HYDAC ELECTRONIC, the HY-TTC 500, is more than a match for the steadily growing demands of mobile machines. Using the most cutting-edge process technology, our concept is based on the ideal combination of a main processor and safety monitoring. These two systems work in harmony to achieve the highest performance and extremely high diagnostics coverage for the application at the same time. This means that very complex tasks can be tackled and any problems (critical cases/functions) can be safely identified and dealt with.

Its unique feature is that completely separate shutdown groups are created with a single controller. This means it is possible to shut down special work functions securely during driving operation. Even if a problem arises, an individual error does not lead to a complete loss of control because the faulty group is shut down whilst maintaining partial functionality of the machine. Up to three separate shutdown paths are available to achieve this.

The safety concept of this new controller series was tested by independent testers according to the current safety standards IEC 61508 and EN ISO 13849. Safety level SIL 2 was achieved for IEC 61508 and Performance Level PL d for EN ISO 13849. This means that all controllers in the series can be used for almost every safety-critical application.

Very flexible configurations of all inputs and outputs offer the possibility of using one controller type for different machines. For example, switching outputs that are not normally used as such can be configured to read analogue sensor data.

With the high number of channels (almost 100) these controllers are suitable for all large machines from the construction, agricultural, municipal, crane and lifting industries.

The HY-TTC 500 controllers provide the ideal platform for a centralized architecture. They can also be expanded using extension modules such as our HY-TTC 30X series to produce a decentralized network. Up to 7 CAN interfaces are available for this and this large number offers great flexibility for the network architecture.

It is possible to keep both drive information and sensor data separate.

A CANopen Safety Master is available for secure data transfer. A real-time clock (RTC; only on HY-TTC 580) and a wake-up pin provide options for further applications.

Both the developer and the production team can make direct use of the Ethernet interface on the HY-TTC 580 which enables very fast communication for programming during the implementation and also later for downloading the final application.
Description

The controller HY-TTC 540 is based on a modern 32 bit microcontroller platform.

Practically all the system diagnostics is handled by an optimised safety component, so the entire computing capacity is available to the main processor for the actual application.

The HY-TTC 540 has an impressive number of highly flexible inputs and outputs. The outputs in particular provide high individual and total currents or can alternatively be used as inputs.

To achieve differentiated safety levels, two separate PWM shutdown groups are available.

The HY-TTC 540 was developed in accordance with the international standards IEC 61508 and ISO/EN 13849 and is certified by TÜV NORD. It meets the requirements of Functional Safety according to SIL 2 and PL d.

The module is protected in a proven, robust and compact housing, specially designed for the off-highway automotive industry.

Technical data

<table>
<thead>
<tr>
<th>Ambient conditions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature</td>
<td>-40...+85 °C (with full load)</td>
</tr>
<tr>
<td>Operating altitude</td>
<td>0...4,000 m</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>8...32 V (max. 0.5...32 V CPU operative)</td>
</tr>
<tr>
<td>Peak voltage</td>
<td>45 V max. (1 ms)</td>
</tr>
<tr>
<td>Idle current</td>
<td>400/200 mA at 12/24 V</td>
</tr>
<tr>
<td>Standby current</td>
<td>≤1 mA max.</td>
</tr>
<tr>
<td>Current consumption</td>
<td>60 A max. (complete voltage and temperature range)</td>
</tr>
</tbody>
</table>

Fulfills the following standards

<table>
<thead>
<tr>
<th>Mark</th>
<th>Compliance with 2004/108/EC</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-mark</td>
<td>ECE-R10 Rev-4</td>
</tr>
<tr>
<td>Functional safety</td>
<td>EN ISO 13849 -PL d- IEC 61508 - SIL 2-</td>
</tr>
<tr>
<td>EMC</td>
<td>EN 13306: ISO 14982: CISPR 25</td>
</tr>
<tr>
<td>ESD</td>
<td>ISO 10605</td>
</tr>
<tr>
<td>Protection class</td>
<td>EN 60529 IP 67; ISO 20653 IP 69k</td>
</tr>
<tr>
<td>Electrical</td>
<td>ISO 16750-2; ISO 7637-2,-3</td>
</tr>
<tr>
<td>Temperature</td>
<td>ISO 16750-4</td>
</tr>
<tr>
<td>Vibration, shock, bump</td>
<td>ISO 16750-3</td>
</tr>
</tbody>
</table>

Dimensions and weight

<table>
<thead>
<tr>
<th>Dimensions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing dimensions</td>
<td>231.3 x 204.9 x 38.8 mm</td>
</tr>
<tr>
<td>Minimum clearance for connection</td>
<td>316 x 205 x 40 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>1,200 g</td>
</tr>
</tbody>
</table>

Features

32-Bit TI TMS 550 Dual-core lockstep CPU, 180 MHz, 298 DMIPS, FPU; 3MB int. Flash, 256 kB int RAM, 2 MB ext RAM
64 KB EEPROM
Safety Companion CPU
4 x CAN, 50 kb/s up to 1 Mbit/s
4 x configurable CAN Node terminations

IN

8 x Analogue-IN 0...5 V, 0...24 mA or 0...100 mA, range configurable via software
8 x Analogue-IN 0...5 V, 0...10 V or 0...24 mA, range configurable via software
8 x Analogue-IN 0...5 V, 0...32 V or 0...100 mA, range configurable via software
6 x Timer-IN (timer input 0.1 Hz...20 kHz) / Timer-IN (714 mA (DSM) / Analogue-IN 0...32 V) configurable pull-up/down, encoder
6 x Timer-IN (timer inputs 0.1 Hz...20 kHz) / Analogue-IN (0...32 V) configurable pull-up/down, encoder
8 x Timer-IN (0...1 Hz...10 kHz)
8 x Analogue-IN, 0...32 V
K15 and wake up

OUT

28 x PWM-OUT 4 A high-side, current measurement, configurable as Digital-OUT
8 x Digital-OUT 4 A high-side, with current monitoring, overload and load detection, configurable as 8 x Analogue-IN (0...32 V) with configurable pull-up/down or LED controller
8 x Digital-OUT 4 A low-side, with current monitoring, overload and load detection, configurable as 8 x Analogue-IN (0...32 V)
Wiring up to 8 Digital-OUT high-side and 8 Digital-OUT low-side as full bridge control for the control of direct current motors
Internal monitoring of board temperature, sensor supply and battery voltage
Connector types: 154 pole male
1 x Sensor supply 5...10 V / max. 2.5 W configurable with 1V increments
2 x sensor supply 5 V (500 mA)
Programming in C or CODESYS® Safety SIL 2 with CANopen Safety Master

Note: 1) All I/Os and interfaces are protected against short circuit to GND and BAT+. 2) All I/Os are configurable as digital-IN. 3) All I/Os have 12 bit resolution.

Special features

- SIL 2 / PL d certified
- Safety Companion CPU
- CODESYS® Safety SIL 2 with CANopen Safety Master
- CODESYS® 3.X
- Two alternative PWM shutdown groups
- 28 PWM power outputs with current measurement
- 96 configurable inputs and outputs give great flexibility to the I/O groups
- Excellent computing performance
- 4 CAN-bus interfaces
Block circuit diagram

HY-TTC 540

TMS 570
ARM® Cortex™-R4F 32-bit RISC CPU
Dual core lockstep
- 32 bit
- 3 MB Flash
- 256 kB RAM
- 180 MHz

64 kB ext. EEPROM
2 MB ext. RAM

Sensor supply
1 x 5 .. 10 V max. 2.5 W (configurable in 1 V steps)
2 x 5 V / max. 500 mA

Internal monitoring:
- Board temperature
- Battery voltage
- Sensor supply

8 x Analogue-IN
0 .. 5 V or
0 .. 24 mA or
0 .. 100 kΩ / 12 bit
configurable via software

8 x Analogue-IN
0 .. 5 V or
0 .. 10 V or
0 .. 24 mA / 12 bit
configurable via software

8 x Analogue-IN
0 .. 5 V or
0 .. 32 V or
0 .. 24 mA / 12 bit
configurable via software

8 x Analogue-IN
0 .. 5 V or
0 .. 10 V or
0 .. 24 mA / 12 bit
configurable via software

8 x Analogue-IN
0 .. 5 V or
0 .. 32 V or
0 .. 24 mA / 12 bit
configurable via software

8 x Analogue-IN
0 .. 5 V or
0 .. 10 V or
0 .. 24 mA / 12 bit
configurable via software

8 x Digital-OUT
4 A high-side with current monitoring configurable as Analogue-IN (0 .. 32 V)

8 x Digital-OUT
4 A high-side

8 x Digital-OUT
4 A low-side with current monitoring configurable as Analogue-IN (0 .. 32 V)

Safety Companion

JTAG

4 x CAN

K15

Wake up

Shutdown group A

Shutdown group B

28 x PWM-OUT / Digital-OUT
4 A high-side with current measurement configurable as Digital-IN

8 x Analogue-IN
0 .. 5 V or
0 .. 10 V or
0 .. 24 mA / 12 bit
configurable via software

8 x Analogue-IN
0 .. 5 V or
0 .. 32 V or
0 .. 24 mA / 12 bit
configurable via software

6 x Timer-IN
0.1 Hz .. 20 kHz
Pull-up/Down or
Timer-IN 7/14 mA, DSM or Analogue-IN 0 .. 32 V

6 x Timer-IN
0.1 Hz .. 20 kHz
Pull-up/Down or
Analogue-IN 0 .. 32 V

8 x Digital-OUT
4 A high-side

8 x Digital-OUT
4 A low-side

8 x Digital-OUT
4 A high-side

8 x Digital-OUT
4 A low-side

2 x 5 V / max. 500 mA

8 x Analogue-IN
0 .. 32 V / 12 bit

8 x Analogue-IN
0 .. 32 V / 12 bit

8 x Analogue-IN
0 .. 32 V / 12 bit

8 x Analogue-IN
0 .. 32 V / 12 bit

8 x Analogue-IN
0 .. 32 V / 12 bit

8 x Analogue-IN
0 .. 32 V / 12 bit

8 x Analogue-IN
0 .. 32 V / 12 bit

8 x Analogue-IN
0 .. 32 V / 12 bit

Wake up
**Model code**

HY-TTC 540 – XX – 2.3M – 003M – 00 – S2Pd – 000

**Programming environment**

CP = C programming  
CD = CODESYS® or CODESYS® 3.X

**RAM**

2.3M = 2 MB ext. RAM, 256 kB int. RAM

**Flash**

003M = 3 MB Flash (3 MB int. Flash)

**Equipment options**

00 = standard

**Functional safety**

S2Pd = SIL 2 and Performance Level d

**Modification number**

000 = standard

**Note:**

On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

**Accessories**

Appropriate accessories, such as cables and connectors, service tools, software etc. can be found in the Accessories section.

**Dimensions**

The information in this brochure relates to the operating conditions and applications described. For applications and operating conditions not described, please contact the relevant technical department. Subject to technical modifications.

HYDAC ELECTRONIC GmbH  
Hauptstraße 27  
66128 Saarbrücken, Germany  
Tel. +49 6897 509-01  
Fax +49 6897 509-1726  
E-mail: electronic@hydac.com  
Internet: www.hydac.com
Description
The controller HY-TTC 580 is based on a modern 32 Bit microcontroller platform. The HY-TTC 580 is currently the largest controller in the 500 series and is particularly suitable therefore for complex control tasks in centralised and decentralised control architectures.

Practically all the system diagnostics is handled by an optimised safety component, so the entire computing capacity is available to the main processor for the actual application. The HY-TTC 580 has an impressive number of highly flexible inputs and outputs. The outputs in particular provide high individual and total currents or can alternatively be used as inputs.

To achieve differentiated safety levels, three separate PWM shutdown groups are available.

The HY-TTC 580 was developed in accordance with the international standards IEC 61508 and ISO/EN 13849 and is certified by TÜV NORD. It meets the requirements of Functional Safety according to SIL 2 and PL d.

The module is protected in a proven, robust and compact housing, specially designed for the off-highway automotive industry.

Special features
- SIL 2 / PL d certified
- Safety Companion CPU
- CODESYS® Safety SIL 2 with CANopen Safety Master
- CODESYS® 3.X
- Three alternative PWM shutdown groups
- 36 PWM power outputs with current measurement
- 96 configurable inputs and outputs give great flexibility to the I/O groups
- Excellent computing performance
- High number of interfaces, communication and information interfaces
- 7 CAN-bus interfaces
- Ethernet interface for extremely fast software download
- RTC Real Time Clock

Technical data

<table>
<thead>
<tr>
<th>Ambient conditions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature</td>
<td>-40...+85 °C (with full load)</td>
</tr>
<tr>
<td>Operating altitude</td>
<td>0...4,000 m</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>8...32 V (Max. 5.5...32 CPU operative)</td>
</tr>
<tr>
<td>Peak voltage</td>
<td>45 V max. (1 ms)</td>
</tr>
<tr>
<td>Idle current</td>
<td>400/200 mA at 12/24 V</td>
</tr>
<tr>
<td>Standby current</td>
<td>≤1 mA max.</td>
</tr>
<tr>
<td>Current consumption</td>
<td>60 A max. (complete voltage and temperature range)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Features</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>E-mark</td>
<td>Compliant with 2004/108/EC</td>
</tr>
<tr>
<td>Functional safety</td>
<td>EN ISO 13849-PL d-IEC 61508-SIL 2-</td>
</tr>
<tr>
<td>EMC</td>
<td>EN 13309; ISO 14982; CISPR 25</td>
</tr>
<tr>
<td>ISO10605</td>
<td></td>
</tr>
<tr>
<td>Protection class</td>
<td>EN 60929 IP 67; ISO 25563 IP 69K</td>
</tr>
<tr>
<td>Temperature</td>
<td>ISO 16750-2; ISO 7837-2-3</td>
</tr>
<tr>
<td>Vibration, shock, bump</td>
<td>ISO 16750-3</td>
</tr>
</tbody>
</table>

Dimensions and weight

| Housing dimensions          | 231.3 x 204.9 x 38.8 mm |
| Minimum clearance for connection | 316 x 205 x 40 mm |
| Weight                      | 1,200 g |

Features

- 32-Bit TI TMS 570 Dual-core lockstep CPU, 180 MHz, 298 DMIPS, FPU, 3MB int. Flash, 256 KB int. RAM, 8 MB ext. Flash, 2 MB ext RAM
- 64 KB EEPROM
- Safety Companion CPU
- 7 x CAN, 50 kbit/s up to 1 Mbit/s
- 4 x configurable CAN Node terminations
- 1 x Ethernet, up to 10 Mbit/s for software download / debug purposes
- 1 x LIN
- 1 x RS 232
- 1 x RTC

IN

- 8 x Analogue-IN 0...5 V, 0...24 mA or 0...100kΩ, range configurable via software
- 8 x Analogue-IN 0...5 V, 0...10 V or 0...24 mA, range configurable via software
- 8 x Analogue-IN 0...5 V, 0...32 V or 0...24 mA, range configurable via software
- 6 x Timer-IN (Timer inputs 0.1 Hz...20 kHz) / Timer-IN (7/14 mA) / Analogue-IN (0...32 V) configurable pull-up/down, encoder
- 6 x Timer-IN (Timer inputs 0.1 Hz...20 kHz) / Analogue-IN (0...32 V) configurable pull-up/down, encoder
- K 15 and wake up

OUT

- 8 x Programmable OUT 4 A high-side, current measurement, configurable as digital OUT or timer outputs (0...10 kHz)
- 8 x Digital-OUT 4 A high-side, with current monitoring, overload and load detection, configurable as 8 x Analogue-IN (0...32 V) with configurable pull-up/down or LED controller
- 8 x Digital-OUT 4 A low-side, with current monitoring, overload and load detection, configurable as 8 x Analogue-IN (0...32 V)
- Wiring up to 8 Digital-OUT high-side and 8 digital-OUT low-side as full bridge control for the control of direct current motors

Multipurpose I/Os

- 8 x Voltage.OUT 15...85 % Vref or Voltage.OUT 0...75 % Vref or Digital.OUT 4 A high-side or LED controller or Analogue-IN, 0...32 V
- Internal monitoring of board temperature, sensor supply and battery voltage
- 1 x Sensor supply 5...10 V / max. 2.5 W configurable with increments of 1 V
- 2 x sensor supply 5 V (300 mA)
- Programming in C, CODESYS® or CODESYS® Safety SIL 2 with CANopen Safety Master

Note: All I/Os and interfaces are protected against short circuit to GND and BAT+.
- All I/Os are configurable as Digital-IN.
- All I/Os have 12 bit resolution.

Note: For more information, please refer to the HYDAC Safety SIL 2 with CANopen Safety Master documentation.
**Model code**

HY-TTC 580 – XX – 2.3M – 011M – 00 – S2Pd – 000

**Programming environment**
- CP = C programming
- CD = CODESYS® or CODESYS® Safety SIL 2

**RAM**
- 2.3M = 2 MB ext. RAM, 256 kB int. RAM

**Flash**
- 011M = 11 MB Flash (8 MB ext. Flash, 3 MB int. Flash)

**Equipment options**
- 00 = standard

**Functional safety**
- S2Pd = SIL 2 and Performance Level d

**Modification number**
- 000 = standard

**Note:**

On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

**Accessories**

Appropriate accessories, such as cables and connectors, service tools, software etc. can be found in the Accessories section.

**Dimensions**

HYDAC ELECTRONIC GmbH
Hauptstraße 27
66128 Saarbrücken, Germany
Tel. +49 6897 509-01
Fax +49 6897 509-1726
E-mail: electronic@hydac.com
Internet: www.hydac.com

The information in this brochure relates to the operating conditions and applications described.

For applications and operating conditions not described, please contact the relevant technical department.

Subject to technical modifications.
Universal Compact Controller

HY-TTC 30-H

Description

The HY-TTC 30-H is a compact controller, based on an Infineon XC22xx microcontroller, which was specially developed for use in low-cost applications or smaller machines. With its 30 freely configurable I/Os it can be operated with a wide variety of sensors and actuators. The 30-H version is best suited to controlling proportional functions. Six out of the eight PWM outputs have integrated current measurement which means that up to three hydraulic axes can be current controlled.

The HY-TTC 30-H was specially developed for vehicles and machines used in rugged operating environments and at extreme operating temperatures. The module is protected in a proven, robust and compact housing, specially designed for the off-highway automotive industry.

Special features

- 30 inputs and outputs:
  - 10 analogue-inputs
  - 4 timer-inputs
  - 8 PWM-Outputs, high-side:
    - 6 with integrated current measurement
    - 2 digital-outputs, low-side
    - 6 ratiometric voltage outputs
- Robust, very compact die-cast aluminium housing
- Waterproof, 48-pin male connection

Technical data

<table>
<thead>
<tr>
<th>Ambient conditions</th>
<th>Operating temperature</th>
<th>-40 °C .. +85 °C (with full load)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Operating altitude</td>
<td>0 .. 4,000 m</td>
</tr>
<tr>
<td></td>
<td>Supply voltage</td>
<td>8 .. 32 V</td>
</tr>
<tr>
<td></td>
<td>Peak voltage</td>
<td>40 V max.</td>
</tr>
<tr>
<td></td>
<td>Idle current</td>
<td>40 .. 120 mA</td>
</tr>
<tr>
<td></td>
<td>Standby current</td>
<td>≤1 mA</td>
</tr>
<tr>
<td></td>
<td>Current consumption</td>
<td>24 A max.</td>
</tr>
</tbody>
</table>

Fulfills the following standards

- Compliant with 2004/108/EC
- ECE-R10 Rev.4
- EN 13309/ ISO 14982/ CISPR 25
- ISO 16065
- ISO 16750-2 / ISO 7637-2-3, limited to 40 V with external load dump protection
- EN 60529 IP 67 / ISO 20653 IP 6K9K
- ISO 16750-4

Dimensions and weight

- Housing dimensions: 147 x 92 x 38 mm
- Minimum clearance for connection: 208 x 94 x 38 mm
- Weight: 330 g

Features

- Infineon XC 22xx microcontroller, 80 MHz, 768 kB int. Flash, 82 kB int. RAM
- 8 KByte EEPROM
- 1 x CAN, 125 kbit/s up to 1 Mbit/s with configurable termination
- 2 x Node ID pins for optional configuration of CAN-ID

IN

- 6 x Analogue-IN 0 .. 5 V / 0 .. 10 V or 0 .. 25 mA or 25 mA LED lamps OUT configurable via software
- 2 x Analogue-IN 0 .. 5 V / 0 .. 10 V / 0 .. 25 mA / 0 .. 65 kOhm or 25 mA LED lamps OUT configurable via software
- 2 x Analogue-IN 0 .. 32 V with configurable pull-up/down in digital voltage input mode
- 4 x Timer-IN (timer inputs 0.1 Hz .. 10 kHz) / Analogue-IN 0 .. 32 V configurable pull-up/down, 1 encoder

OUT

- 6 x PWM-OUT 3 A high-side, current measurement, overload and wirebreak detection configurable as 6 x Timer-IN (10 Hz - 10 kHz) / Analogue-IN 0 .. 32 V with integrated pull-up
- 2 x PWM-OUT / Digital-OUT 3 A high side, overload and wirebreak detection configurable as 2 x Analogue-IN 0 .. 32 V with integrated pull-up
- 2 x Digital-OUT 3 A low-side, overload and wirebreak detection configurable as 2 x Analogue-IN 0 .. 32 V with integrated pull-up
- 6 x Analogue-OUT 15 % .. 85 % V_{bat} (ratiometric) configurable as 0 V .. 75 % V_{bat} with 10 kOhm low-side load or 6 x Analogue-IN 0 .. 32 V
- Dedicated power supply pins for high-side outputs
- Internal monitoring of board temperature, sensor supply, K15 input and battery voltage
- 1 x sensor supply 5 V (100 mA)

Note: 1) All I/Os and interfaces are protected against short circuit to GND and BAT+.
2) All analogue inputs have 10 bit resolution.
**HY-TTC 30-H**

**XC 2200**
- 768 kB Flash
- 82 kB RAM
- 80 MHz
- CAN controller up to 1 Mbit/s

**EEPROM**
- 8 KByte

**Node-ID Inputs**

**Sensor supply**
- 5 V 100 mA

**Internal monitoring:**
- Board temperature
- Battery voltage
- Sensor supply
- K 15 input

**JTAG**

**CAN**

**4 x Timer-IN**
- 0.1 Hz .. 10 kHz
- Analogue-IN
- 0 - 32 V
- Pull-Up/Down

**2 x Analogue-IN**
- 0 - 32 V
- Pull-up/Down

**2 x Analogue-IN**
- 0 - 5 V / 0 - 10 V / 0 - 25 mA
- 0 - 65 kOhm / 10 bit
- 25 mA LED lamps OUT

**6 x Analogue-IN**
- 0 - 5 V / 0 - 10 V / 0 - 25 mA / 10 bit
- 25 mA LED lamps OUT

**6 x Analogue-OUT**
- (ratiometric)
- Configurable as
- 6 x Voltage-OUT
- 6 x Analogue-IN
- 0 - 32 V

**6 x PWM-OUT**
- 3 A (high-side)
- With current measurement configurable as
- 6 x Timer-IN
- 10 Hz - 10 kHz
- 6 x Analogue-IN
- 0 - 32 V

**2 x PWM-OUT**
- 3 A (high-side)
- Configurable as
- 2 x Timer-IN
- 10 Hz - 10 kHz
- 2 x Analogue-IN
- 0 - 32 V

**2 x Digital-OUT**
- 3 A (low-side)
- Configurable as
- 2 x Analogue-IN
- 0 - 32 V
**Model code**

**Firmware**
- CP = C/C++

**Equipment options**
- 00 = standard
- 10 = developer version

**Modification number**
- 000 = standard

**Note**

On units with a different modification number, please read the label or the technical amendment details supplied with the unit.

**Accessories**

Appropriate accessories, such as electrical connectors, service tools, software, etc. can be found in the Accessories section.

---

**Note**

The information in this brochure relates to the operating conditions and applications described. For applications and operating conditions not described, please contact the relevant technical department. Subject to technical modifications.

---

**Dimensions**

[Diagram of the device with dimensions labeled: 78 x 7 x 7, 78 x 146.6 x 7, 7 x 123.4 x 7, 38 x 4 x 7, 92 x 4 x 7]
Description
The HY-TTC 30S-H is a compact controller, based on an Infineon XC22xx microcontroller, which was specially developed for use in low-cost applications or smaller machines. With its 28 freely configurable I/Os it can be operated with a wide variety of sensors and actuators.

The HY-TTC 30S-H module was developed in accordance with the international standard ISO/EN 13849 and is certified by TÜV NORD. It meets the requirements of Functional Safety according to PL c (Performance Level c).

The HY-TTC 30S-H version is best suited to controlling proportional functions. Six out of the eight PWM outputs have integrated current measurement which means that up to three hydraulic axes can be current controlled.

The 30S-H version has been optimised for system expansion to include additional hydraulic functions.

The module is protected in a proven, robust and compact housing, specially designed for the off-highway automotive industry.

Technical data

### Ambient conditions
- **Operating temperature**: -40 .. +85 °C (with full load)
- **Operating altitude**: 0 .. 4,000 m
- **Supply voltage**: 8 .. 32 V
- **Peak voltage**: 40 V max.
- **Idle current**: 40 .. 120 mA
- **Standby current**: ≤1 mA
- **Current consumption**: 24 A max.

### Fulfils the following standards
- **E-mark**: Compliant with 2004/108/EC
- **E-mark**: ECE-R10 Rev.4
- **Functional safety**: EN ISO 13849 - PL c
- **EMC**: EN 13309 / ISO 14982 / CISPR 25
- **ESD**: ISO 10605
- **Electrical**: ISO 16750-2 / ISO 7637-2-3, limited to 40 V with external load dump protection
- **Protection class**: EN 60529 IP 67 / ISO 20653 IP 6K9K
- **Temperature**: ISO 16750-4
- **Vibration, shock, bump**: ISO 16750-3

### Dimensions and weight
- **Housing dimensions**: 146.6 x 92 x 38 mm
- **Minimum clearance for connection**: 208 x 94 x 39 mm
- **Weight**: 330 g

### Features
1) Infineon XC 22xx microcontroller, 80 MHz, 768 kB int. Flash, 82 kByte int. RAM, 8 kByte EEPROM
2) 1 x CAN, 125 kbit/s up to 1 Mbit/s, termination configurable via pin
3) 2 x Node ID pins for optional configuration
4) 2 x Analogue-IN 0 .. 5 V / 0 .. 10 V / 0 .. 25 mA or 25 mA LED lamps OUT configurable via software, PL c capable
5) 2 x Analogue-IN 0 .. 32 V with configurable pull-up/down, digital voltage input mode, PL c capable
6) 4 x Timer-IN (timer inputs 0.1 Hz .. 10 kHz) / Analogue-IN 0 .. 32 V, 1 encoder configurable pull-up/down in digital voltage input mode, PL c capable
7) 6 x Analogue-OUT 15 % .. 85 % V
8) 6 x Analogue-OUT 15 % .. 85 % V, 10 kOhm low-side load or Analogue-IN 0 .. 32 V

### Note:
1) All I/Os and interfaces are protected against short circuit to GND and BAT+.
2) All analogue inputs have 10 bit resolution.
3) All analogue inputs can be used as digital inputs with configurable switching thresholds.
4) All inputs can be used for functional safety.
5) If two inputs of the same type are connected in parallel for redundancy, they are part of the safety design and cannot be controlled directly via the software.
Block circuit diagram

HY-TTC 30S-H

XC 22xx
- 768 kB Flash
- 82 kB RAM
- 80 MHz
- Software Watchdog

CAN controller up to 1 Mbit/s

EEPROM 8 KByte

Node-ID Inputs

Sensor supply 5 V 100 mA

JTAG

CAN

4 x Timer-IN
- 0.1 Hz, 10 kHz
- Analogue-IN
- 0 - 32 V
- Pull-Up/Down

2 x Analogue-IN
- 0 - 32 V
- Pull-up/Down

2 x Analogue-IN
- 0 - 5 V / 0 - 10V / 0 - 25 mA
- 0 - 65 kOhm / 10 bit
- 25 mA LED lamps OUT

6 x Analogue-IN
- 0 - 5 V / 0 - 10V / 0 - 25 mA / 10 bit
- 25 mA LED lamps OUT

6 x PWM-OUT
- 3 A (high-side)
- with current measurement configurable as
- 6 x Timer-IN
- 10 Hz - 10 kHz
- or
- 6 x Analogue-IN
- 0 - 32 V

2 x PWM-OUT
- 3 A (high-side)
- configurable as
- 2 x Timer-IN
- 10 Hz - 10 kHz
- or
- 2 x Analogue-IN
- 0 - 32 V

2 x Digital-OUT
- 3 A (low-side)
- Use as safety switch

6 x Analogue-OUT (ratiometric)
- configurable as
- 6 x Voltage-OUT
- or
- 6 x Analogue-IN
- 0 - 32 V

Internal monitoring:
- Board temperature
- Battery voltage
- Sensor supply
- K 15 input

Watchdog
Model code

**Firmware**
CP = C/C++

**Equipment options**
00 = standard

**Functional safety**
Pc = requirements for PL c

**Modification number**
000 = standard

Note
On units with a different modification number, please read the label or the technical amendment details supplied with the unit.

Accessories
Appropriate accessories, such as electrical connectors, service tools, software, etc. can be found in the Accessories section.

Dimensions

Note
The information in this brochure relates to the operating conditions and applications described.
For applications and operating conditions not described, please contact the relevant technical department.
Subject to technical modifications.

HYDAC ELECTRONIC GmbH
Hauptstraße 27
66128 Saarbrücken, Germany
Tel. +49 6897 509-01
Fax +49 6897 509-1726
E-mail: electronic@hydac.com
Internet: www.hydac.com
In the fast-moving and varied world of the mobile machine, today’s manufacturers attach great importance to flexibility.

Expansions or changes to machine functions must not be achieved by re-designing the machine. The preferred option is to use controls, therefore, which enable quick and uncomplicated expansion of on-board electronics, based on their internal interfaces. This means that it must be possible to incorporate, with the minimum outlay, inputs and outputs which were not provided in the basic version of a machine, into the present machine control.

HYDAC ELECTRONIC meets this requirement for additional inputs and outputs with its simple-to-integrate I/O expansion modules. The manufacturers of machines using HYDAC control technology are therefore not restricted in terms of expanding the functions of their products in the future.

The communication and integration of the expansion modules takes place via CANopen. It enables their inputs and outputs to be configured and parameterized via the control configuration of the available controller in a simple and uncomplicated way.

**HYDAC expansion modules for a variety of applications**

The versions of the I/O expansion module provide additional varied PWM outputs with internal current measurement and an integrated PID control device, alongside numerous powerful switch outputs. These permit very simple proportional controls to be implemented.

The detection of digital switch and analogue current/voltage signals is possible using digital and analogue inputs which can be parameterized differently.

The HY-TTC 30X series of I/O expansion modules provides an outstanding power balance combined with extremely compact design. The particularly powerful PWM outputs offers the possibility of driving valves using on-board electronics directly via proportional voltage outputs. Generally speaking, this series of instruments offers great flexibility and electrical power and can therefore provide the optimal solution for almost all common tasks.

Of particular note are our I/O expansion modules with increased functional safety which include both the well-proven HY-TTC 48XS and the newly developed HY-TTC 30XS series. The 30XS-H version has been optimised for system expansion to include additional hydraulic functions and the 30XS-I version to include additional inputs. These modules combine the advantages of decentralization with simultaneously secure signal processing and control, a combination which is completely new to the mobile controller market.
The range of I/O expansion modules

In the following table, basic information on the I/O expansion modules is summarized. You will find more detailed descriptions including all the technical data and the relevant block circuit diagram in the individual data sheets.

<table>
<thead>
<tr>
<th>Type</th>
<th>HY TTC 30X-H</th>
<th>HY TTC 30X-O</th>
<th>HY TTC 30X-I</th>
<th>HY TTC 30XS-H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional safety (certified by TÜV Nord)</td>
<td></td>
<td></td>
<td></td>
<td>EN 13849 PL c</td>
</tr>
<tr>
<td>Communication</td>
<td>CANopen DS 401</td>
<td>CANopen DS 401</td>
<td>CANopen DS 401</td>
<td>CANopen DS 304/401</td>
</tr>
<tr>
<td>Total I/O</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>PWM-OUT with current measurement</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>PWM-OUT</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Current measurement inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. current consumption</td>
<td>24 A</td>
<td>24 A</td>
<td>24 A</td>
<td>24 A</td>
</tr>
<tr>
<td>Analogue-IN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 x 0.5 V / 0.10 V / 0.25 mA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 x 0.32 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 x 0.5 V / 0.10 V / 0.25 mA / 0.65 kΩ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 x 0.32 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 x 0.5 V / 0.10 V / 0.25 mA / 0.65 kΩ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timer-IN</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Digital-IN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 x 3 A low-side</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage-OUT</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Stabilized sensor supply</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 x 5 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The total I/O and current measurement specifications are as follows:

- **Total I/O**: 30
- **PWM-OUT**: 6
- **PWM-OUT with current measurement**: 2
- **Max. current consumption**: 24 A
- **Analogue-IN**: 10 total, 12 total, 18 total, 10 total
- **Current measurement inputs**: 2 x 0.32 V
- **Timer-IN**: 4
- **Digital-IN**: 2 x 3 A low-side
- **Digital-OUT**: 8 x 3 A high-side
- **Voltage-OUT**: 6
- **Stabilized sensor supply**: 1 x 5 V
<table>
<thead>
<tr>
<th>Type</th>
<th>HY TTC 30XS-I</th>
<th>HY-TTC 36X</th>
<th>HY-TTC 48X</th>
<th>HY-TTC 48XS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional safety (certified by TÜV Nord)</td>
<td>EN 13849 PL c</td>
<td></td>
<td></td>
<td>EN 13849 PL d</td>
</tr>
<tr>
<td>Communication</td>
<td>CANopen DS 304/401</td>
<td>CANopen DS 401</td>
<td>CANopen DS 401</td>
<td>CANopen DS 304/401</td>
</tr>
<tr>
<td>Total I/O</td>
<td>30</td>
<td>40</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>PWM-OUT with current measurement</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PWM-OUT</td>
<td>2</td>
<td>4</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Current measurement inputs</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Max. current consumption</td>
<td>24 A</td>
<td>25 A</td>
<td>25 A</td>
<td>25 A</td>
</tr>
<tr>
<td>Analogue-IN</td>
<td>8 total 6 x 0..5 V / 0..10 V / 0.. .25 mA 10 x 0.. .32 V 2 x 0..5 V / 0..10 V / 0.. .25 mA / 0.. .65 kΩ</td>
<td>8 x 0..5 V / 4..20 mA</td>
<td>16 total 8 x 0..5 V / 4..20 mA 8 x 0..32 V</td>
<td>16 total 8 x 0..5 V / 4..20 mA 8 x 0..32 V</td>
</tr>
<tr>
<td>Timer-IN</td>
<td>8</td>
<td>8</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Digital-IN</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Digital-OUT</td>
<td>8 x 4 A high-side</td>
<td>8 x 4 A high-side</td>
<td>8 x 4 A high-side</td>
<td></td>
</tr>
<tr>
<td>Voltage-OUT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stabilized sensor supply</td>
<td>1 x 5 V</td>
<td>1 x 8.5 V / 10 V / 14.5 V 2 x 5 V</td>
<td>1 x 8.5 V / 10 V / 14.5 V 2 x 5 V</td>
<td>1 x 8.5 V / 10 V / 14.5 V 2 x 5 V</td>
</tr>
</tbody>
</table>
Description

The HY-TTC 30X-H module is an intelligent I/O module which can be controlled and parameterized both via CANopen Standard according to CiA DS 401 and via SAE J 1939.

The HY-TTC 30X-H was specifically designed for use in low-cost applications or smaller machines. It provides a means of expanding control systems with additional inputs and outputs, and hence additional functionality, in a simple and uncomplicated way.

The 30X-H version has been optimised for expansion to include additional hydraulic functions.

The PID control devices built into the instrument make it possible to develop independent proportional controls in conjunction with the powerful PWM outputs and the current measurement.

The module is protected in a proven, robust and compact housing, specially designed for the off-highway automotive industry.

Special features

- Freely configurable Node-ID via CAN
- 30 inputs and outputs:
  - 10 analogue inputs
  - 4 timer inputs
  - 8 PWM outputs, high-side:
    - 6 with integrated current measurement
  - 2 digital outputs, low-side
  - 6 ratiometric Voltage outputs
- Robust, very compact die-cast aluminium housing
- Waterproof, 48-pin male connection

Technical data

Ambient conditions

- Operating temperature: -40 .. +85 °C (with full load)
- Supply voltage: 8 .. 32 V
- Peak voltage: 40 V max.
- Idle current: 40 .. 120 mA
- Standby current: ≤1 mA
- Current consumption: 24 A max.

Fulfilts the following standards

- E-mark: Compliant with 2004/108/EC
- E-mark: ECE-R10 Rev.4
- EMC: EN 13309 / ISO 14982 / CISPR 25
- ESD: ISO 10605
- Electrical: ISO 16750-2 / ISO 7637-2-3, limited to 40 V with external load dump protection
- Temperature: ISO 16750-4
- Vibration, shock, bump: ISO 16750-3
- Communication profile: CANopen CiA DS 401 / SAE J1939

Dimensions and weight

- Housing dimensions: 147 x 92 x 38 mm
- Minimum clearance for connection: 208 x 94 x 38 mm
- Weight: 330 g

Features

- Infineon XC 22xx microcontroller, 80 MHz, 768 kB int. Flash, 82 kB int. RAM
- 8 kByte EEPROM
- 1 x CAN, 50 kbit/s up to 1 Mbit/s with configurable termination
- 2 x Node ID pins for optional configuration of CAN-ID

IN

- 6 x Analogue-IN 0 .. 5 V / 0 .. 10 V or 0 .. 25 mA or 25 mA LED lamps OUT configurable via software
- 2 x Analogue-IN 0 .. 5 V / 0 .. 10 V / 0 .. 25 mA / 0 .. 65 kOhm or 25 mA LED lamps OUT configurable via software
- 2 x Analogue-IN 0 .. 32 V with configurable pull-up/down in digital voltage input mode
- 4 x Timer-IN (timer inputs 0.1 Hz .. 10 kHz) / Analogue-IN 0 .. 32 V configurable pull-up/down, 1 encoder

OUT

- 6 x PWM-OUT 3 A high-side, current measurement, overload and wirebreak detection configurable as 6 x Timer-IN (10 Hz - 10 kHz) / Analogue-IN 0 .. 32 V with integrated pull-up
- 2 x PWM-OUT / digital-OUT 3 A high-side, current measurement, overload and wirebreak detection configurable as 2 x Timer-IN (10 Hz - 10 kHz) / Analogue-IN 0 .. 32 V with integrated pull-up
- 2 x Digital-OUT 3 A low-side, overload and wirebreak detection configurable as 2 x Analogue-IN 0 .. 32 V with integrated pull-up
- 6 x Analogue-OUT 15 % .. 85 % V (ratiometric) configurable as 0 V .. 75 % V with 10 kOhm low-side load or 6 x Analogue-IN 0 .. 32 V
- Dedicated power supply pins for high side outputs
- Internal monitoring of board temperature, sensor supply, K15 input and battery voltage
- 1 x sensor supply 5 V (100 mA)

Note:

1) All I/Os and interfaces are protected against short circuit to GND and BAT+.
2) All analogue inputs have 10 bit resolution.
**Block circuit diagram**

**HY-TTC 30X-H**

- **XC 2200**
  - 768 kB Flash
  - 82 kB RAM
  - 80 MHz
  - CAN controller up to 1 Mbit/s

- **EEPROM**
  - 8 KByte
  - Node-ID Inputs
  - Sensor-ID Inputs
  - 5 V supply 100 mA

- **Internal monitoring:**
  - Board temperature
  - Battery voltage
  - Sensor supply
  - K 15 input

- **CAN**
  - 4 x Timer-IN
    - 0.1 Hz .. 10 kHz
    - or
    - Analogue-IN
    - 0 - 32 V
    - Pull-up/Down

- **2 x Analogue-IN**
  - 0 - 32 V
  - Pull-up/Down

- **2 x Analogue-IN**
  - 0 - 5 V / 0 - 10 V / 0 - 25 mA
  - 0 - 65 kOhm / 10 bit
  - or
  - 25 mA LED lamps OUT

- **6 x Analogue-IN**
  - 0 - 5 V / 0 - 10 V / 0 - 25 mA
  - 0 - 25 mA / 10 bit
  - or
  - 25 mA LED lamps OUT

- **6 x Analogue-OUT**
  - (ratiometric)
  - configurable as
  - 6 x Voltage-OUT
  - or
  - 6 x Analogue-IN
  - 0 - 32 V

- **6 x PWM-OUT**
  - 3 A high-side
  - with current measurement configurable as
  - 6 x Timer-IN
    - 10 Hz - 10 kHz
    - or
  - 6 x Analogue-IN
    - 0 - 32 V

- **2 x PWM-OUT**
  - 3 A high-side
  - configurable as
  - 2 x Timer-IN
    - 10 Hz - 10 kHz
    - or
  - 2 x Analogue-IN
    - 0 - 32 V

- **2 x Digital-OUT**
  - 3 A (low-side)
  - configurable as
  - 2 x Analogue-IN
    - 0 - 32 V
**Model code**

**HY-TTC 30X – H – FXX – 00 – 000**

**CAN protocol**
- F11 = CANopen slave
- F12 = CAN J1939 slave

**Equipment options**
- 00 = standard

**Modification number**
- 000 = standard

**Note**
On units with a different modification number, please read the label or the technical amendment details supplied with the unit.

**Accessories**
Appropriate accessories, such as electrical connectors, service tools, software, etc. can be found in the Accessories section.

**Dimensions**

Note the information in this brochure relates to the operating conditions and applications described.

For applications and operating conditions not described, please contact the relevant technical department.

Subject to technical modifications.
Description

The HY-TTC 30X-O module is an intelligent I/O module which can be controlled and parameterized both via CANopen Standard according to CiA DS 401 and via SAE J 1939.

The HY-TTC 30X-O was specially designed for use in low-cost applications or smaller machines. It provides a means of expanding control systems with additional inputs and outputs, and hence additional functionality, in a simple and uncomplicated way.

The 30X-O version has been optimised for expansion to include additional inputs.

The module is protected in a proven, robust and compact housing, specially designed for the off-highway automotive industry.

Special features

- Freely configurable Node-ID via CAN
- 30 inputs and outputs - 12 analogue inputs - 4 timer inputs - 8 digital outputs, high-side - 6 ratiometric voltage outputs
- Robust, very compact die-cast aluminium housing
- Waterproof, 48-pin male connection

Technical data

<table>
<thead>
<tr>
<th>Ambient conditions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature</td>
<td>-40 .. +85 °C (with full load)</td>
</tr>
<tr>
<td>Operating altitude</td>
<td>0 .. 4,000 m</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>8 .. 32 V</td>
</tr>
<tr>
<td>Peak voltage</td>
<td>40 V max.</td>
</tr>
<tr>
<td>Idle current</td>
<td>40 .. 120 mA</td>
</tr>
<tr>
<td>Standby current</td>
<td>≤ 1 mA</td>
</tr>
<tr>
<td>Current consumption</td>
<td>24 A max.</td>
</tr>
</tbody>
</table>

Fulfils the following standards

- E-mark
- EMC
- ESD
- Electrical
- Protection class
- Temperature
- Vibration, shock, bump
- Communication profile

Dimensions and weight

- Housing dimensions: 147 x 92 x 38 mm
- Minimum clearance for connection: 208 x 94 x 38 mm
- Weight: 330 g

Features

- Infineon XC 22xx microcontroller, 80 MHz, 768 kB int. Flash, 82 kByte int. RAM
- 8 kByte EEPROM
- 1 x CAN, 50 kbit/s up to 1 Mbit/s with configurable termination
- 2 x Node ID pins for optional configuration of CAN-ID
- 6 x Analogue-IN 0 .. 5 V / 0 .. 10 V or 0 .. 25 mA or 25 mA LED lamps OUT configurable via software
- 2 x Analogue-IN 0 .. 5 V / 0 .. 10 V / 0 .. 25 mA / 0 .. 65 kOhm or 25 mA LED lamps OUT configurable via software
- 2 x Analogue-IN 0 .. 32 V with integrated pull-up
- 2 x Analogue-IN 0 .. 32 V with configurable pull-up/down in digital voltage input mode
- 4 x Timer-IN (timer inputs 0.1 Hz .. 10 kHz) / Analogue-IN 0 .. 32 V, 1 encoder configurable pull-up/down in Digital-IN mode
- 8 x Digital-OUT 3 A high-side, overload and wirebreak detection configurable as 8 x Timer-IN (10 Hz .. 10 kHz) / Analogue-IN 0 .. 32 V with integrated pull-up
- 6 x Voltage-OUT 0 V .. 75 % V_{max} with 10 kOhm low-side load, configurable 15 % .. 85 % V_{max} (ratiometric) or 6 x Analogue-IN 0 .. 32 V
- Dedicated power supply pins for high-side outputs
- Internal monitoring of board temperature, sensor supply, K15 input and battery voltage
- 1 x sensor supply 5 V (100 mA)

Note:

1) All I/Os and interfaces are protected against short circuit to GND and BAT+.
2) All analogue inputs have 10 bit resolution.
HY-TTC 30X-O

**XC 2200**
- 768 kB Flash
- 82 kB RAM
- 80 MHz

**EEPROM**
- 8 KByte

**CAN controller**
- up to 1 Mbit/s

**Node-ID Inputs**

**Sensor supply**
- 5 V 100 mA

---

**4 x Timer-IN**
- 0.1 Hz .. 10 kHz
- or
- Analogue-IN
- 0 - 32 V
- Pull-up/Down

---

**2 x Analogue-IN**
- 0 - 32 V / 10 bit
- Pull-up/Down

---

**2 x Analogue-IN**
- 0 - 32 V / 10 bit
- Pull-up

---

**2 x Analogue-IN**
- 0 - 5 V / 0 - 10V / 0 - 25 mA
- 0 - 65 kOhm / 10 bit
- or
- 25 mA LED lamps OUT

---

**6 x Analogue-IN**
- 0 - 5 V / 0 - 10V / 0 - 25 mA
- 0 - 25 mA / 10 bit
- or
- 25 mA LED lamps OUT

---

**8 x Digital-OUT**
- 3 A high-side
- configurable as
- 8 x timer-IN
- 10 Hz - 10 kHz
- or
- 6 x Analogue-IN
- 0 - 32 V

---

**6 x Voltage-OUT**
- configurable as
- 6 x Analogue-OUT
- (ratiometric)
- or
- 6 x Analogue-IN

---

**Internal monitoring:**
- Board temperature
- Battery voltage
- Sensor supply
- K 15 input

---

**Block circuit diagram**

**HY-TTC 30X-O**
### Model code

**HY-TTC 30X – O – FXX – 00 – 000**

### CAN protocol

- F11 = CANopen slave
- F12 = CAN J1939 slave

### Equipment options

- 00 = standard

### Modification number

- 000 = standard

### Note

On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

### Accessories

Appropriate accessories, such as electrical connectors, service tools, software, etc. can be found in the Accessories section.

### Dimensions

![Dimensions diagram]

### Note

The information in this brochure relates to the operating conditions and applications described. For applications and operating conditions not described, please contact the relevant technical department. Subject to technical modifications.

**HYDAC ELECTRONIC GmbH**

Hauptstraße 27
66128 Saarbrücken, Germany

Tel. +49 6897 509-01
Fax +49 6897 509-1726
E-mail: electronic@hydac.com
Internet: www.hydac.com
Description

The HY-TTC 30X-I module is an intelligent I/O module which can be controlled and parameterized both via CANopen Standard according to CiA DS 401 and via SAE J 1939.

The HY-TTC 30X-I was specially designed for use in low-cost applications or smaller machines. It provides a means of expanding control systems with additional inputs and outputs, and hence additional functionality, in a simple and uncomplicated way.

The 30X-I version has been optimised for expansion to include additional inputs.

The module is protected in a proven, robust and compact housing, specially designed for the off-highway automotive industry.

Special features

- Freely configurable Node-ID via CAN
- 30 inputs and outputs:
  - 18 analogue inputs
  - 8 timer-inputs
  - 4 PWM outputs, high-side
  2 with integrated current measurement
- Robust, very compact die-cast aluminium housing
- Waterproof, 48-pin male connection

Technical data

Ambient conditions

- Operating temperature: -40 .. +85 °C (with full load)
- Operating altitude: 0 .. 4,000 m
- Supply voltage: 8 .. 32 V
- Peak voltage: 40 V max.
- Idle current: 40 .. 120 mA
- Standby current: ≤ 1 mA
- Current consumption: 12 A max.

Fulfils the following standards

- E-mark: Compliant with 2004/108/EC
- EMC: EN 13309/ ISO 14982/ CISPR 25
- ESD: ISO 10605
- Electrical: ISO 16750-2 / ISO 7637-2-3, limited to 40 V with external load dump protection
- Temperature: ISO 16750-4
- Vibration, shock, bump: ISO 16750-4
- Communication profile: CANopen CiA DS 401/ SAE J1939

Dimensions and weight

- Housing dimensions: 147 x 92 x 38 mm
- Minimum clearance for connection: 208 x 94 x 38 mm
- Weight: 330 g

Features

- Infineon XC 22xx microcontroller, 80 MHz, 768 kB int. Flash, 82 kByte int. RAM
- 8 kByte EEPROM
- 1 x CAN, 50 kbit/s up to 1 Mbit/s with configurable termination
- 2 x Node ID pins for optional configuration of CAN-ID
- 6 x Analogue-IN 0 .. 5 V / 0 .. 10 V / 0 .. 25 mA or 25 mA LED lamps OUT configurable via software
- 2 x Analogue-IN 0 .. 5 V / 0 .. 10 V / 0 .. 25 mA / or 0 .. 65 kOhm or 25 mA LED lamps OUT configurable via software
- 2 x Analogue-IN 0 .. 32 V with integrated pull-up/pull-down in digital voltage input mode
- 6 x Analogue-IN 0 .. 32 V
- 4 x Timer-IN (timer inputs 0.1 Hz .. 10 kHz) / Analogue-IN 0 .. 32 V configuruable pull-up/down digital voltage input mode, 1 encoder
- 4 x Timer-IN (timer input 10 Hz .. 10 kHz) / Analogue-IN 0 .. 32 V with integrated pull-up/pull-down
- 2 x PWM-OUT / Digital-OUT 3 A high-side, current measurement, overload and wirebreak detection configurable as 2 x timer-IN (10 Hz - 10 kHz) / Analogue-IN with integrated pull-up/pull-down
- Dedicated power supply pins for high side outputs
- Internal monitoring of board temperature, sensor supply, K15 input and battery voltage
- 1 x sensor supply 5 V (100 mA)

Note:

1) All I/Os and interfaces are protected against short circuit to GND and BAT+
2) All analogue inputs have 10 bit resolution
**Block circuit diagram**

**HY-TTC 30X-I**

- **XC 2200**
  - 768 kB Flash
  - 82 kB RAM
  - 80 MHz
  - CAN controller up to 1 Mbit/s

- **EEPROM 8 KByte**

- **Node-ID Inputs**

- **Sensor supply 5 V 100 mA**

- **CAN**

- **4 x Timer-IN**
  - 0.1 Hz .. 10 kHz
  - Analogue-IN
  - 0 - 32 V
  - Pull-up/Down

- **4 x Timer-IN**
  - 10 Hz – 10 kHz
  - Analogue-IN
  - Pull-up

- **2 x PWM-OUT**
  - 3 A high-side
  - with current measurement configurable as
  - 2 x Timer-IN
  - 10 Hz - 10 kHz
  - or
  - 2 x Analogue-IN
  - 0 - 32 V

- **2 x PWM-OUT**
  - 3 A high-side
  - configurable as
  - 2 x Timer-IN
  - 10 Hz - 10 kHz
  - or
  - 2 x Analogue-IN
  - 0 - 32 V

- **2 x Analogue-IN**
  - 0 - 5 V / 0 - 10V / 0 - 25 mA
  - 0 - 65 kOhm / 10 bit
  - or
  - 25 mA LED lamps OUT

- **6 x Analogue-IN**
  - 0 - 5 V / 0 - 10V / 0 - 25 mA
  - 10 bit
  - or
  - 25 mA LED lamps OUT

- **2 x Analogue-IN**
  - 0 - 32 V / 10 bit
  - Pull-up

- **2 x Analogue-IN**
  - 0 - 32 V
  - Pull-up/Down

- **6 x Analogue-IN**
  - 0 - 32 V / 10 bit

- **Internal monitoring:**
  - Board temperature
  - Battery voltage
  - Sensor supply
  - K 15 input
Model code

HY-TTC 30X – I – FXX – 00 – 000

CAN protocol
F11 = CANopen slave
F12 = CAN J1939 slave

Equipment options
00 = standard

Modification number
000 = standard

Note
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

Accessories
Appropriate accessories, such as electrical connectors, service tools, software, etc. can be found in the Accessories section.

Dimensions

Note
The information in this brochure relates to the operating conditions and applications described.
For applications and operating conditions not described, please contact the relevant technical department.
Subject to technical modifications.
**Description**

The HY-TTC 30XS-H module was developed for distributed applications with increased functional safety.

Using the general standard, CANopen Safety to CIA DS 304 and CIA DS 401, the module can be easily controlled and integrated in the existing control system.

The HY-TTC 30XS-H module was developed in accordance with the international standard ISO/EN 13849 and is certified by TÜV NORD. It meets the requirements of Functional Safety according to PL c (Performance Level c).

The 30XS-H version has been optimised for system expansion to include additional hydraulic functions.

The module is protected in a proven, robust and compact housing, specially designed for the off-highway automotive industry.

**Special features**

- **PL c certified**
- **30 inputs and outputs:**
  - 10 analogue inputs
  - 4 timer inputs
  - 8 PWM outputs, high-side:
    - 6 with integrated current measurement
    - 2 digital outputs, low-side
    - 6 ratiometric voltage outputs
- Freely configurable Node-ID via pin
- Robust, very compact die-cast aluminium housing
- Waterproof, 48-pin male connection

**Technical data**

**Ambient conditions**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature</td>
<td>-40 ... +85 °C (with full load)</td>
</tr>
<tr>
<td>Operating altitude</td>
<td>0 ... 4,000 m</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>6 ... 32 V</td>
</tr>
<tr>
<td>Peak voltage</td>
<td>40 V max.</td>
</tr>
<tr>
<td>Idle current</td>
<td>40 ... 120 mA</td>
</tr>
<tr>
<td>Standby current</td>
<td>5 mA</td>
</tr>
<tr>
<td>Current consumption</td>
<td>24 A max.</td>
</tr>
</tbody>
</table>

**Fullfil the following standards**

- **Equipment**: Compliant with 2004/108/EC
- **E-mark**: ECE-R10 Rev.4
- **Functional safety**: EN ISO 13849 PL c
- **EMC**: EN 13309 / ISO 14982 / CISPR 25
- **ESD**: ISO 10605
- **Electrical**:
  - ISO 16750-2 / ISO 7637-2-3, limited to 40 V with external load dump protection
  - ISO 16750-4
  - ISO 16750-3
- **Temperature**: ISO 16750-4
- **Vibration, shock, bump**: ISO 16750-3
- **Communication profile**: CANopen CiA DS 304/401

**Dimensions and weight**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing dimensions</td>
<td>146.6 x 92 x 38 mm</td>
</tr>
<tr>
<td>Minimum clearance</td>
<td>208 x 94 x 39 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>330 g</td>
</tr>
</tbody>
</table>

**Features**

- Infineon XC 22xx microcontroller, 80 MHz, 768 kB int. Flash, 82 kByte int. RAM
- 8 kByte EEPROM
- 1 x CAN, 125 kbit/s up to 1 Mbit/s, termination configurable via pin
- 2 x Node ID pin for optional configuration of the CANopen-ID
- 6 x Analogue-IN 0 .. 5 V / 0 .. 10 V / 0 .. 25 mA or 25 mA LED lamps OUT configurable via software, PL c capable
- 2 x Analogue-IN 0 .. 5 V / 0 .. 10 V / 0 .. 25 mA / 0 .. 65 kOhm or 25 mA LED lamps OUT configurable via software, PL c capable
- 2 x Analogue-IN 0 .. 32 V with configurable pull-up/down, digital voltage input mode, PL c capable
- 4 x Timer-IN (timer inputs 0.1 Hz ... 10 kHz) / Analogue-IN 0 .. 32 V configurable pull-up/down in digital voltage input mode, encoder, PL c capable
- 2 x PWM-OUT / Digital-OUT 3 A high-side, overload and wirebreak detection configurable as Timer-IN (10 Hz - 10 kHz) / Analogue-IN 0 .. 32 V with integrated pull-up, PL c capable
- 2 x PWM-OUT / Digital-OUT 3 A high-side, overload and wirebreak detection configurable as 2 x Timer-IN (10 Hz-10 kHz) / Analogue-IN 0 .. 32 V with integrated pull-up, PL c capable
- 2 x Digital-OUT 3 A low-side, for use as safety switch for high-side PWM-OUTs
- 6 x Analogue-OUT 15 % .. 85 % V Bat+ (ratiometric)
- 6 x Analogue-OUT 15 % .. 85 % V Bat+ with 10 kOhm low-side load or Analogue-IN 0 .. 32 V

**Dedicated power supply pins for high-side outputs**

**Internal monitoring of board temperature, sensor supply, K15 input and battery voltage**

1 x sensor supply 5 V (100 mA)

**Note:**

1. All I/Os and interfaces are protected against short circuit to GND and BAT+.
2. All analogue inputs have 10 bit resolution.
3. All analogue inputs can be used as digital inputs with configurable switching thresholds.
4. All inputs can be used for functional safety if two inputs of the same type are connected in parallel for redundancy.
5. These outputs are part of the safety design and cannot be controlled directly via the software.
HY-TTC 30XS-H

Block circuit diagram

**XC 22xx**
- 768 kB Flash
- 82 kB RAM
- 80 MHz
- Software Watchdog
  
  **EEPROM**
- 8 KByte
  
  **Node-ID Inputs**
  
  **Sensor supply**
- 5 V 100 mA

**CAN**

**4 x Timer-IN**
- 0.1 Hz .. 10 kHz
  
or
  
**Analogue-IN**
- 0 - 32 V
  
  Pull-up/Down

**2 x Analogue-IN**
- 0 - 32 V
  
  Pull-up/Down

**2 x Analogue-IN**
- 0 - 5 V / 0 - 10V / 0 - 25 mA
  
  0 - 65 KOhm / 10 bit
  
or
  
25 mA LED lamps OUT

**6 x Analogue-IN**
- 0 - 5 V / 0 - 10V / 0 - 25 mA / 10 bit
  
or
  
25 mA LED lamps OUT

**Internal monitoring:**
- Board temperature
- Battery voltage
- Sensor supply
- K 15 input

**6 x PWM-OUT**
- 3 A high-side
  
  with current measurement configurable as
  
6 x Timer-IN
- 10 Hz - 10 kHz
  
or
  
6 x Analogue-IN
- 0 - 32 V

**2 x PWM-OUT**
- 3 A high-side
  
  configurable as
  
2 x Timer-IN
- 10 Hz - 10 kHz
  
or
  
2 x Analogue-IN
- 0 - 32 V

**2 x Digital-OUT**
- 3 A low-side
  
  use as safety switch

**6 x Analogue-OUT**
- (ratiometric)
  
  configurable as
  
6 x Voltage-OUT
  
or
  
6 x Analogue-IN

**Watchdog**
Model code

HY-TTC 30XS – H – F13 – 00 – Pc – 000

CAN protocol
F13 = CANopen safety slave

Equipment options
00 = standard

Functional safety
Pc = requirements for PL c

Modification number
000 = standard

Note
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

Accessories
Appropriate accessories, such as electrical connectors, service tools, software, etc. can be found in the Accessories section.

Dimensions

Note
The information in this brochure relates to the operating conditions and applications described.
For applications and operating conditions not described, please contact the relevant technical department.
Subject to technical modifications.

HYDAC ELECTRONIC GmbH
Hauptstraße 27
66128 Saarbrücken, Germany
Tel. +49 6897 509-01
Fax +49 6897 509-1726
E-mail: electronic@hydac.com
Internet: www.hydac.com
Universal Compact I/O Expansion Module
HY-TTC 30XS-I

Description
The HY-TTC 30XS-I module was developed for distributed applications with increased functional safety.

Using the general standard, CANopen Safety to CiA DS 304 and CiA DS 401, the module can be easily controlled and integrated in the existing control system.

The HY-TTC 30XS-I module was developed in accordance with the international standard ISO/EN 13849 and is certified by TÜV NORD. It meets the requirements of Functional Safety according to PL c (Performance Level c).

The 30XS-I version has been optimised for system expansion to include additional inputs.

The module is protected in a proven, robust and compact housing, specially designed for the off-highway automotive industry.

Special features
- PL c certified
- 30 inputs and outputs:
  - 18 analogue inputs
  - 8 timer-inputs
  - 4 PWM outputs, high-side
  - 2 with integrated current measurement
- Freely configurable Node-ID via pin
- Robust, very compact die-cast aluminium housing
- Waterproof, 48-pin male connection

Technical data

Ambient conditions
- Operating temperature: -40 .. +85 °C (with full load)
- Operating altitude: 0 .. 4,000 m
- Supply voltage: 8 .. 32 V
- Peak voltage: 40 V max.
- Idle current: 40 .. 120 mA
- Standby current: ≤ 1 mA
- Current consumption: 12 A max.

Complies with the following standards
- Functional safety: EN ISO 13849 PL c
- EMC: EN 13309 / ISO 14982 / CISPR 25
- ESD: ISO 10605
- Temperature: ISO 16750-4
- Vibration, shock, bump: ISO 16750-3
- Communication profile: CANopen CiA DS 304/401

Dimensions and weight
- Housing dimensions: 146.6 x 92 x 38 mm
- Minimum clearance for connection: 208 x 92 x 38 mm
- Weight: 330 g

Features
- Infineon XC 22xx microcontroller, 80 MHz, 768 kB int. Flash, 82 kByte int. RAM
- 8 kByte EEPROM
- 1 x CAN, 125 kbit/s up to 1 Mbit/s, termination configurable via pin
- 2 x Node ID pin for optional configuration of the CANopen ID
- 6 x Analogue-IN 0 .. 5 V / 0 .. 10 V / 0 .. 25 mA or 25 mA LED lamps OUT configurable via software, PL c capable
- 2 x Analogue-IN 0 .. 5 V / 0 .. 10 V / 0 .. 25 mA / 0 .. 65 kOhm or 25 mA LED lamps OUT configurable via software, PL c capable
- 2 x Analogue-IN 0 .. 32 V with integrated pull-up
- 6 x Analogue-IN 0 .. 32 V
- 4 x Timer-IN (timer inputs 0.1 Hz .. 10 kHz) / Analogue-IN 0 .. 32 V configurable pull-up/down in digital voltage input mode, 1 encoder, PL c capable
- 4 x Timer-IN (timer input 10 Hz .. 10 kHz) / Analogue-IN 0 .. 32 V with integrated pull-up
- 4 x PWM-OUT / Digital-OUT 3 A high-side, current measurement, overload and wirebreak detection configurable as 2 x Timer-IN (10 Hz - 10 kHz) / Analogue-IN 0 .. 32 V, with integrated pull-up
- Dedicated power supply pins for high-side outputs
- Internal monitoring of board temperature, sensor supply, K15 input and battery voltage
- 1 x sensor supply 5 V (100 mA)

Note:
1) All I/Os and interfaces are protected against short circuit to GND and BAT+.
2) All analogue inputs have 10 bit resolution.
3) All analogue inputs can be used as digital inputs with configurable switching thresholds.
4) All inputs can be used for functional safety, if two inputs of the same type are connected in parallel for redundancy.
HY-TTC 30XS-I

Block circuit diagram

XC 22xx
- 768 kB Flash
- 82 kB RAM
- 80 MHz
- Software Watchdog
- CAN controller up to 1 Mbit/s

EEPROM
- 8 KByte

Node-ID Inputs

Sensor supply
- 5 V 100 mA

CAN

4 x Timer-IN
- 0.1 Hz .. 10 kHz
or
Analogue-IN
- 0 - 32 V
Pull-up/Down

4 x Timer-IN
- 10 Hz .. 10 kHz
or
Analogue-IN
- 0 - 32 V
Pull-up

2 x Analogue-IN
- 0 - 5 V / 0 - 10V / 0 - 25 mA
- 0 - 65 kOhm / 10 bit
or
- 25 mA LED lamps OUT

2 x Analogue-IN
- 0 - 5 V / 0 - 10V / 0 - 25 mA / 10 bit
or
- 25 mA LED lamps OUT

2 x Analogue-IN
- 0 - 32 V
Pull-up/Down

2 x Analogue-IN
- 0 - 32 V
Pull-up

6 x Analogue-IN
- 0 - 32 V

Internal monitoring:
- Board temperature
- Battery voltage
- Sensor supply
- K 15 input

2 x PWM-OUT
- 3 A high-side
- with current measurement configurable as
  - 2 x timer-IN
  - 10 Hz - 10 kHz
  or
  - 2 x Analogue-IN
  - 0 - 32 V

2 x PWM-OUT
- 3 A high-side
- configurable as
  - 2 x Timer-IN
  - 10 Hz - 10 kHz
  or
  - 2 x Analogue-IN
  - 0 - 32 V
Model code

HY-TTC 30XS – I – F13 – 00 – Pc – 000

CAN protocol
F13 = CANopen safety slave

Equipment options
00 = standard

Functional safety
Pc = requirements for PL c

Modification number
000 = standard

Note
The information in this brochure relates to the operating conditions and applications described.
For applications or operating conditions not described, please contact the relevant technical department.
Subject to technical modifications.

Accessories
Appropriate accessories, such as cables and connectors, service tools, software etc. can be found in the Accessories section.

Dimensions

Note
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.
**Description**

The HY-TTC 36X module is an intelligent I/O module which can be controlled and parameterized via CANopen Standard according to CiA DS 401.

It provides a means of expanding control systems with additional inputs and outputs, and hence additional functionality, in a simple and uncomplicated way.

The PID control devices built into the instrument make it possible to add independent proportional controls in conjunction with the powerful PWM outputs and the current measurement.

The module is protected in a proven, extremely compact housing of the 16-bit controller series, which was specially designed for the off-highway vehicle industry.

**Special features**

- 40 inputs and outputs:
  - 4 PWM outputs
  - 8 digital outputs
  - 8 analogue outputs
  - 4 current meas. inputs
  - 16 digital inputs
- Robust aluminium die cast housing with pressure equalization via a waterproof Gore-Tex® membrane
- Waterproof, 80-pin male connection
- e12 type approval

**Technical data**

**Ambient conditions**

- Operating temperature: -40 .. +85 °C (with full load) to EN 60068-2
- Operating altitude: 0 .. 4,000 m
- Supply voltage: 8 .. 32 V
- Peak voltage: 45 V max. (1 ms)
- Idle current: 0.15 A max. at 9 V
- Standby current: 0.5 mA max.
- Current consumption: 25 A max. (complete voltage and temperature range)

**Complies with the following standards**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE mark</td>
<td>Compliant with 2004/108/EC</td>
</tr>
<tr>
<td>E-mark</td>
<td>2009/19/EC</td>
</tr>
<tr>
<td>EMC</td>
<td>ISO 13766 (up to 200 V/m, 20 MHz .. 1 GHz)</td>
</tr>
<tr>
<td>ESD</td>
<td>IEC 61000-4-2</td>
</tr>
<tr>
<td>Load dump</td>
<td>ISO 7637-2</td>
</tr>
<tr>
<td>IP class</td>
<td>EN 60529 IP 65 / IP 67, DIN 40050 IP 6k6k</td>
</tr>
<tr>
<td>Temperature</td>
<td>EN 60068-2-1, -14Nb, -2, -78, -30</td>
</tr>
<tr>
<td>Vibration, shock, bump</td>
<td>IEC 60068-2-29, -64, -27, -32</td>
</tr>
<tr>
<td>Communication profile</td>
<td>CANopen CiA DS 401</td>
</tr>
</tbody>
</table>

**Dimensions and weight**

- Housing dimensions: 148 x 181 x 40 mm
- Minimum clearance for connection: 198 x 203 x 40 mm
- Weight: 652 g

**Features**

- 16 bit Infineon XC 2287 microcontroller, 80 MHz, 768 kB int. Flash, 82 kB int. RAM
- 1 x CAN, up to 1 Mbit/s
- IN
  - 8 x Analogue-IN 0 .. 5 V or 4 .. 20 mA (0 .. 22.7 mA) / 10 bit, configurable via software
  - 4 x current feedback, configurable as 4 x Digital-OUT / low-side 2 A
  - 8 x Timer-IN (timer inputs 0.1 Hz .. 10 kHz)
  - 8 x Digital-IN
- OUT
  - 4 x PWM-OUT 2 A high-side, configurable as 4 x Timer inputs
  - 8x Digital-OUT 4 A high-side, configurable as 8 x Analogue-IN
- Internal monitoring of circuit board temperature, sensor supply and battery voltage
- Connector types: 52-pole Tyco PN 1393450-5 / 28-pole Tyco PN 1393436-4
- 1 x sensor supply 8.5 V / 10.0 V (30 mA) or 14.5 V (40 mA) configurable
- 2 x sensor supply 5 V (30 mA)

**Note:** All I/O’s and interfaces mentioned below are protected against short circuit to GND and BAT+.
**Block circuit diagram**

**HY-TTC 36X**

- **XC 2287**
  - 768 kB Flash
  - 82 kB RAM
  - 80 MHz int. clock
  - 16 bit bus
  - CAN controller up to 1 Mbit/s
  - UART controller

- **Sensor supply**
  - 1 x 8.5 / 10.0 V (30 mA)
  - or 14.5 V (40 mA)
  - (configurable)
  - 2 x 5 V (30 mA)

- **Internal monitoring:**
  - Board temperature
  - Battery voltage
  - Sensor supply

- **8 x Analogue-IN**
  - 0 .. 5 V or
  - 4 .. 20 mA (0 .. 22.7 mA) / 10 bit
  - configurable via software

- **4 x current measurement**
  - configurable as 4 x Digital-OUT
  - 2 A low-side

- **8 x Timer-IN**
  - 8 timer inputs
  - 0.1 Hz .. 10 kHz
  - high / low active

- **8 x Digital-IN**
  - high / low active

- **4 x PWM-OUT**
  - 2 A high-side
  - configurable as 4 x Timer input

- **8 x Digital-OUT**
  - 4 A high-side
  - configurable as 8 x Analogue-IN
### Model code

<table>
<thead>
<tr>
<th>CAN protocol</th>
<th>HY-TTC 36X – F11 – 00 – 000</th>
</tr>
</thead>
<tbody>
<tr>
<td>F11</td>
<td>CANopen</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equipment options</th>
<th>00 = standard</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Modification number</th>
<th>000 = standard</th>
</tr>
</thead>
</table>

### Note

The information in this brochure relates to the operating conditions and applications described. For applications and operating conditions not described, please contact the relevant technical department. Subject to technical modifications.

### Note

On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

### Accessories

Appropriate accessories, such as cables and connectors, service tools, software etc. can be found in the Accessories section.

### Dimensions

- 52-pole Tyco PN 1393450-5 / 28-pole Tyco PN 1393436-4
- Dimensions:
  - Width: 216.00 mm
  - Height: 80.00 mm
  - Depth: 147.12 mm

HYDAC ELECTRONIC GmbH
Hauptstraße 27
66128 Saarbrücken, Germany
Tel. +49 6897 509-01
Fax +49 6897 509-1726
E-mail: electronic@hydac.com
Internet: www.hydac.com
Description

The HY-TTC 48X module is an intelligent I/O module which can be controlled and parameterized via CANopen Standard according to CiA DS 401.

It provides a means of expanding control systems with additional inputs and outputs, and hence additional functionality, in a simple and uncomplicated way.

The PID control devices built into the instrument make it possible to add independent proportional controls in conjunction with the powerful PWM outputs and the current measurement.

The module is protected in a proven, extremely compact housing of the 16-bit controller series, which was specially designed for the off-highway vehicle industry.

Special features

- 48 inputs and outputs:
  - 8 PWM outputs
  - 4 current feedbacks
  - 8 digital outputs
  - 16 analogue inputs
  - 12 digital inputs
- Robust aluminium die cast housing with pressure equalization via a waterproof Gore-Tex® membrane
- Waterproof, 80-pin male connection
- e12 type approval

Technical data

Ambient conditions

- Operating temperature: -40 °C to 85 °C (with full load) to EN 60068-2
- Operating altitude: 0 to 4,000 m
- Supply voltage: 8 to 32 V
- Peak voltage: 45 V max. (1 ms)
- Idle current: 0.15 A max. at 9 V
- Standby current: 0.5 mA max.
- Current consumption: 25 A max. (complete voltage and temperature range)

Complies with the following standards

- CE mark: Compliant with 2004/108/EC
- E-mark: 2009/19/EC
- EMC: ISO 13766 (up to 200 V/m, 20 MHz to 1 GHz)
- ESD: IEC 61000-4-2
- Load dump: ISO 7637-2
- IP class: EN 60529 IP 65 / IP 67
- Temperature: EN 60068-2-1; -14Nb; -2; -78; -30
- Vibration, shock, bump: IEC 60068-2-29; -64; -27; -32
- Communication profile: CANopen CiA DS 401

Dimensions and weight

- Housing dimensions: 148 x 181 x 40 mm
- Minimum clearance for connection: 198 x 203 x 40 mm
- Weight: 675 g

Features*

- 16 bit Infineon XC 2287 microcontroller, 80 MHz, 768 kB int. Flash, 82 kB int. RAM
- 1 x CAN, up to 1 Mbit/s
- IN
  - 8 x Analogue-IN 0 .. 5 V or 4 .. 20 mA (0 .. 22.7 mA) / 10 bit, configurable via software
  - 8 x Analogue-IN 0 .. 32 V / 10 bit, voltage range configurable via software
  - 4 x current feedback, configurable as 4 x Digital-OUT / low-side 2 A
  - 4 x Timer-IN (timer input 0.1 Hz to 10 kHz)
  - 8 x Digital-IN
- OUT
  - 8 x PWM-OUT 2 A high-side, configurable as 8 x Timer inputs
  - 8x Digital-OUT 4 A high-side, configurable as 8 x Analogue-IN
  - Internal monitoring of circuit board temperature, sensor supply and battery voltage
  - Connector types: 52-pole Tyco PN 1393450-5 / 28-pole Tyco PN 1393436-4
  - 1 x sensor supply 8.5 V / 10.0 V (30 mA) or 14.5 V (40 mA) configurable
  - 2 x sensor supply 5 V (30 mA)

Note: * All I/O’s and interfaces mentioned below are protected against short circuit to GND and BAT*.
CANopen communication

CAN

XC 2287
- 768 kB Flash
- 82 kB RAM
- 80 MHz int. clock
- 16 bit bus

CAN controller up to 1 Mbit/s

K 15
- Sensor supply
  - 1 x 8.5 / 10.0 V (30 mA)
  - or 14.5 V (40 mA)
    (configurable),
  - 2 x 5 V (30 mA)

Internal monitoring:
- Board temperature
- Battery voltage
- Sensor supply

8 x Analogue-IN
- 0 .. 5 V or
- 4 .. 20 mA (0 .. 22.7 mA) / 10 bit
  configurable via software

8 x Analogue-IN
- 0 .. 32 V / 10 bit
  voltage range
  configurable via software

8 x PWM-OUT
- 2 A high-side
  configurable as 8 x Timer-IN

8 x Digital-OUT
- 4 A high-side
  configurable as 8 x Analogue-IN

4 x current measurement
- configurable as 4 x digital-OUT
- 2 A low-side

4 x Timer-IN
- (4 timer inputs
  0.1 Hz .. 10 kHz)
  high / low active

8 x Digital-IN
- high / low active

Block circuit diagram
HY-TTC 48X
Model code

<table>
<thead>
<tr>
<th>CAN protocol</th>
<th>HY-TTC 48X – F11 – 00 – 000</th>
</tr>
</thead>
<tbody>
<tr>
<td>F11 = CANopen</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equipment options</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>00 = standard</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Modification number</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>000 = standard</td>
<td></td>
</tr>
</tbody>
</table>

Note
The information in this brochure relates to the operating conditions and applications described. For applications and operating conditions not described, please contact the relevant technical department. Subject to technical modifications.

Accessories
Appropriate accessories, such as cables and connectors, service tools, software etc. can be found in the Accessories section.

Dimensions

52-pole Tyco PN 1393450-5 / 28-pole Tyco PN 1393436-4

HYDAC ELECTRONIC GmbH
Hauptstraße 27
66128 Saarbrücken, Germany
Tel. +49 6897 509-01
Fax +49 6897 509-1726
E-mail: electronic@hydac.com
Internet: www.hydac.com
Description

The HY-TTC 48XS module is an intelligent I/O module which is certified according to CiA DSP 304 via CANopen Safety and which can be driven and parameterized according to CiA DSP 401.

The HY-TTC 48XS module was developed in accordance with the international standard ISO/EN 13849 and is certified by TÜV NORD. Therefore, it meets the requirements of safety levels PL d (Performance Level d).

For the CPU, it uses the safety CPU XC2287M which was specially developed by Infineon for safety applications. This offers enhanced safety features for the protection of the internal RAM and Flash memories.

The module is protected in a proven, robust and compact housing, specially designed for the off-highway automotive industry.

Special features

- PL d certified
- Additional watchdog CPU
- 48 inputs and outputs:
  - 16 power outputs
  - 4 current measurement inputs
  - 8 analogue inputs: voltage/current
  - 8 analogue inputs: voltage, configurable
- All inputs and outputs are configurable and are protected against overvoltage and short circuits
- Stabilized, adjustable sensor voltage supply with internal monitoring
- No reset caused by dip in voltage when starting engine
- Robust aluminium die-cast housing with a waterproof 80-pole male connection and pressure equalization via a waterproof Gore-Tex® membrane

Technical data

Ambient conditions

<table>
<thead>
<tr>
<th>Operating temperature</th>
<th>-40 .. +85 °C (with full load) to EN 60068-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating altitude</td>
<td>0 .. 4,000 m</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>8 .. 32 V</td>
</tr>
<tr>
<td>Permitted voltage drop</td>
<td>up to ≥ 4 V (U_{bat}) without reset to ISO 7637-1 (for engine start in 12 V systems)</td>
</tr>
<tr>
<td>Peak voltage</td>
<td>45 V max. (1 ms)</td>
</tr>
<tr>
<td>Idle current</td>
<td>0.15 A max. at 9 V</td>
</tr>
<tr>
<td>Standby current</td>
<td>0.5 mA max.</td>
</tr>
<tr>
<td>Current consumption</td>
<td>25 A max. (complete voltage and temperature range)</td>
</tr>
</tbody>
</table>

Complies with the following standards

- Compliant with 2004/108/EC
- ECE-R10 Rev.3
- EN ISO 13849 PL d
- ISO 13766 (up to 100 V/m, 20 MHz .. 1 GHz)
- IEC 61000-4-2
- ISO 7637-2, 173V, 2 Ohm
- EN 60529 IP 65 / IP 67
- DIN 40050 IP 6k9k
- EN 60068-2-1; -14Nb; -2; -78; -30
- IEC 60068-2-29; -64; -27; -32
- CANopen CiA DS 304/401

Dimensions and weight

| Housing dimensions     | 148 x 181 x 40 mm |
| Minimum clearance for connection | 198 x 203 x 40 mm |
| Weight                | 664 g |

Features*

- 16-Bit Infineon XC2287M microcontroller, 80 MHz, 832 kB int. Flash, 50 kB int. RAM, 512 kB ext. RAM, 8 KByte EEPROM
- Watchdog CPU freescale HC 908, including monitoring software
- CRC checker for supervising Flash memory, Integrated Memory Protection Unit (MPU), Error Correcting Code (ECC)
- 1 x CAN, up to 1 Mbit/s
- IN
  - 8 x Analogue-IN 0 .. 5 V or 4 .. 20 mA / 10 bit, configurable via software
  - 8 x Analogue-IN 0 .. 32 V / 10 bit, range configurable via software
  - 4 x current measurement, configurable as 4 x Digital-OUT / 2 A low-side
  - 4 x Timer-IN (timer input 0.1 Hz .. 10 kHz)
  - 8 x Digital-IN
- OUT
  - 8 x PWM-OUT 2 A high-side, configurable as 8 x Timer inputs
  - 8x Digital-OUT 4 A high-side, configurable as 8 x Analogue-IN
- Internal monitoring of board temperature, sensor supply and battery voltage
  - 52-pol. Tyco PN 1393450-5 / 28-pol. Tyco PN 1393436-4
  - 1 x sensor supply 8.5 V / 10.0 V (30 mA) / 14.5 V (40 mA) configurable
  - 2 x sensor supply 5 V (30 mA)

Note: * All I/Os and interfaces are protected against short circuit to GND and BAT+.
**Block circuit diagram**

**HY-TTC 48XS**

**XC 2287 M**
- 832 kB Flash
- 50 kB RAM
- 80 MHz int. clock
- 16 bit bus

**CAN controller**
- up to 1 Mbit/s

**CAN**

**EEPROM**
- 8 KByte

**512 kB ext. RAM**

**K 15**
- Sensor supply
  - 1 x 8.5 / 10.0 V (30 mA)
  - or 14.5 V (40 mA)
  - (configurable),
  - 2 x 5 V (30 mA)

**Internal monitoring:**
- Board temperature
- Battery voltage
- Sensor supply

**8 x Analogue-IN**
- 0 .. 5 V
- 4 .. 20 mA / 10 bit
  - (configurable via software)

**8 x Analogue-IN**
- 0 .. 32 V / 10 bit
  - (range configurable via software)

**4 x current measurement**
- configurable as 4 x Digital-OUT
  - 2 A low-side

**4 x Timer-IN**
- (4 timer inputs
  - 0.1 Hz .. 10 kHz)
  - high / low active

**8 x Digital-IN**
- high / low active

**8 x PWM-OUT**
- 2 A high-side
  - configurable as 8 x Timer input

**8 x Digital-OUT**
- 4 A high-side
  - configurable as 8 x Analogue-IN

**Watchdog CPU**
- 68HC908

**8 x Analogue-IN**
- 0 .. 5 V
- 4 .. 20 mA / 10 bit
  - (configurable via software)

**8 x Analogue-IN**
- 0 .. 32 V / 10 bit
  - (range configurable via software)

**4 x current measurement**
- configurable as 4 x Digital-OUT
  - 2 A low-side

**4 x Timer-IN**
- (4 timer inputs
  - 0.1 Hz .. 10 kHz)
  - high / low active

**8 x Digital-OUT**
- 4 A high-side
  - configurable as 8 x Analogue-IN

**Watchdog CPU**
- 68HC908
**Model code**

HY-TTC 48XS – F13 – 00 – Pd – 000

**CAN protocol**
F13 = CANopen safety

**Equipment options**
00 = standard
01 = 250 kbit/s CAN baud rate

**Functional safety**
Pd = Performance Level d

**Modification number**
000 = standard

**Note**

The information in this brochure relates to the operating conditions and applications described. For applications and operating conditions not described, please contact the relevant technical department. Subject to technical modifications.

**Dimensions**

52-pole Tyco PN 1393450-5 / 28-pole Tyco PN 1393436-4

**Accessories**

Appropriate accessories, such as cables and connectors, service tools, software etc. can be found in the Accessories section.
4 Displays with integrated controller

■ Easy operation due to graphical user interface
EASE of use and the provision of vehicle information have had a significant role in mobile machinery for a long time. The displays must also be clearly legible in poor light conditions and the graphical display should be as intuitive and self-explanatory as possible. Designing the (right) operating and display instruments as well as ensuring the best lay-out for the driver’s field of vision are a serious challenge for the design engineer. HYDAC ELECTRONIC, with its programmable displays which can be parameterized to suit every application, has a solution to the display problem which is both extremely flexible and yet simple to operate.

■ Display, user interface and control in one housing
Vehicle data, parameters and values are displayed ergonomically and important information is highlighted dynamically, and action can be taken in response to the situation displayed visually. HYDAC ELECTRONIC offers a range of displays with a built-in controller which copes exceedingly well with these demands. The flexible layout of the displays together with the ergonomic operation of the machine using a visual reference brings significant improvement in convenience to every machine builder. The units in the HY-eVision² series are provided with a touchscreen, camera inputs and other features to meet high visual demands. The higher resolution and 3D capability of these units are just two examples.

Whatever the requirements, HYDAC ELECTRONIC has the right unit.

<table>
<thead>
<tr>
<th>Type</th>
<th>Processor</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY-eVision² 7.0</td>
<td>32 bit ARM Cortex A8 800 MHz</td>
</tr>
<tr>
<td>HY-eVision² 10.4</td>
<td>32 bit ARM Cortex A8 800 MHz</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Screen diagonal</th>
</tr>
</thead>
<tbody>
<tr>
<td>7&quot; (17.8 cm, 16:9)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Resolution (pixels)</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 x 480</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 GB Flash</td>
</tr>
<tr>
<td>512 MB RAM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x CAN (optional 4 x CAN)</td>
</tr>
<tr>
<td>4 x CAN</td>
</tr>
<tr>
<td>1 x LAN</td>
</tr>
<tr>
<td>1 x LAN</td>
</tr>
<tr>
<td>1 x RS232</td>
</tr>
<tr>
<td>1 x RS232</td>
</tr>
<tr>
<td>1 x USB (Host)</td>
</tr>
<tr>
<td>1 x USB (OTG)</td>
</tr>
<tr>
<td>2 x camera</td>
</tr>
<tr>
<td>2 x camera</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Special features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating option: Standard or Touch</td>
</tr>
<tr>
<td>Operating option: Standard-Touch or Polariised-Touch</td>
</tr>
<tr>
<td>Buzzer</td>
</tr>
<tr>
<td>Buzzer</td>
</tr>
<tr>
<td>Ambient light sensor</td>
</tr>
<tr>
<td>Ambient light sensor</td>
</tr>
<tr>
<td>10 function keys</td>
</tr>
<tr>
<td>10 function keys</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Programming</th>
</tr>
</thead>
<tbody>
<tr>
<td>CODESYS® V3.5</td>
</tr>
<tr>
<td>CODESYS® V3.5</td>
</tr>
</tbody>
</table>
Universal Mobile Display with Integrated Controller
HY-eVision² 7.0

**Description**

The compact 7” TFT back-lit colour display with integrated high-end eVision² display controller is notable for its very high image quality, low reflection, high colour saturation and optimum readability, even under the most adverse light conditions.

The display is protected by a robust aluminium / plastic housing and can either be built directly into the instrument panel or surface-mounted in the field of vision of the driver/operator using a RAM Mount® in the cockpit.

Ten programmable illuminated control keys along with the optional touchscreen feature create an easy-to-use human-machine interface.

Up to two external cameras can be connected to the display via the two integrated composite video ports and controlled via software.

**Technical data**

**Ambient conditions**
- Operating temperature: -20 .. +60 °C
- Storage temperature range: -30 .. +80 °C
- Supply voltage: 9 .. 32 V DC

**Complies with the following standards**
- E mark: Compliant with 2004/108/EC
- E-mark: ECE-R10 Rev.3
- EMC: EN 13309
- ESD: ISO 10605
- IP class: ISO 20653 IP6K5
- Temperature: ISO 16750-4
- Vibration, shock, bump: ISO 16750-3

**Dimensions and weight**
- Housing dimensions: 235 x 135 x 52.4 mm (touch 235 x 135 x 53.4 mm)
- Housing material: Aluminium, anodised / reinforced glass fibre
- Weight: 1.1 kg

**Display**
- Screen diagonal: 7.0” (17.8 cm) / 16:9 format
- Pixels: 800 x 480
- Active area: 152.4 mm x 91.4 mm
- Pixel size: 0.1905 mm x 0.1905 mm
- Luminance: 500 cd/m²
- Viewing angle: Vertical: ±60° / Horizontal: ±70°
- Contrast ratio: 600:1
- Reaction time: 5 ms
- LCD type: TFT (active matrix)
- Touchscreen: Resistive
- Backlight: LED
- Life of backlight: ≥ 50,000 h at +25 °C (constant)

**Features**
- LCD with backlight and high contrast
- Auto-dimming via ambient light sensor
- 32 bit ARM Cortex A8 microcontroller, 800 MHz, 1 GB Flash, 512 MB RAM
- 34-pole central male connection
- K15 for ignition input
- 2 x composite video interface for external camera
- 2 x CAN interface, 125 kbit/s .. 1 Mbit/s (optional 4 x CAN interface)
- 1 x RS232 and 1 x Ethernet interface for debugging 100 Mbit/s
- 1 x USB 2.0 host
- Real-time clock (buffered with GoldCap)
- Buzzer
- Sleep Modus
- 2.5G modem and GPS module (option)
- MicroSD card for memory expansion (option)

Note: All external interfaces are protected against short circuit to GND and BAT+.
HY-eVision² 7.0

**Block circuit diagram**

**ARM Cortex A8**
Multimedia processor
- 512 MB RAM
- 1 GB Flash

**7.0” LCD Display**
800 x 480 pixels

**Touchscreen**
(option)

**CAN driver**
2 channels
125 kbit/s .. 1 Mbit/s

**USB 2.0 Host**
Type B

**10 / 100 Ethernet**
Full Duplex

**RTC**

**2.5G modem**
GPS module
(option)

**CAN driver**
2 channels
125 kbit/s .. 1 Mbit/s
(option)

**ARM**
Cortex A8
Multimedia processor

**Multimedia processor**

**512 MB RAM**

**1 GB Flash**

**10 keys with optional lighting**

**Ambient light sensor**
for auto-dimming

**Buzzer**

**Keypad**

**Camera 1**
analogue

**AD converter**

**RS232**

**Camera 2**
analogue

**Touchscreen**
(option)

**HY-eVision 7.0**

**7.0” LCD Display**
800 x 480 pixels

**USB 2.0 Host**
Type B

**10 / 100 Ethernet**
Full Duplex

**RTC**

**2.5G modem**
GPS module
(option)

**CAN driver**
2 channels
125 kbit/s .. 1 Mbit/s

**ARM**
Cortex A8
Multimedia processor

**Multimedia processor**

**512 MB RAM**

**1 GB Flash**

**10 keys with optional lighting**

**Ambient light sensor**
for auto-dimming

**Buzzer**

**Keypad**

**Camera 1**
analogue

**AD converter**

**Camera 2**
analogue

**Touchscreen**
(option)
**Model code**

**HY-eVision² 7.0 – CD – P – R– 00 XX XX – E – 000**

**Firmware**
CD = CODESYS® run-time system for CODESYS® development environment

**RAM memory**
P = 512 MByte

**Flash memory**
R = 1 GByte

**Functional safety**
00 = standard (not provided)

**Equipment options**
00 = none (standard is panel-mounted version)
04 = with 4 CAN interfaces
07 = with GPS and GSM function

**Operating options**
00 = none
01 = with touchscreen function

**Resolution**
E = 800 x 480 pixels

**Modification number**
000 = standard

**Note:**
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

**Accessories**
Appropriate accessories, such as cables and connectors, cameras etc. can be found in the Accessories section.

---

**Dimensions**

[Image of dimensions]

**Note**

The information in this brochure relates to the operating conditions and applications described.
For applications and operating conditions not described, please contact the relevant technical department.
Subject to technical modifications.

HYDAC ELECTRONIC GmbH
Hauptstraße 27
66128 Saarbrücken, Germany
Tel. +49 6897 509-01
Fax +49 6897 509-1726
E-mail: electronic@hydac.com
Internet: www.hydac.com
Description

The high resolution 10.4" TFT back-lit colour display with integrated high performance multimedia controller is notable for its very high image quality and optimum readability, even under the most adverse lighting conditions. Seven programmable control keys and three navigation keys along with the optional touchscreen feature create an easy-to-use human-machine interface. The display is protected by a robust aluminium die-cast housing and can either be built directly into the instrument panel or surface-mounted in the field of vision of the driver/operator in the cockpit using a "RAM Mount®" system.

Up to two external cameras can be connected to the display via the two integrated composite video ports and the pictures displayed simultaneously via software.

Special features

- 10.4" monitor with large angle of view, high contrast ratio and touchscreen function
- Display of PDF documents, images, videos
- 3D capability, picture-in-picture function
- 4 CAN-interfaces
- 2 composite video interfaces
- Both camera pictures can be displayed simultaneously
- USB 2.0 interface (OTG)
- Programming in CODESYS® V3
- Waterproof and dustproof IP 65 die-cast aluminium housing
- 7 programmable function keys and 3 navigation keys
- Operation possible in 12 V and 24 V systems
- Real-time clock with GoldCap
- Sleep mode
- Anti-glare display surface
- Polarised display (optional)
- e12 type approval

Technical data

Ambient conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature</td>
<td>-30 .. +60 °C</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>-30 .. +80 °C</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>9 .. 32 V DC</td>
</tr>
</tbody>
</table>

Complies with the following standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-mark</td>
<td>ECE-R10 Rev.3</td>
</tr>
<tr>
<td>EMC</td>
<td>EN 13309</td>
</tr>
<tr>
<td>ESD</td>
<td>ISO 10605</td>
</tr>
<tr>
<td>Electrical</td>
<td>ISO 16750-2, ISO 7637-3</td>
</tr>
<tr>
<td>IP class</td>
<td>EN 6052 IP 65 / ISO 20653 IP6K5</td>
</tr>
<tr>
<td>Temperature</td>
<td>ISO 16750-4</td>
</tr>
<tr>
<td>Vibration, shock, bump</td>
<td>ISO 16750-3</td>
</tr>
</tbody>
</table>

Dimensions and weight

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing dimensions</td>
<td>280 x 232 x 62 mm</td>
</tr>
<tr>
<td>Housing material</td>
<td>Aluminium</td>
</tr>
<tr>
<td>Weight</td>
<td>2.5 kg</td>
</tr>
</tbody>
</table>

Display

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen diagonal</td>
<td>10.4&quot; (26 cm) / 4:3 format</td>
</tr>
<tr>
<td>Pixels</td>
<td>1,024 x 768</td>
</tr>
<tr>
<td>Active area</td>
<td>210.4 mm x 157.8 mm</td>
</tr>
<tr>
<td>Pixel size</td>
<td>0.2055 mm x 0.2055 mm</td>
</tr>
<tr>
<td>Luminance</td>
<td>500 cd/m²</td>
</tr>
<tr>
<td>Viewing angle</td>
<td>Vertical: 88° / Horizontal: 88°</td>
</tr>
<tr>
<td>Contrast ratio</td>
<td>1,200:1</td>
</tr>
<tr>
<td>Reaction time</td>
<td>10 ms</td>
</tr>
<tr>
<td>LCD type</td>
<td>TFT (active matrix)</td>
</tr>
<tr>
<td>Touchscreen</td>
<td>Resistive</td>
</tr>
<tr>
<td>Backlight</td>
<td>LED</td>
</tr>
<tr>
<td>Life of backlight</td>
<td>≥ 50,000 h at +25 °C (continuous)</td>
</tr>
</tbody>
</table>

Features

- LCD with backlight and high contrast
- 32 bit ARM Cortex A8 800 Mhz multimedia processor
- 1 GB Flash, 512 MB RAM
- 4 x standard Amphenol male connections (C1 .. C4)
- K15 for ignition input
- 2 x composite video interface for external camera
- 4 x CAN interface, 125 kbit/s .. 1 Mbit/s
- 1 x RS232 interface
- 1 x Ethernet interface for debugging, 100 Mbit/s
- 1 x USB 2.0 OTG (Host or Device)
- Sleep mode
- Real-time clock, buzzer
- Programming: CODESYS® V3, Support for CANopen Master

Note: All external interfaces are protected against short circuit to GND and BAT+.
ARM Cortex A8
Multimedia processor
- 512 MB RAM
- 1 GB Flash

RTC

10.4" LCD Display
1,024 x 768 pixels
Touchscreen

CAN driver
4 channels
125 kbit/s .. 1 Mbit/s

USB 2.0 OTG
Type B

10 / 100 Ethernet
Full Duplex

RS232

Buzzer

Keypad
10 keys with lighting

Camera 1
analogue
AD converter

Camera 2
analogue
AD converter

HY-eVision² 10.4
Model code

HY-eVision\textsuperscript{2} 10.4 – CD – P – R – 00 XX 03 – G – 000

Firmware

CD = CoDeSys\textsuperscript{®} run-time system
for CoDeSys\textsuperscript{®} development environment
00 = none, only with Linux operating system

RAM memory

P = 512 MByte

Flash memory

R = 1 GByte

Functional safety

00 = standard (not provided)

Equipment options

00 = none
01 = polarised display

Operating options

03 = with touchscreen function and keypad lighting

Resolution

G = 1,024 x 768 pixels

Modification number

000 = standard

Note:
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

Accessories
Appropriate accessories, such as cables and connectors, cameras etc. can be found in the Accessories section.

Note
The information in this brochure relates to the operating conditions and applications described.
For applications and operating conditions not described, please contact the relevant technical department.
Subject to technical modifications.

HYDAC ELECTRONIC GmbH
Hauptstraße 27
66128 Saarbrücken, Germany
Tel. +49 6897 509-01
Fax +49 6897 509-1726
E-mail: electronic@hydac.com
Internet: www.hydac.com

Dimensions
5 Accessories

The right accessories are needed to turn control devices, visualization solutions and expansion modules into customised complete solutions.

Whether it is the wiring and connectors, the mounting accessories for installing devices, or the relevant proven operating elements that you need – the wide range of products from HYDAC always offers the right solution for every application.

The range of accessories from HYDAC also includes starter packages, termination boards, as well as test rigs and presentation boards for training and development purposes.

5.1 Cable harnesses, cabling and connection technology
- Cable harnesses for controllers
- Cable harnesses for displays
- Connection blocks
- Installation accessories

5.2 Accessories for training, development, testing and servicing
- Starter kits for CODESYS®
- Starter kits for C programming
- JTAG adapters
- Break-Out Box (BOB)
- Controller test rigs
- Manual Controller Test Rig (MTB)
- Remote Controlled Controller Test Rig (RTB)
- Accessories for MTB/RTB

5.3 Sensors
- Sensors for applications with increased functional safety / diagnostics
- Electronic pressure transmitters
- Electronic pressure switches
- Electronic temperature transmitters
- Electronic temperature switches
- Sensors for distance and position
- Level sensors
- Flow rate transmitters and flow switches
- Speed sensors
- Sensors for potentially explosive atmospheres
- Condition monitoring products
- Service unit
- Monitoring and display units

5.4 Operating elements, pilot control units and radio controls
## 5.1 Cable harnesses for controllers

<table>
<thead>
<tr>
<th>Type</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ZBS AK-080-0.8-2s</strong></td>
<td>6127440</td>
</tr>
<tr>
<td>Connection cable 80 cm and 80 Pins (28 + 52 pole, i.e. HY-TTC 50 / 60 / 90 / 94) with mating connector on both ends</td>
<td></td>
</tr>
<tr>
<td><strong>ZBS AK-080-1.5-2s</strong></td>
<td>6127481</td>
</tr>
<tr>
<td>Connection cable 150 cm and 80 Pins (28 + 52 pole, i.e. HY-TTC 50 / 60 / 90 / 94) with mating connector on both ends</td>
<td></td>
</tr>
<tr>
<td><strong>ZBS AK-080-3.0-1s</strong></td>
<td>6081986</td>
</tr>
<tr>
<td>Cable harness for HY-TTC 50 / 60 / 90 / 94 3 m flying lead with mating connector on one end</td>
<td></td>
</tr>
<tr>
<td><strong>ZBS AK-080-3.0-1s-TTC77</strong></td>
<td>6139188</td>
</tr>
<tr>
<td>Cable harness for HY-TTC 77 3 m flying lead with mating connector on one end</td>
<td></td>
</tr>
</tbody>
</table>
Cable harnesses for controllers

<table>
<thead>
<tr>
<th>Type</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZBS AK-060-3.0-1s HY-TTC 200 cable harness 60 pole 3 m flying lead</td>
<td>6081989</td>
</tr>
<tr>
<td>Note: For full connection, both ZBS AK-060-3.0-1s and ZBS AK-094-3.0-1s are required.</td>
<td></td>
</tr>
</tbody>
</table>

| ZBS AK-094-3.0-1s HY-TTC 200 cable harness 94 pole 3 m flying lead | 6081990 |
| Note: For full connection, both ZBS AK-060-3.0-1s and ZBS AK-094-3.0-1s are required. |

| ZBS AK-154-3.0-1s-TTC200 Combined order of: ZBS AK-060-3.0-1s and ZBS AK-094-3.0-1s | 6158300 |

| ZBS AK-154-3.0-1s HY-TTC 540 / 580 cable harness 154 pole 3 m flying lead | 6153711 |

| ZBS AKP-080-0.5-2s Programming cable (CAN) for the 16-Bit controllers HY-TTC 50 / 60 / 90 / 94 including power supply for direct “stand alone” operation. Features such as indicator lamps for $U_{ib}$ as well as a switch for K15 and a button to reset the controller provide additional functionality. A useful accessory for commissioning and service. | 6149786 |

| ZBS AKP-080-0.5-2s-TTC77 Programming cable (CAN) for the controller HY-TTC 77 including power supply for direct “stand alone” operation. Features such as indicator lamps for $U_{ib}$ and K15 as well as a switch for K15 provide additional functionality. A useful accessory for commissioning and service. | 61499787 |
## Cable harnesses for I/O expansion modules

<table>
<thead>
<tr>
<th>Type</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZBS AK-048-3.0-1s</td>
<td>6148656</td>
</tr>
<tr>
<td>HY-TTC 30X cable harness 48 pole 3 m flying lead</td>
<td></td>
</tr>
<tr>
<td>ZBS AK-080-3.0-1s</td>
<td>6081986</td>
</tr>
<tr>
<td>Cable harness for HY-TTC 36X / 48X / 48XS</td>
<td></td>
</tr>
</tbody>
</table>

## PCAN-Dongle

<table>
<thead>
<tr>
<th>Type</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZBS PCAN-USB</td>
<td>on request</td>
</tr>
</tbody>
</table>
## Cable harnesses for displays

<table>
<thead>
<tr>
<th>Type</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZBS AKV-015-1.0-2s HY-eVision² 10.4 Cable harness for power supply with USB</td>
<td>6137851</td>
</tr>
<tr>
<td>ZBS AKV-034-1.0-2s HY-eVision² 7.0 Cable harness for power supply with USB and camera connection</td>
<td>6137854</td>
</tr>
<tr>
<td>ZBS AKP-030-1.0-2s HY-eVision² 10.4 Programming cable harness</td>
<td>922240</td>
</tr>
<tr>
<td>ZBS AKP-034-1.0-2s HY-eVision² 7.0 Programming cable harness (2 CAN)</td>
<td>922277</td>
</tr>
<tr>
<td>ZBS AKP-034-1.0-2s-4CAN HY-eVision² 7.0 Programming cable harness (4 CAN)</td>
<td>6158297</td>
</tr>
<tr>
<td>ZBS AK-034-3.0-1s HY-eVision² 7.0 Cable harness 34 pole 3 m flying lead</td>
<td>6127483</td>
</tr>
</tbody>
</table>
## Connectors

<table>
<thead>
<tr>
<th>Type</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZBS AS-028 HY-TTC 50 series, connection kit 28 pole</td>
<td>6082667</td>
</tr>
<tr>
<td>Note: The complete order includes: ZBS AS-028 and ZBS AS-052</td>
<td></td>
</tr>
<tr>
<td>ZBS AS-052 HY-TTC 50 series, connection kit 52 pole</td>
<td>6082668</td>
</tr>
<tr>
<td>Note: The complete order includes: ZBS AS-028 and ZBS AS-052</td>
<td></td>
</tr>
<tr>
<td>ZBS AS-060 HY-TTC 200 and HY-Vision connection kit 60 pole</td>
<td>6091033</td>
</tr>
<tr>
<td>Note: The complete order includes: ZBS AS-060 and ZBS AS-094</td>
<td></td>
</tr>
<tr>
<td>ZBS AS-094 HY-TTC 200 and HY-Vision connection kit 94 pole</td>
<td>6091034</td>
</tr>
<tr>
<td>Note: The complete order includes: ZBS AS-060 and ZBS AS-094</td>
<td></td>
</tr>
<tr>
<td>ZBS AS-034 HY-eVision² 7.0 connection kit</td>
<td>6114948</td>
</tr>
<tr>
<td>Pins are supplied</td>
<td></td>
</tr>
<tr>
<td>ZBS AS-030 HY-eVision² 10.4 connector</td>
<td>6158298</td>
</tr>
<tr>
<td>ZBS AS-048 HY-TTC 30 series, connection kit</td>
<td>6158445</td>
</tr>
</tbody>
</table>
## Connectors

<table>
<thead>
<tr>
<th>Type</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZBS MTB-AS-43</td>
<td></td>
</tr>
<tr>
<td>ECU connection block</td>
<td></td>
</tr>
<tr>
<td>plug terminal for</td>
<td></td>
</tr>
<tr>
<td>ZBS MTB-RACK Height 43</td>
<td>on request</td>
</tr>
<tr>
<td>ZBS MTB-AS-63</td>
<td></td>
</tr>
<tr>
<td>ECU connection block</td>
<td></td>
</tr>
<tr>
<td>plug terminal for</td>
<td></td>
</tr>
<tr>
<td>ZBS MTB-RACK Height 63</td>
<td>on request</td>
</tr>
<tr>
<td>ZBS RTB-AS-43</td>
<td></td>
</tr>
<tr>
<td>ECU connection block</td>
<td></td>
</tr>
<tr>
<td>plug terminal for</td>
<td></td>
</tr>
<tr>
<td>ZBS RTB-RACK Height 43</td>
<td>on request</td>
</tr>
<tr>
<td>ZBS RTB-AS-63</td>
<td></td>
</tr>
<tr>
<td>ECU connection block</td>
<td></td>
</tr>
<tr>
<td>plug terminal for</td>
<td></td>
</tr>
<tr>
<td>ZBS RTB-RACK Height 63</td>
<td>on request</td>
</tr>
<tr>
<td>ZBS-AS-058</td>
<td>6158449</td>
</tr>
<tr>
<td>HY-TTC 500 series, connection kit 58 pole</td>
<td></td>
</tr>
<tr>
<td>ZBS-AS-096</td>
<td>6158450</td>
</tr>
<tr>
<td>HY-TTC 500 series, connection kit 96 pole</td>
<td></td>
</tr>
</tbody>
</table>
## Installation accessories

<table>
<thead>
<tr>
<th>Type</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZBS RM-10.4</td>
<td>6137801</td>
</tr>
<tr>
<td>RAM-Mount; mounting bracket for HY-eVision² 10.4</td>
<td></td>
</tr>
<tr>
<td>ZBS RM-07.0</td>
<td>6137777</td>
</tr>
<tr>
<td>RAM-Mount; mounting bracket for HY-eVision² 7.0</td>
<td></td>
</tr>
</tbody>
</table>
5.2 Accessories for training, development, testing and service purposes

Starter kits

For a project to be effective it is necessary to have the right accessories and suitable tools to hand. In the case of application development the individual components must also be properly combined and must be compatible with each other.

If some application software is to be developed for a HYDAC mobile controller it is best to use one of our starter kits. These kits contain all the necessary tools and products for the operation of a HY-TTC controller.

The project's sensors and actuators can be connected to the particular connector interface thus ensuring that the electronics and valve technology actually used are always connected directly to the controller. This saves a lot of time during development and carrying out initial testing.

The starter kits are also available in two different versions:

1. For programming and development in CODESYS®
2. For programming and development in C
3. For I/O expansion modules

The starter kits are made up of the following components:

- **Starter kit for CODESYS®**
  - The relevant controller
  - The connector interface, i.e. a circuit board with the mating connector for the cable harness on one side and spring clips for connecting sensors and actuators on the other side
  - The cable harness to connect the controller to the connector interface
  - The CAN dongle which connects the computer with the CAN interface of the controller
  - A CD containing the driver software and the complete CODESYS®-Package for the relevant controller
  - A manual of the correct commissioning of the starter kit

- **Starter kit for C**
  - The relevant controller with access to the JTAG interface (debugging)
  - The JTAG adapter which connects the relevant debugger with the JTAG interface of the controller
  - The connector interface, i.e. a circuit board with the mating connector for the cable harness on one side and spring clips for connecting sensors and actuators on the other side
  - The cable harness which connects the controller to the connector interface
  - The CAN dongle which connects the computer with the CAN interface of the controller
  - A CD containing the driver software for the relevant controller
  - A manual of the correct commissioning of the starter kit

- **Starter kit for I/O expansions**
  - The relevant I/O expansion
  - The connector interface, i.e. a circuit board with the mating connector for the cable harness on one side and spring clips for connecting sensors and actuators on the other side
  - The cable harness which connects the I/O expansion to the connector interface
  - A USB memory stick with the driver software and CANopen package
  - A manual of the correct commissioning of the starter kit
## Starter kits for CODESYS®

<table>
<thead>
<tr>
<th>Type</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY-TTC 50 CODESYS® Starter kit</td>
<td>on request</td>
</tr>
<tr>
<td>HY-TTC 60 CODESYS® Starter kit</td>
<td>922197</td>
</tr>
<tr>
<td>HY-TTC 90 CODESYS® Starter kit</td>
<td>922169</td>
</tr>
<tr>
<td>HY-TTC 94 CODESYS® Starter kit</td>
<td>923617</td>
</tr>
<tr>
<td>HY-TTC 200 CODESYS® Starter kit</td>
<td>921138</td>
</tr>
<tr>
<td>HY-TTC 540 CODESYS® Starter kit</td>
<td>924366</td>
</tr>
<tr>
<td>HY-TTC 580 CODESYS® Starter kit</td>
<td>924149</td>
</tr>
</tbody>
</table>
## Starter kits for C programming

<table>
<thead>
<tr>
<th>Type</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY-TTC 50 C Starter kit</td>
<td>on request</td>
</tr>
<tr>
<td>HY-TTC 60 C Starter kit</td>
<td>924181</td>
</tr>
<tr>
<td>HY-TTC 90 C Starter kit</td>
<td>on request</td>
</tr>
<tr>
<td>HY-TTC 94 C Starter kit</td>
<td>924178</td>
</tr>
<tr>
<td>HY-TTC 200 C Starter kit</td>
<td>924177</td>
</tr>
<tr>
<td>HY-TTC 540 C Starter kit</td>
<td>924365</td>
</tr>
<tr>
<td>HY-TTC 580 C Starter kit</td>
<td>924105</td>
</tr>
<tr>
<td>HY-TTC 30-H C Starter kit</td>
<td>924146</td>
</tr>
<tr>
<td>HY-TTC 30S-H C Starter kit</td>
<td>924150</td>
</tr>
</tbody>
</table>
## Starter kits for I/O expansions

<table>
<thead>
<tr>
<th>Type</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY-TTC 30X-H-Starter kit</td>
<td>924142</td>
</tr>
<tr>
<td>HY-TTC 30XS-H-Starter kit</td>
<td>924148</td>
</tr>
</tbody>
</table>
## JTAG adapters

<table>
<thead>
<tr>
<th>Type</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ZBS JTAG-01</strong></td>
<td></td>
</tr>
<tr>
<td>TTC50FAM JTAG Adapter Board</td>
<td>6158299</td>
</tr>
<tr>
<td>For HY-TTC 50 / 60 / 90 / 94 / 77</td>
<td></td>
</tr>
<tr>
<td><strong>ZBS JTAG-02</strong></td>
<td></td>
</tr>
<tr>
<td>JTAG Adapter Board</td>
<td>6158358</td>
</tr>
<tr>
<td>For HY-TTC 200</td>
<td></td>
</tr>
<tr>
<td><strong>ZBS JTAG-03</strong></td>
<td></td>
</tr>
<tr>
<td>JTAG Adapter</td>
<td>6158443</td>
</tr>
<tr>
<td>For HY-TTC 30x</td>
<td></td>
</tr>
<tr>
<td><strong>ZBS JTAG-04</strong></td>
<td></td>
</tr>
<tr>
<td>JTAG Adapter</td>
<td>6158360</td>
</tr>
<tr>
<td>For HY-TTC 540 / 580</td>
<td></td>
</tr>
</tbody>
</table>
To simplify the commissioning process or to speed up field diagnostics on the machine, we can offer various Break-Out Boxes which are compatible with our controllers. These boxes can be connected to the existing cable using the integrated, (approximately 0.8 mm long), connecting cable.

Using the 2 mm bridging connector with test points, the actual signal levels for each pin on the controller can be accessed. Additionally, by removing the bridging connector, external signals can be connected to the wiring harness.
# Break-Out Box (BOB)

<table>
<thead>
<tr>
<th>Type</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZBS BOB-K-080</td>
<td>6127439</td>
</tr>
<tr>
<td>Break-Out Box in carry case for HY-TTC 50 / 60 / 90 / 94 / 36X / 48X / 48XS</td>
<td></td>
</tr>
<tr>
<td>ZBS BOB-K-048</td>
<td>6156290</td>
</tr>
<tr>
<td>Break-Out Box in carry case for HY-TTC 30X series</td>
<td></td>
</tr>
<tr>
<td>ZBS BOB-TESTKIT-00-000</td>
<td>on request</td>
</tr>
<tr>
<td>Test cables to supplement the Break-Out Boxes, consisting of cables and jumper plugs in 2 mm and 4 mm technology.</td>
<td></td>
</tr>
</tbody>
</table>
Controller test rigs

To match the development of controller test rigs, HYDAC ELECTRONIC has expanded the testing and servicing capabilities of the HY-TTC series. Fast and reliable test procedures are a key factor in the efficient implementation of functional safety control software. This is particularly so in respect of functions with functional safety.

Crucially, the HYDAC controller test rig offers significant reductions in total development time. HYDAC’s controller test rig is capable of simulating virtually any input condition or output state. The time saving is considerable because program errors are detected and eliminated prior to commissioning.

Configuration

The configuration of all controller test rigs can be customized. The connection is made via a universal connector. Each pin of the connector is firmly assigned to a module channel. A wide range of pluggable I/O modules is available allowing the test rig to emulate the individual client’s target system.

Our input modules provide all standard sensor signals: voltage, current and frequency. Using the output modules, a resistive load can be applied to the channels of a controller. Configuration is carried out either manually via a selector switch or remotely via control software.

To simplify the ordering process, in the datasheets you will find an overview table which shows the choice of components suitable for the particular controller.

Software

Configuration is carried out either manually via a selector switch or remotely via control software.

The Remote Controlled Controller Test Rig (RTB) can be configured and controlled via the TSE (HYDAC Test und Simulations Tool). A basic version of the TSE is included for configuration of the RTB. The full, licensed version of the TSE allows controllers and whole controller architectures to be emulated on the PC. In addition, whole test sequences for function and error tests can be performed automatically.

Automatic function

For fast, reliable, complete and repeatable test series, an automatic version of our controller test rigs is available. This equipment can be configured and controlled externally via PC based software. Moreover it is possible to evaluate, via the existing connection, the voltage and current measurements present in the modules. This allows fully automatic test runs to be created.
Special features
- Can be used for all HY-TTC controllers
- All essential controller functions accessible
- Configuration can be altered simply using switches
- Cascadable
- Compact design in stable housing
- Max. 90 A / 960 W
- Suitable for 24 V and 12 V systems

Description
The MTB is a powerful tool for manual testing and verifying of ECU software during development. The test rig is modular in design and can therefore be adapted to the individual requirements of the application. Over 3 or 5 rows, the stable 19" rack provides the installation space for 15 or 27 modules in total. Three special modules for power supply, communications and internal sensor power supply are already installed in fixed module positions in the rack. These modules provide the battery supply, the communication interfaces (CAN, RS232, LIN), plus a sensor power supply. The optional labelling set can be used to label the fully populated MTB, front and back, to suit all our controllers.

On the back, input terminals are available for battery voltage with max. 90A. The ECU can also be installed directly here. To connect the ECU to the MTB there are plug-in connection terminals on the back. Each of these plug-in terminals is allocated to a fixed slot on the front which guarantees unambiguous assignment to the connected ECU pin.

Through the use of pluggable I/O modules, all essential ECU functions can be tested. This means that each of the I/O modules provides the drive for four controller pins. Configuration switches are used to drive the input and outputs individually. In addition, the connection between controller pin and module channel can be broken via the Break-Out connection block. When disconnected, external signals or actuator can also be directly connected to a controller pin.

Technical data

<table>
<thead>
<tr>
<th>Ambient conditions</th>
<th>230 V AC ±10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>max. 250 VA</td>
</tr>
<tr>
<td>Power consumption</td>
<td>max. 90 A</td>
</tr>
<tr>
<td>Supply U_{bat}</td>
<td>max. 960 W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimensions and weight</th>
<th>Rack 43</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>450 x 550 x 280 mm</td>
</tr>
<tr>
<td></td>
<td>450 x 817 x 280 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>approx. 17 kg</td>
</tr>
<tr>
<td></td>
<td>approx. 28 kg</td>
</tr>
</tbody>
</table>
**Model code**

4 = 4 rows in total (3 usable rows)
3 = Euro card height 3HE

V = Supply module, installed
K = Communication module
    CAN, RS232, LIN, installed
S = Supply pins module, installed

**Device address**
AO = 0, (0, 1, 2, 3)

**Equipment options**
00 = standard

**Modification number**
000 = standard

---

6 = 6 rows in total (5 usable rows)
3 = Euro card height 3HE

V = Supply module, installed
K = Communication module
    CAN, RS232, LIN, installed
S = Supply pins module, installed

**Device address**
AO = 0, (0, 1, 2, 3)

**Equipment options**
00 = standard

**Modification number**
000 = standard

**Note**

On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

**Accessories**

Suitable accessories can be found in the Accessories section.
# Module configuration

## ZBS MTB-RACK-43-VKG-A0-00-000

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2</strong></td>
<td>200</td>
<td>201</td>
<td>202</td>
<td>203</td>
<td></td>
</tr>
<tr>
<td><strong>1</strong></td>
<td>100</td>
<td>101</td>
<td>102</td>
<td>103</td>
<td>110</td>
</tr>
<tr>
<td><strong>0</strong></td>
<td>000</td>
<td>001</td>
<td>002</td>
<td>003</td>
<td>010</td>
</tr>
</tbody>
</table>

**Input or switch**

**Input, switch or CAN**

**Fuse**

**Power-out supply-pins**

## ZBS MTB-RACK-63-VKG-A0-00-000

<table>
<thead>
<tr>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>0</strong></td>
<td>700</td>
<td>701</td>
<td>702</td>
<td>703</td>
<td>710</td>
</tr>
<tr>
<td><strong>1</strong></td>
<td>600</td>
<td>601</td>
<td>602</td>
<td>603</td>
<td>610</td>
</tr>
<tr>
<td><strong>2</strong></td>
<td>500</td>
<td>501</td>
<td>502</td>
<td>503</td>
<td>510</td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>400</td>
<td>401</td>
<td>402</td>
<td>403</td>
<td>410</td>
</tr>
<tr>
<td><strong>4</strong></td>
<td>300</td>
<td>301</td>
<td>302</td>
<td>303</td>
<td>310</td>
</tr>
</tbody>
</table>

**Input or switch**

**Input, switch or CAN**

**Fuse**

**Power-out supply-pins**
Block circuit diagram

ZBS MTB-RACK-43-VKG-A0-00-000 / ZBS MTB-RACK-63-VKG-A0-00-000

One CAN channel illustrated

One power supply channel illustrated

Overview

<table>
<thead>
<tr>
<th>Controller</th>
<th>Rack 4.3</th>
<th>Rack 6.3</th>
<th>MTB IN</th>
<th>MTB INSW</th>
<th>MTB OUT</th>
<th>Blind covers</th>
<th>Cable harness</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY-TTC 50</td>
<td>1 x</td>
<td>4 x</td>
<td>2 x</td>
<td>6 x</td>
<td>3 x</td>
<td></td>
<td>ZBS AK-080-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 60</td>
<td>1 x</td>
<td>6 x</td>
<td>2 x</td>
<td>6 x</td>
<td>1 x</td>
<td></td>
<td>ZBS AK-080-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 90/94</td>
<td>1 x</td>
<td>6 x</td>
<td>2 x</td>
<td>6 x</td>
<td>1 x</td>
<td></td>
<td>ZBS AK-080-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 77</td>
<td>1 x</td>
<td>8 x</td>
<td>2 x</td>
<td>7 x</td>
<td>8 x</td>
<td></td>
<td>ZBS AK-080-3.0-1s-TTC77</td>
</tr>
<tr>
<td>HY-TTC 200</td>
<td>1 x</td>
<td>7 x</td>
<td>2 x</td>
<td>9 x</td>
<td>7 x</td>
<td></td>
<td>ZBS AK-154-3.0-1s-TTC200</td>
</tr>
<tr>
<td>HY-TTC 30X-H</td>
<td>1 x</td>
<td>4 x</td>
<td>4 x</td>
<td>7 x</td>
<td></td>
<td></td>
<td>ZBS AK-048-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 30X-I</td>
<td>1 x</td>
<td>7 x</td>
<td>1 x</td>
<td>7 x</td>
<td></td>
<td></td>
<td>ZBS AK-048-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 30X-O</td>
<td>1 x</td>
<td>4 x</td>
<td>4 x</td>
<td>7 x</td>
<td></td>
<td></td>
<td>ZBS AK-048-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 36X</td>
<td>1 x</td>
<td>5 x</td>
<td>2 x</td>
<td>3 x</td>
<td>5 x</td>
<td></td>
<td>ZBS AK-080-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 48X/48XS</td>
<td>1 x</td>
<td>6 x</td>
<td>2 x</td>
<td>4 x</td>
<td>3 x</td>
<td></td>
<td>ZBS AK-080-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 540</td>
<td>1 x</td>
<td>13 x</td>
<td>11 x</td>
<td>3 x</td>
<td></td>
<td></td>
<td>ZBS AK-154-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 580</td>
<td>1 x</td>
<td>11 x</td>
<td>13 x</td>
<td>3 x</td>
<td></td>
<td></td>
<td>ZBS AK-154-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 30-H</td>
<td>1 x</td>
<td>4 x</td>
<td>4 x</td>
<td>7 x</td>
<td></td>
<td></td>
<td>ZBS AK-048-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 30S-H</td>
<td>1 x</td>
<td>4 x</td>
<td>4 x</td>
<td>7 x</td>
<td></td>
<td></td>
<td>ZBS AK-048-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 30XS-H</td>
<td>1 x</td>
<td>4 x</td>
<td>4 x</td>
<td>7 x</td>
<td></td>
<td></td>
<td>ZBS AK-048-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 30XS-I</td>
<td>1 x</td>
<td>7 x</td>
<td>1 x</td>
<td>7 x</td>
<td></td>
<td></td>
<td>ZBS AK-048-3.0-1s</td>
</tr>
</tbody>
</table>

Note

The information in this brochure relates to the operating conditions and applications described.

For applications and operating conditions not described, please contact the relevant technical department.

Subject to technical modifications.

HYDAC ELECTRONIC GmbH
Hauptstraße 27
66128 Saarbrücken, Germany
Tel. +49 6897 509-01
Fax +49 6897 509-1726
E-mail: electronic@hydac.com
Internet: www.hydac.com
Special features
- Up to 4 controller pins on one module
- Digital signals, high and low-side
- Frequency signals
- Voltage signals
- Current signals
- External signal supply possible

Description
The Universal Input Module allows a signal to be applied to the input of an ECU. Almost any output signals from a sensor can be simulated with this module. By using a multi-stage selector switch, the type of signal can be selected. A proportional control provides adjustment of the required signal value.

Possible signal types are digital switching states, frequency, voltage and current signals. The module can be used to drive both digital and analogue inputs.

The real-time signal level can be measured at the Break-Out Plug. This jumper plug connects the pin of the controller with the electronics of the module. When disconnected, external sensors can also be directly connected to the controller.

Technical data

<table>
<thead>
<tr>
<th>Functions</th>
<th>0: switch low-side active (switching to GND)</th>
<th>1: switch high-side active (switching to +UBat)</th>
<th>2: rpm 1 Hz – 6.5 kHz low-side active</th>
<th>3: rpm 1 Hz – 6.5 kHz high-side active</th>
<th>4: current source 0..25 mA</th>
<th>5: voltage 0..5 V</th>
<th>6: voltage 0..16 V</th>
<th>7: voltage 0..32 V</th>
<th>8: dual voltage 0..5 V, slave-slot inverted</th>
<th>9: dual voltage 0.5..4.5 V, slave-slot inverted</th>
<th>10: dual voltage 0.5..4.5 V master, slave-slot 0.5..2.5 V (following)</th>
<th>11: dual current 0..25 mA, slave-slot inverted</th>
<th>12: dual rpm +/-1 Hz..2.0 kHz low-side active, slave signal with 90 °, phase shift (direction dependent)</th>
<th>13: dual rpm +/-1 Hz..2.0 kHz high-side active, slave signal with 90 °, phase shift (direction dependent)</th>
<th>14: dual switch master = HS, slave = HS inverted (switching to +UBat)</th>
<th>15: dual switch master = LS, slave = LS inverted (switching to GND)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>71 x 129 x 210 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>285 g</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: All voltages are limited to the rear voltage supply (Power Logic).
Block circuit diagram

ZBS MTB-IN-00-000

Model code

<table>
<thead>
<tr>
<th>Equipment options</th>
<th>ZBS MTB – IN – 00 – 000</th>
</tr>
</thead>
<tbody>
<tr>
<td>00 = standard</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Modification number</th>
<th>000 = standard</th>
</tr>
</thead>
</table>

Note
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

Accessories
Suitable accessories can be found in the Accessories section.

Note
The information in this brochure relates to the operating conditions and applications described.
For applications and/or operating conditions not described, please contact the relevant technical department.
Subject to technical modifications.

HYDAC ELECTRONIC GmbH
Hauptstraße 27
66128 Saarbrücken, Germany
Tel. +49 6897 509-01
Fax +49 6897 509-1726
E-mail: electronic@hydac.com
Internet: www.hydac.com
Switch Input Module for Manual Controller Test Rig
ZBS MTB-INSW-00-000

Special features
- Up to 4 controller pins on one module
- High and low-side switches
- External signal supply possible

Description
The Switch Input Module allows a digital signal to be applied to the input of an ECU. By using a multi-stage selector switch, the type of signal (high-side or low-side) can be selected. The connection to the pre-selected signal is via a switch.

In contrast to the MTB-IN-00-000 input module, this input module can be used to drive purely digital inputs.

The real-time signal level can be measured at the Break-Out Plug. This jumper plug connects the pin of the controller with the electronics of the module. When this plug is disconnected, external sensors can also be directly connected to the controller.

Technical data

<table>
<thead>
<tr>
<th>Functions</th>
<th>0: switch low-side active (switching to GND)</th>
<th>1: switch high-side active (switching to rear voltage supply [Power Logic Slot O])</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>71 x 129 x 210 mm</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>250 g</td>
<td></td>
</tr>
</tbody>
</table>
Block circuit diagram

ZBS MTB-INSW-00-000

Note

The information in this brochure relates to the operating conditions and applications described. For applications and/or operating conditions not described, please contact the relevant technical department. Subject to technical modifications.

Model code

ZBS MTB – INSW – 00 – 000

Equipment options

00 = standard

Modification number

000 = standard

Note

On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

Accessories

Suitable accessories can be found in the Accessories section.
**Universal Output Module for Manual Controller Test Rig**

**ZBS MTB-OUT-00-000**

### Special features
- 4 controller pins on one module
- Resistive load can be applied; High and low-side
- Status monitoring with LED
- Short circuit switched to $U_{Bat}$ or GND for maximum current limiting function
- External actuator connection possible

### Description

The Universal Output Module provides a means of applying a purely resistive or complex real load, or alternatively a fault signal, to the output of a controller. The battery voltage ($U_{Bat}$) and the ground signal (GND) sockets are available for this. Both signals are protected with an electronic fuse element.

The real-time output condition is indicated via an LED.

The real-time signal level can be measured at the Break-Out Plug. This jumper plug connects the pin of the controller with the electronics of the module. When disconnected, external actuator can also be directly connected to the controller.

### Technical data

| Functions | 1: Low side load (resistance 22 $\Omega$ to GND): jumper plug between R and GND  
|           | 2: High-side load (resistance 22 $\Omega$ to $+U_{Bat}$): jumper plug between R and $+U_{Bat}$ |
| Resistive load | 22 $\Omega$ |
| Electronic fuse element 5 A for $U_{Bat}$ and GND |
| LED for status monitoring; ON for $U_{out} > 9V$ |
| Dimensions | 71 x 129 x 210 mm |
| Weight | 270 g |
Block circuit diagram for a slot (PIN)

ZBS MTB-OUT-00-000

![Block circuit diagram]

**Model code**

<table>
<thead>
<tr>
<th>Equipment options</th>
<th>ZBS MTB – OUT – 00 – 000</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>Standard</td>
</tr>
</tbody>
</table>

| Modification number | 000 = standard |

**Note**

The information in this brochure relates to the operating conditions and applications described.
For applications and/or operating conditions not described, please contact the relevant technical department.
Subject to technical modifications.

**On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.**

**Accessories**
Suitable accessories can be found in the Accessories section.

**HYDAC ELECTRONIC GmbH**
Hauptstraße 27
66128 Saarbrücken, Germany
Tel.  +49 6897 509-01
Fax  +49 6897 509-1726
E-mail: electronic@hydac.com
Internet: www.hydac.com
Remote Controlled Controller
Test Rig Chassis (19" Rack)
ZBS RTB-RACK-43-VGKS-A0-00-000
ZBS RTB-RACK-63-VGKS-A0-00-000

Special features
- Can be used for all HY-TTC controllers
- All essential controller functions accessible
- The configuration can be changed directly or remotely
- Can be completely remotely controlled via CAN
- Error mode test via CAN
- Values shown in display
- 15 device-configurations can be saved
- Cascadable
- Compact design in stable housing
- Max. 90 A / 960 W
- Suitable for 24 V and 12 V systems

Description
The RTB is an intelligent, powerful tool for testing and verifying controller software during development. The test rig is modular in design and can therefore be adapted to the individual requirements of the application. The RTB is cascadable via addressing.

Over 3 or 5 rows, the stable 19" rack provides the installation space for 14 or 26 modules in total. Four modules for power supply, communications and internal power supply are already installed in fixed module positions in the rack. These modules provide the battery supply, reference points (GND) for analogue and digital signals, the communication interfaces (CAN, RS232, LIN), plus a sensor power supply. The optional labelling set can be used to label the fully populated RTB on the back, to suit all our controllers.

On the back, input terminals are available for battery voltage with max. 90 A. The ECU can also be installed directly here. To connect the ECU to the RTB there are plug-in connection terminals on the rear. Each of these plug-in terminals is allocated to a fixed slot on the front which guarantees unambiguous assignment to the connected ECU pin.

Through the use of pluggable I/O modules, all essential controller functions can be tested. This means that each of the I/O modules provides the drive for four controller pins. In addition, the connection between controller pin and module channel can be broken via the Break-Out Connection Block. When disconnected, external actuators or sensors can also be directly connected to a controller pin. Configuration switches are used to drive the input and outputs individually.

Automatic function
The test rig can be configured and remotely controlled via the CAN interface located on the back. The software required for this is not included and must be ordered separately from HYDAC ELECTRONIC. However, all functions can also be activated directly on the test rig. The communication module can store up to 15 configurations directly on the test rig. Once stored, a configuration can be re-activated at any time to adapt the test rig quickly and simply to the project to be processed.

Technical data

<table>
<thead>
<tr>
<th>Ambient conditions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>230 V AC ±10 %</td>
</tr>
<tr>
<td>Power consumption</td>
<td>max. 250 VA</td>
</tr>
<tr>
<td>Supply $U_{bat}$</td>
<td>90 A nominal current, 90 A peak current</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>max. 960 W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimensions and weight</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>450 x 550 x 280 mm (Rack 43)</td>
</tr>
<tr>
<td></td>
<td>450 x 817 x 280 mm (Rack 63)</td>
</tr>
<tr>
<td>Weight</td>
<td>approx. 17 kg (Rack 43)</td>
</tr>
<tr>
<td></td>
<td>approx. 28 kg (Rack 63)</td>
</tr>
</tbody>
</table>
**Communication module, permanently installed in RACK**

The data interfaces of the connected controller can be tested using the communications module. Specifically using the CAN interface, it is possible to enable termination resistors and to switch short circuits to other states.

In addition to the communications test, this module can be used to upload a saved configuration, or to start the device self-test.

**Sensor supply simulation module, permanently installed in the RACK**

The sensor supply simulation module allows the sensor power supply supplied by the ECU to be tested. It is thus possible to measure the real-time voltage as well as the current. In addition different error signals can be switched.
Block circuit diagram

ZBS RTB-RACK-43-VGKS-A0-00-000
ZBS RTB-RACK-63-VGKS-A0-00-000

Communication module, permanently installed in RACK

One CAN channel illustrated

Sensor supply simulation module

One power supply channel illustrated
Model code

ZBS RTB-RACK – 43 – VGKS – AO – 00 – 000
4 = 4 rows in total (3 usable rows)
3 = Euro card height 3HE
V = supply module, built-in
G = supply pins module
K = communication module
2x CAN, 1x RS232, 1x LIN, built-in
S = sensor supply simulation module, built-in

Device address
AO = 0

Equipment options
00 = standard

Modification number
000 = standard

ZBS RTB-RACK – 63 – VGKS – AO – 00 – 000
6 = 6 rows in total (5 usable rows)
3 = Euro card height 3HE
V = supply module, built-in
G = supply pins module
K = communication module
2x CAN, 1x RS232, 1x LIN, built-in
S = sensor supply simulation module, built-in

Device address
AO = 0, (0, 1, 2, 3)

Equipment options
00 = standard

Modification number
000 = standard

Note
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

Accessories
Suitable accessories can be found in the Accessories section.
# Module configuration

**ZBS RTB-RACK-43-VGKS-A0-00-000**

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Sensor Supply Simulation</td>
</tr>
<tr>
<td></td>
<td>200 201 202 203</td>
<td>210 211 212 213</td>
<td>220 221 222 223</td>
<td>230 231 232 233</td>
<td>240 241 242 243</td>
<td>250 251 252 253</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100 101 102 103</td>
<td>110 111 112 113</td>
<td>120 121 122 123</td>
<td>130 131 132 133</td>
<td>140 141 142 143</td>
<td>150 151 152 153</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td></td>
<td>Fuse supply-pins</td>
</tr>
<tr>
<td></td>
<td>000 001 002 003</td>
<td>010 011 012 013</td>
<td>020 021 022 023</td>
<td>030 031 032 033</td>
<td>040 041 042 043</td>
<td>050 051 052 053</td>
</tr>
</tbody>
</table>

**ZBS RTB-RACK-63-VGKS-A0-00-000**

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
</tr>
<tr>
<td></td>
<td>700 701 702 703</td>
<td>710 711 712 714</td>
<td>720 721 722 723</td>
<td>730 731 732 733</td>
<td>740 741 742 743</td>
<td>750 751 752 753</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
</tr>
<tr>
<td></td>
<td>600 601 602 603</td>
<td>610 611 612 613</td>
<td>620 621 622 623</td>
<td>630 631 632 633</td>
<td>640 641 642 643</td>
<td>650 651 652 653</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td></td>
<td>Sensor Supply Simulation</td>
</tr>
<tr>
<td></td>
<td>500 501 502 503</td>
<td>510 511 512 513</td>
<td>520 521 522 523</td>
<td>530 531 532 533</td>
<td>540 541 542 543</td>
<td>550 551 552 553</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td></td>
</tr>
<tr>
<td></td>
<td>400 401 402 403</td>
<td>410 411 412 413</td>
<td>420 421 422 423</td>
<td>430 431 432 433</td>
<td>440 441 442 443</td>
<td>450 451 452 453</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td>Input or Output</td>
<td></td>
<td>Fuse supply-pins</td>
</tr>
<tr>
<td></td>
<td>300 301 302 303</td>
<td>310 311 312 313</td>
<td>320 321 322 323</td>
<td>330 331 332 333</td>
<td>340 341 342 343</td>
<td>350 351 352 353</td>
</tr>
</tbody>
</table>
## Overview

<table>
<thead>
<tr>
<th>Controller</th>
<th>Rack 4.3</th>
<th>Rack 6.3</th>
<th>RTB IN</th>
<th>RTB OUT</th>
<th>Blind covers</th>
<th>Cable harness</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY-TTC 50</td>
<td>1 x</td>
<td></td>
<td>6 x</td>
<td>6 x</td>
<td>2 x</td>
<td>ZBS AK-080-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 60</td>
<td>1 x</td>
<td>8 x</td>
<td>6 x</td>
<td></td>
<td></td>
<td>ZBS AK-080-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 90/94</td>
<td>1 x</td>
<td>8 x</td>
<td>6 x</td>
<td></td>
<td></td>
<td>ZBS AK-080-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 77</td>
<td>1 x</td>
<td></td>
<td>10 x</td>
<td>7 x</td>
<td>9 x</td>
<td>ZBS AK-080-3.0-1s-TTC77</td>
</tr>
<tr>
<td>HY-TTC 200</td>
<td>1 x</td>
<td>9 x</td>
<td>9 x</td>
<td></td>
<td>8 x</td>
<td>ZBS AK-154-3.0-1s-TTC200</td>
</tr>
<tr>
<td>HY-TTC 30X-H</td>
<td>1 x</td>
<td>4 x</td>
<td>4 x</td>
<td></td>
<td>6 x</td>
<td>ZBS AK-048-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 30X-I</td>
<td>1 x</td>
<td>7 x</td>
<td>1 x</td>
<td></td>
<td>6 x</td>
<td>ZBS AK-048-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 30X-O</td>
<td>1 x</td>
<td>4 x</td>
<td>4 x</td>
<td></td>
<td>6 x</td>
<td>ZBS AK-048-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 36X</td>
<td>1 x</td>
<td>7 x</td>
<td>3 x</td>
<td></td>
<td>4 x</td>
<td>ZBS AK-080-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 48X/48XS</td>
<td>1 x</td>
<td>8 x</td>
<td>4 x</td>
<td></td>
<td>2 x</td>
<td>ZBS AK-080-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 540</td>
<td>1 x</td>
<td>13 x</td>
<td>11 x</td>
<td></td>
<td>2 x</td>
<td>ZBS AK-154-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 580</td>
<td>1 x</td>
<td>11 x</td>
<td>13 x</td>
<td></td>
<td>2 x</td>
<td>ZBS AK-154-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 30-H</td>
<td>1 x</td>
<td>4 x</td>
<td>4 x</td>
<td></td>
<td>6 x</td>
<td>ZBS AK-048-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 30S-H</td>
<td>1 x</td>
<td>4 x</td>
<td>4 x</td>
<td></td>
<td>6 x</td>
<td>ZBS AK-048-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 30XS-H</td>
<td>1 x</td>
<td>4 x</td>
<td>4 x</td>
<td></td>
<td>6 x</td>
<td>ZBS AK-048-3.0-1s</td>
</tr>
<tr>
<td>HY-TTC 30XS-I</td>
<td>1 x</td>
<td>7 x</td>
<td>1 x</td>
<td></td>
<td>6 x</td>
<td>ZBS AK-048-3.0-1s</td>
</tr>
</tbody>
</table>

### Note

The information in this brochure relates to the operating conditions and applications described. For applications and/or operating conditions not described, please contact the relevant technical department. Subject to technical modifications.
Universal Input Module for RTB
ZBS RTB-IN-00-000

Special features
- Up to 4 controller pins on one module
- Digital signals, high and low-side
- Frequency signals
- Voltage signals
- Current signals
- External signal supply possible
- 2 alternative functions can be configured

Description
The Universal Input Module allows a signal to be applied to the input of an ECU.
Almost any output signals from a sensor can be simulated with this module via a selection menu. The type of signal can be selected from the selection menu. An incremental control provides adjustment of the required signal value.
Possible signal types are digital switching states, frequency, voltage and current signals. The module can be used to drive both digital and analogue inputs. To test signals with increased requirements of functional safety, two channels can also be configured as "master-slave". For this type of operation, various antivalent signal types are available.
The real-time signal level can be measured at the Break-Out Plugs. This jumper plug connects the pin of the controller with the electronics of the module. When this plug is disconnected, external sensors can also be directly connected to the controller.
When disconnected, external signals or actuators can also be directly connected to a controller pin.

Technical data

<table>
<thead>
<tr>
<th>Functions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage source</td>
<td>0 ... 36.0 V</td>
</tr>
<tr>
<td>Current source</td>
<td>0 ... 25.5 mA</td>
</tr>
<tr>
<td>Resistance</td>
<td>38 Ω ... 50 kΩ</td>
</tr>
<tr>
<td>High-side switch to +U_b</td>
<td></td>
</tr>
<tr>
<td>Low-side switch to GND</td>
<td></td>
</tr>
<tr>
<td>High-side rpm</td>
<td>1 ... 24,000 min⁻¹, 0.1 ... 24,000 min⁻¹ for remote control</td>
</tr>
<tr>
<td>Low-side rpm</td>
<td>1 ... 24,000 min⁻¹, 0.1 ... 24,000 min⁻¹ for remote control</td>
</tr>
<tr>
<td>High-side-PWM</td>
<td>0.1 ... 99.9 % for 1 ... 24,000 Hz, 0.1 ... 24,000 min⁻¹ for remote control</td>
</tr>
<tr>
<td>Low-side PWM</td>
<td>0.1 ... 99.9 % bei 1 ... 24,000 Hz, 0.1 ... 24,000 min⁻¹ for remote control</td>
</tr>
<tr>
<td>Bosch-ABS sensor</td>
<td>1 ... 550 Hz</td>
</tr>
<tr>
<td>Wirebreak</td>
<td>&quot;Master-slave&quot; mode</td>
</tr>
<tr>
<td>Short circuit to Rail1 or Rail2</td>
<td></td>
</tr>
</tbody>
</table>

Note: All functions apart from the current output functions are limited to the rear voltage supply (Power Logic).
All voltage output functions can alternatively be limited to U_fuel.

Dimensions and weight

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>71 x 129 x 210 mm</td>
<td>290 g</td>
</tr>
</tbody>
</table>
Block circuit diagram

ZBS RTB-IN-00-000

![Block circuit diagram]

Model code

Equipment options
00 = standard

Modification number
000 = standard

Note
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

Accessories
Suitable accessories can be found in the Accessories section.

Note
The information in this brochure relates to the operating conditions and applications described.
For applications and/or operating conditions not described, please contact the relevant technical department.
Subject to technical modifications.

HYDAC ELECTRONIC GmbH
Hauptstraße 27
66128 Saarbrücken, Germany
Tel. +49 6897 509-01
Fax +49 6897 509-1726
E-mail: electronic@hydac.com
Internet: www.hydac.com
Universal Output Module for RTB
ZBS RTB-OUT-00-000

Special features
- 4 controller pins on one module
- Electronic load can be applied; High and low-side
- Level monitoring via display
- Error signals (short circuit) can be switched to U_bat or GND for maximum current limiting function
- Connection to external actuator possible
- 2 alternative functions can be configured

Description
The Universal Output Module provides a means of applying a purely electronic or complex real load, or alternatively a fault signal, to the output of a controller. Battery voltage (U_bat) and ground signal (GND) or internal potential sockets are available for this. All signals are protected with an electronic fuse element.

The simulation resistance is designed as a built-in electronic load. For the simulation of shared current measurement channels several slots (channels/pins) of a module can be interconnected over an internal rail.

The real-time output level is displayed in the display for each channel (slot).

The real-time signal level can be measured at the Break-Out Plugs. This jumper plug connects the pin of the controller with the electronics of the module. When the plug is disconnected, external actuators can also be directly connected to the controller.

Technical data

<table>
<thead>
<tr>
<th>Functions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HS output with electronic load (2.5 .. 30 Ω); maximum 2.3 A and 40 W at &lt;35 °C heat sink temperature</td>
<td></td>
</tr>
<tr>
<td>LS output with electronic load (2.5 .. 30 Ω); maximum 2.3 A and 40 W at &lt;35 °C heat sink temperature</td>
<td></td>
</tr>
<tr>
<td>HS output with ext. load, max. 5 A</td>
<td></td>
</tr>
<tr>
<td>LS output with ext. load, max. 5 A</td>
<td></td>
</tr>
<tr>
<td>Connection to Rail1 or Rail2 or to internal rail</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimensions and weight</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>71 x 129 x 210 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>390 g</td>
</tr>
</tbody>
</table>
Block circuit diagram

ZBS RTB-OUT-00-000

Note

The information in this brochure relates to the operating conditions and applications described.

For applications and/or operating conditions not described, please contact the relevant technical department.

Subject to technical modifications.

Model code

ZBS RTB – OUT – 00 – 000

Equipment options

00 = standard

Modification number

000 = standard

Note

On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

Accessories

Suitable accessories can be found in the Accessories section.
Special features

- 2 separately diagnostic CAN interfaces
- Switchable termination
- Wirebreak simulation
- Short-circuit simulation
- Special functions for remote control of voltage sources

Description

The data interfaces of the connected controller can be tested using the additional communications module. Specifically using the CAN interface, it is possible to enable termination resistors and to switch short circuits to other states.

This module is provided as an extension for controllers with more than two CAN interfaces. The function of the permanently installed communication module does not change.

For remote control of voltage sources, an reverse additional voltage in the range 0 .. 10.0 V can be output. The value of the voltage can only be changed via the remote control function of the controller test rig.

The module can only be operated via a slot on the right-hand rack side.

Technical data

<table>
<thead>
<tr>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switchable termination (120 or 60 Ohm)</td>
</tr>
<tr>
<td>Voltage source 0 .. 10.0 V for remote control</td>
</tr>
<tr>
<td>Short-circuit simulation of each CAN line (U_{Bat}, GND and CAN-H / CAN-L)</td>
</tr>
<tr>
<td>Wirebreak simulation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimensions and weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
</tr>
<tr>
<td>Weight</td>
</tr>
</tbody>
</table>
Block circuit diagram

ZBS RTB-CAN-00-000

One CAN channel illustrated

CANH

F1 (0.1 A PS)
S5
F2 (0.1 A PS)
S6
F5 (0.1 A PS)
S1

CANL

F3 (0.1 A PS)
S7
F4 (0.1 A PS)
S8

Rail 1

Rail 2

Rail 2

Note

The information in this brochure relates to the operating conditions and applications described.
For applications and/or operating conditions not described, please contact the relevant technical department.
Subject to technical modifications.

Model code

ZBS RTB – CAN – 00 – 000

Equipment options
00 = standard

Modification number
000 = standard

Note

On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

Accessories

Suitable accessories can be found in the Accessories section.
## Accessories for MTB/RTB

<table>
<thead>
<tr>
<th>Type</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ZBS MTB-MBP-314</strong></td>
<td>on request</td>
</tr>
<tr>
<td>Blind cover, (3 HE 14 TE 2.5 mm)</td>
<td></td>
</tr>
</tbody>
</table>

| **ZBS MTB-BS-TTCxx-43**  | on request   |
| Labelling kit for front and rear for ZBS MTB-Rack Height 43 | |

| **ZBS MTB-BS-TTCxx-63**  | on request   |
| Labelling kit for front and rear for ZBS MTB-Rack Height 63 | |

| **ZBS MTB-BS-BLANK**    | on request   |
| unmarked (can be labelled) |              |

| **ZBS RTB-RACK-MOUNT-43** | on request   |
| 19” mounting kit for mounting the ZBS RTB/MTB-RACK Height 43 in a 19” control box | |

| **ZBS RTB-RACK-MOUNT-63** | on request   |
| 19” mounting kit for mounting the ZBS RTB/MTB-RACK Height 63 in a 19” control box | |
The range of sensors includes products for measuring pressure, temperature, distance, position, level, flow volume, speed as well as contamination and oil condition. In addition to products for standard applications, the product portfolio also covers special applications such as potentially explosive atmospheres or applications with increased requirements in respect of functional safety. Almost all these products are developed, manufactured and marketed by HYDAC ELECTRONIC. Suitability for the application is tested on HYDAC test rigs. As a Tier 1 automotive supplier, HYDAC ELECTRONIC is certified in accordance with the rigorous quality standard ISO/TS 16949 and therefore meets the very high requirements regarding product quality, production processes and continuous improvement processes.

Note: Not all feature combinations are possible. For precise information, please consult the relevant data sheet from the sensor product catalogue.

### Sensors for applications with increased functional safety / diagnostics

<table>
<thead>
<tr>
<th>Functional Safety</th>
<th>HDA 4700</th>
<th>HDA 8700</th>
<th>HLS 100</th>
<th>HLS 200</th>
<th>HLT 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured variable</td>
<td>Pressure</td>
<td>Pressure</td>
<td>Position</td>
<td>Position</td>
<td>Position / distance</td>
</tr>
<tr>
<td>Accuracy (max. error)</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measurement principle</td>
<td>Thin-film strain gauge</td>
<td>Thin-film strain gauge</td>
<td>Hall sensors</td>
<td>IR-light barriers</td>
<td>Magnetostriction</td>
</tr>
<tr>
<td>Number of outputs</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Output</td>
<td>Analogue</td>
<td>Analogue</td>
<td>PWM</td>
<td>P-switch outputs</td>
<td>Analogue</td>
</tr>
<tr>
<td>CANopen</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Available as individual units</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>OEM product for large volume production</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PL d</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Category</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>SIL 2</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Diagnostics-capable</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Note:
Not all feature combinations are possible. For precise information, please consult the relevant data sheet.
## Pressure transmitters

<table>
<thead>
<tr>
<th>Electronic pressure transmitters</th>
<th>HDA 4800</th>
<th>HDA 4700</th>
<th>HDA 4400</th>
<th>HDA 4300</th>
<th>HDA 4100</th>
<th>HDA 3800</th>
<th>HDA 7400</th>
<th>HDA 8700</th>
<th>HDA 8400</th>
<th>HDA 9000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy (max. error)</td>
<td>0.25</td>
<td>0.5</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>0.3</td>
<td>1.0</td>
<td>0.5</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Low pressure (up to 40 bar)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>High pressure (from 40 bar)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Relative pressure</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Absolute pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Number of switching outputs</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Analogue output</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Available as individual units</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>OEM product for large volume production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flush membrane</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CANopen Version</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>ECE type authorisation (approved for road vehicles)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Approval for potentially explosive atmospheres</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Approvals for shipping</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UL Approval</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Increased functional safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

**Note:**
Not all feature combinations are possible. For precise information, please consult the relevant data sheet.
# Electronic pressure switches

<table>
<thead>
<tr>
<th>Electronic pressure switches</th>
<th>EDS 3400</th>
<th>EDS 3300</th>
<th>EDS 3100</th>
<th>EDS 300</th>
<th>EDS 8000</th>
<th>EDS 601</th>
<th>EDS 1700</th>
<th>EDS 4400</th>
<th>EDS 4300</th>
<th>EDS 4100</th>
<th>EDS 820</th>
<th>EDS 810</th>
<th>EDS 710</th>
<th>EDS 410</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy (max. error)</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>0.5</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Low pressure (up to 40 bar)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>High pressure (from 40 bar)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Relative pressure</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Absolute pressure</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Number of switching outputs</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Analogue output</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Digital display</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Programmable</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Factory-set (not field-adjustable)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>DESINA-compliant</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>VDMA Menu Navigation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Available as individual units</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>OEM product for large volume production</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Flush membrane</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>IO Link Interface</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>ECE type authorisation (approved for road vehicles)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Approval for potentially explosive atmospheres</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Approvals for shipping</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>UL Approval</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Note:**
Not all feature combinations are possible. For precise information, please consult the relevant data sheet.
# Temperature transmitters

<table>
<thead>
<tr>
<th>Electronic temperature transmitters</th>
<th>ETS 4100</th>
<th>ETS 4500</th>
<th>ETS 7000</th>
<th>HTT 8000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy % (max. error)</td>
<td>0.8</td>
<td>2.0</td>
<td>2.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Temperature range</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>-25 .. +100 °C</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Pressure resistant to 125 bar</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Pressure resistant to 600 bar</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Probe length in mm</td>
<td>6</td>
<td>50-350</td>
<td>10.7</td>
<td>50-350</td>
</tr>
<tr>
<td>Analogue output</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Available as individual units</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>OEM product for large volume production</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Approval for potentially explosive atmospheres</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection class</td>
<td>IP 65</td>
<td>IP 65</td>
<td>IP 67</td>
<td>IP 67</td>
</tr>
</tbody>
</table>

Note: Not all feature combinations are possible. For precise information, please consult the relevant data sheet.

# Temperature switches

<table>
<thead>
<tr>
<th>Electronic temperature switches</th>
<th>ETS 3200</th>
<th>ETS 3800</th>
<th>ETS 320</th>
<th>ETS 380</th>
<th>ETS 1700</th>
<th>HTS 8000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy (max. error)</td>
<td>1 °C</td>
<td>1 °C</td>
<td>1 °C</td>
<td>1 °C</td>
<td>1 °C</td>
<td>3 %</td>
</tr>
<tr>
<td>Pressure resistant to 600 bar</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Integrated probe</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Separate probe</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Number of switching outputs</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Analogue output</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Digital display</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Programmable</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>In-Tank</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factory-set (not field-adjustable)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>VDMA Menu Navigation</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Available as individual units</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>OEM product for large volume production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>IO Link Interface</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UL Approval</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Not all feature combinations are possible. For precise information, please consult the relevant data sheet.
### Sensors for distance and position

<table>
<thead>
<tr>
<th>Sensors for distance and position</th>
<th>HLT 1000-R2</th>
<th>HLT 2100-R1</th>
<th>HLT 2500-F1</th>
<th>HLT 2500-L2</th>
<th>HLS 528</th>
<th>IES 2010/2015</th>
<th>IWE 40</th>
<th>HLS 100</th>
<th>HLS 200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range in mm</td>
<td>50 to 2,500</td>
<td>50 to 4,000</td>
<td>50 to 4,000</td>
<td>50 to 4,000</td>
<td>up to 6,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For cylinder installation</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of switching outputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>1 (PWM)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Analogue output</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CANopen Version</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device Net</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proflibus</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EtherCAT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Available as individual units</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OEM product for large volume production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Increased functional safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Not all feature combinations are possible. For precise information, please consult the relevant data sheet.

### Level sensors

<table>
<thead>
<tr>
<th></th>
<th>ENS 3000</th>
<th>HNS 526</th>
<th>HNT 1000</th>
<th>HNS 3000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement principle</td>
<td>capacitive</td>
<td>ultrasound-based</td>
<td>magnetostrictive</td>
<td>magnetostrictive</td>
</tr>
<tr>
<td>Measuring range</td>
<td>250 to 730</td>
<td>280 to 6,400</td>
<td>250 to 2,500</td>
<td>250 to 2,500</td>
</tr>
<tr>
<td>With temperature probe</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Mechanical connection</td>
<td>Screw connection</td>
<td>M30x1</td>
<td>G 3/4</td>
<td>G 3/4</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>M12x1</td>
<td>M12x1</td>
<td>M12x1 cable outlet</td>
<td>M12x1</td>
</tr>
<tr>
<td>Number of switching outputs</td>
<td>1, 2 + 4</td>
<td>1 + 2</td>
<td>1, 2 + 4</td>
<td></td>
</tr>
<tr>
<td>Analogue output</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>CANopen Version</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>VDMA Menu Navigation</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>IO Link Interface</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UL Approval</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Target Applications</td>
<td>Industry</td>
<td>Industry</td>
<td>Industry, mobile</td>
<td>Industry, mobile</td>
</tr>
</tbody>
</table>

**Note:** Not all feature combinations are possible. For precise information, please consult the relevant data sheet.
## Flow rate transmitters / Flow switches

<table>
<thead>
<tr>
<th>Flow rate transmitters, flow switches</th>
<th>EVS 3110</th>
<th>EVS 3100</th>
<th>HFS 2100</th>
<th>HFS 2500</th>
<th>HFT 2100</th>
<th>HFT 2500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy (max. error) in %</td>
<td>2</td>
<td>2</td>
<td>10</td>
<td>5</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Measurement principle</td>
<td>Turbine</td>
<td>Turbine</td>
<td>Float principle</td>
<td>Float principle</td>
<td>Float principle</td>
<td>Float principle</td>
</tr>
<tr>
<td>Pressure-resistant</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Water-based media</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil / viscous fluids</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direction of flow optional</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation position optional</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. number of switching contacts</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Analogue output</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Display</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATEX approval</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Not all feature combinations are possible. For precise information, please consult the relevant data sheet.

## Speed sensors

<table>
<thead>
<tr>
<th>Speed sensors</th>
<th>HSS 110</th>
<th>HSS 120</th>
<th>HSS 130</th>
<th>HSS 210</th>
<th>HSS 220</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flange</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screw-in thread</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Probe length in mm</td>
<td>18.4</td>
<td>30, 35, 45</td>
<td>16, 32</td>
<td>0 .. 50 adjustable</td>
<td>0 .. 48 adjustable</td>
</tr>
<tr>
<td>Oil / viscous fluids</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Salt water</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleaning agent, salt spray</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direction of rotation detection</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Available as individual units</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Outputs</td>
<td>1 NPN 1 PWM analogue</td>
<td>2 NPN</td>
<td>2 NPN</td>
<td>2 Push-Pull</td>
<td>2 NPN</td>
</tr>
<tr>
<td>IP class</td>
<td>IP 67 IP 6K9K</td>
<td>IP 67 IP 69K</td>
<td>IP 67 IP 69K</td>
<td>IP 67</td>
<td>IP 68</td>
</tr>
</tbody>
</table>

Note: Not all feature combinations are possible. For precise information, please consult the relevant data sheet.
## Sensors for potentially explosive atmospheres

<table>
<thead>
<tr>
<th>Sensors for potentially explosive atmospheres</th>
<th>HDA 4700</th>
<th>HDA 4400</th>
<th>HDA 4300</th>
<th>HDA 4100</th>
<th>EDS 4400</th>
<th>EDS 4300</th>
<th>EDS 4100</th>
<th>ETS 4500</th>
<th>HFS 2500</th>
<th>HFS 2100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured variable</td>
<td>Pressure</td>
<td>Pressure</td>
<td>Pressure</td>
<td>Pressure</td>
<td>Pressure</td>
<td>Pressure</td>
<td>Pressure</td>
<td>Temp.</td>
<td>Flow</td>
<td>Flow</td>
</tr>
<tr>
<td>Accuracy</td>
<td>0.5</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>2.0</td>
<td>5, 10</td>
<td>10</td>
</tr>
<tr>
<td>Available as individual units</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>OEM product for large volume production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
</tr>
<tr>
<td>Flush membrane</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
</tr>
<tr>
<td>ATEX Intrinsically safe</td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
</tr>
<tr>
<td>Flush membrane ATEX-Intrinsically safe</td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
</tr>
<tr>
<td>CSA Intrinsically safe</td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td></td>
<td></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
</tr>
<tr>
<td>IECEEx Intrinsically safe</td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
</tr>
<tr>
<td>Flush membrane IECEx Intrinsically safe</td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
</tr>
<tr>
<td>ATEX, IECEx, CSA, flameproof enclosure</td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
</tr>
<tr>
<td>Flush membrane ATEX, IECEx, CSA, flameproof enclosure</td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
<td><img src="Yes" alt="Checkmark" /></td>
</tr>
</tbody>
</table>

**Note:** Not all feature combinations are possible. For precise information, please consult the relevant data sheet.
### Condition monitoring products

<table>
<thead>
<tr>
<th></th>
<th>CMU 1000</th>
<th>CSIB 2</th>
<th>HLB 1300</th>
<th>AS 1000</th>
<th>AS 3000</th>
<th>EY 1356</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement channels</td>
<td>Condition Monitoring Unit</td>
<td>Interface module</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measurement inputs</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outputs</td>
<td>8 HSI / SMART 8 analogue sensors 4 digital signals</td>
<td></td>
<td>2 analogue signals 4 relays</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface</td>
<td>Ethernet RS 232 USB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visualization</td>
<td>CMWIN</td>
<td>Oil condition sensor</td>
<td>AquaSensor</td>
<td>AquaSensor</td>
<td>Contamination switch</td>
<td></td>
</tr>
<tr>
<td>Sensor</td>
<td>AquaSensor</td>
<td>Oil condition sensor</td>
<td>AquaSensor</td>
<td>Contamination switch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measured variable</td>
<td>rel. humidity temperature dielectric constants</td>
<td>Saturation level or temperature</td>
<td>Saturation level or temperature</td>
<td>Particles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>Analogue 2 switch output</td>
<td>Analogue 2 switch output</td>
<td>1 analogue 2 switch output I/O Link</td>
<td>switching signal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Service unit

<table>
<thead>
<tr>
<th></th>
<th>HMG 500</th>
<th>HMG 510</th>
<th>HMG 3010</th>
<th>HDA 4748-H</th>
<th>ETS 4148-H</th>
<th>EVS 3108-H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portable data recorder</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of measurement inputs</td>
<td>2</td>
<td>2</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface</td>
<td>USB</td>
<td>USB RS 232</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measurement inputs</td>
<td>HSI</td>
<td>HSI</td>
<td>HSI Analogue Frequency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connection to CAN bus</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visualization</td>
<td>CMWIN</td>
<td>HMGWIN CMWIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automatic sensor detection, HSI</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Measured variable</td>
<td>Pressure</td>
<td>Temp.</td>
<td>Flow rate</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Monitoring and display units

<table>
<thead>
<tr>
<th></th>
<th>HDA 5500</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring and display unit</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Inputs</td>
<td>3 analogue</td>
<td></td>
</tr>
<tr>
<td>Outputs</td>
<td>Analogue 4 relays</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>0.5</td>
<td></td>
</tr>
</tbody>
</table>
5.4 Operating elements, pilot control units and radio controls

For operating elements, pilot control units and radio controls please contact HYDAC Mobile Hydraulics.

- **Operating controls**

- **Pilot control units**

- **Radio remote controls**

---

**Nordhydraulic**

HYDAC INTERNATIONAL GMBH

Head Office
Industriegebiet
66380 Sulzbach/Saar
Germany
Tel. +49 6897 509-01
Fax +49 6897 509-577
E-mail: mobilevalves@hydac.com
Internet: www.hydac.com
6 Service

Services in support of HYDAC Control Technology

The support of the customer in each phase of the business relationship is one of the responsibilities which HYDAC has set itself. Whether it is in initial planning, in the required risk analysis, in the choice of components or the choice of architecture, we are happy to help you with our experience in system development.

We also offer expert technical support if there are queries during the development of the application as well as for problems in implementation in the field.

To minimize our customers’ dependency on support, HYDAC offers a comprehensive training programme – in predefined training blocks or customized to specific areas of interest.

The functionality of the programmable control hardware from HYDAC is provided by the software application.

By choosing the proven programming platform CODESYS®, which is available free of charge, programming of our controllers is easy-to-learn. The proven programming language C/C++ is also available as an option.

Program development can be approached in different ways:
- Application development by the customer himself
- Application development by a competent systems integrator
- Application development by HYDAC, possibly as provider of the complete system
# The Training Module for Control Technology

Know-how – an invaluable asset for every company. HYDAC offers its customers expert help in developing this asset. A comprehensive training portfolio ensures that participants can develop their knowledge base in a structured way whilst working with our products in control technology.

For information on individual modules and the particular topics covered, please see the following table:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hardware training courses</strong></td>
<td></td>
</tr>
</tbody>
</table>
| The principles of the mobile controller | ● Design and function of a mobile controller on the basis of block circuit diagrams  
● Features of the hardware  
● Input and output types and their characteristics  
● Implemented features of the hardware  
● Available communication interfaces |
| The controller hardware of the 16-bit platform with expansions | ● Operating conditions  
● Characteristics of the inputs and outputs  
● Communication options  
● The differences between the available 16-bit controllers  
● The safety concept of the HY-TTC 90  
● Programming options |
| The controller hardware of the 32-bit platform with expansions | ● Operating conditions  
● Characteristics of the inputs and outputs  
● Communication options  
● The safety concept of the HY-TTC 200  
● Implemented features of the hardware  
● Programming options |
| Visualization hardware training course | ● Operating conditions  
● Characteristics and options  
● Communication options  
● Options in programming |
| **Programming training courses** | |
| Introduction to CODESYS® 2.3 | ● Installation of the development environment  
● Introduction to user interface  
● Options in program representation to IEC 61131-3  
● Concept of the target systems  
● Download and debugging |
| Programming the 16-bit controllers in CODESYS® 2.3 | ● Setup of the hard and software  
● Settings in the control configuration  
● Transferring application to the instrument  
● Application and entry of inputs  
● Setting outputs  
● Utilizing communication interfaces  
● Debug options |
| Programming the 32-bit controllers in CODESYS® 2.3 | ● Setup of the hard and software  
● Settings in the control configuration  
● Transferring application to the controller  
● Application and entry of inputs  
● Setting outputs  
● Utilizing communication interfaces  
● Debug options |
| Programming the HY-eVision² using CODESYS® 3.x | ● Installation of the development environment  
● Hardware and software setup  
● Creating new projects  
● Use of HY-eVision² features in an application  
● Applications download onto the HY-eVision²  
● Communication options in the application |
HYDAC regularly offers related training modules which have been put together from the modules described above to provide a structured build-up of knowledge. Participation in the training module designed for new customers provides an ideal introduction to working with HYDAC control technology. It gives a technical overview of the hardware on offer and is a first step to understanding the CODESYS® programming environment and its use in control hardware.

The highly topical issue of functional safety is addressed and the feasibility of implementation is demonstrated in the form of examples. The visualization hardware and programming using CoDeSys® is also part of this training course.

Taking part in this training module is recommended to anyone who appreciates having detailed knowledge of the technology he is applying.

HYDAC can also offer more advanced courses which are specially tailored to the customer’s requirements.

Interested? Then please contact us. We will be happy to advise you in creating your individual training programme.

### Functional safety – a hot topic

Everyone is talking about the introduction of the new Machinery Directive. Many are anxious about the introduction.

HYDAC is offering its customers expert support every step of the way towards safe application.

You will find detailed information in our “Safety Flyer” in the download section of our website www.hydac.com
Global Presence. Local Expertise. www.hydac.com

HYDAC Head Office
HYDAC Companies
HYDAC Sales and Service Partners