HYDAC INTERNATIONAL

Control Technology for Mobile Machines
Product Catalogue

TTControl
HYDAC INTERNATIONAL

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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.

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1 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 for mobile machines

Development resources and software development

On-site service and spare part supply - 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.

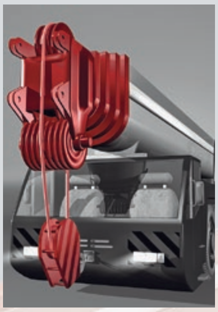
HYDAC measurement and control technology – for a wide variety of industries and applications

1

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.

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

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

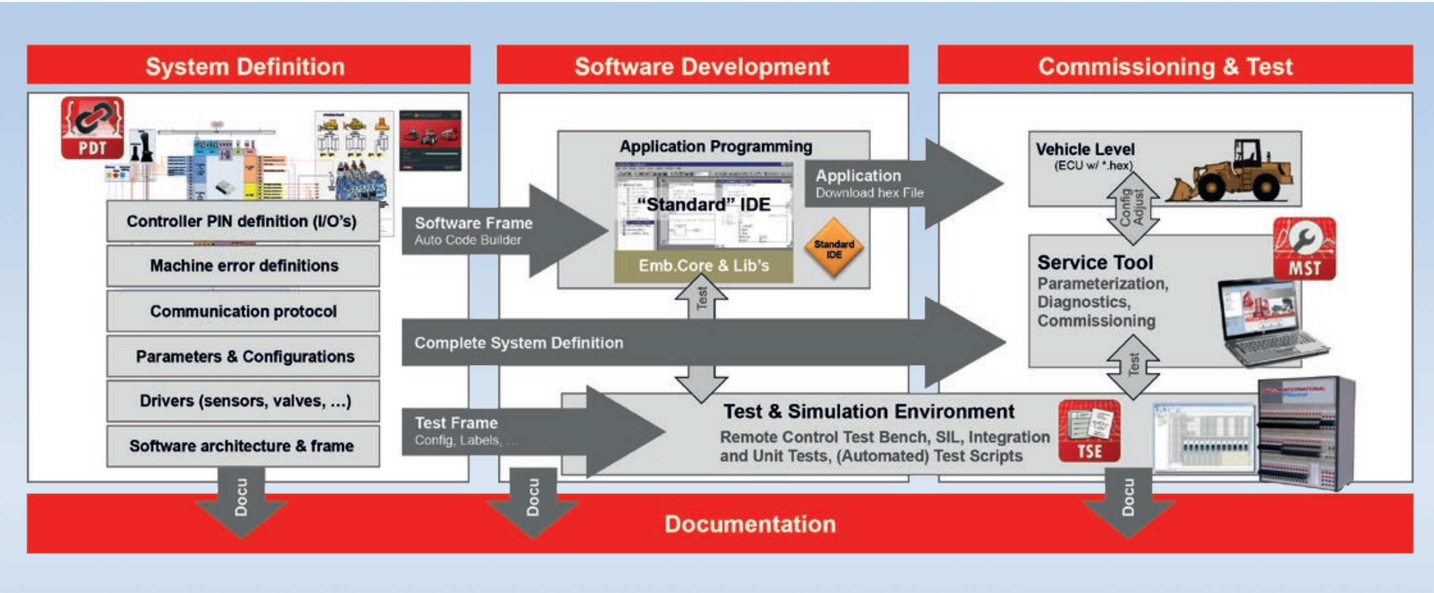
- Configuration of the test rig

MATCH – “Mobile Application Tool Chain”

MATCH

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.

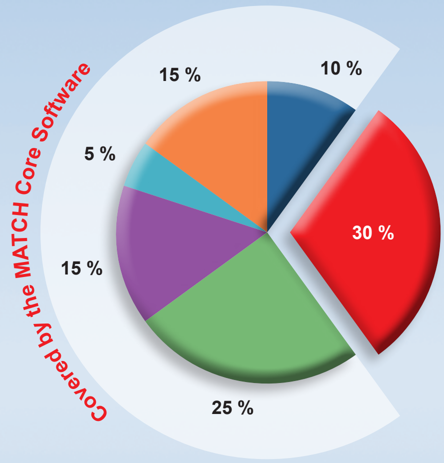
In response to the new market challenges outlined, HYDAC is currently developing an integrated tool chain intended as a comprehensive approach to system software development of mobile machines. This method of embedded software development is hardware-neutral and has multi-controller capability. It is 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.

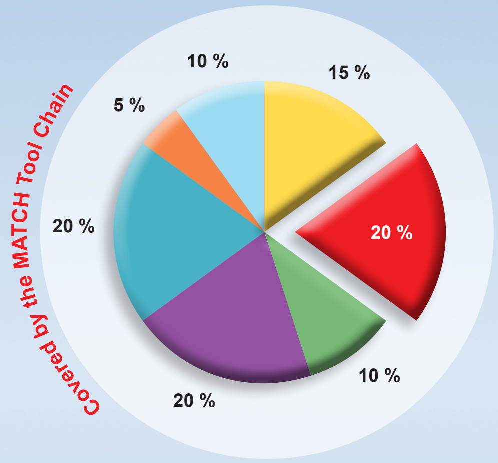
The close interaction between individual system parts can drastically reduce the development times required. A reduction of up to 50 % is quite feasible.

Proportion of embedded software already covered by MATCH when developing a machine application.



- **Machine Specific Application Software**
- Error Management
- NvMem Data Management
- Development Diagnostics
- Service Tool Interface and Data Binding
- I/O Driver Modules

Applications covered by MATCH in system software development within a machine life cycle.



- **Software Development**
- Commissioning
- Software Test
- Documentation
- End-of-line
- Field Service
- System Development

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.

A reference model as the basis of the design

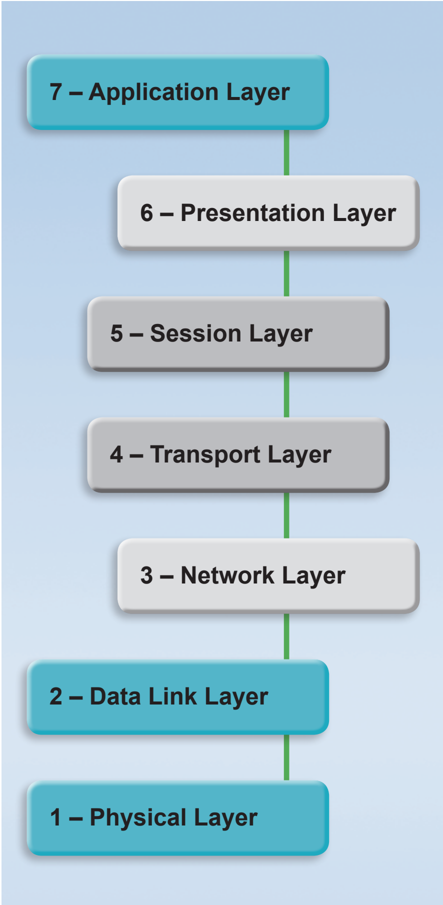


Fig. 1: **OSI reference model**

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).

	Differential voltage CAN-high – CAN-low	
	CAN-High-Speed	CAN-Low-Speed
Logical "1"	0 V	5 V
Logical "0"	2 V	2.2 V

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

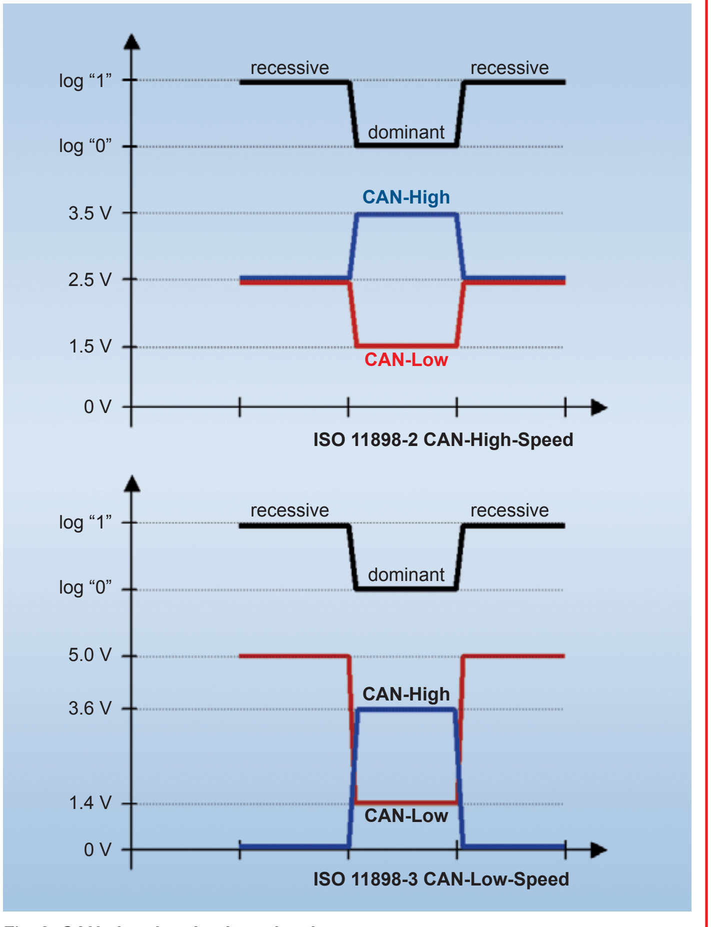


Fig. 2: **CAN signal and voltage level**

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.

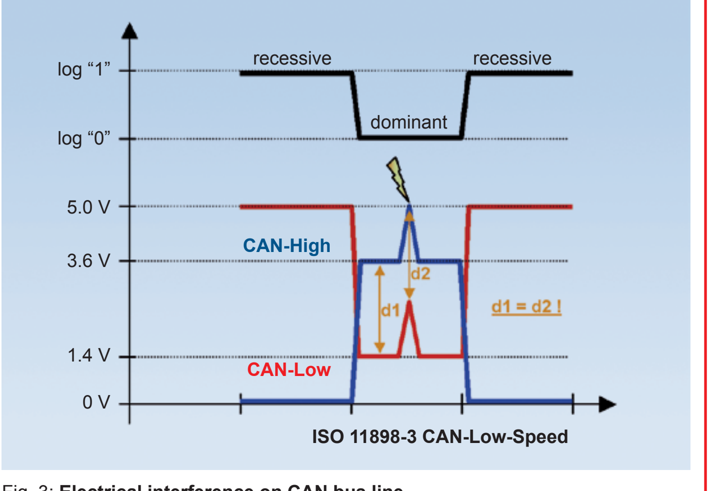


Fig. 3: **Electrical interference on CAN bus line**

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.

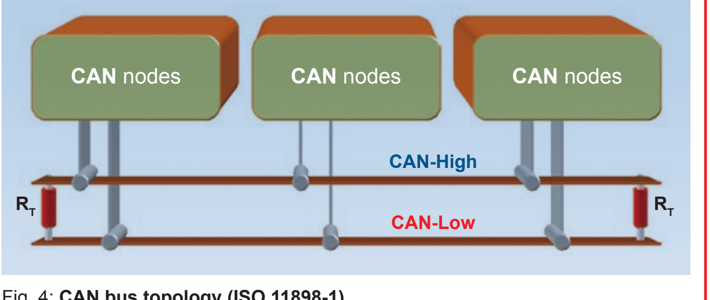


Fig. 4: **CAN bus topology (ISO 11898-1)**

CAN communication

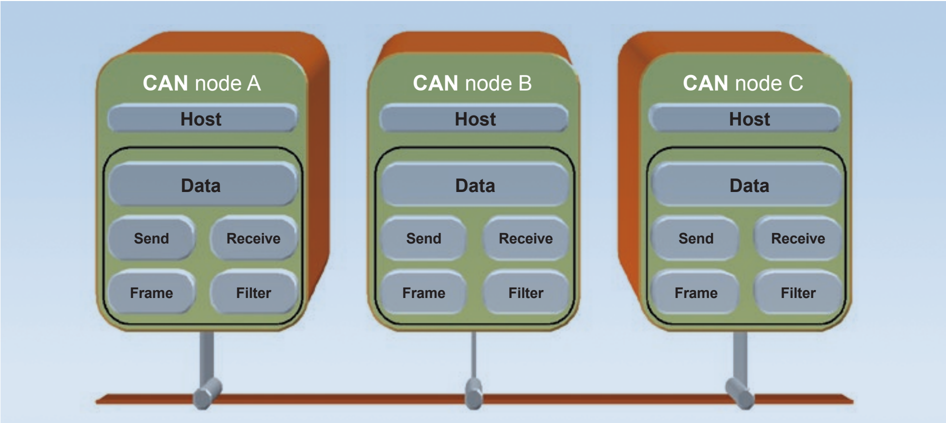


Fig. 5: **Schematic of CAN communication (1)**

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.

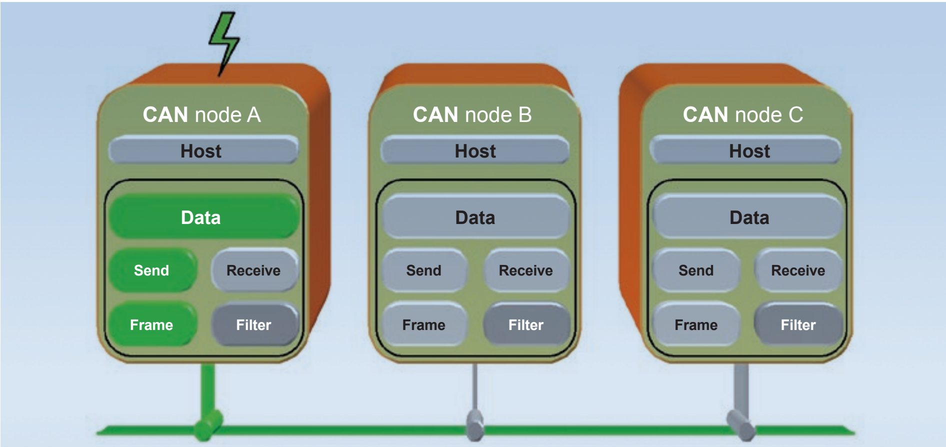


Fig. 6: **Schematic of CAN communication (2)**

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

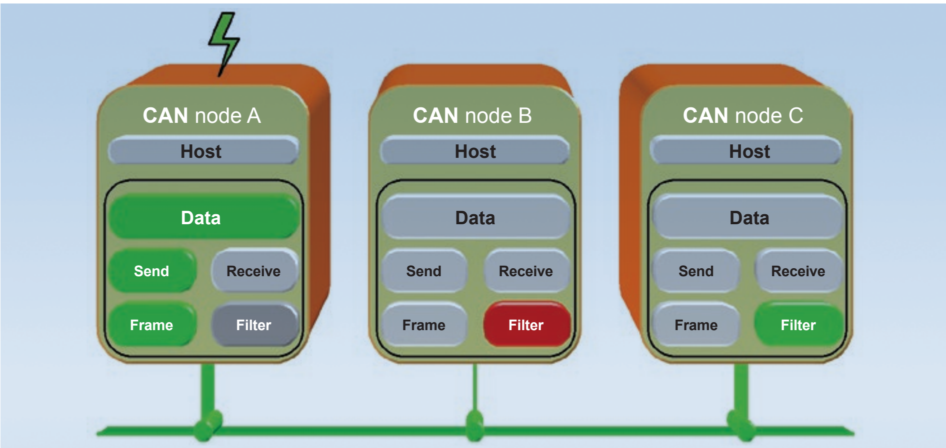


Fig. 7: **Schematic of CAN communication (3)**

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.

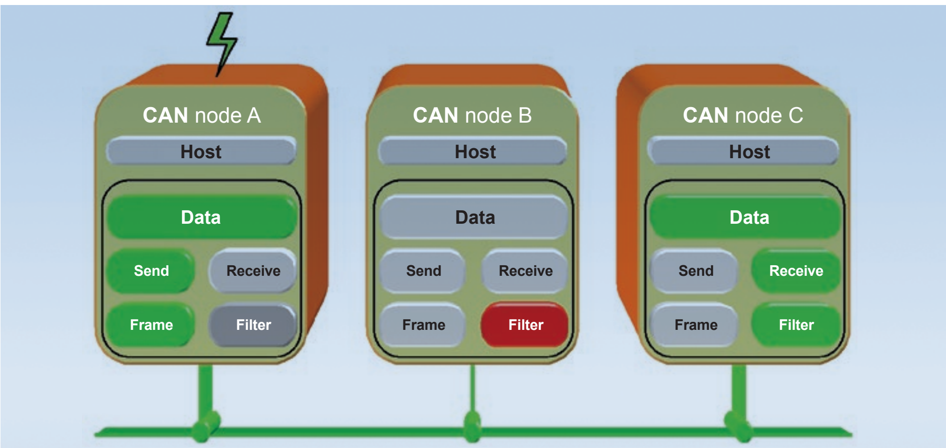


Fig. 8: **Schematic of CAN communication (4)**

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														
		Arbitration Field		Control Field				CRC Field		ACK Field				
Bus Idle	SOF	Identifier	RTR	IDE	r	DLC	Data Field	CRC Sequence	DEL	ACK	DEL	EOF	ITM	Bus Idle
	1	11	1	1	1	4	0 .. 64	15	1	1	1	7	3	

Fig. 9: **Format of a CAN Data frame**

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.

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.

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.

Extended Data Frame																	
		Arbitration Field					Control Field				CRC Field		ACK Field				
Bus Idle	SOF	Base-Identifier	SRR	IDE	Extended-Identifier	RTR	r1	r0	DLC	Data Field	CRC Sequence	DEL	ACK	DEL	EOF	ITM	Bus Idle
	1	11	1	1	18	1	1	1	4	0 .. 64	15	1	1	1	7	3	

Fig. 10: **Format of an extended CAN Data frame**

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.

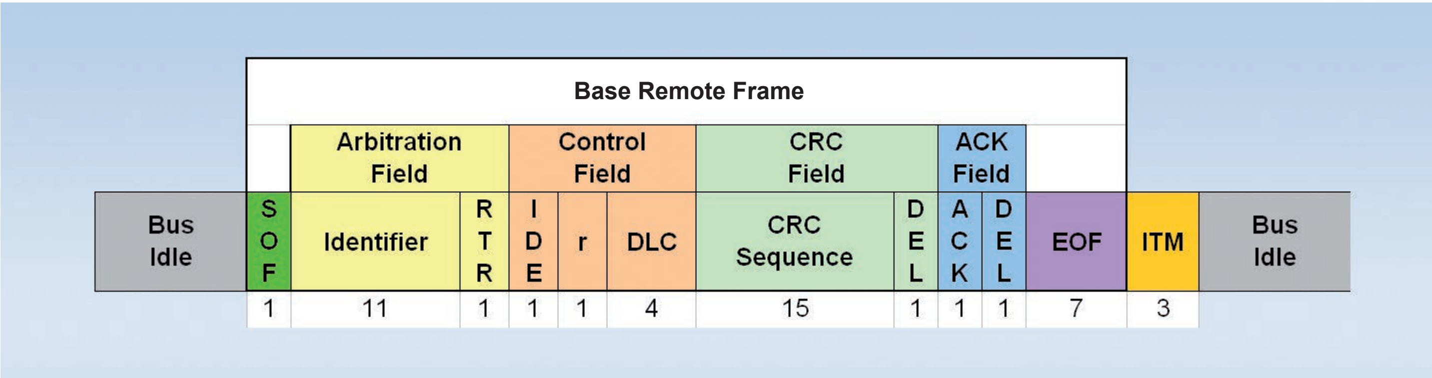


Fig. 11: **Format of a CAN Remote frame**

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.

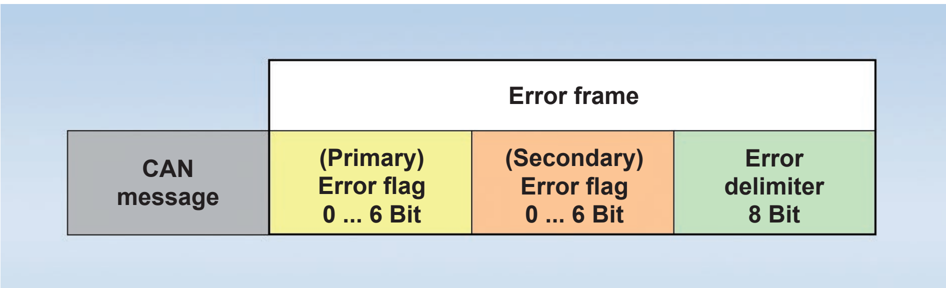


Fig. 12: **Format of a CAN Error frame**

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 nodes wishing to transmit place the bits onto the bus. As soon as there is a difference, 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).

Fig. 13: **Arbitration of transmission rights**

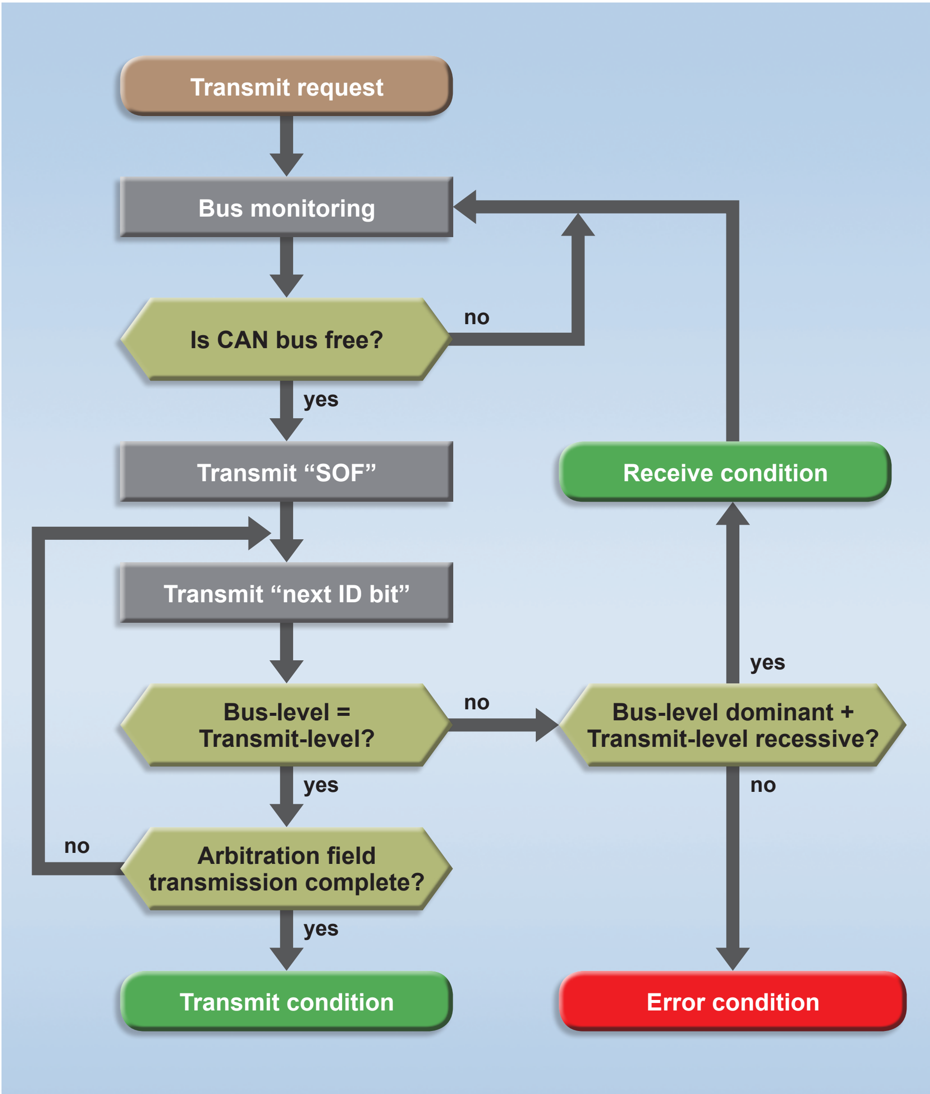


Fig. 14: **Bus access using CSMA/CA**

Speed and line length

The possible data transmission rates in CAN networks is currently 1 Mbits/s max. (also 1 MBaud). 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.

Bit rate	Cable length
10 kbits/s	6.7 km
20 kbits/s	3.3 km
50 kbits/s	1.3 km
125 kbits/s	530 m
250 kbits/s	270 m
500 kbits/s	130 m
1 Mbits/s	40 m

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.

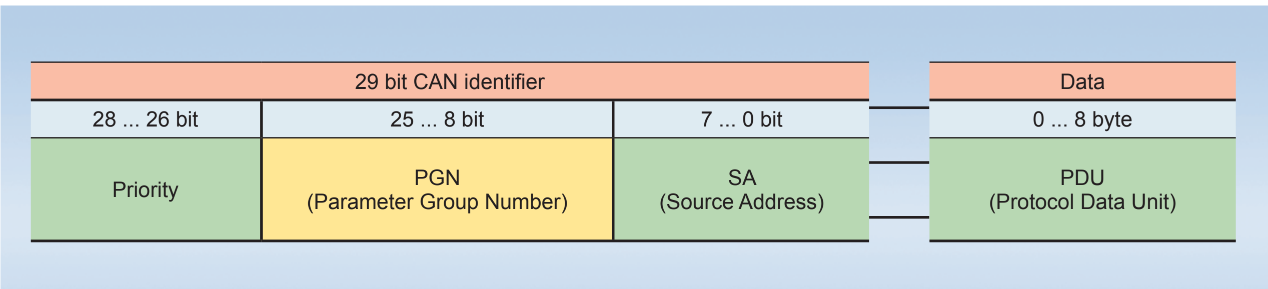


Fig. 15: **Data format in the CAN J1939 protocol**

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 ...

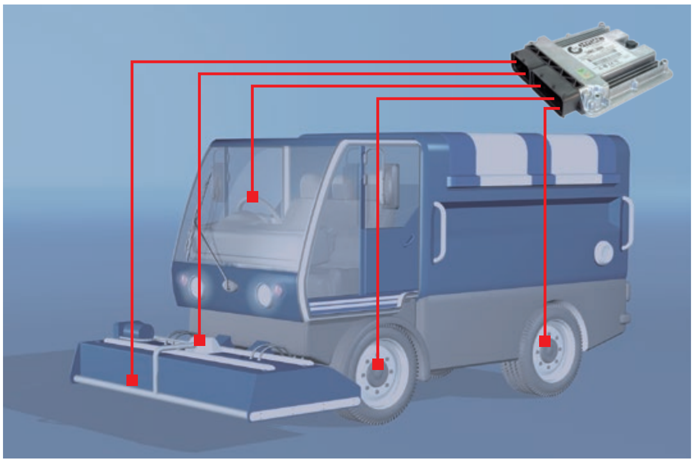


Fig. 16:
Centralized control structure using the example of a municipal vehicle

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.

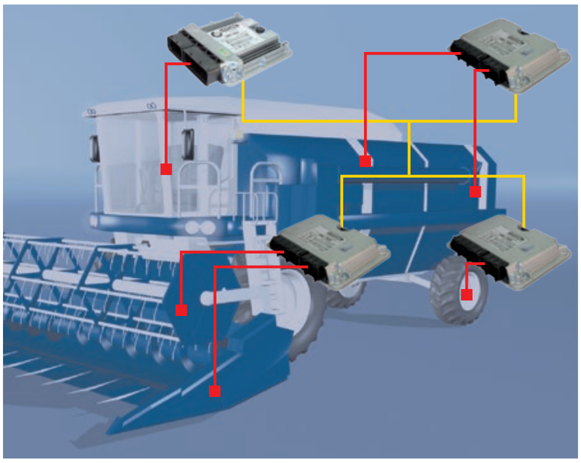


Fig. 17:
Decentralized control architecture using the example of a combine harvester

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.

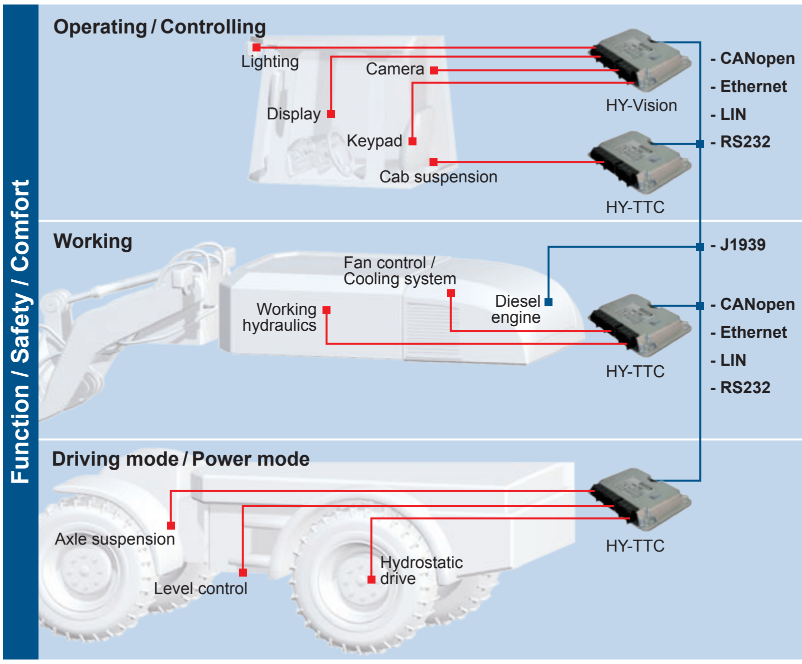


Fig. 18:
Organization of a machine into functional levels

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Architecture examples
“Centralized control system”

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

Fig. 19:
Centralized structure using a controller

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

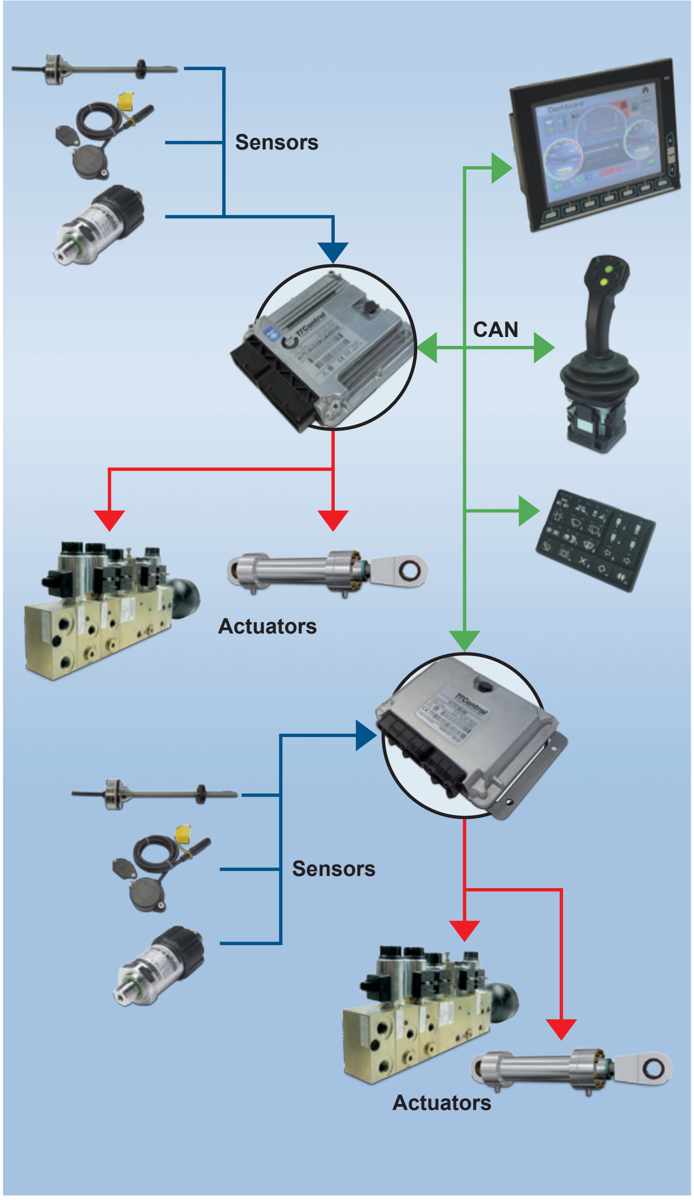


Fig. 20:
Centralized structure using a controller and an I/O expansion module

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.

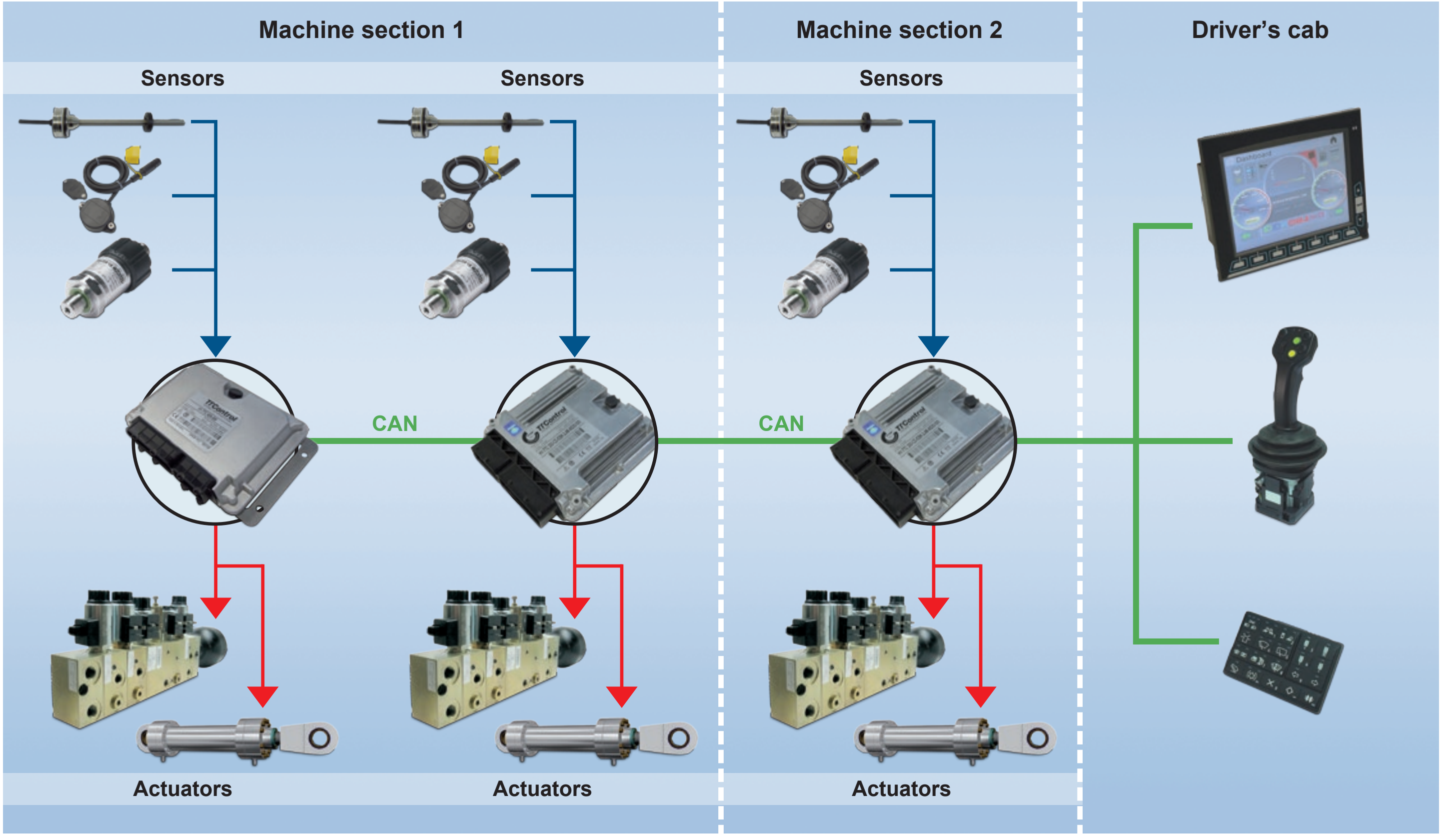


Fig. 21: **Decentralized structure with two controllers and an I/O expansion module**

Entire networks of controllers, displays, operating elements and expansion modules can easily be created.

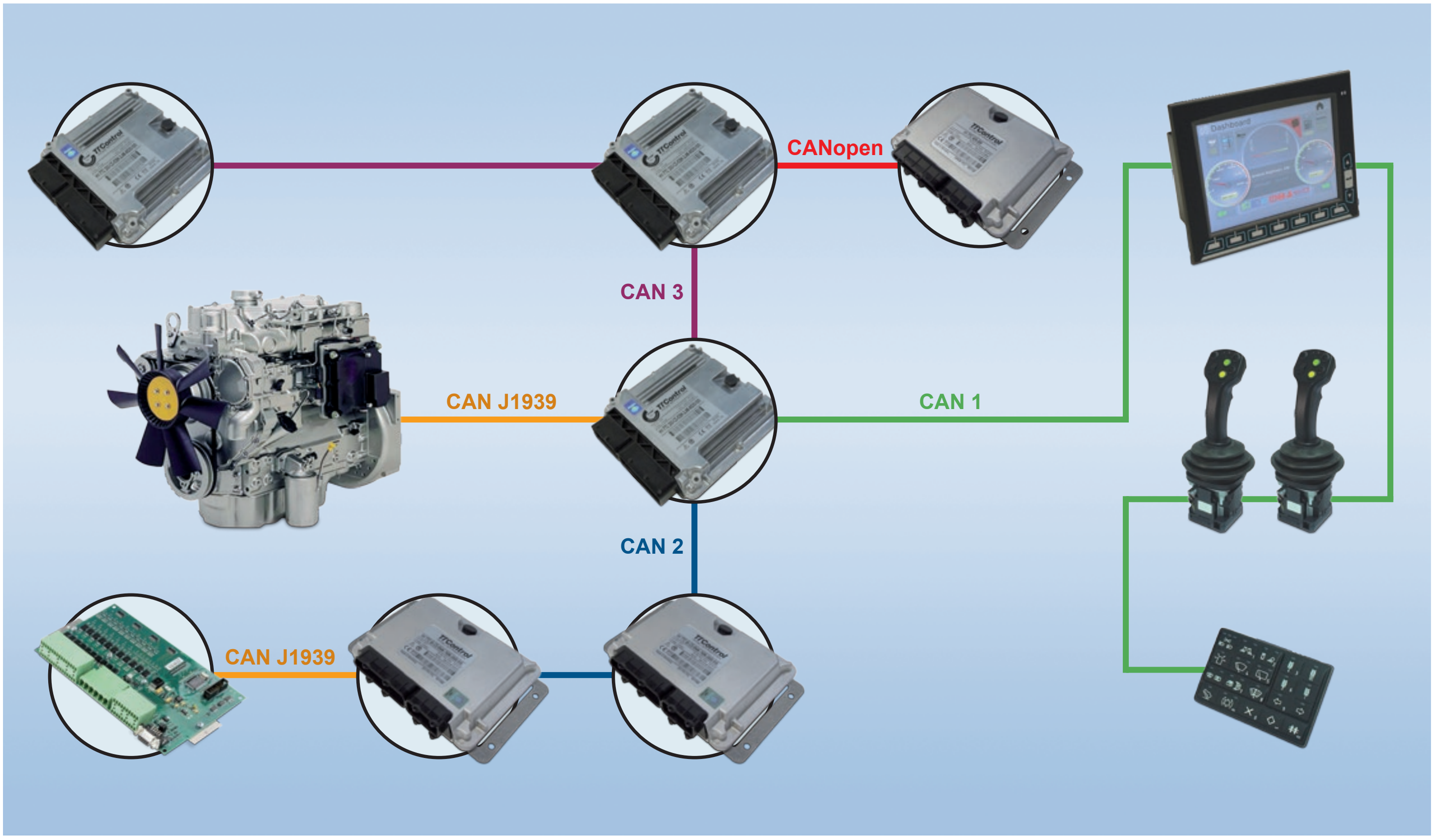


Fig. 22: **Decentralized structure with several controllers, I/O expansion modules and sub-networks**

Specification of inputs and outputs

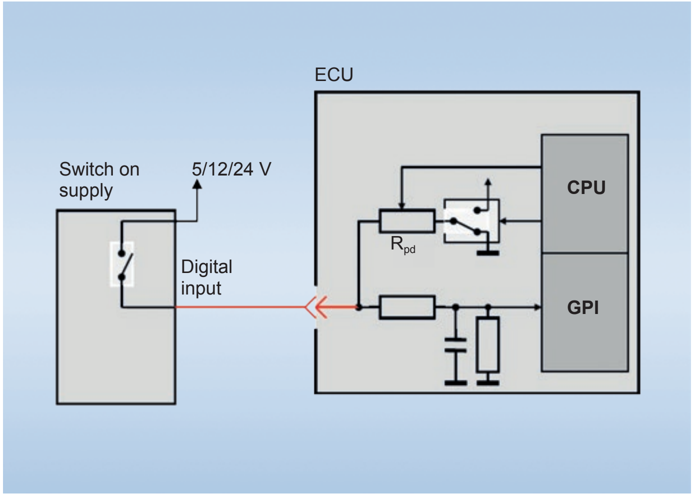
The key question with every new system is – how can we link the components such as sensors and actuators to the control components? We would like to show you examples of wiring diagrams for some commonly used elements. The block wiring diagrams shown here can also be found in the "User Manuals" for the particular control components.

The majority of block wiring diagrams shown here are in the 16 bit controller series, such as HY-TTC 60 or HY-TTC 94. At this point we have only given a brief description of the most common type of channel. Apart from those listed here, there are also other channels such as timer/counter inputs or voltage proportional outputs. For a decription of these channels, please refer to the relevant descriptions of our controllers.

The "classic" switch as input signal

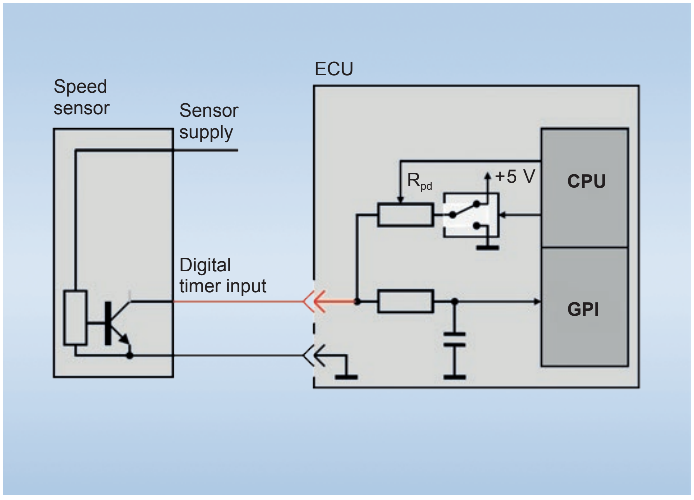
Switches are found in most machines because many functions can only be switched on or off. Electrically, there are two possibilities of producing a switching signal: switching the voltage supply (high-side) or switching the earth wire (low-side). When a switch is open, an internally defined signal level 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 R_{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 R_{pd}.

To adjust the inputs to the switching elements, on many of our controllers, the resistance value of R_{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.



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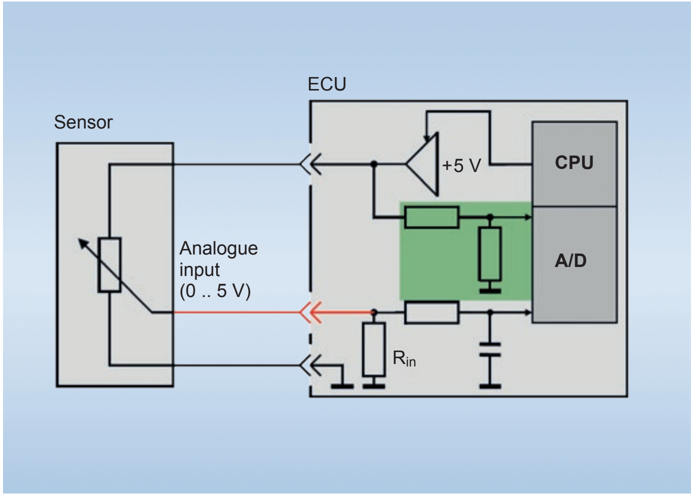
When “black” and “white” is not enough: analogue signal acquisition

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.

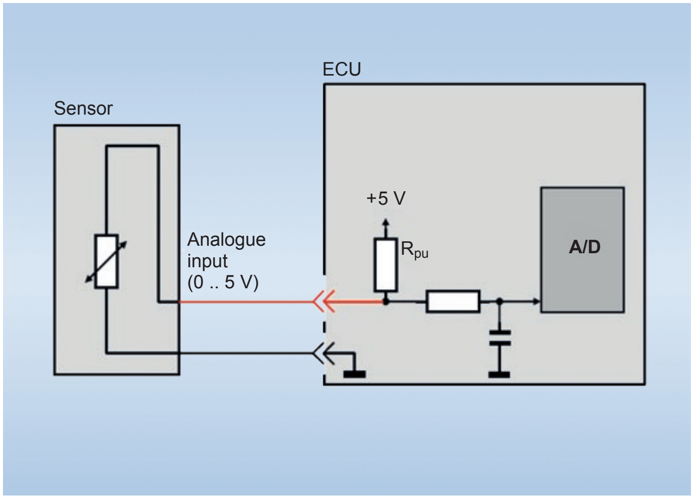
Another difference with analogue sensors is whether they have integrated electronics or are simply passive components, for example, potentiometers or resistance temperature sensors like PT100 or PT 1000. For passive sensors, our controllers supply a stable 5 V from internal sensor supply voltages.

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”.



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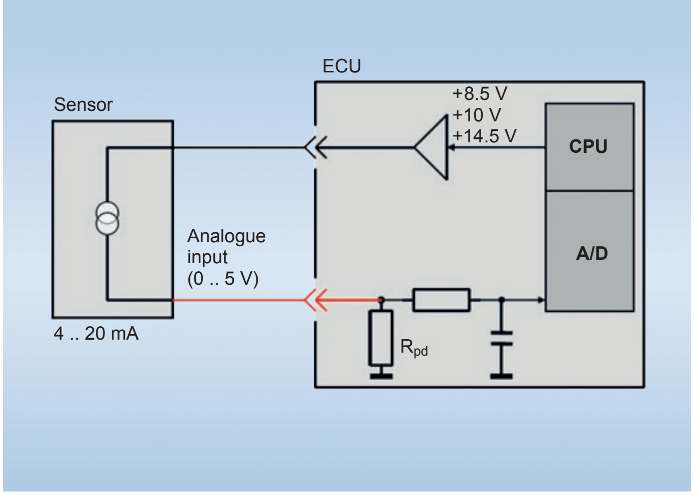
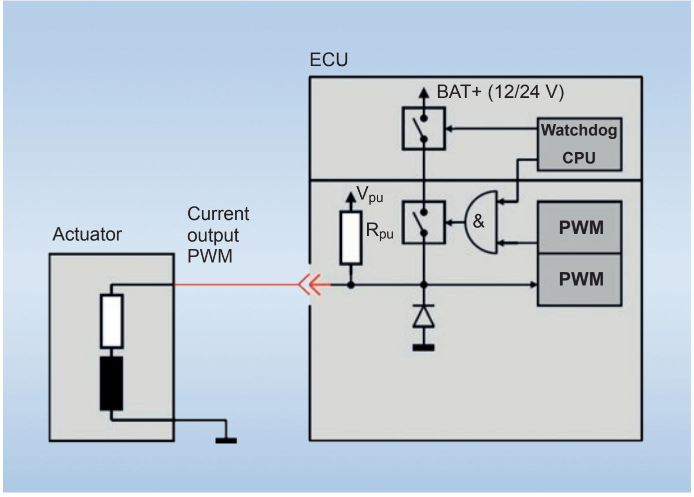
As previously stated, current signals can also be measured. Some analogue inputs from our controllers provide a connectible low resistance shunt. The sensor supply is therefore dependent on the parameters of your sensor. In the example shown here, the ECU's internal sensor supply is used. When connecting 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.



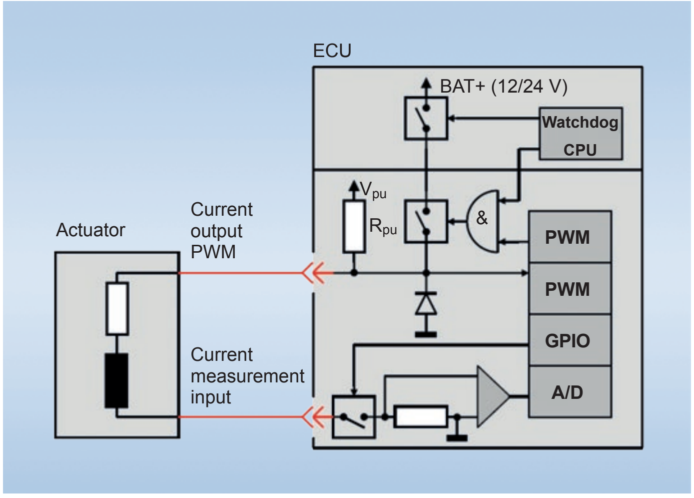
The maximum current which an output of this kind can drive is dependent on the particular controller. Usually, solenoids up to 2 A (sometimes up to 4 A) can be connected directly. When designing the system, you must also take into account the total current. This is indicated on our controllers. It is 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.

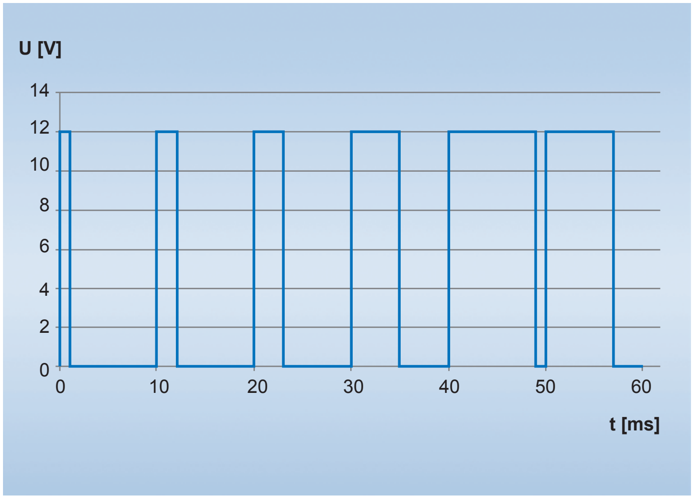
One problem when operating proportional valves with solenoid coils is that the solenoid coil increases its resistance as it heats up. This increase in internal resistance has the effect of reducing the coil current for the same supply voltage. Since the coil current is in turn proportional to the positioning 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*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.



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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:

Functional Safety
PL d, Cat 2 *
SIL 2 **

* Classification of the risk level: Performance Level PL a to e with relevant category

** Safety Integrity Level; SIL 1 to SIL 4

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.

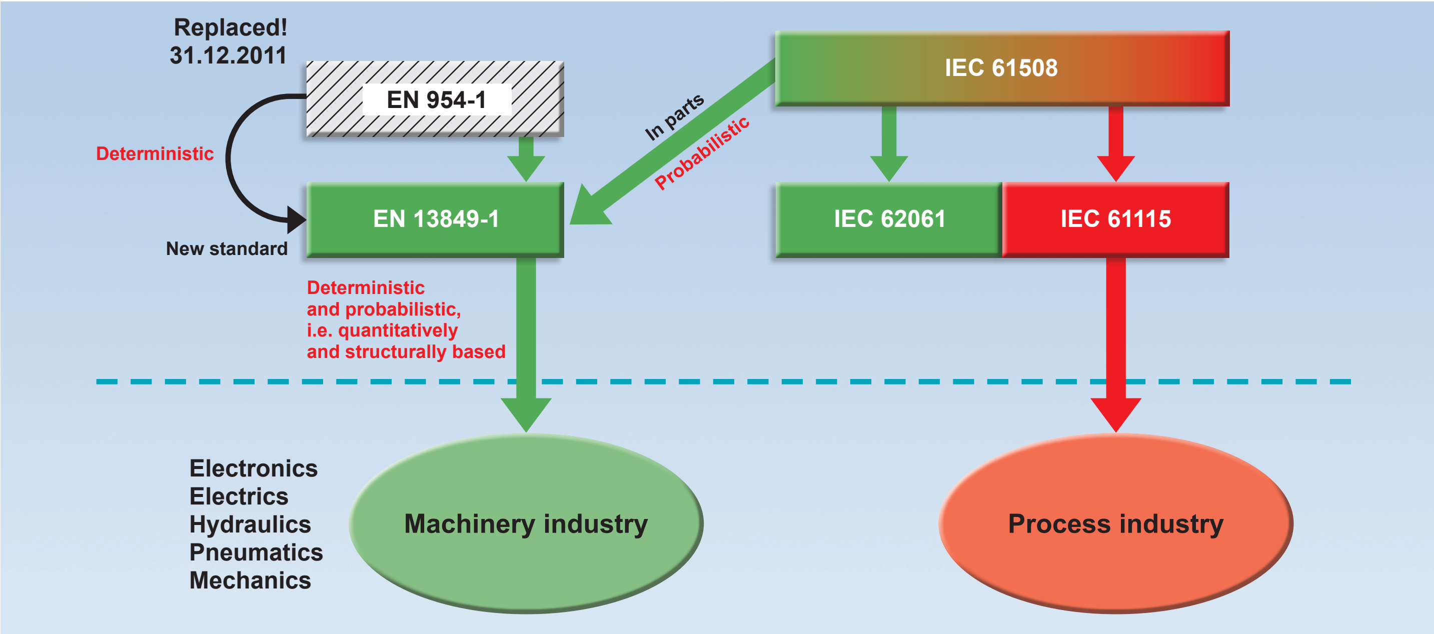


Fig. 23: **Current standards situation**

IEC 61508 – The basic standard

IEC 61508 is an international standard for designing **E**lectrical / **E**lectronic and **P**rogrammable **E**lectronic Systems (also known as E/E/PE) which fulfil a safety function. It is published by the **I**nternational **E**lectrotechnical **C**ommission (**IEC**).

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.

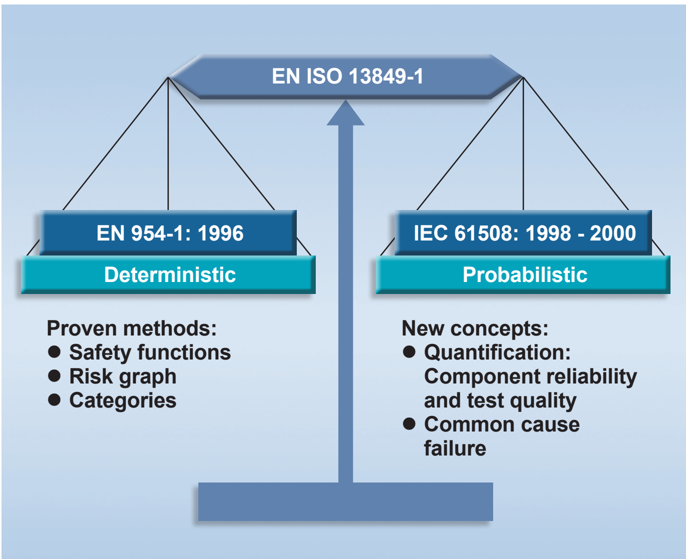


Fig. 24: **Affect of existing standards on EN 13849-1**

General Situation of Safety Standards – Worldwide and European

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.

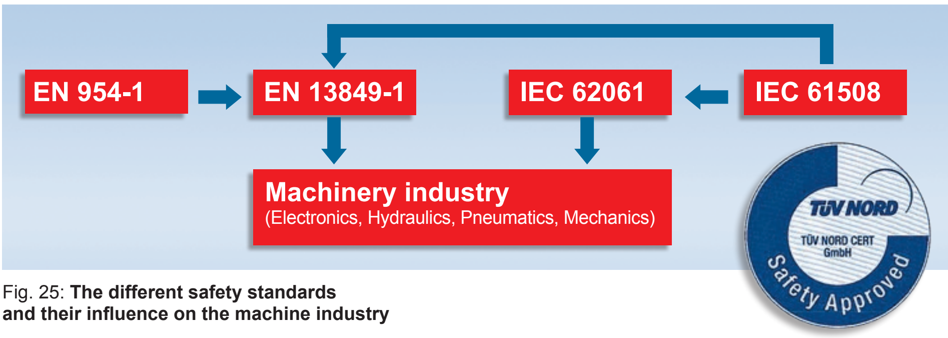


Fig. 25: **The different safety standards and their influence on the machine industry**

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 specifc approaches are explained.

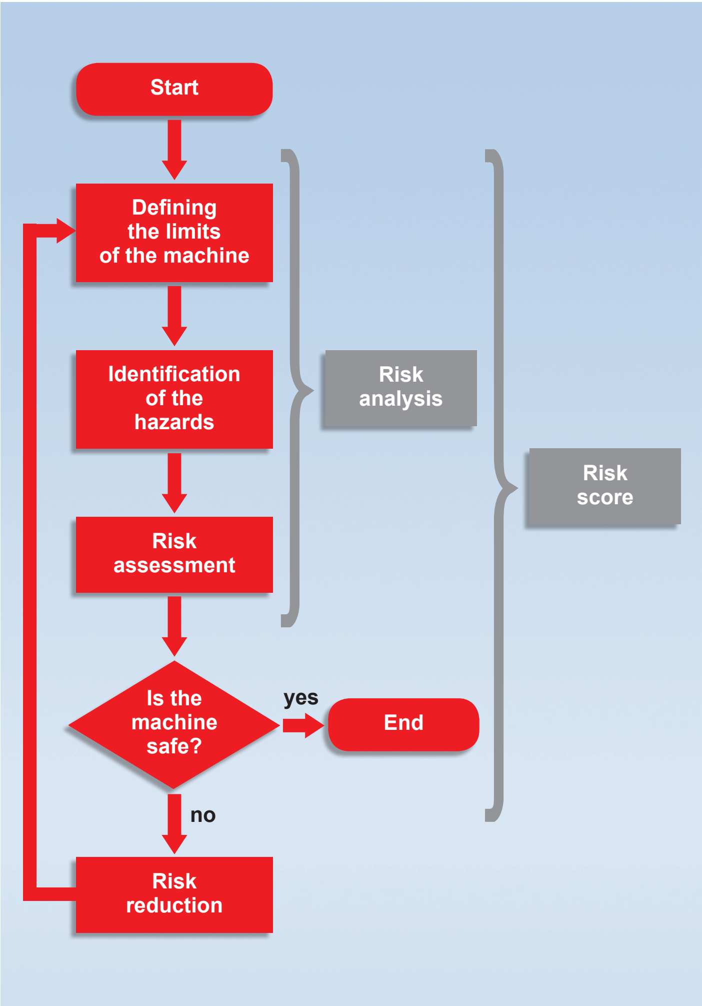


Fig. 26: **Risk analysis and risk score**

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.

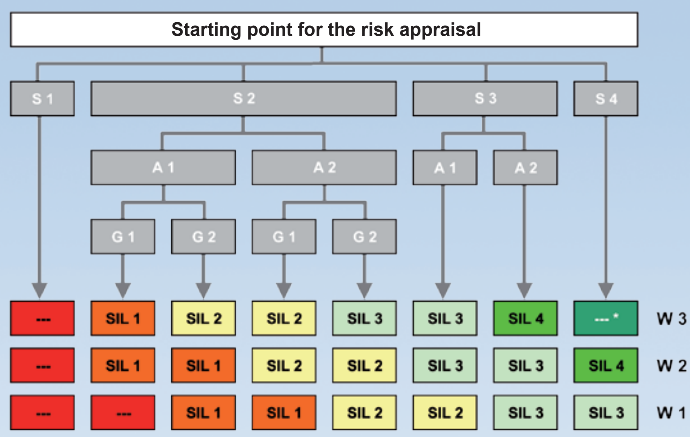
IEC 61508 defines a comprehensive safety life cycle as its basis. During the entire product life cycle the functional safety of the complete system must be reliably maintained. In addition, all activities which take place during the different stages of the product life cycle must be adequately documented.

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.



* PCT protective device alone not sufficient

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

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

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 **P**robability of dangerous **F**ailures per **H**our (**PFH**).

SIL 1 is the lowest and SIL 4 the highest level.

SIL	Probability of dangerous failures per hour
4	$\geq 10^{-9}$ .. $< 10^{-8}$
3	$\geq 10^{-8}$ .. $< 10^{-7}$
2	$\geq 10^{-7}$ .. $< 10^{-6}$
1	$\geq 10^{-6}$ .. $< 10^{-5}$

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.

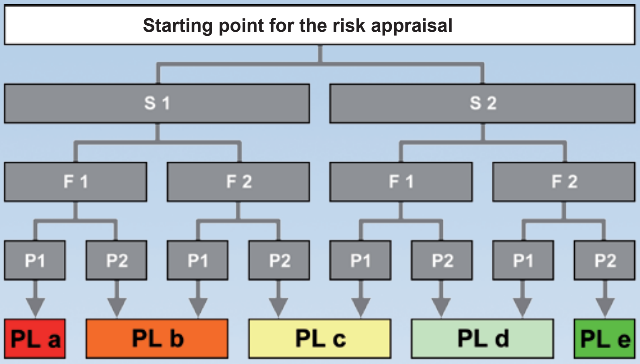
EN ISO 13849 contains safety requirements and principles for the development and integration of safety-related parts in control systems.
The standard is based on the same parameters which are described in the older EN 954. The deterministic[1)] concept of EN 954 has however been extended to include probabilistic[2)], 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.



Seriousness of injury
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

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

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.

Performance Level	Average probability of failure per hour
a	$> 10^{-5} .. < 10^{-4}$
b	$> 3 \times 10^{-6} .. < 10^{-5}$
c	$> 10^{-6} .. < 3 \times 10^{-4}$
d	$> 10^{-7} .. < 10^{-6}$
e	$> 10^{-8} .. < 10^{-7}$

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[1]"** 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).

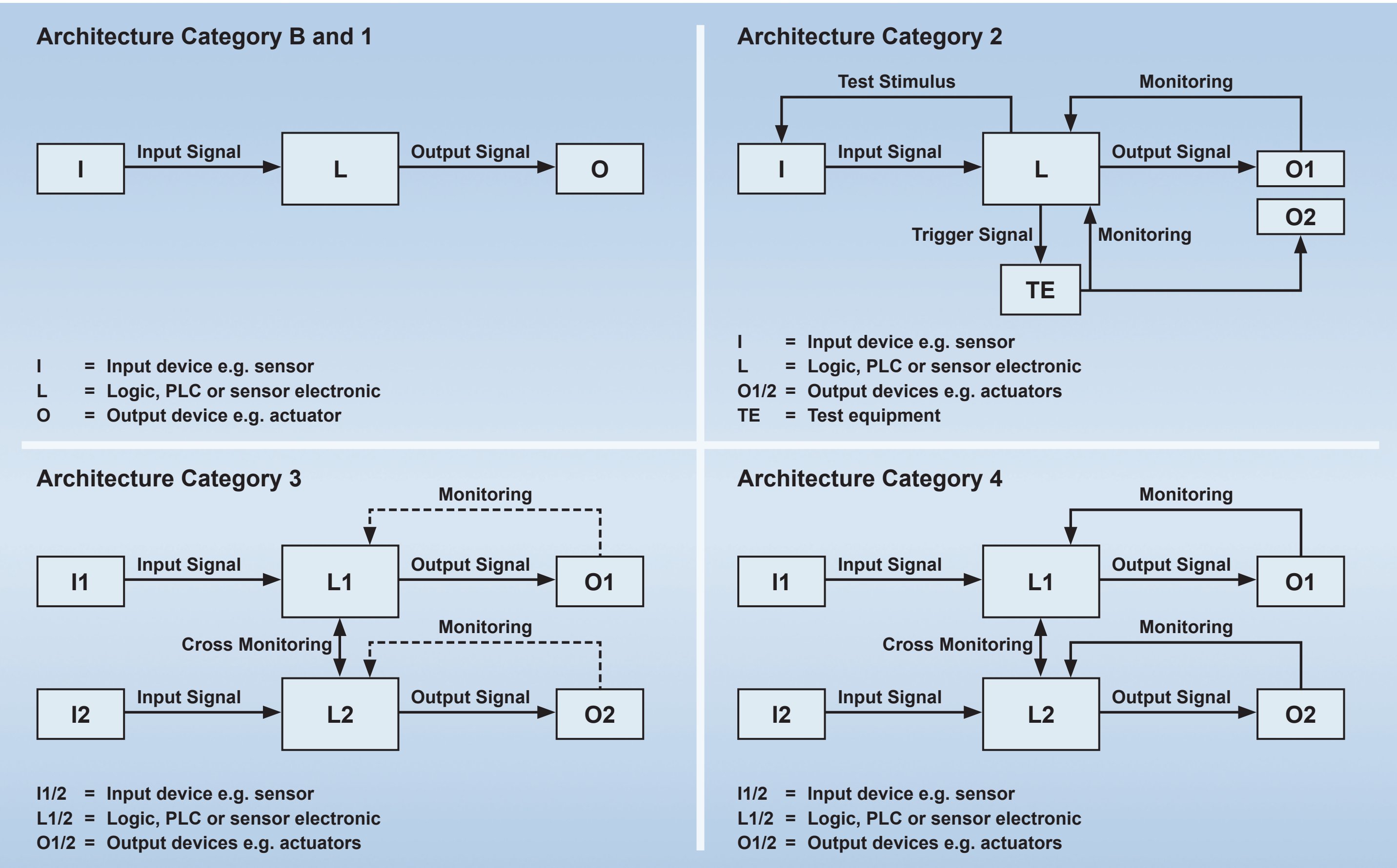


Fig. 29: **Control categories and architectures**

The achievable performance level is therefore determined by selecting the system architecture category, the **diagnostic coverage** (**DC_{avg}**)[2] achieved and the **mean time to dangerous failure** (**$MTTF_d$**)[3].
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) $MTTF_d$ = Mean time to dangerous failure

The competing standards IEC 61508, EN ISO 13849 and IEC 62061

1

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 (Marcov 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

Summary

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.)

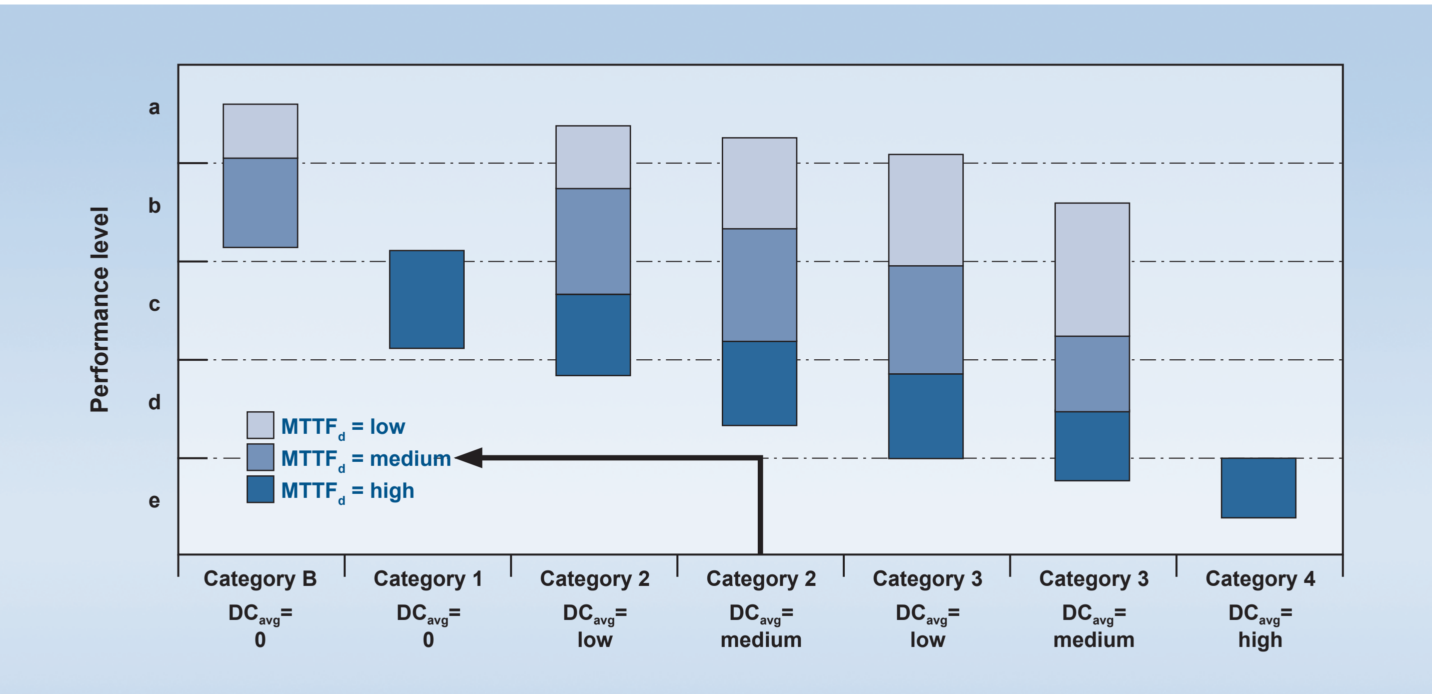


Fig. 30: **Determining the PL using the bar chart**

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).

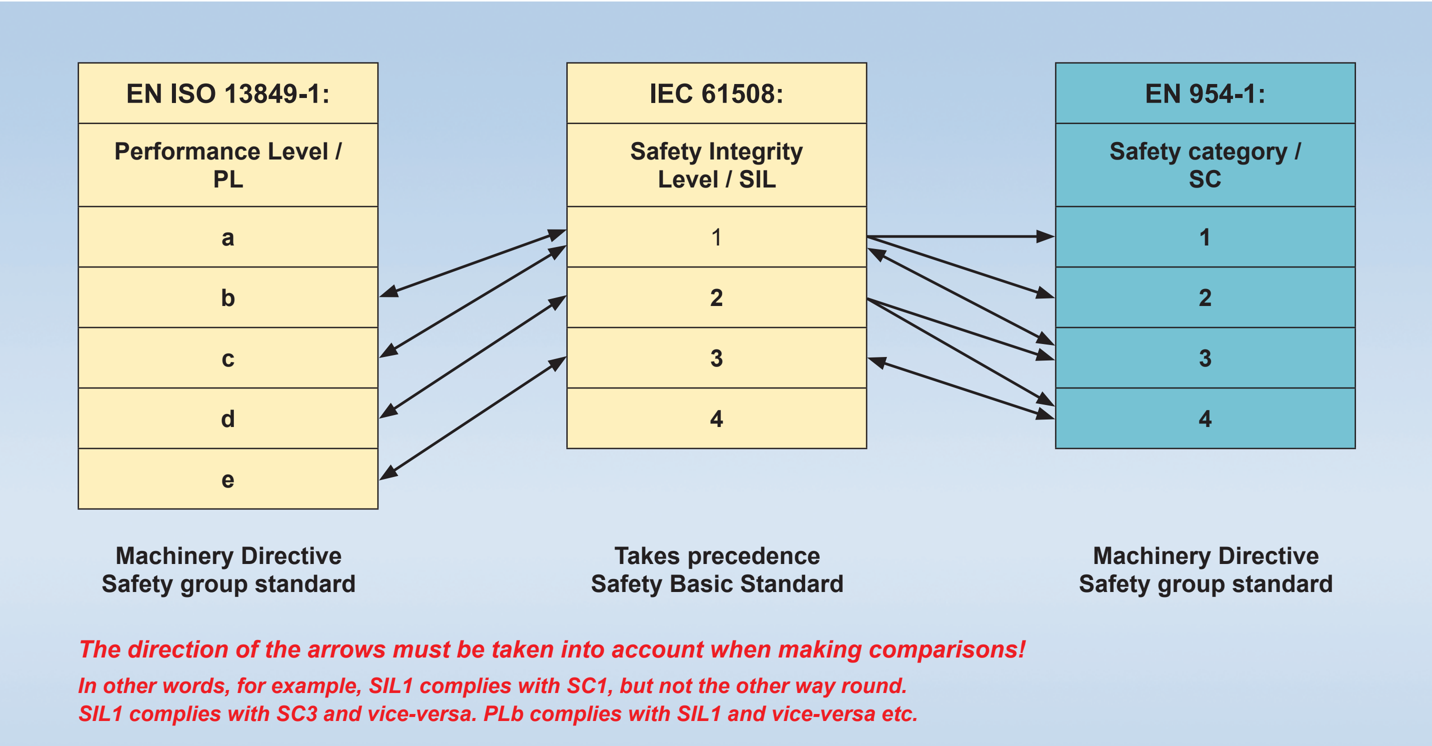


Fig. 31: **Correspondence table SIL ←→ PL**

The control units which comply with these standards are listed and described in this catalogue. The sensors are listed separately in the electronics catalogue.

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® (**Co**ntroller **De**velopment **Sys**tem) 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 direct 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-compiler**[1)] 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-Debugger2)**
HY-TTC 50/60/90/94	Altium TASKING VX-toolset for C166 v2.2r3 Standard Edition	Lauterbach Base Station: Power Debug USB2 LA-7708 Lauterbach-Debug Cable: OCDS-C166S-V2 LA-7759 ICD for XC2000
HY-TTC 200	Diab Data Compiler from Wind River Version 5.1.2	Lauterbach Base Station: Power Debug USB2 LA-7708 Lauterbach-Debug Cable: BDM-MPC500/800 LA-7722
HY-TTC 500	TI ARM C/C++ CODE GENERATION TOOLS 5.0.4 February 2013	Lauterbach Base Station: Power Debug Interface USB 3 Lauterbach-Debug Cable: JTAG-CORTEX-A/R LA-7843
HY-TTC 30	Tasking VX-Toolset C166 V3.0-r3	Lauterbach Base Station: Power Debug Interface USB 3 Lauterbach Debug Cable: OCDS-C166S-V2 LA-7759 for XC2267
HY-TTC 77	Tasking VX-Toolset C166 V3.0-r3	Lauterbach Base Station: Power Debug Interface / USB 2 LA-7708 Lauterbach Debug Cable: OCDS-C166S-V2 LA-7759 for XC2288H (XC2288H license)

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® version 3.5. This version enables visualization packages, specially developed for displays, to be integrated. Ready-to-use installations of the CODESYS® 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® 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.

2 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

TÜV NORD
TÜV NORD CERT GmbH
Safety Approved

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.

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

[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

				
	16 bit controllers	**32 bit controller**	**32-bit microcontroller platform**	
Type	**Specially for 12 V** vehicle voltage **HY-TTC 77**	Functional Safety PL d **HY-TTC 200**	Functional Safety PL d SIL 2 **HY-TTC 540**	Functional Safety PL d SIL 2 **HY-TTC 580**
Processor	16-bit Infineon XC 2288 H 80 MHz Watchdog-CPU	32 bit freescale MPC 555 40 MHz Watchdog-CPU	32 bit TI TMS 570 Dual-core lockstep CPU 180 MHz Companion CPU	
Memory	1.6 MB int. Flash 138 kB RAM 8 kB EEprom	448 kB Flash 2 MB ext. Flash 26 kB RAM 512 kB ext.RAM (optional 1 MB) 16 kBit EEprom	3 MB Flash 256 kB RAM 2 MB ext.RAM 64 kB EEPROM	3 MB Flash 8 MB ext. Flash 256 kB RAM 2 MB ext.RAM 64 kB EEPROM
Interfaces	2 x CAN	2 x CAN 1 x RS232 1 x LIN	4 x CAN	7 x CAN 1 x RS232 1 x LIN 1 x RTC 1 x Ethernet
Inputs and outputs[1)] (Example configuration)	65 total 18 PWM 30 Analogue-IN 2 Timer-IN 7 Digital-IN 8 Digital-OUT	69 total 12 PWM (8 with current meas.) 8 Analogue-IN 8 Timer-IN 17 Digital-IN 22 Digital-OUT 2 Analogue-OUT	96 total 28 PWM (28 with current meas.) 32 Analogue-IN 20 Timer-IN 16 Digital-OUT	96 total 36 PWM (36 with current meas.) 24 Analogue-IN 12 Timer-IN 8 Multipurpose I/O 16 Digital-OUT
Functional Safety (certified by TÜV Nord)		EN 13849 PL d	IEC 61508 SIL 2 EN 13849 PL d	
Programming	C	CODESYS® V2.3 C / C++	CODESYS®, CODESYS® Safety SIL 2 C / C++	

HYDAC INTERNATIONAL

Universal Mobile Controller
HY-TTC 50

2

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

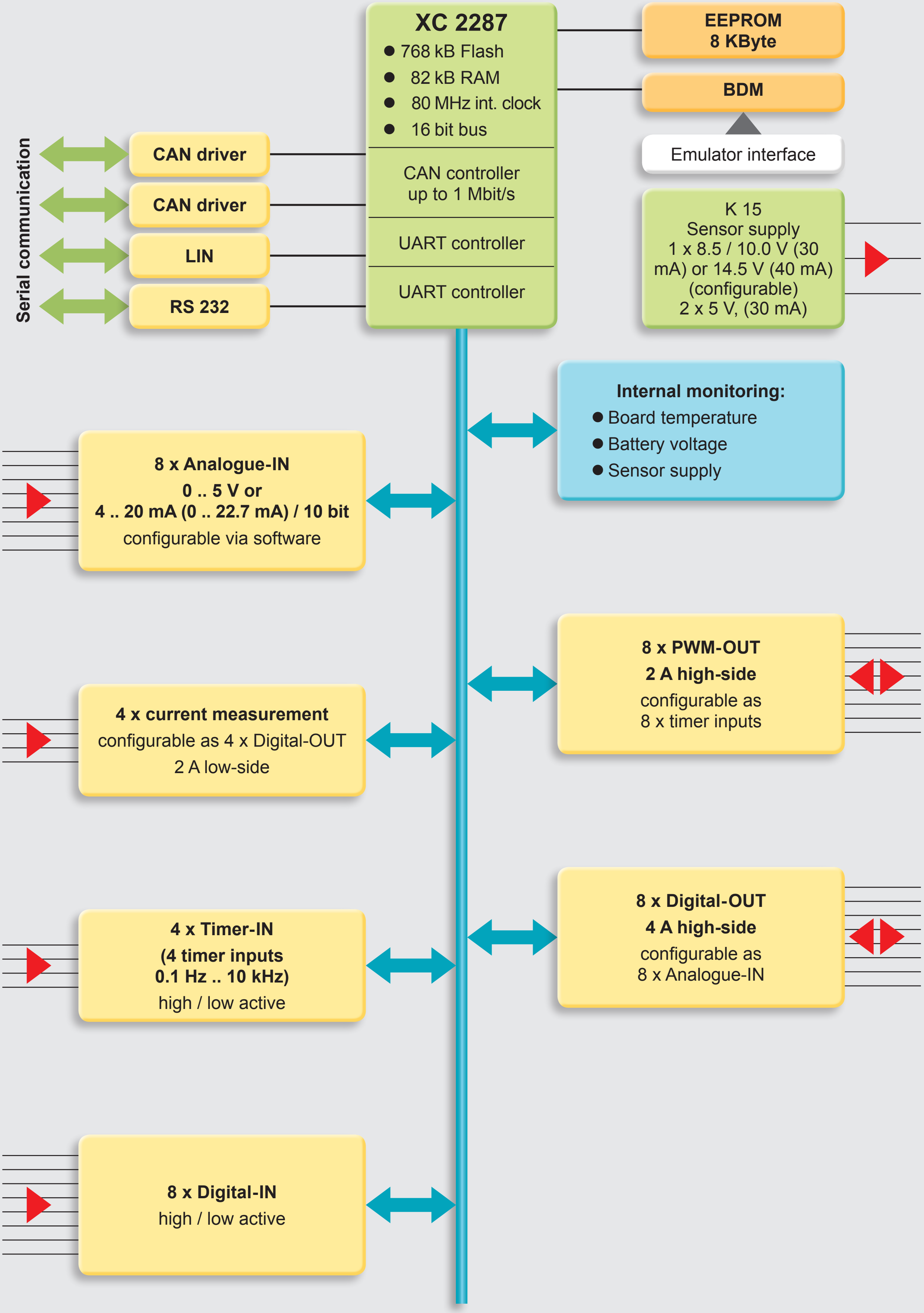
Technical data

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_{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	25 A max. (complete voltage and temperature range)
Fulfils 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 .. 1 GHz)
ESD	IEC 61000-4-2
Load dump	ISO 7637-2
Protection class	EN 60529 IP 65 / IP 67 DIN 40050 IP 6k9k
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	652 g
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+.

Block circuit diagram

HY-TTC 50



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

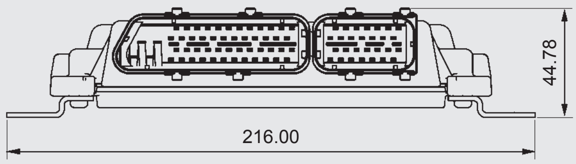
Modification number
000 = standard

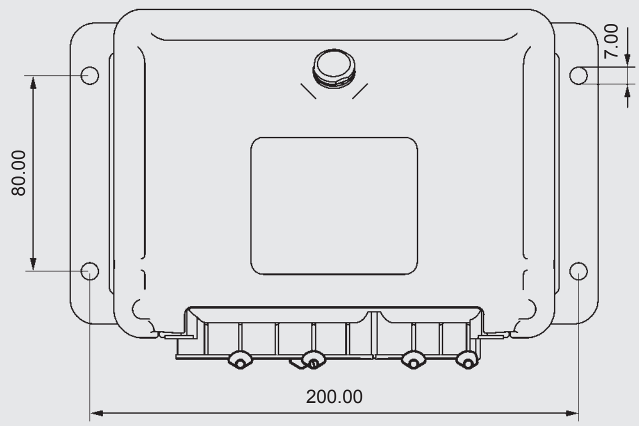
Note:
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

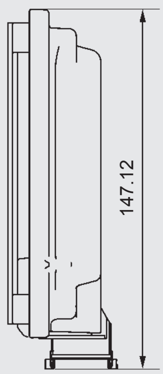
Accessories
Appropriate accessories, such as cables and connectors, service tools, software etc. can be found in the Accessories section.

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.

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2

HYDAC INTERNATIONAL

Universal Mobile Controller HY-TTC 60

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

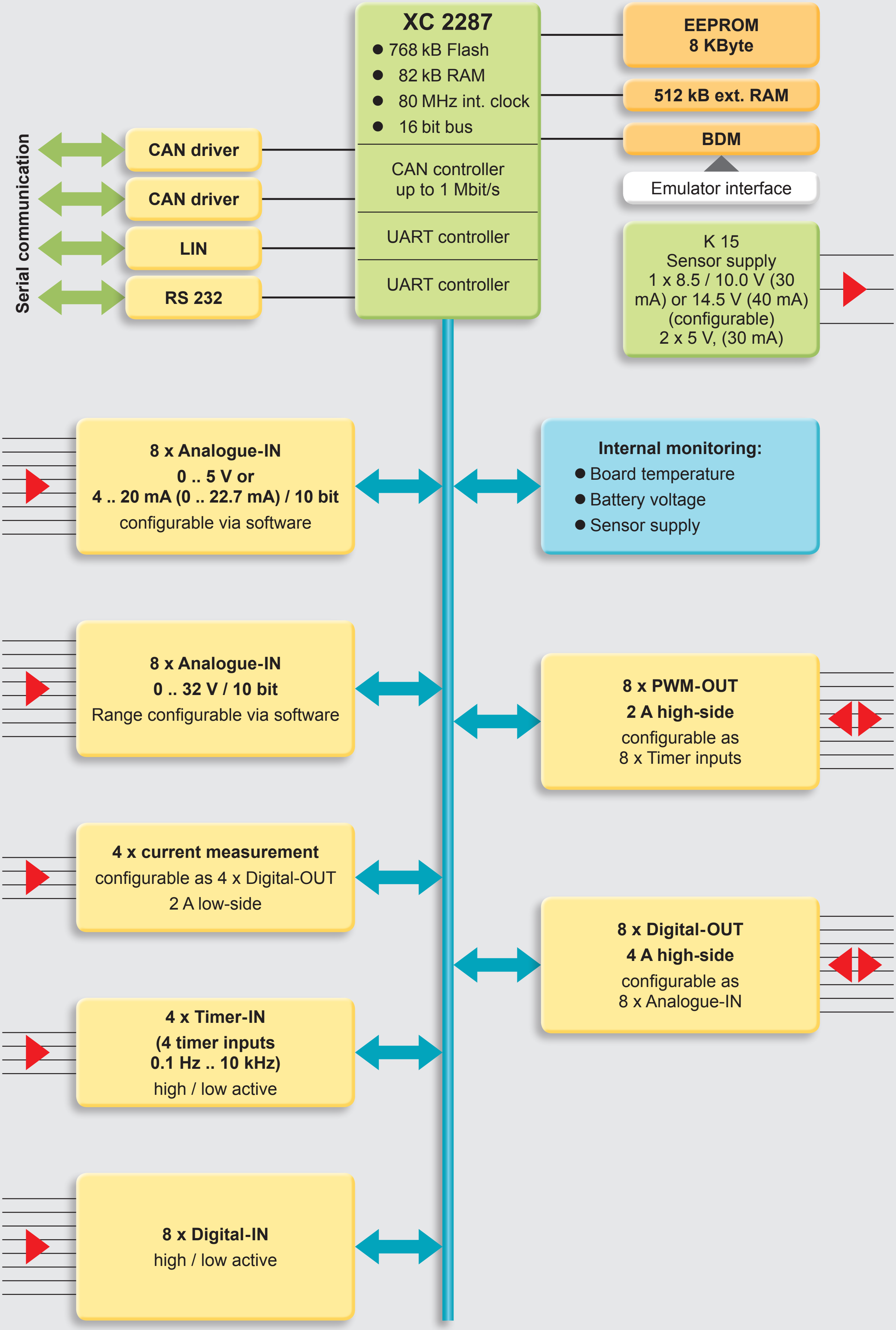
Ambient conditions	
Operating temperature	-40 .. +85 °C (with full load) to EN 60068-2
Operating altitude	0 .. 4,000 m
Supply voltage	8 .. 32 V
Permitted voltage drop	up to ≥4 V (U_{Bat}) without reset to ISO 7637-1 (for engine start in 12 V systems)
Peak voltage	45 V max. (1 ms)
Idle current	0.15 A max. at 9 V
Standby current	0.5 mA max.
Current consumption	25 A max. (complete voltage and temperature range)
Fulfils the following standards	
CE 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 DIN 40050 IP 6k9k
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 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+.

Block circuit diagram

HY-TTC 60



Model code

HY-TTC 60 – XX – 594K – 768K – 00 XX – 000

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

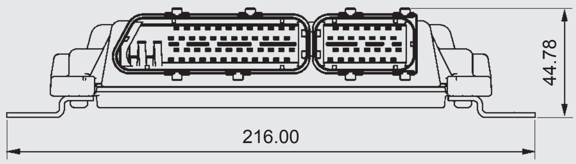
Modification number
000 = standard

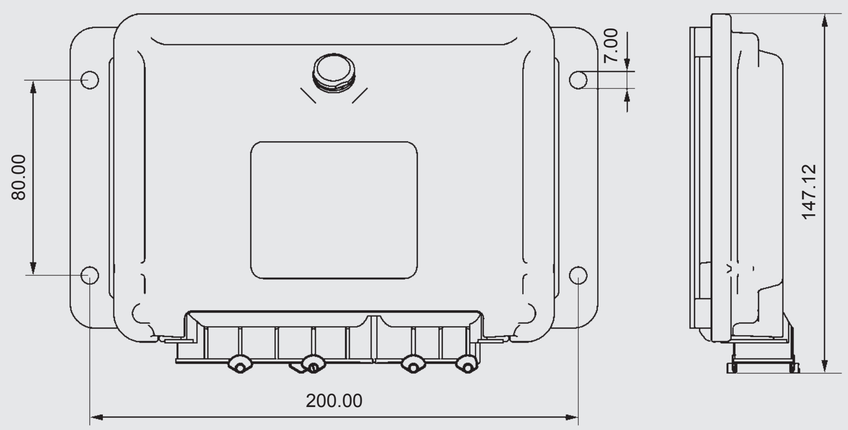
Note:
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

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.

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Subject to technical modifications.

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Universal Mobile Controller
HY-TTC 90

Functional Safety
PL d
SIL 2

TÜV NORD
TÜV NORD CERT GmbH
Safety Approved
DIN EN 61508
DIN EN 13849-1
SIL 2
PL d

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

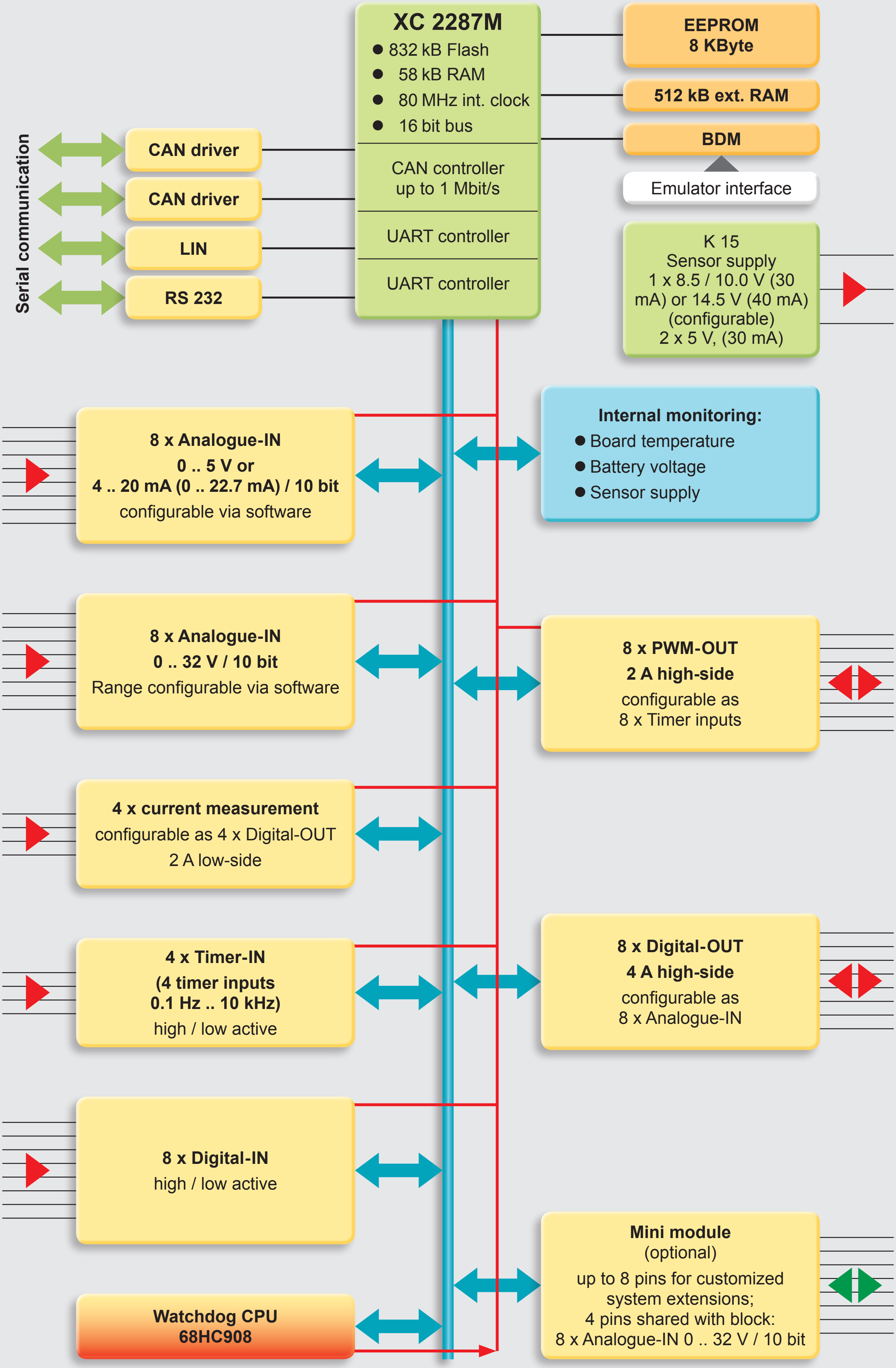
Technical data

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_{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	25 A max. (complete voltage and temperature range)
Fulfils the following standards	
CE mark	Compliant with 2004/108/EC
E-mark	2009/19/EC
Functional safety	IEC 61508 -SIL 2- EN ISO 13849 -PL d-
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 DIN 40050 IP 6k9k
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



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

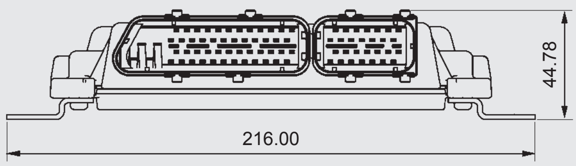
Modification number
000 = standard

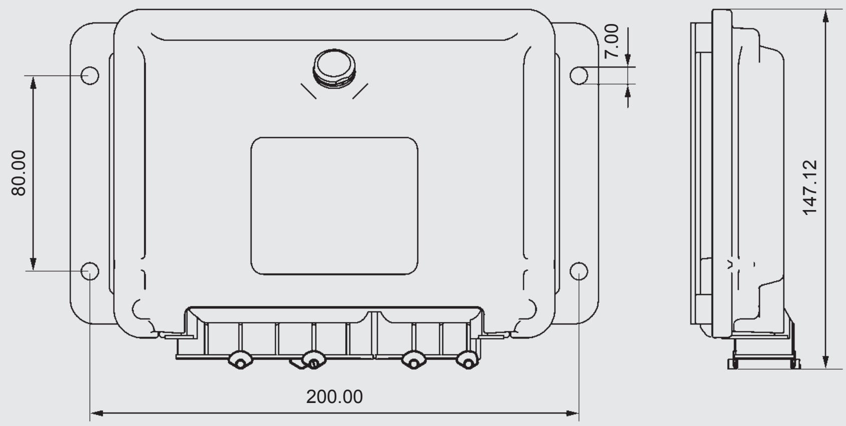
Note:
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

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





Note

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Universal Mobile Controller
HY-TTC 94

Functional Safety
PL d

2

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.

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

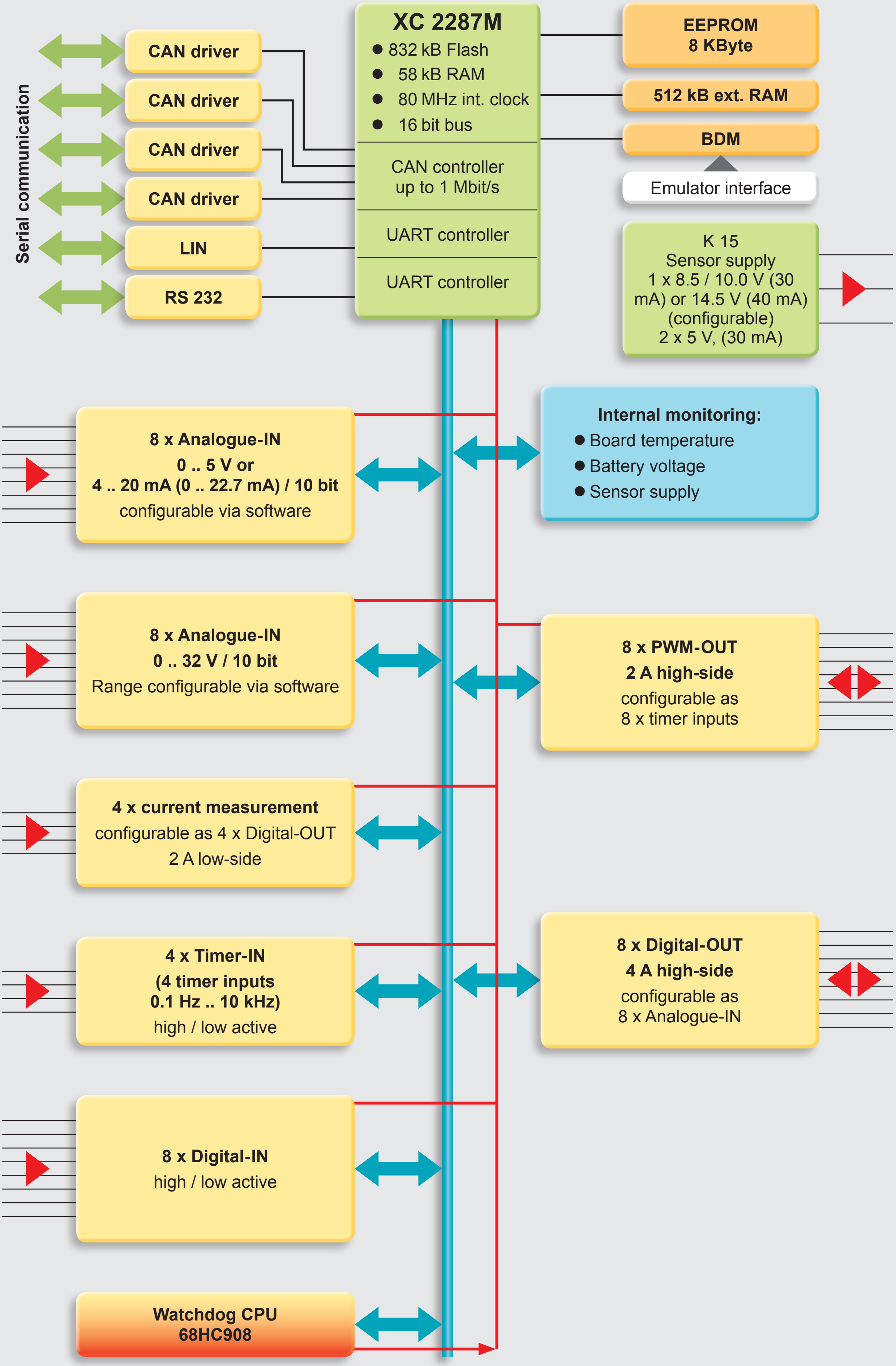
Technical data

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_{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	25 A max. (complete voltage and temperature range)
Fulfils the following standards	
CE mark	Compliant with 2004/108/EC
E-mark	ECE-R10 Rev.3
Functional safety	EN ISO 13849 -PL d-
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 DIN 40050 IP 6k9k
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	664 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	
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-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+.

Block circuit diagram

HY-TTC 94



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

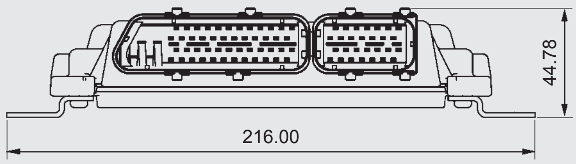
Modification number
000 = standard

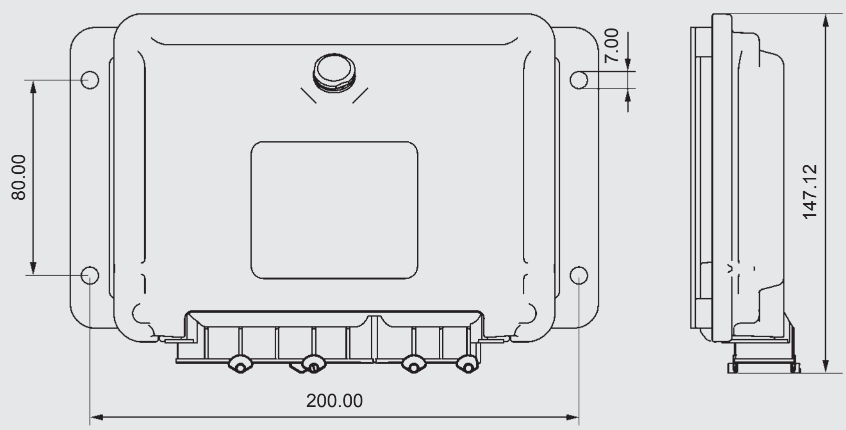
Note:
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

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





Note

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

Subject to technical modifications.

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Universal Mobile Controller
HY-TTC 77

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

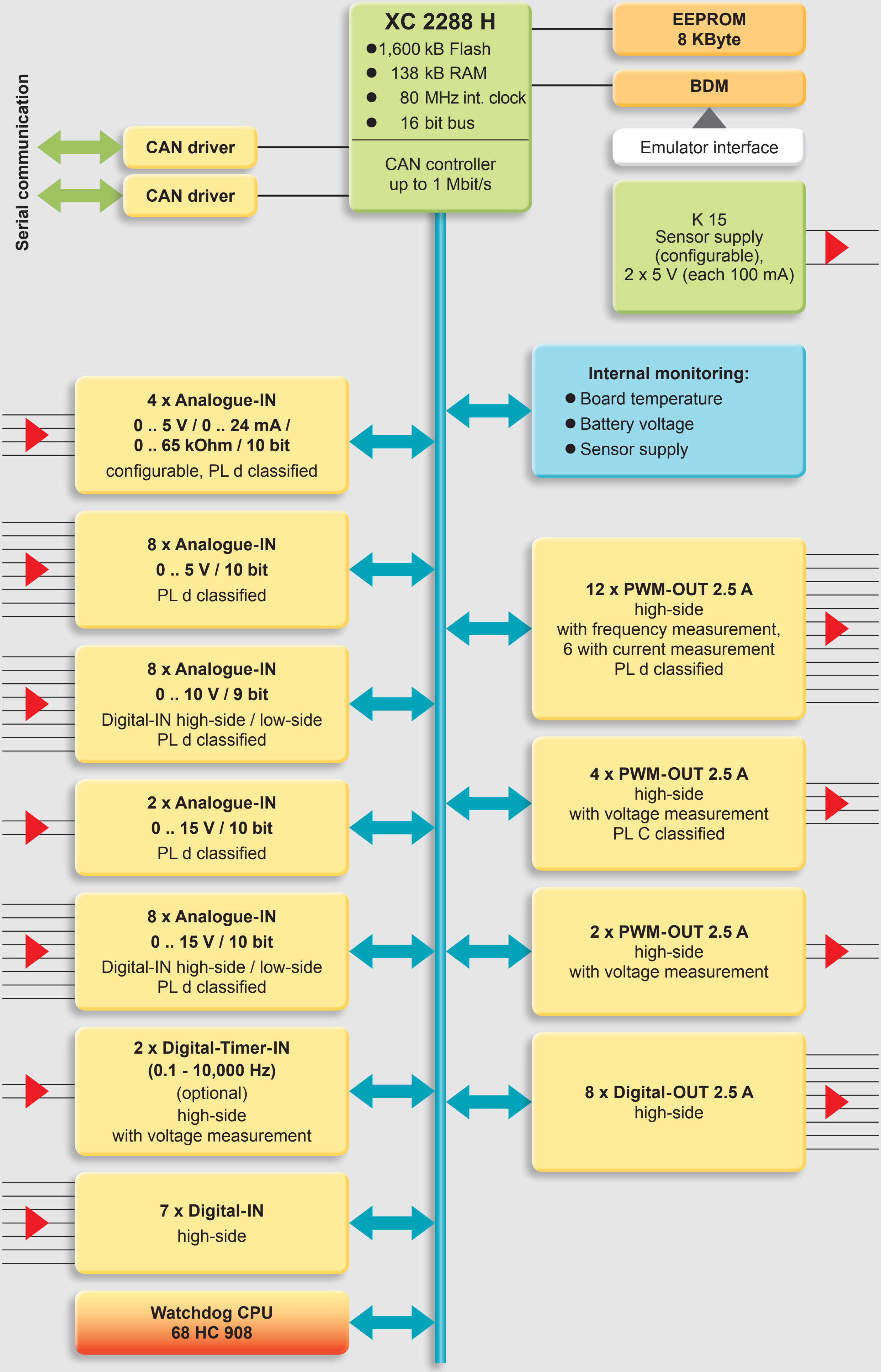
Technical data

Ambient conditions	
Operating temperature	-40 .. +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 ≥4 V (U_{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	
CE 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 DIN 40050 IP 6k9k
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 Digital-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



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

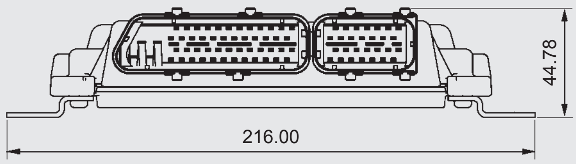
Modification number
000 = standard

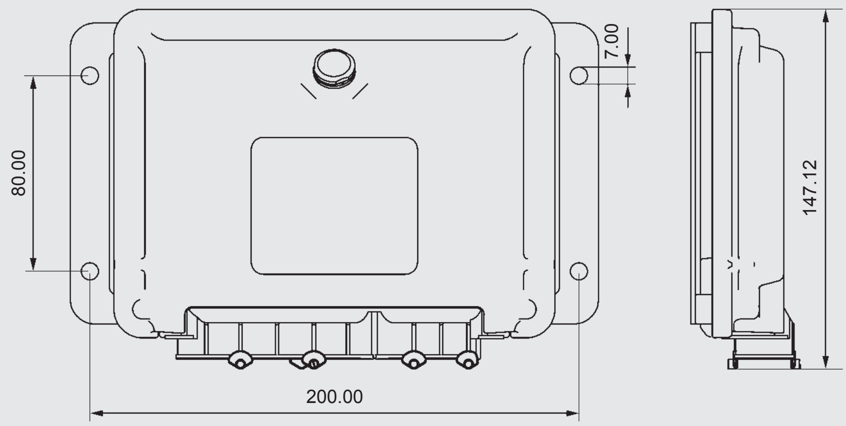
Note:
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

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





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Universal Mobile Controller
HY-TTC 200

Functional Safety
PL d

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

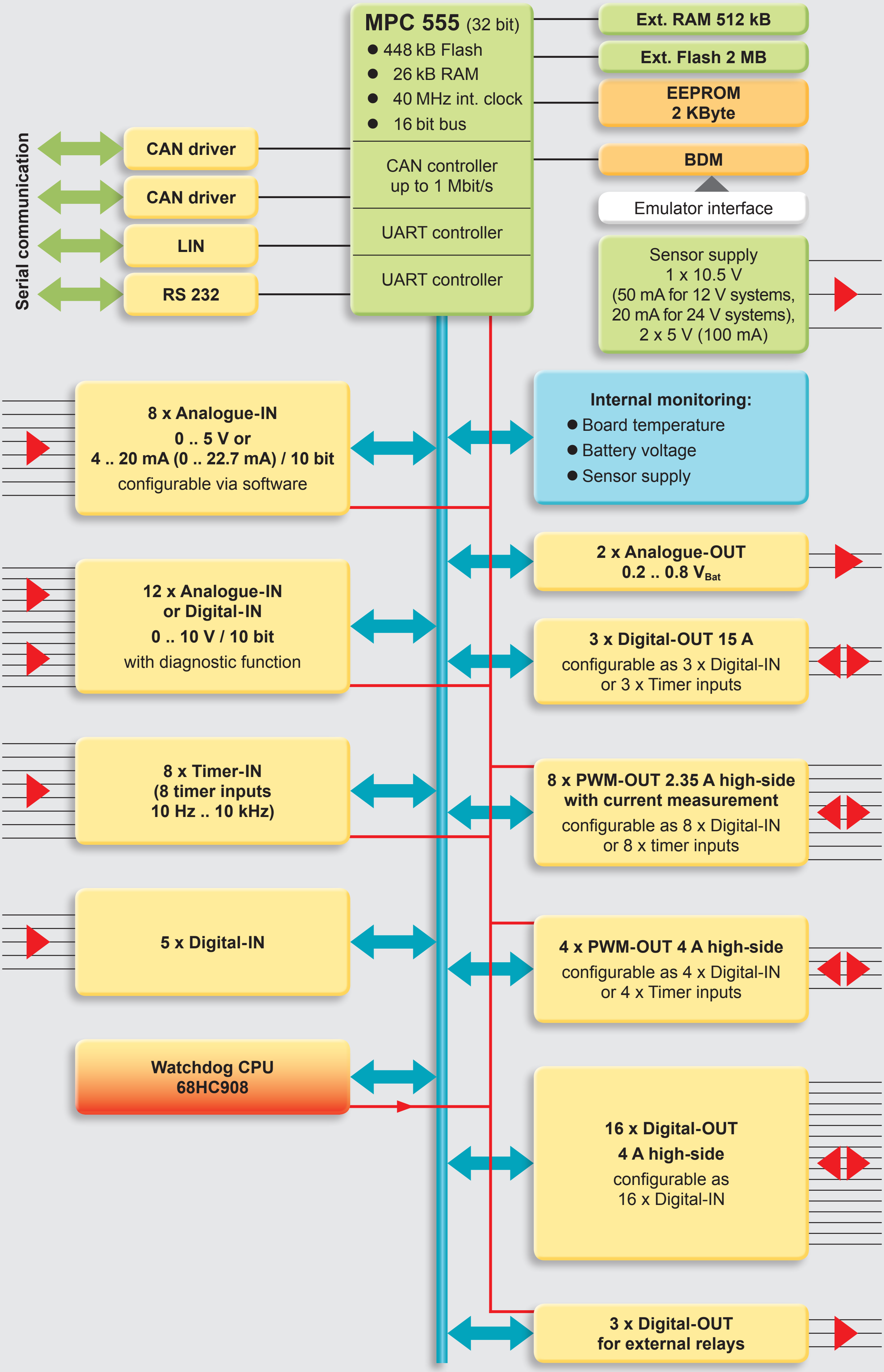
Technical data

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)
Fulfils the following standards	
CE mark	Compliant with 2004/108/EC
E-mark	Compliant with 2006/28/EC
Functional safety	EN ISO 13849 -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
Protection class	EN 60529 IP 65 DIN 40050 IP 6k9k
Temperature	EN 60068-2-1; -14Nb; -2; -78; -30
Vibration, shock, bump	IEC 60068-2-29; -64; -27; -32
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_{Bat}	
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)	
Modular safety concept for centralized and distributed electronic systems	
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 200



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

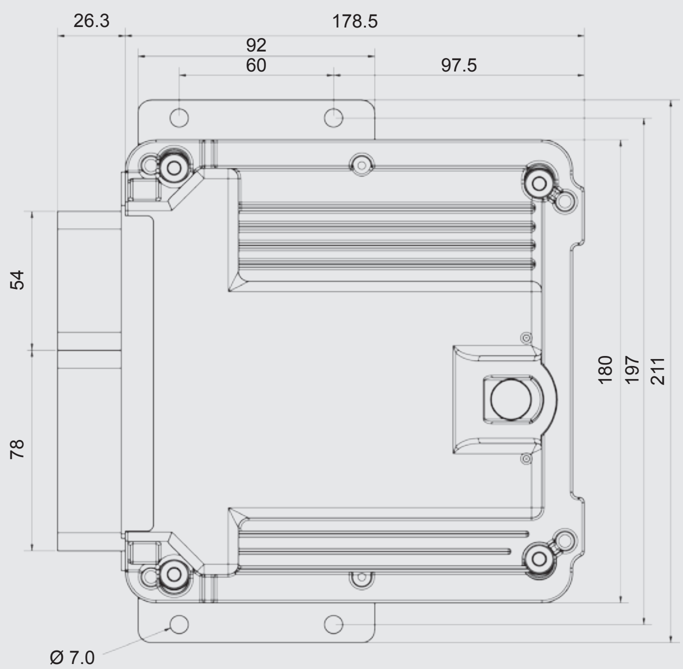
Equipment options
00 = none
10 = with mounting bracket, fitted

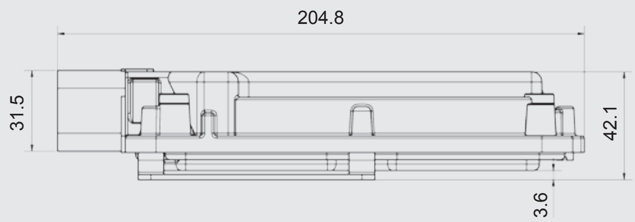
Modification number
000 = standard

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





Note

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Subject to technical modifications.

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2

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.

2

Universal Mobile Controller
HY-TTC 540

Functional Safety
PL d
SIL 2

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.

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

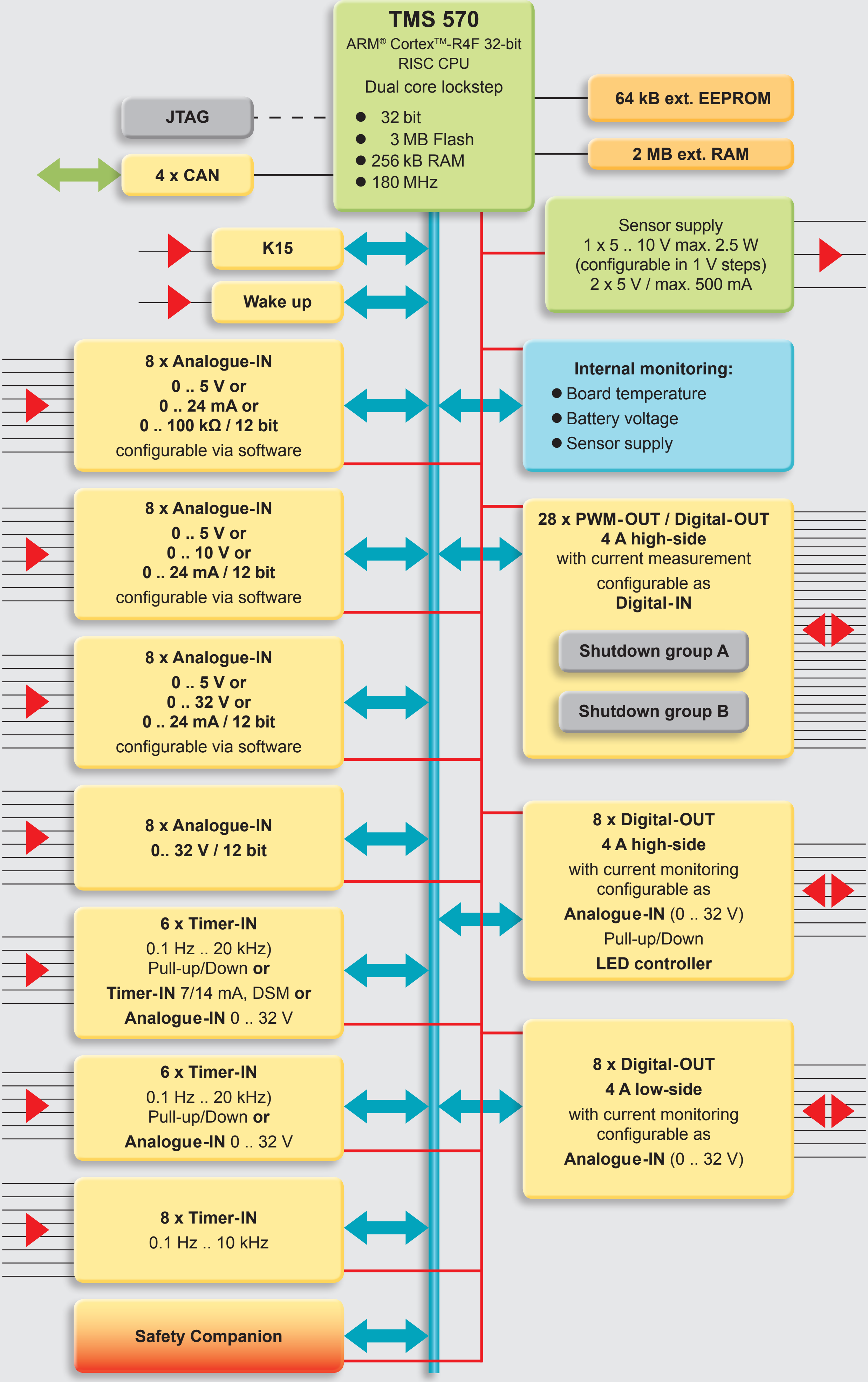
Technical data

Ambient conditions	
Operating temperature	-40 .. +85 °C (with full load)
Operating altitude	0 .. 4,000 m
Supply voltage	8 .. 32 V $_{(Bat+)}$ (5.5 .. 32 V CPU operative)
Peak voltage	45 V max. (1 ms)
Idle current	400/200 mA at 12/24 V
Standby current	≤1 mA max.
Current consumption	60 A max. (complete voltage and temperature range)
Fulfils the following standards	
CE mark	Compliant with 2004/108/EC
E-mark	ECE-R10 Rev.4
Functional safety	EN ISO 13849 -PL d- IEC 61508 -SIL 2-
EMC	EN 13309; ISO 14982; CISPR 25
ESD	ISO 10605
Protection class	EN 60529 IP 67; ISO 20653 IP 6k9k
Electrical	ISO 16750-2; ISO 7637-2,-3
Temperature	ISO 16750-4
Vibration, shock, bump	ISO 16750-3
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[1)2)3)]	
32-Bit TI TMS 570 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 kbit/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 .. 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 input 0.1 Hz .. 20 kHz) / Timer-IN (7/14 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 .. 32V	
K 15 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.

Block circuit diagram

HY-TTC 540



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 **P**erformance **L**evel **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.

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.

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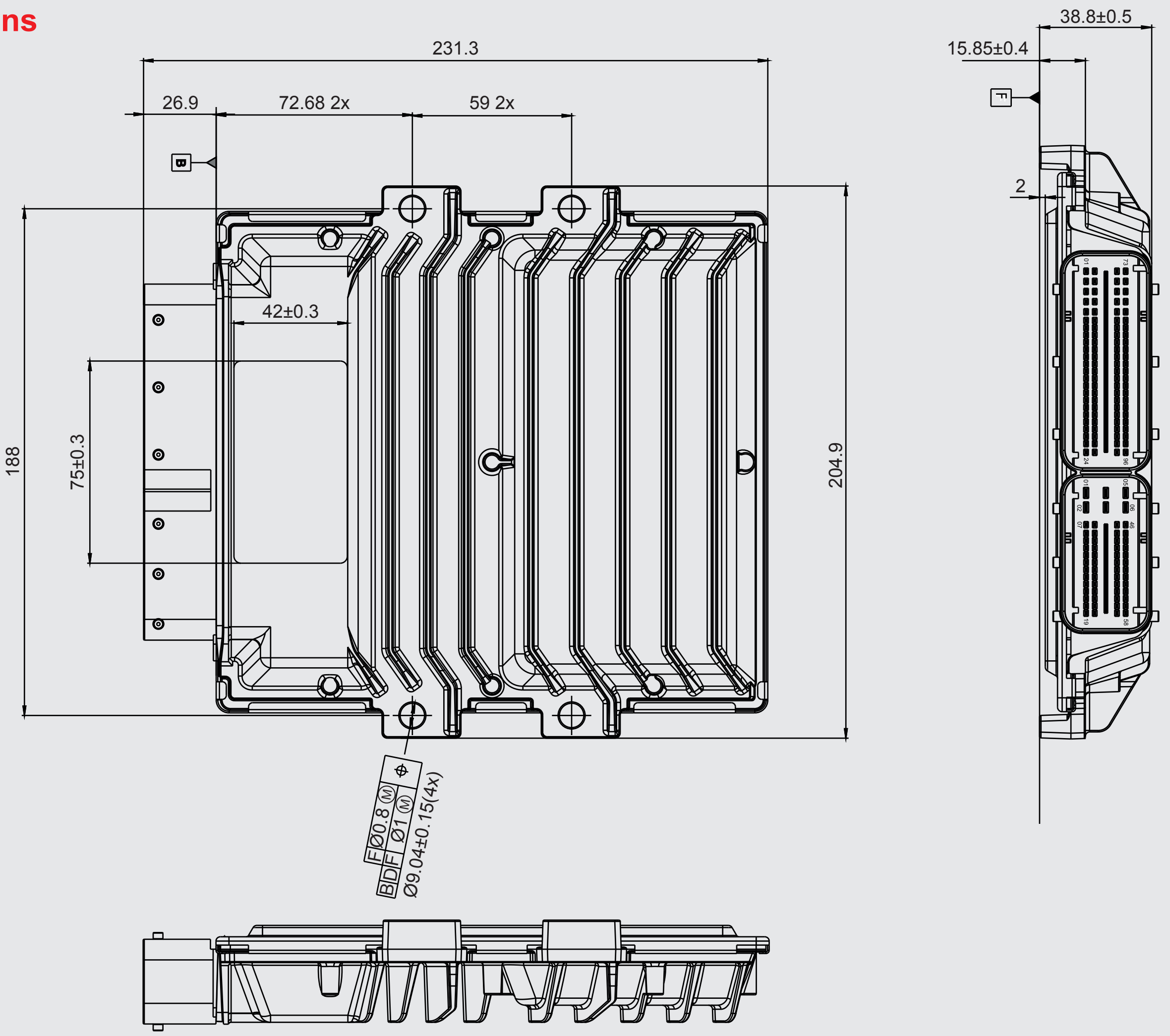
Dimensions



HYDAC INTERNATIONAL

Universal Mobile Controller
HY-TTC 580

Functional Safety
PL d
SIL 2

2

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

Ambient conditions	
Operating temperature	-40 .. +85 °C (with full load)
Operating altitude	0 .. 4,000 m
Supply voltage	8 .. 32 V ($_{Bat+}$) (5.5 .. 32 V CPU operative)
Peak voltage	45 V max. (1 ms)
Idle current	400/200 mA at 12/24 V
Standby current	≤1 mA max.
Current consumption	60 A max. (complete voltage and temperature range)
Fulfils the following standards	
CE mark	Compliant with 2004/108/EC
E-mark	ECE-R10 Rev.4
Functional safety	EN ISO 13849 -PL d- IEC 61508 -SIL 2-
EMC	EN 13309; ISO 14982; CISPR 25
ESD	ISO10605
Protection class	EN 60529 IP 67; ISO 20653 IP 6k9k
Electrical	ISO 16750-2; ISO 7637-2,-3
Temperature	ISO 16750-4
Vibration, shock, bump	ISO 16750-3
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[1)2)3)]	
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 (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	
K 15 and wake up	
OUT	
36 x PWM OUT 4 A high-side, current measurement, configurable as digital-OUT or timer inputs (0.1 .. 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 % V_{Bat+} or Voltage-OUT 0 .. 75 % V_{Bat+} 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	
Connector types: 154 pole male	
1 x Sensor supply 5 .. 10 V / max. 2.5 W configurable with increments of 1 V	
2 x sensor supply 5 V (500 mA)	
Programming in C, CODESYS® 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.

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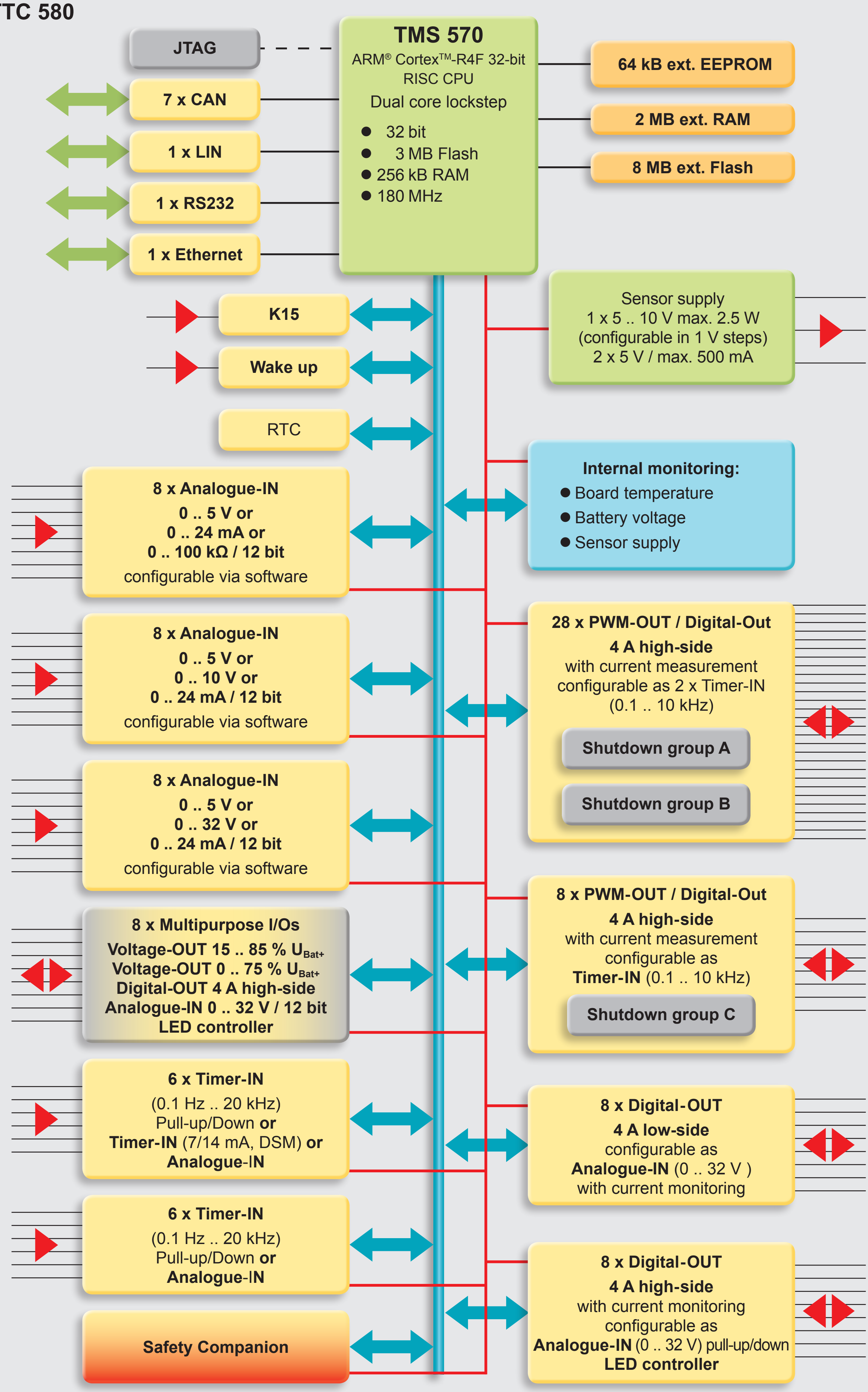
Block circuit diagram

HY-TTC 580



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 **P**erformance **L**evel **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.

Note

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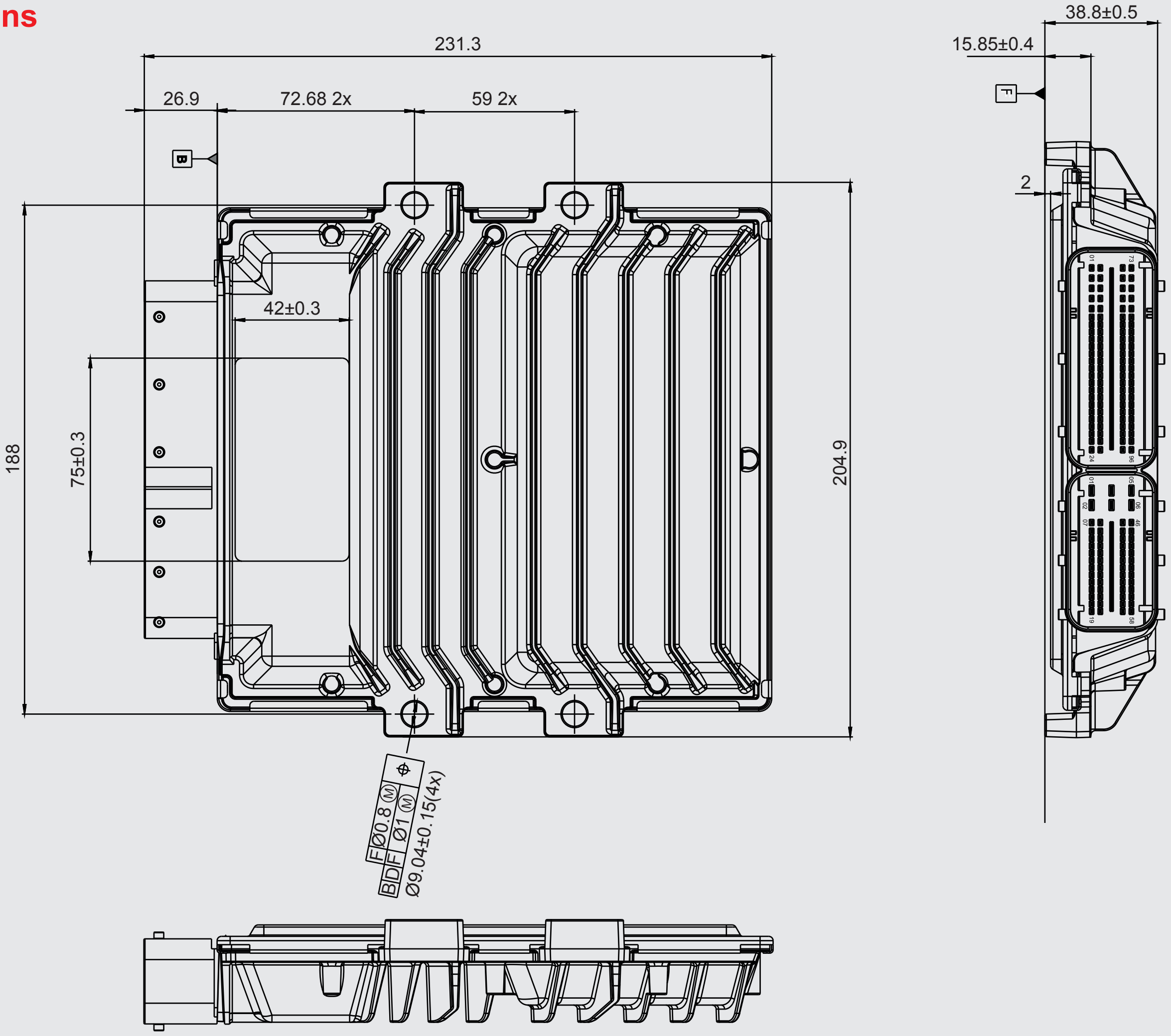
Dimensions



2

Universal Compact Controller HY-TTC 30-H

(Minimum order quantity 1,000 pieces)

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

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	
CE 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
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	147 x 92 x 38 mm
Minimum clearance for connection	208 x 94 x 38 mm
Weight	330 g
Features[1)2)]	
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 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 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_{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.

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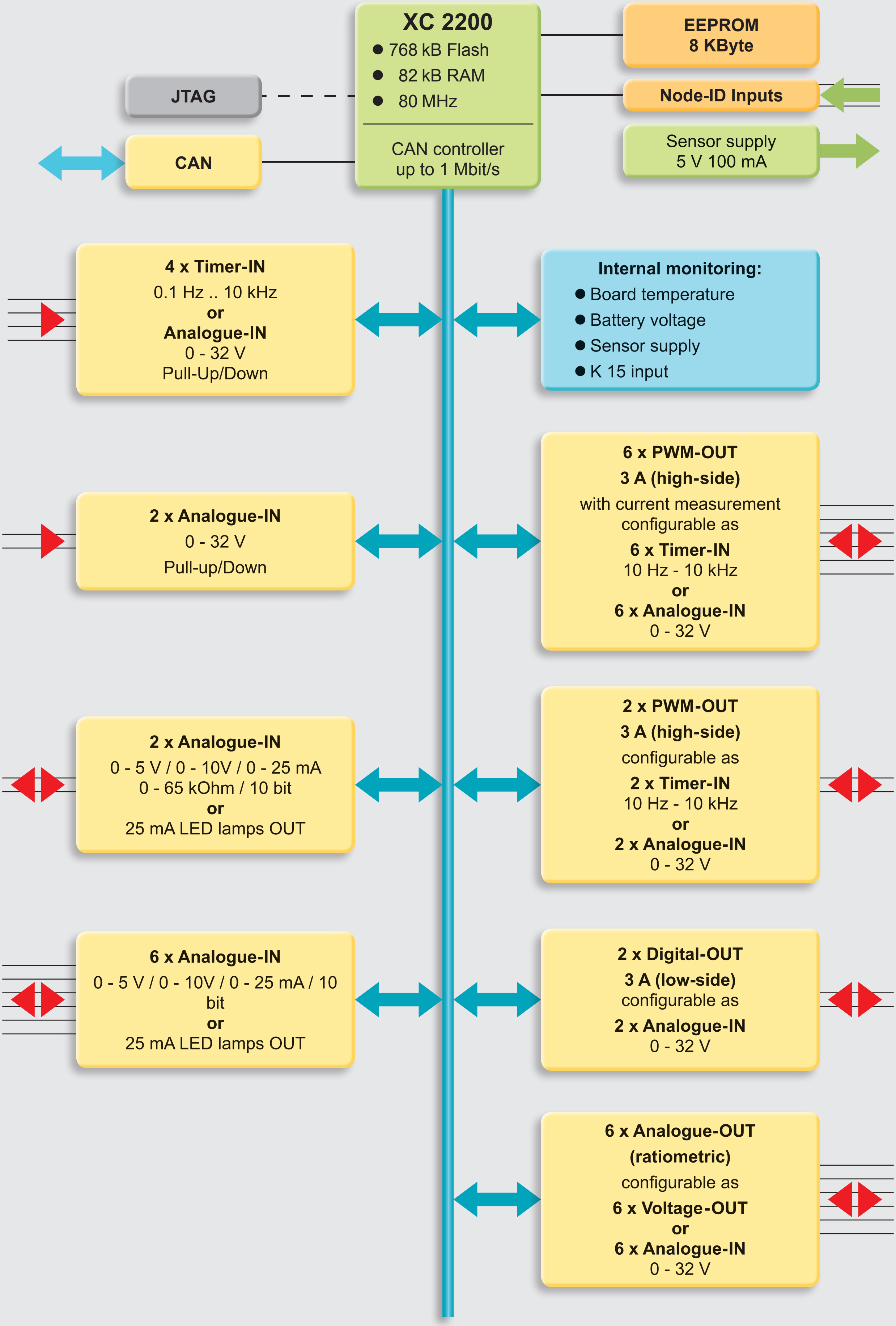
Block circuit diagram

HY-TTC 30-H



Model code

HY-TTC 30 – H – XX – 00 – 000

Firmware
CP = C/C++

Equipment options
00 = standard
10 = developer version

Modification number
000 = standard

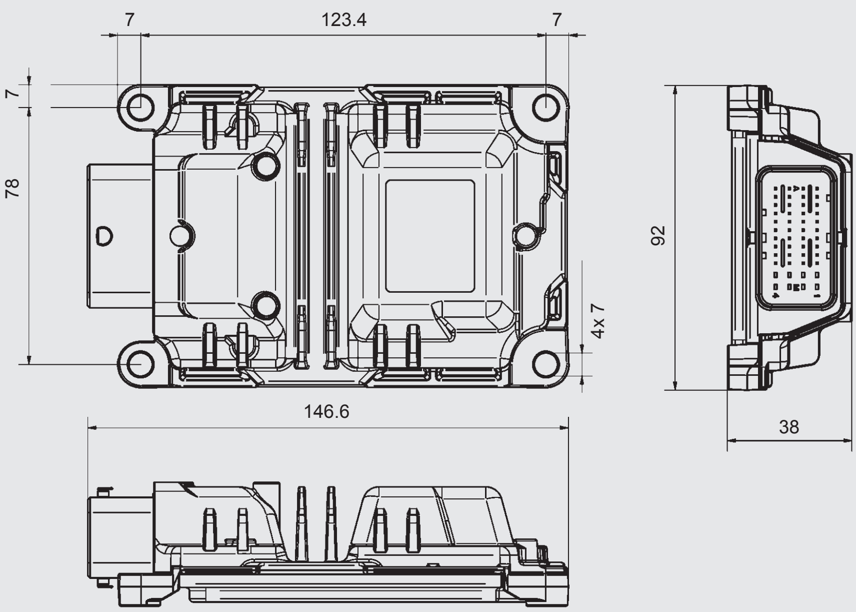
Note

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.

Dimensions



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2

Universal Compact Controller HY-TTC 30S-H

(Minimum order quantity 1,000 pieces)

Functional Safety PL c

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.

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

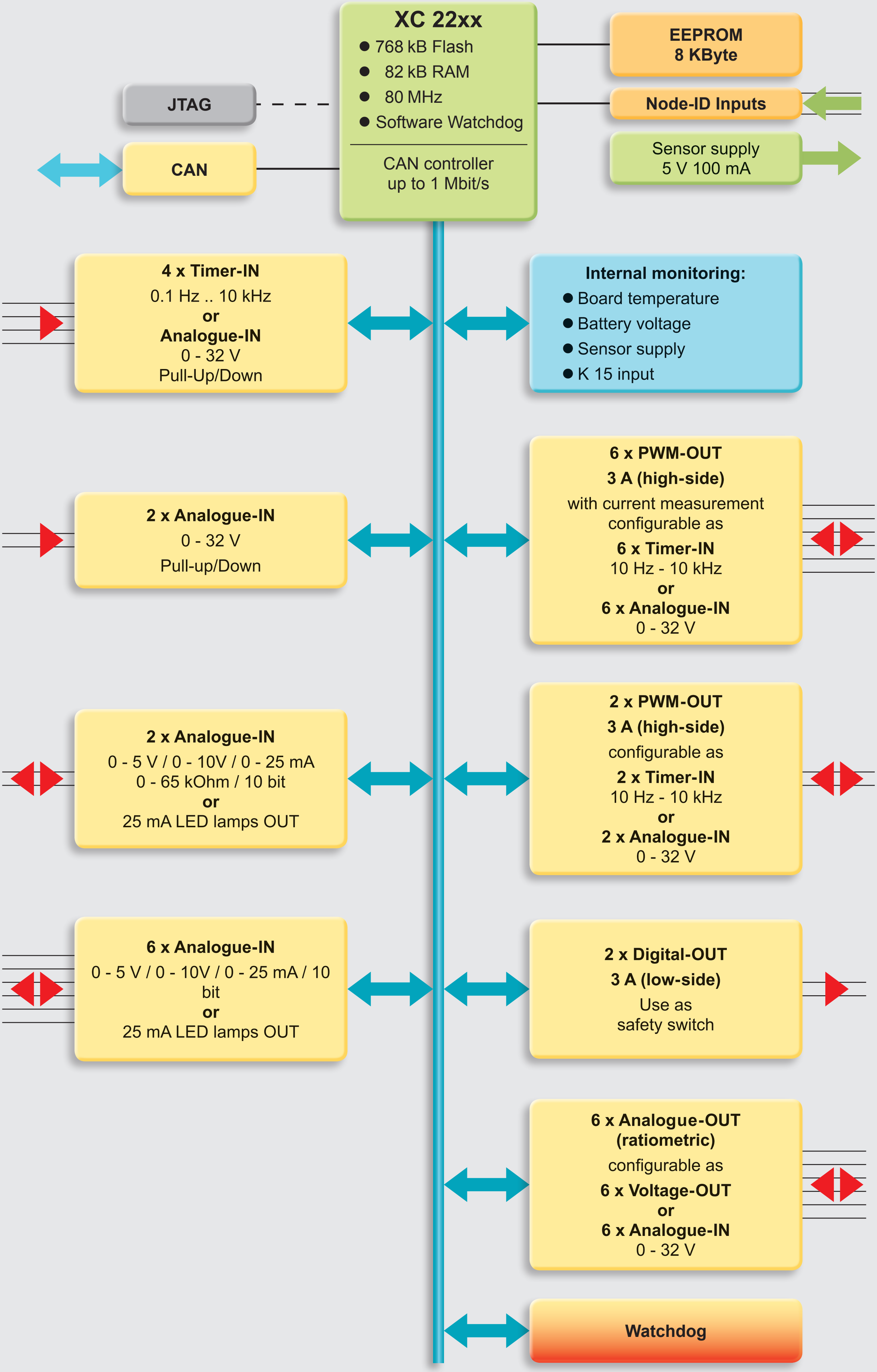
Ambient conditions	
Operating temperature	-40 .. +85 °C (with full load)
Operating altitude	0 .. 4,000 m
Supply voltage	8 .. 32 V
Peak voltage	40 V max.
Idle current	40 .. 120 mA
Standby current	≤1 mA
Current consumption	24 A max.
Fulfils the following standards	
CE mark	Compliant with 2004/108/EC
E-mark	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)2)3)4)]
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 pins for optional configuration
IN
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, 1 encoder configurable pull-up/down in digital voltage input mode, PL c capable
OUT
6 x PWM-OUT / Digital-OUT 3 A high-side, current measurement, 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, current measurement, 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 Digital-OUT 3 A low-side, for use as safety switch for high-side PWM-OUTs[5)]
6 x Analogue-OUT 15 % .. 85 % V_{Bat+} (ratiometric) configurable as 0 V .. 75 % 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.

Block circuit diagram

HY-TTC 30S-H



Model code

HY-TTC 30S – H – XX – 00 – Pc – 000

Firmware
CP = C/C++

Equipment options
00 = standard

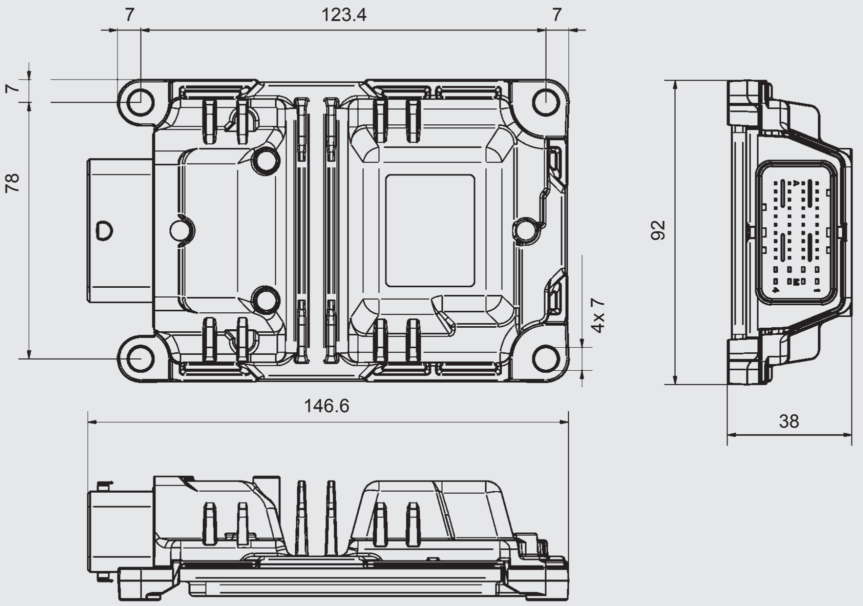
Functional safety
Pc = requirements for PL c

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

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Subject to technical modifications.

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2

3 I/O Expansion Modules

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.

				
Type	**HY TTC 30X-H**	**HY TTC 30X-O**	**HY TTC 30X-I**	**Functional Safety PL c** **HY TTC 30XS-H**
Functional safety (certified by TÜV Nord)				EN 13849 PL c
Communication	CANopen DS 401	CANopen DS 401	CANopen DS 401	CANopen DS 304/401
Total I/O	30	30	30	30
PWM-OUT with current measurement	6		2	6
PWM-OUT	2		2	2
Current measurement inputs				
Max. current consumption	24 A	24 A	24 A	24 A
Analogue-IN	10 total 6 x 0..5 V / 0..10 V / 0..25 mA 2 x 0..32 V 2 x 0..5 V / 0..10 V / 0..25 mA / 0..65 kΩ	12 total 6 x 0..5 V / 0..10 V / 0..25 mA 4 x 0..32 V 2 x 0..5 V / 0..10 V / 0..25 mA / 0..65 kΩ	18 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	10 total 6 x 0..5 V / 0..10 V / 0..25 mA 2 x 0..32 V 2 x 0..5 V / 0..10 V / 0..25 mA / 0..65 kΩ
Timer-IN	4	4	8	4
Digital-IN				
Digital-OUT	2 x 3 A low-side	8 x 3 A high-side		2 x 3 A low-side
Voltage-OUT	6	6		6
Stabilized sensor supply	1 x 5 V	1 x 5 V	1 x 5 V	1 x 5 V

   

Type	Functional Safety PL c HY TTC 30XS-I	HY-TTC 36X	HY-TTC 48X	Functional Safety PL d HY-TTC 48XS
Functional safety (certified by TÜV Nord)	EN 13849 PL c			EN 13849 PL d
Communication	CANopen DS 304/401	CANopen DS 401	CANopen DS 401	CANopen DS 304/401
Total I/O	30	40	48	48
PWM-OUT with current measurement	2			
PWM-OUT	2	4	8	8
Current measurement inputs		4	4	4
Max. current consumption	24 A	25 A	25 A	25 A
Analogue-IN	18 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	8 x 0..5 V / 4..20 mA	16 total 8 x 0..5 V / 4..20 mA 8 x 0..32 V	16 total 8 x 0..5 V / 4..20 mA 8 x 0..32 V
Timer-IN	8	8	4	4
Digital-IN		8	8	8
Digital-OUT		8 x 4 A high-side	8 x 4 A high-side	8 x 4 A high-side
Voltage-OUT				
Stabilized sensor supply	1 x 5 V	1 x 8.5 V / 10 V / 14.5 V 2 x 5 V	1 x 8.5 V / 10 V / 14.5 V 2 x 5 V	1 x 8.5 V / 10 V / 14.5 V 2 x 5 V

Universal Compact I/O Expansion Module
HY-TTC 30X-H

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 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-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)
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	
CE 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
Protection class	EN 60529 IP 67 / ISO 20653 IP 6K9K
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[1)2)]
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
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_{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.

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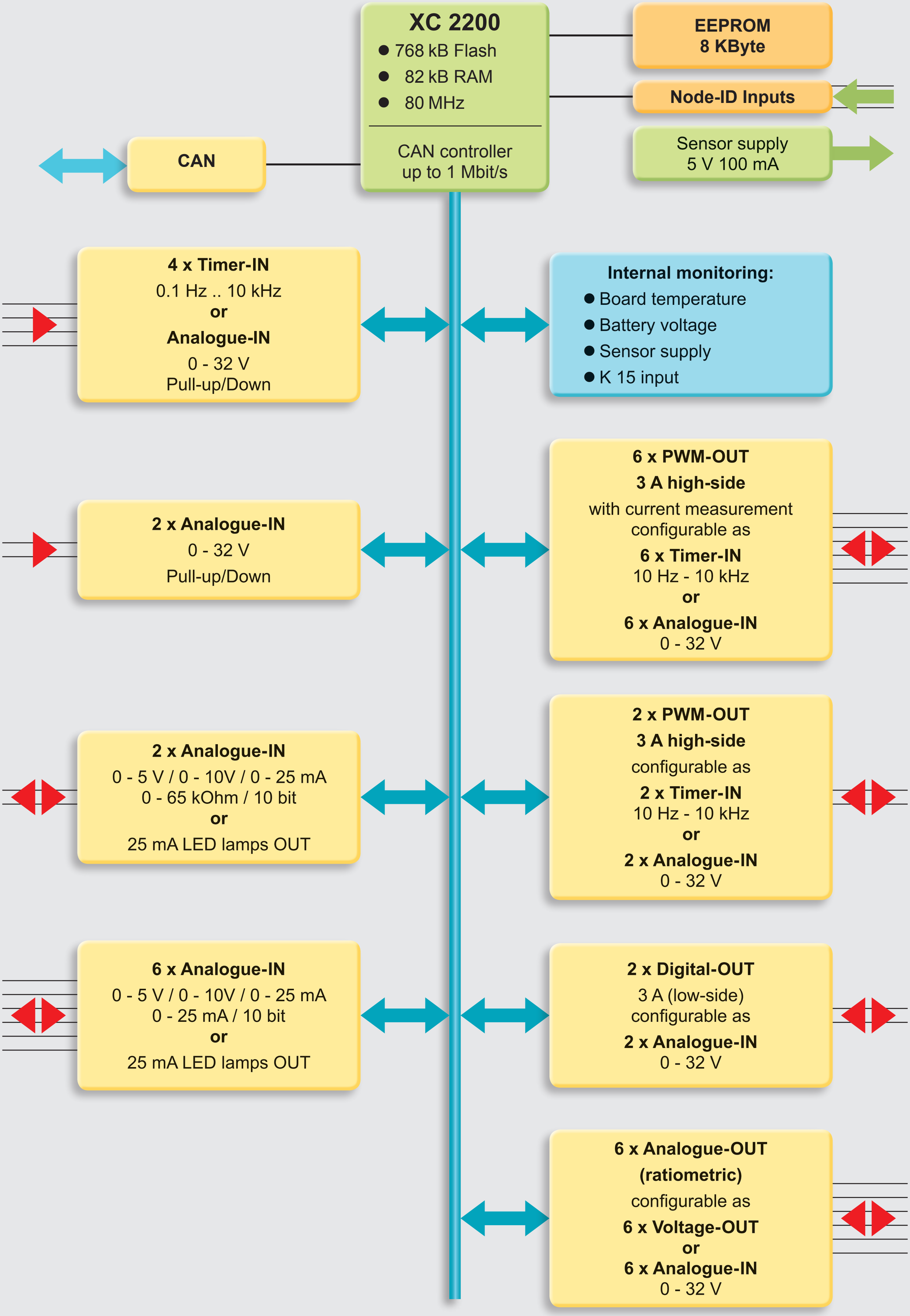
Block circuit diagram

HY-TTC 30X-H



Model code

HY-TTC 30X – H – FXX – 00 – 000

CAN protocol
F11 = CANopen slave
F12 = CAN J1939 slave

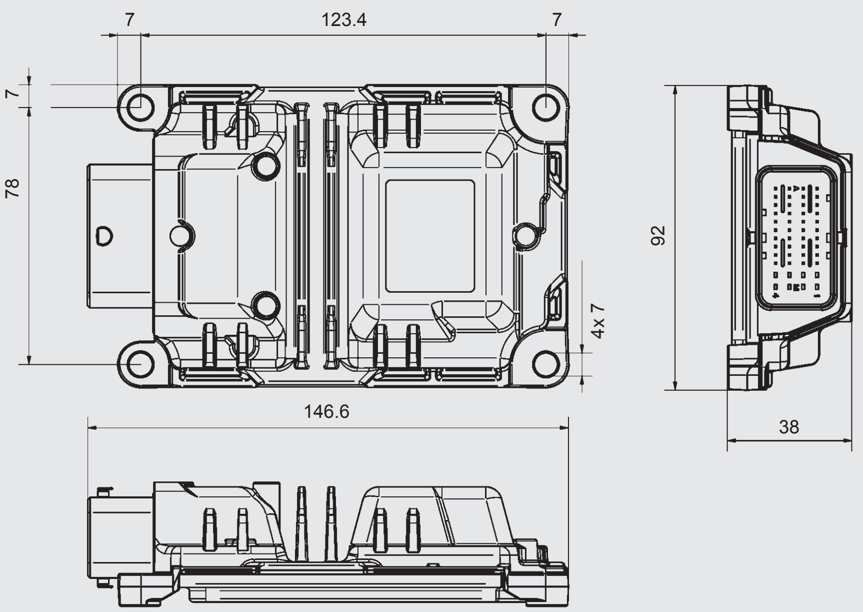
Equipment options
00 = standard

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.

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Subject to technical modifications.

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Universal Compact I/O Expansion Module
HY-TTC 30X-O

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

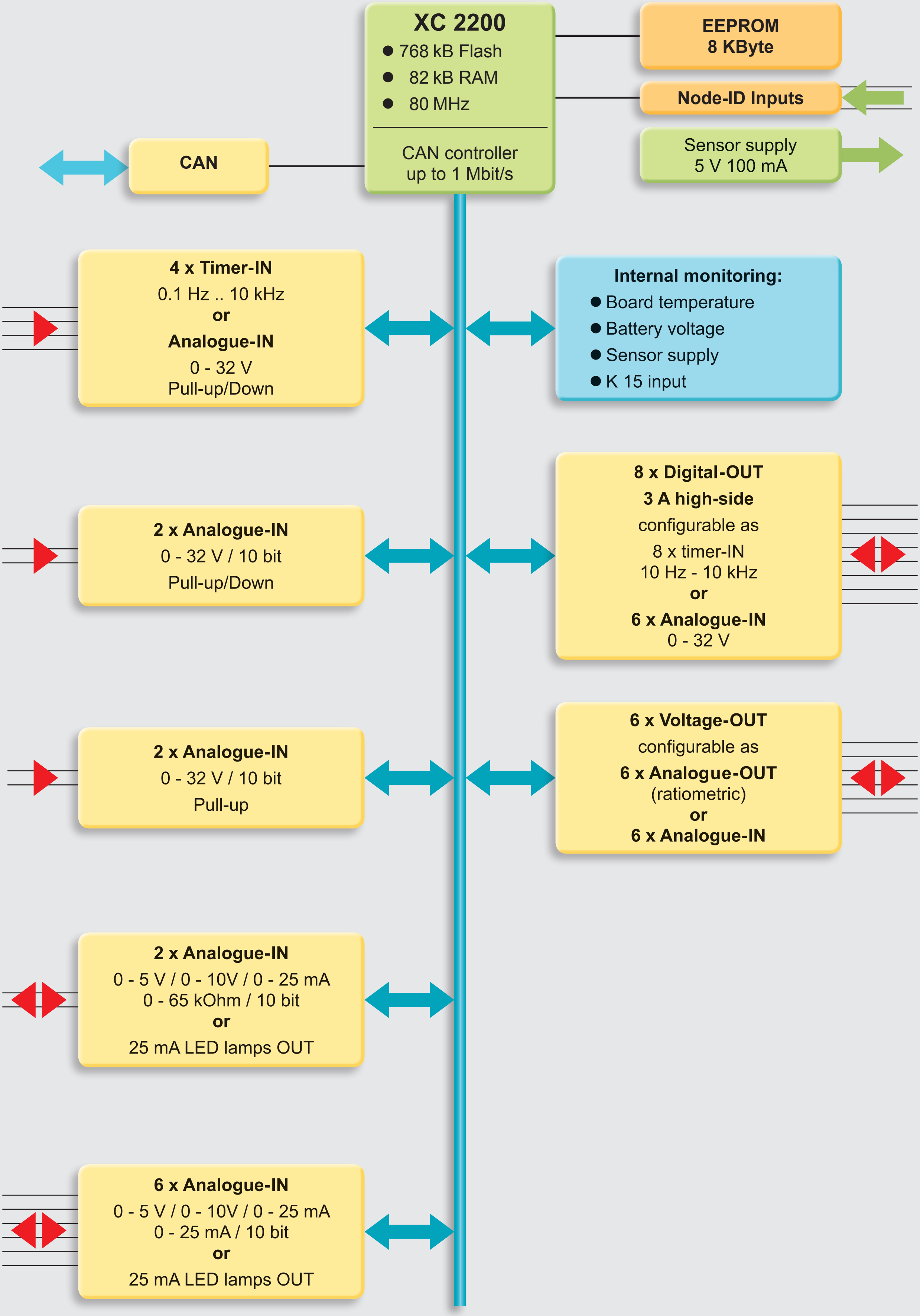
Technical data

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	
CE 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
Protection class	EN 60529 IP 67 / ISO 20653 IP 6K9K
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[1)2)]	
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	
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 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	
OUT	
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_{Bat+} with 10 kOhm low-side load, configurable 15 % .. 85 % V_{Bat+} (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.

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

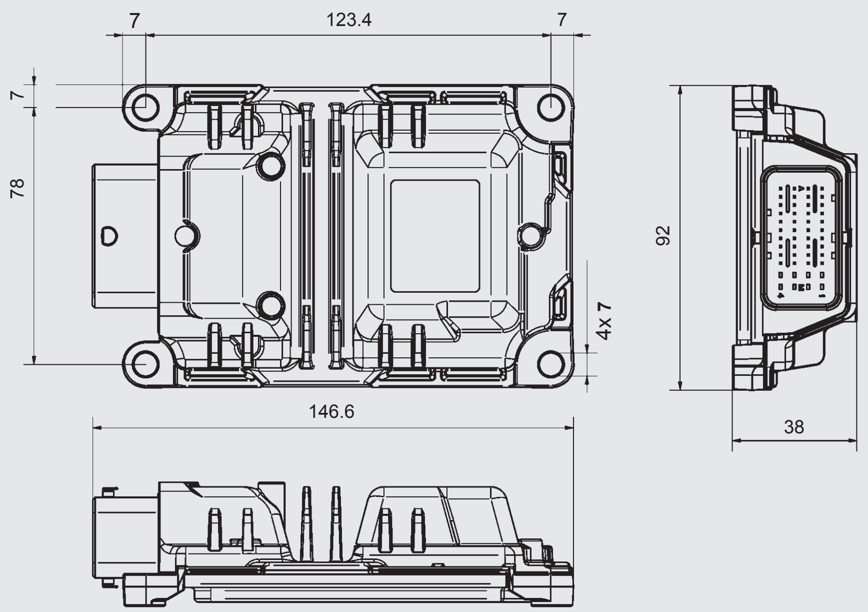
Equipment options
00 = standard

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



Note

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Universal Compact I/O Expansion Module
HY-TTC 30X-I

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	
CE 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
IP class	EN 60529 IP 67 / ISO 20653 IP 6K9K /
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[1)2)]	
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	
IN	
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	
2 x Analogue-IN 0 .. 32 V with configurable pull-up/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 configurable 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	
OUT	
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	
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, 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.

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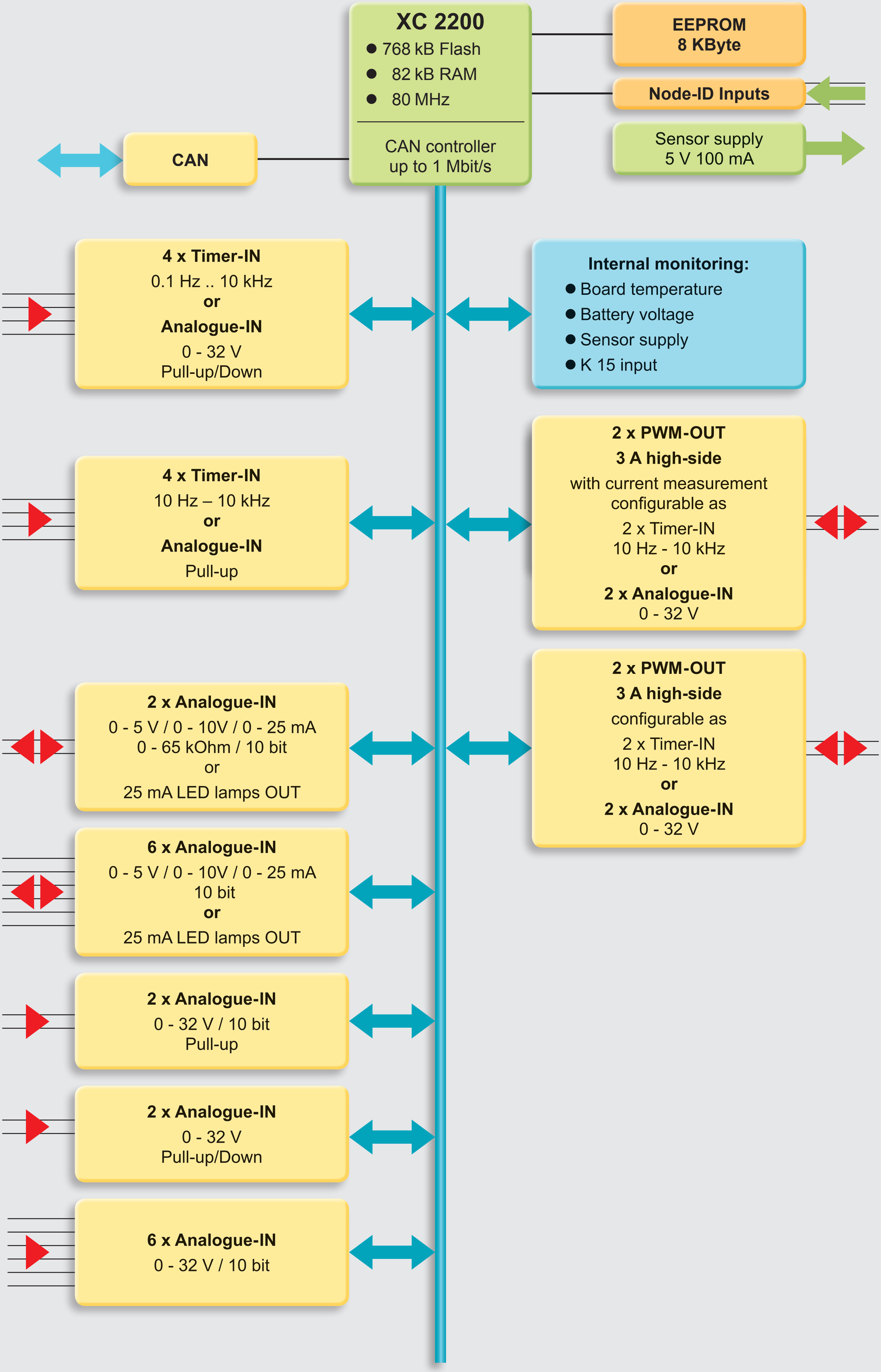
Block circuit diagram

HY-TTC 30X-I



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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

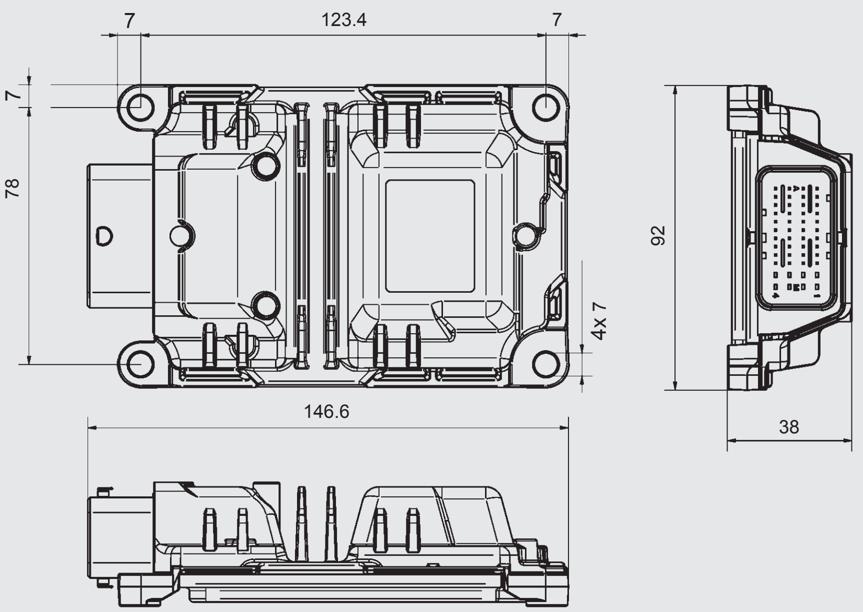
Note

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

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Subject to technical modifications.

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Universal Compact I/O Expansion Module
HY-TTC 30XS-H

Functional Safety
PL c

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

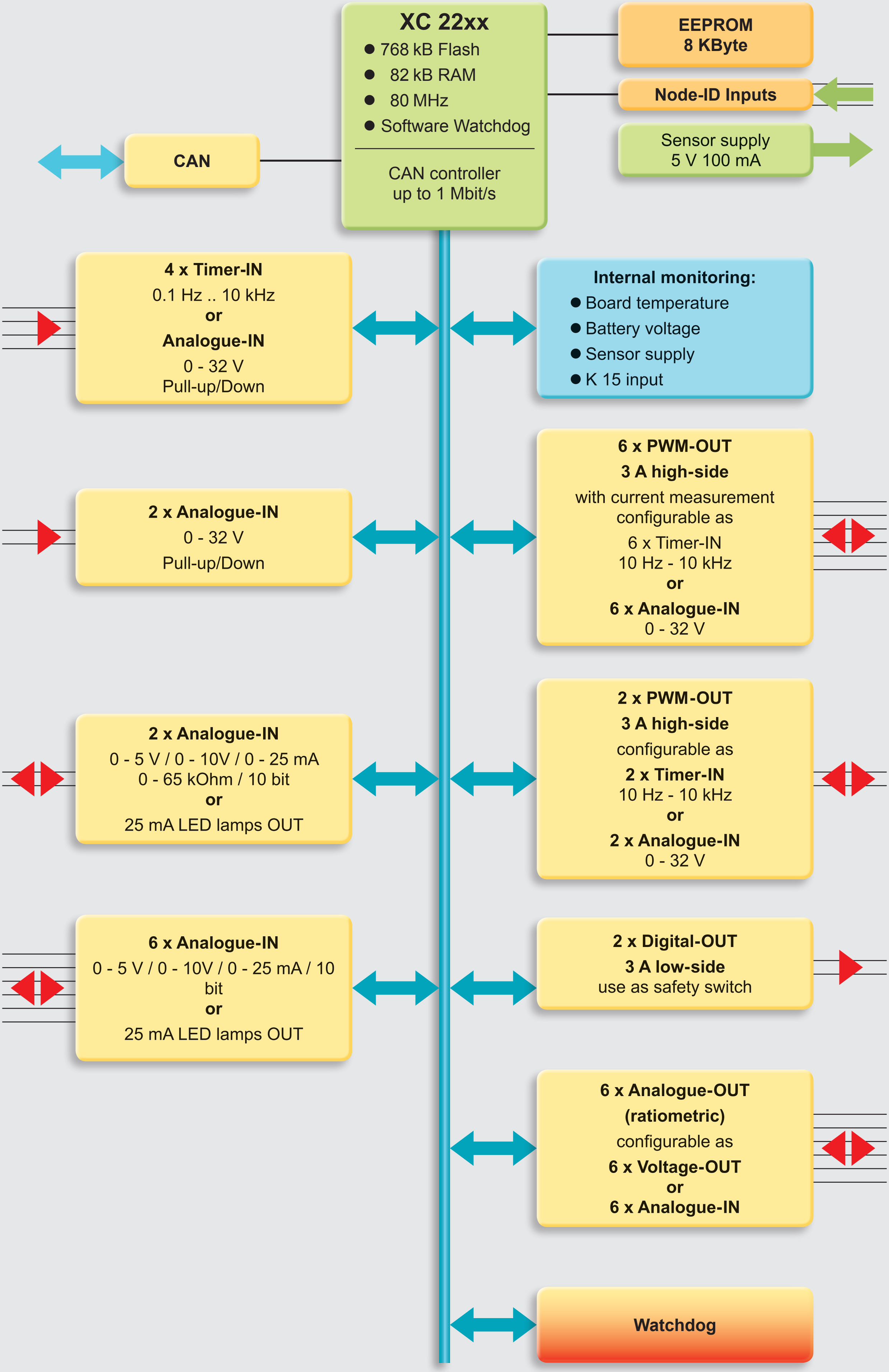
Technical data

Ambient conditions	
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	
CE 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
IP class	EN 60529 IP 67 / ISO 20653 IP 6K9K
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 94 x 39 mm
Weight	330 g
Features[1)2)3)4)]	
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	
IN	
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, 1 encoder, PL c capable	
OUT	
6 x PWM-OUT / Digital-OUT 3 A high-side, current measurement, 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[5)]	
6 x Analogue-OUT 15 % .. 85 % V_{Bat+} (ratiometric) configurable as 0 V .. 75 % 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.

Block circuit diagram

HY-TTC 30XS-H



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Model code

HY-TTC 30XS – H – F13 – 00 – Pc – 000

CAN protocol
F13 = CANopen safety slave

Equipment options
00 = standard

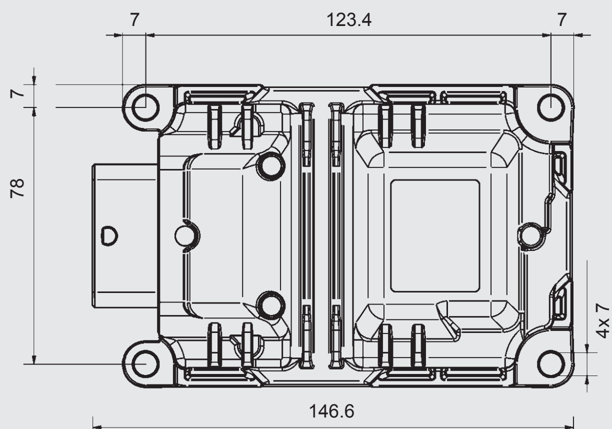
Functional safety
Pc = requirements for PL c

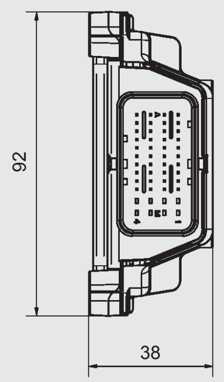
Modification number
000 = standard

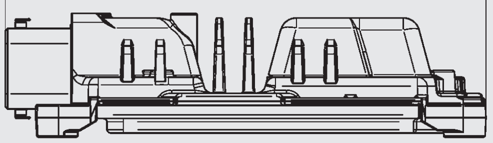
Note
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

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

Dimensions







Note

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Subject to technical modifications.

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Universal Compact I/O Expansion Module
HY-TTC 30XS-I

Functional Safety PL c

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

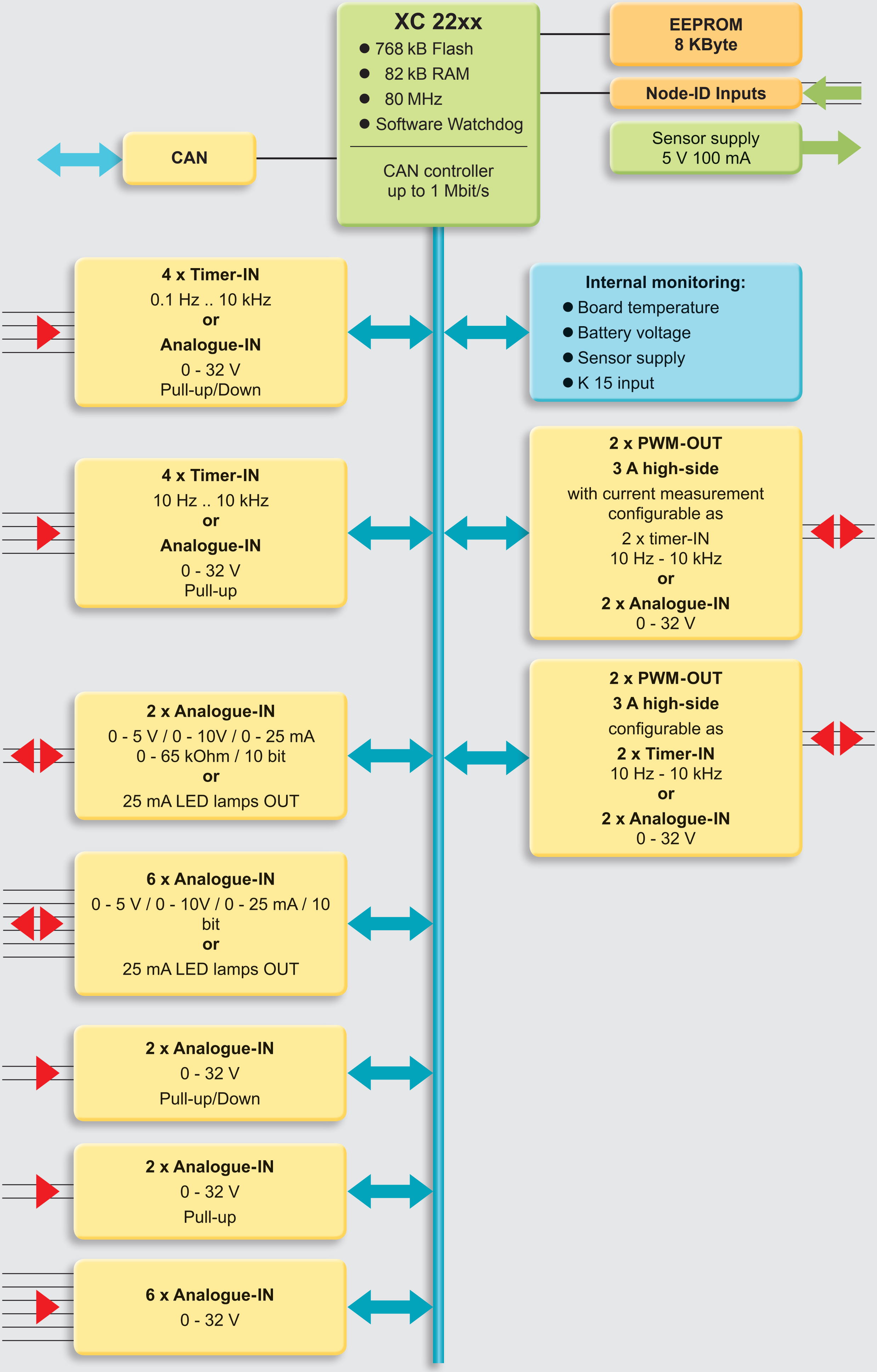
Technical data

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	
CE 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
IP class	EN 60529 IP 67 / ISO 20653 IP 6K9K
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[1)2)3)4)]	
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	
IN	
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	
OUT	
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 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.

Block circuit diagram

HY-TTC 30XS-I



3

Model code

HY-TTC 30XS – I – F13 – 00 – Pc – 000

CAN protocol
F13 = CANopen safety slave

Equipment options
00 = standard

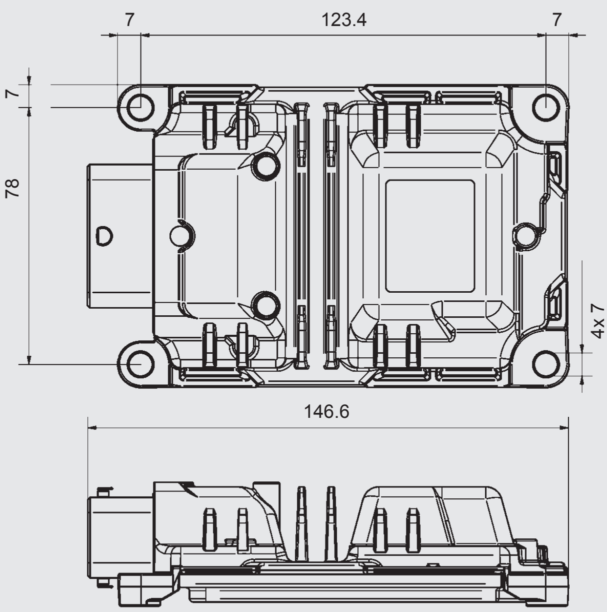
Functional safety
Pc = requirements for PL c

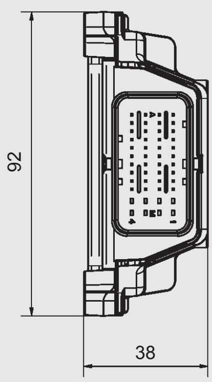
Modification number
000 = standard

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

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

Dimensions





Note

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Universal
I/O Expansion Module
HY-TTC 36X

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

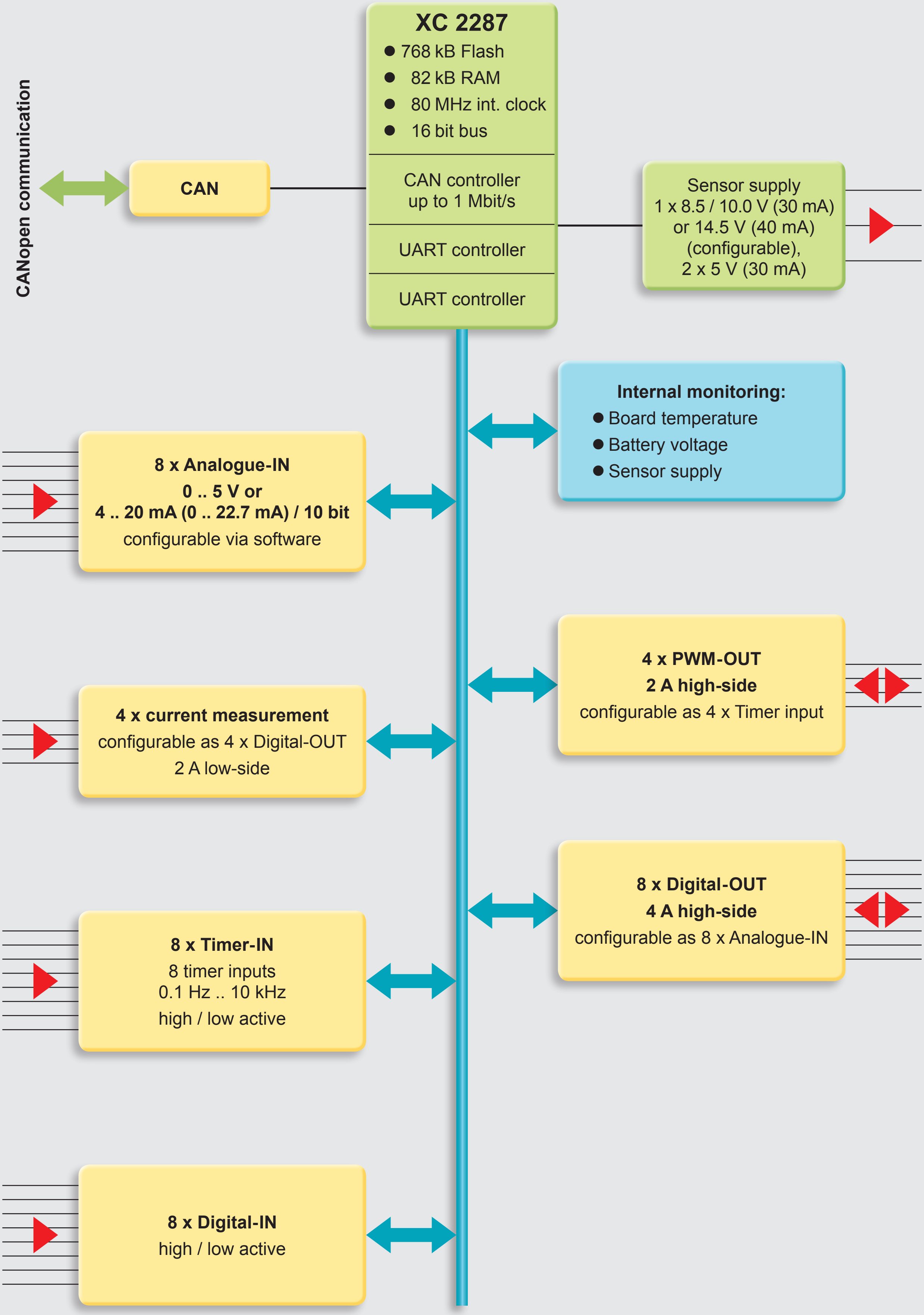
Technical data

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	
CE mark	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
IP class	EN 60529 IP 65 / IP 67 DIN 40050 IP 6k9k
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	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



Model code

HY-TTC 36X – F11 – 00 – 000

CAN protocol
F11 = CANopen

Equipment options
00 = standard

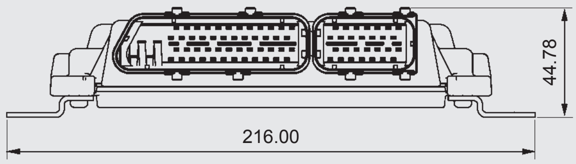
Modification number
000 = standard

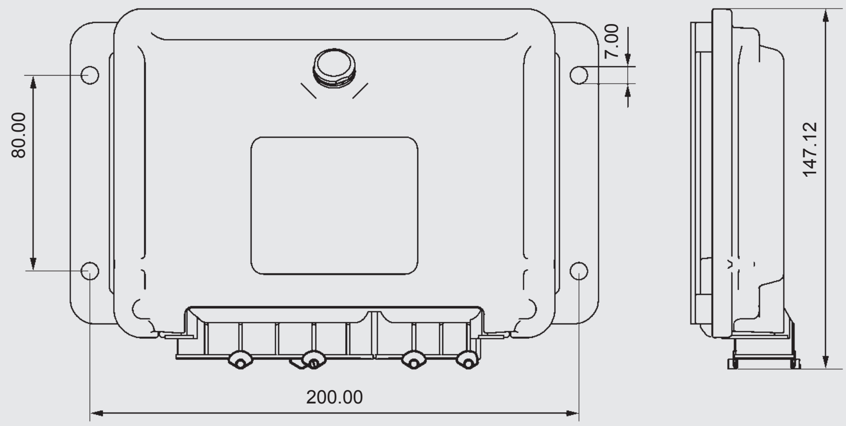
Note
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

Accessories
Appropriate accessories, such 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

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Subject to technical modifications.

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3

Universal I/O Expansion Module
HY-TTC 48X

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 .. +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	
CE mark	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
IP class	EN 60529 IP 65 / IP 67 DIN 40050 IP 6k9k
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 .. 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+.

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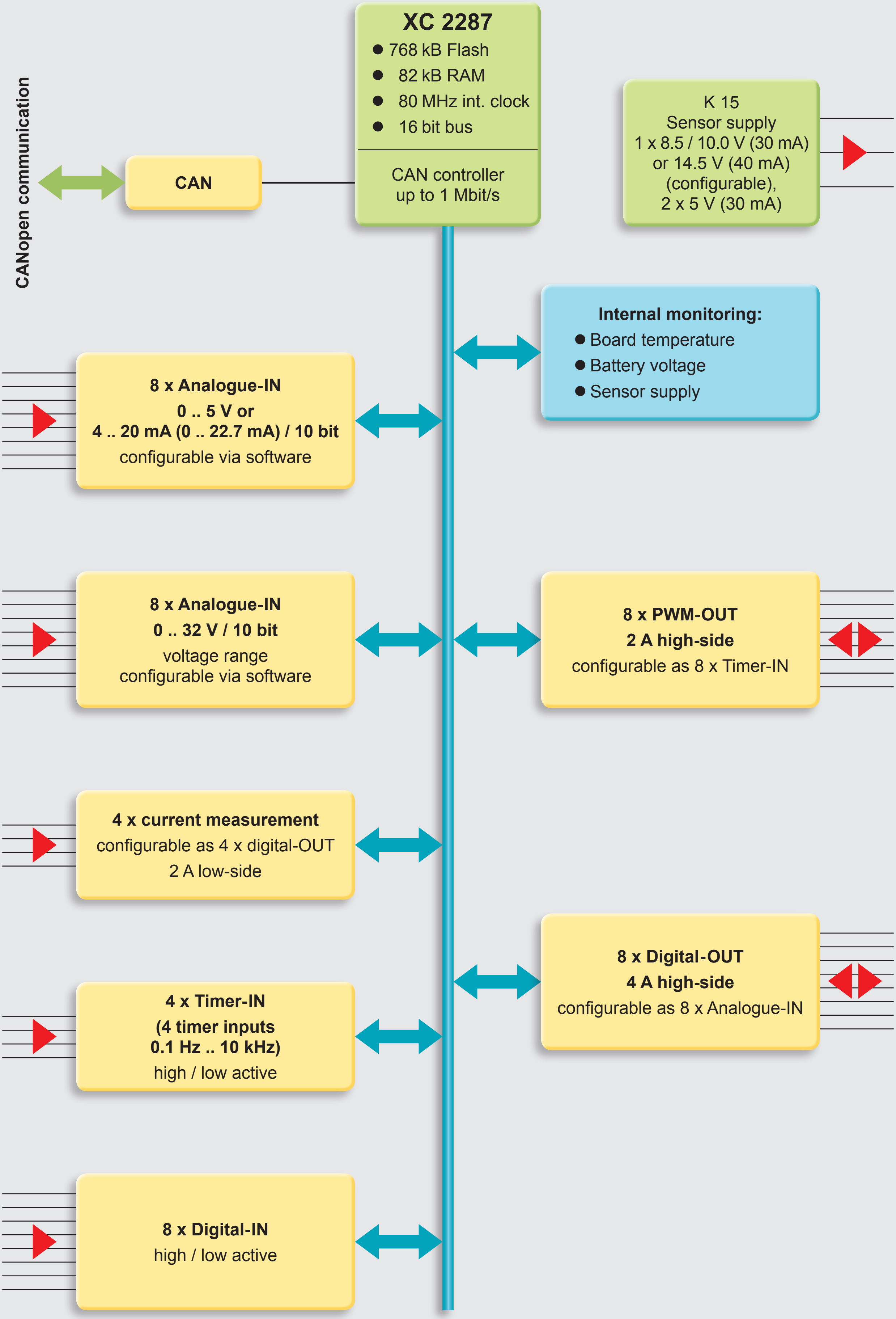
Block circuit diagram

HY-TTC 48X



3

Model code

HY-TTC 48X – F11 – 00 – 000

CAN protocol
F11 = CANopen

Equipment options
00 = standard

Modification number
000 = standard

Note

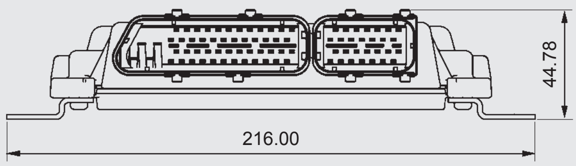
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

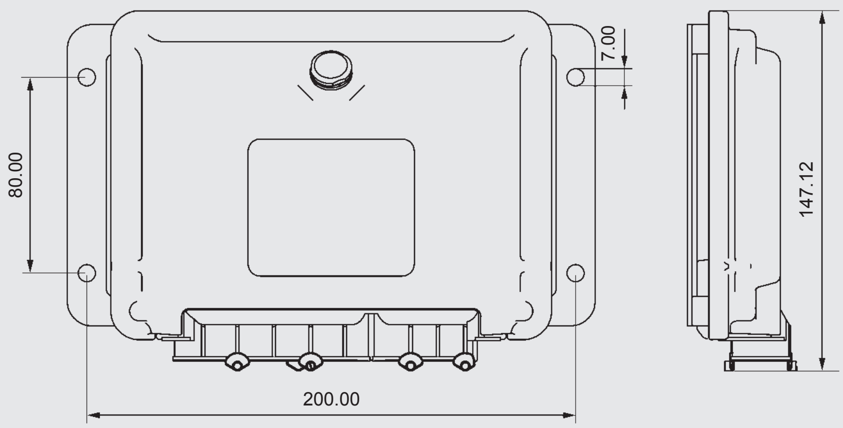
Accessories

Appropriate accessories, such 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





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Universal I/O Expansion Module HY-TTC 48XS

Functional Safety PL d

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

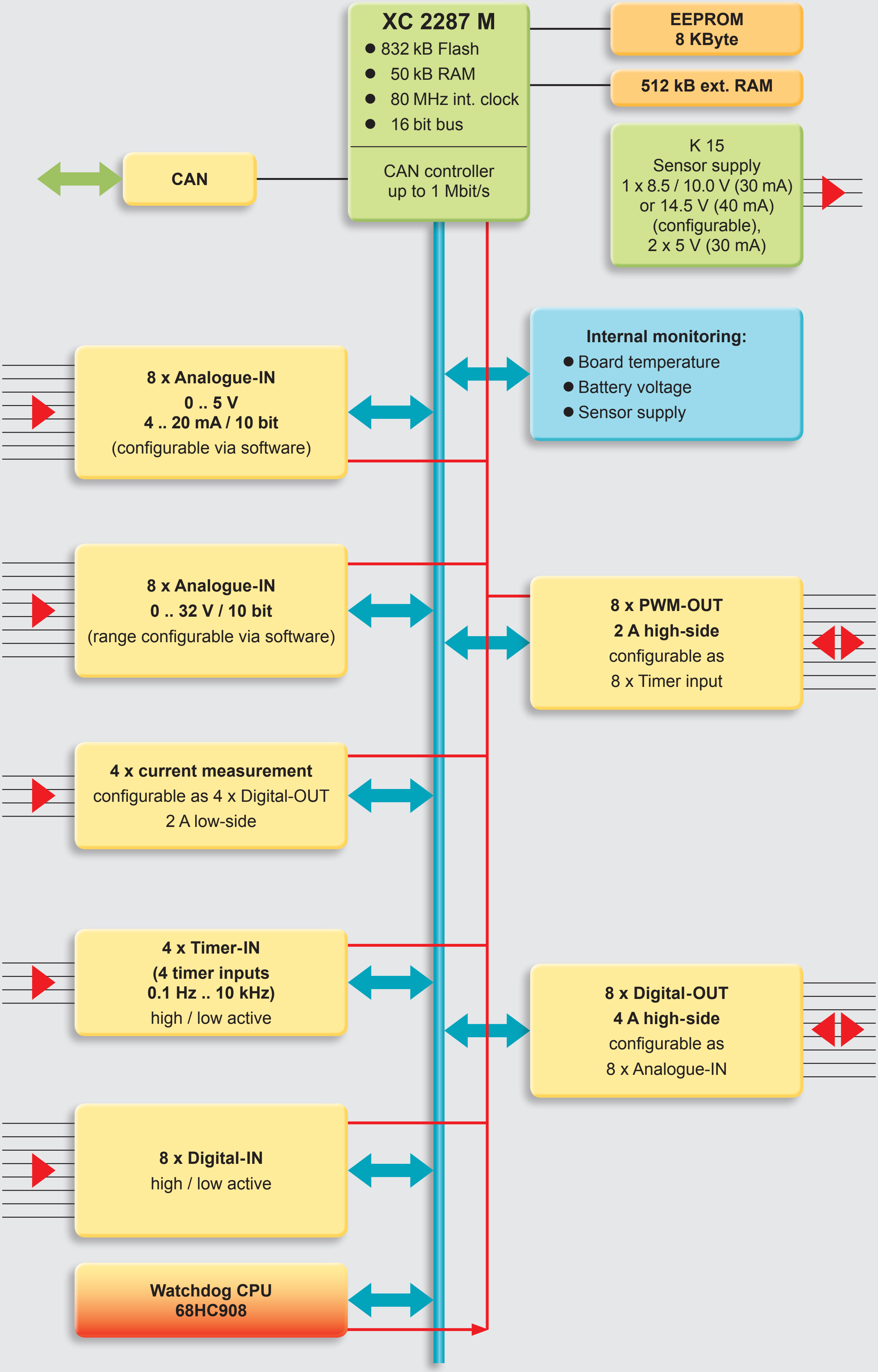
Ambient conditions	
Operating temperature	-40 .. +85 °C (with full load) to EN 60068-2
Operating altitude	0 .. 4,000 m
Supply voltage	8 .. 32 V
Permitted voltage drop	up to ≥ 4 V (U_{Bat}) without reset to ISO 7637-1 (for engine start in 12 V systems)
Peak voltage	45 V max. (1 ms)
Idle current	0.15 A max. at 9 V
Standby current	0.5 mA max.
Current consumption	25 A max. (complete voltage and temperature range)
Complies with the following standards	
CE mark	Compliant with 2004/108/EC
E-mark	ECE-R10 Rev.3
Functional safety	EN ISO 13849 PL d
EMC	ISO 13766 (up to 100 V/m, 20 MHz .. 1 GHz)
ESD	IEC 61000-4-2
Load dump	ISO 7637-2, 173V, 2 Ohm
IP class	EN 60529 IP 65 / IP 67 DIN 40050 IP 6k9k
Temperature	EN 60068-2-1; -14Nb; -2; -78; -30
Vibration, shock, bump	IEC 60068-2-29; -64; -27; -32
Communication profile	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



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

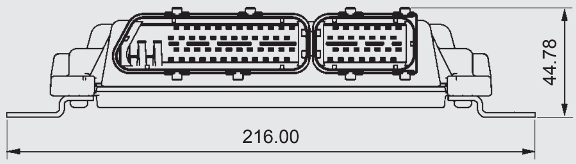
Modification number
000 = standard

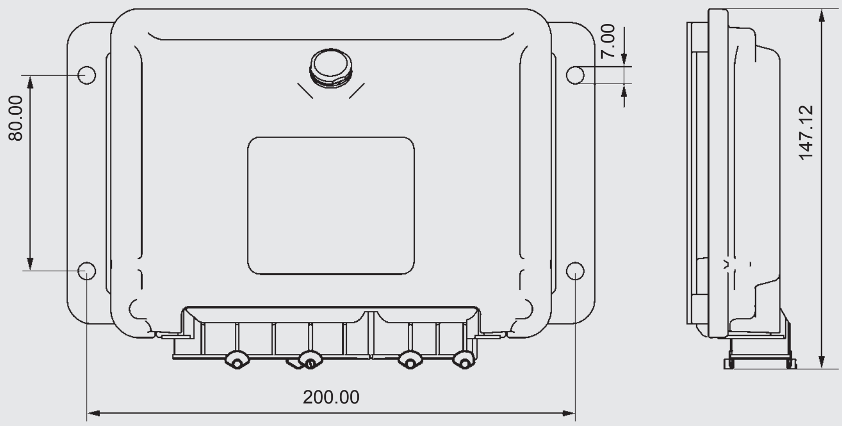
Note
On instruments with a different modification number, please read the label or the technical amendment details supplied with the instrument.

Accessories
Appropriate accessories, such 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





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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-eVision^2 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.

		
Type	**HY-eVision2 7.0**	**HY-eVision^2 10.4**
Processor	32 bit ARM Cortex A8 800 MHz	
Screen diagonal	7" (17.8 cm, 16:9)	10.4" (26 cm, 4:3)
Resolution (pixels)	800 x 480	1,024 x 768
Memory	1 GB Flash 512 MB RAM	1 GB Flash 512 MB RAM
Interfaces	2 x CAN (optional 4 x CAN) 1 x LAN 1 x RS232 1 x USB (Host) 2 x camera	4 x CAN 1 x LAN 1 x RS232 1 x USB (OTG) 2 x camera
Special features	Operating option: Standard or Touch Buzzer Ambient light sensor 10 function keys	Operating option: Standard-Touch or Polarised-Touch Buzzer Ambient light sensor 10 function keys
Programming	CODESYS® V3.5	CODESYS® V3.5

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.

Special features

- 7.0" monitor with large angle of view, high contrast ratio
- Programming in CODESYS® V3
- Display of PDF files, animations and videos, 3D capability
- 2 camera interfaces with picture-in-picture feature
- 2.5G modem and GPS module available as an option
- Real-time clock
- Sleep mode
- Operation possible in 12 V and 24 V systems
- Waterproof and dustproof IP 6K5 housing
- e12 type approval

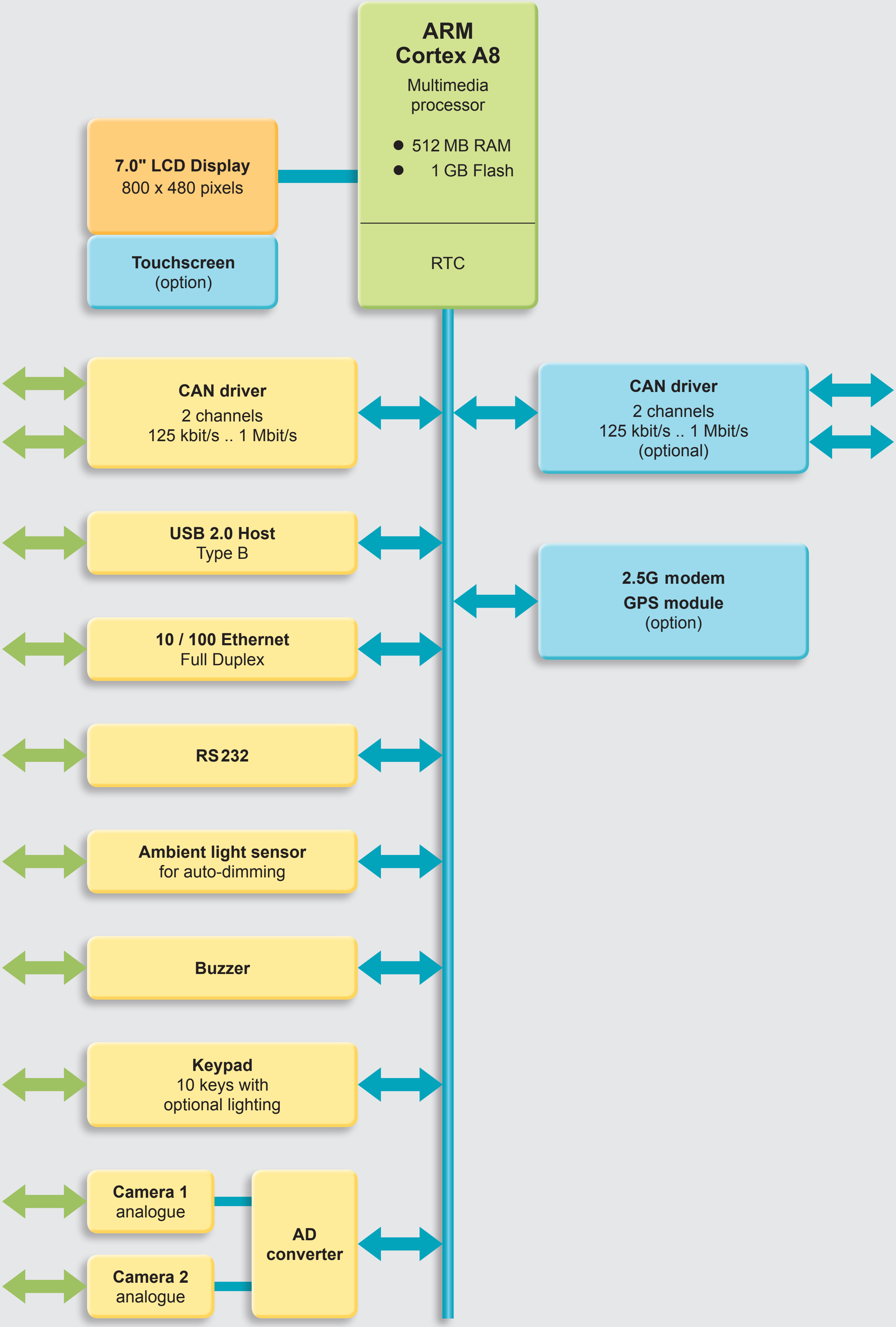
Technical data

Ambient conditions	
Operating temperature	-20 .. +60 °C
Storage temperature range	-30 .. +80 °C
Supply voltage	9 .. 32 V DC
Complies with the following standards	
CE 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+.

Block circuit diagram

HY-eVision² 7.0



4

E 18.511.2/11.14

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.

Note

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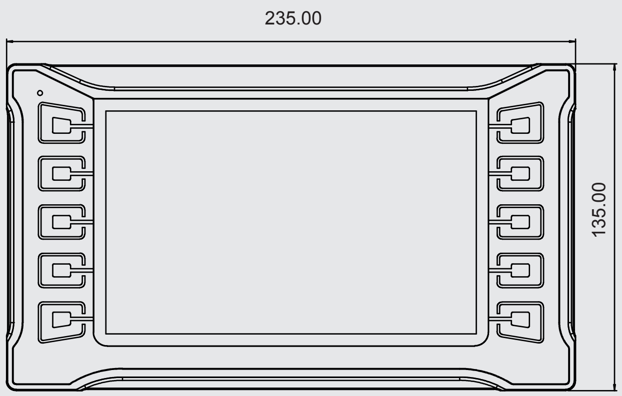
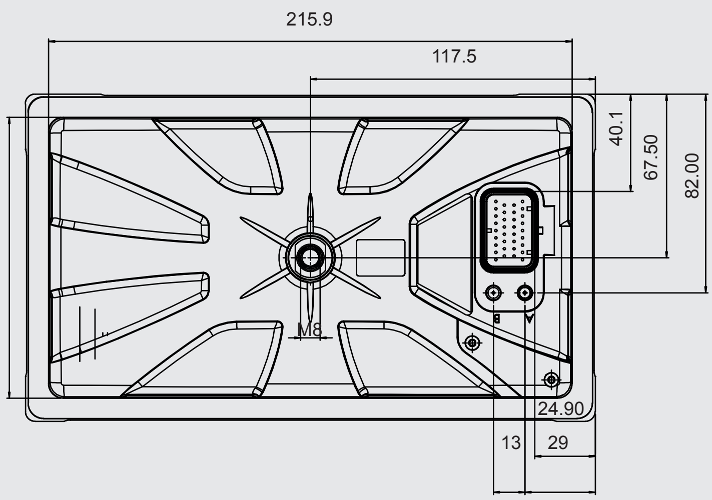
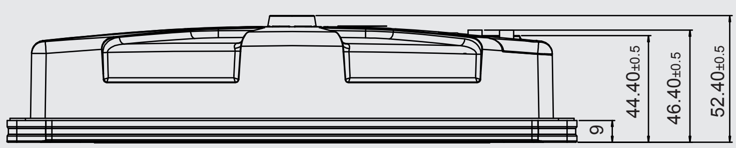
Dimensions







Universal Mobile Display with Integrated Controller
HY-eVision² 10.4

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

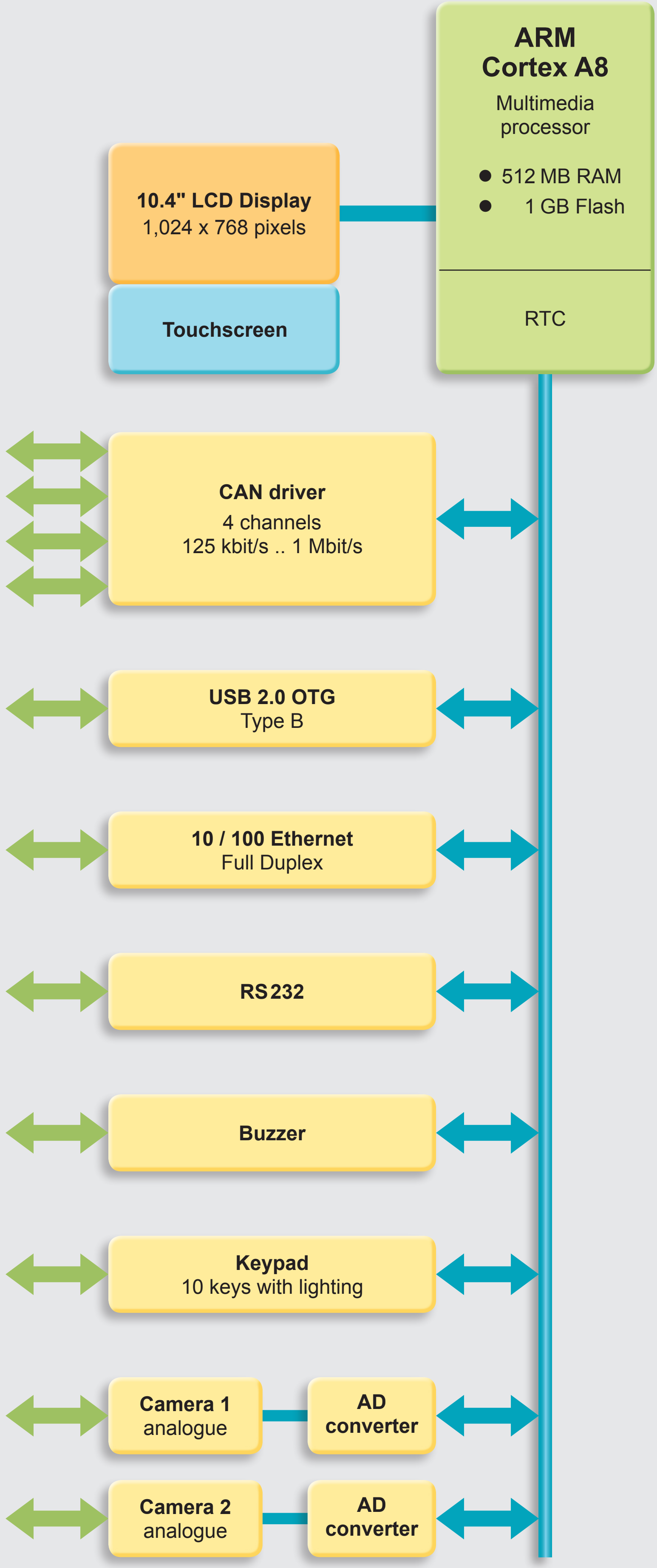
Technical data

Ambient conditions	
Operating temperature	-30 .. +60 °C
Storage temperature range	-30 .. +80 °C
Supply voltage	9 .. 32 V DC
Complies with the following standards	
CE mark	Compliant with 2004/108/EC
E-mark	ECE-R10 Rev.3
EMC	EN 13309
ESD	ISO 10605
Electrical	ISO 16750-2, ISO 7637-3
IP class	EN 6052 IP 65 / ISO 20653 IP6K5
Temperature	ISO 16750-4
Vibration, shock, bump	ISO 16750-3
Dimensions and weight	
Housing dimensions	280 x 232 x 62 mm
Housing material	Aluminium
Weight	2.5 kg
Display	
Screen diagonal	10.4" (26 cm) / 4:3 format
Pixels	1,024 x 768
Active area	210.4 mm x 157.8 mm
Pixel size	0.2055 mm x 0.2055 mm
Luminance	500 cd/m²
Viewing angle	Vertical: 88° / Horizontal: 88°
Contrast ratio	1,200:1
Reaction time	10 ms
LCD type	TFT (active matrix)
Touchscreen	Resistive
Backlight	LED
Life of backlight	≥ 50,000 h at +25 °C (continuous)
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 für CANopen Master	

Note: All external interfaces are protected against short circuit to GND and BAT+.

Block circuit diagram

HY-eVision² 10.4



Model code

HY-eVision² 10.4 – CD – P – R – 00 XX 03 – G – 000

Firmware
CD = CoDeSys® run-time system
for CoDeSys® 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.

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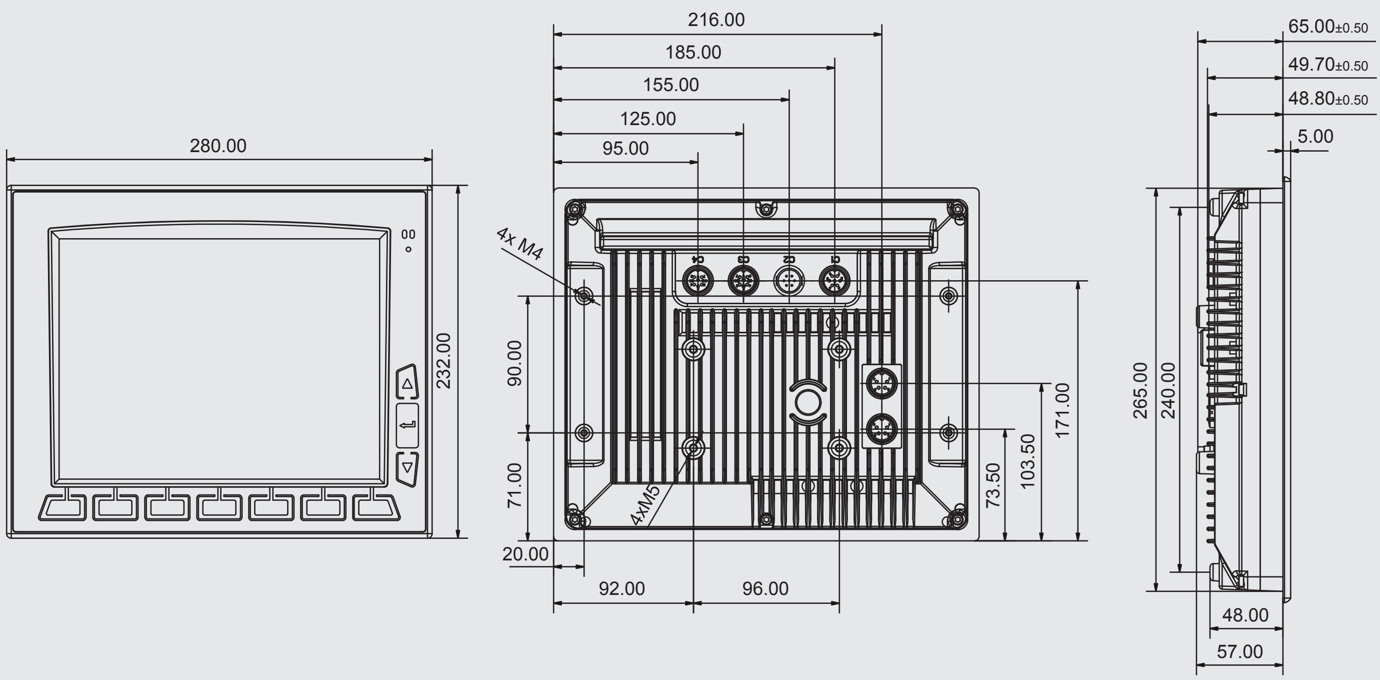
Dimensions



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

	Type	Part no.
	**ZBS AK-080-0.8-2s** Connection cable 80 cm and 80 Pins (28 + 52 pole, i.e. HY-TTC 50 / 60 / 90 / 94) with mating connector on both ends	**6127440**
	**ZBS AK-080-1.5-2s** Connection cable 150 cm and 80 Pins (28 + 52 pole, i.e. HY-TTC 50 / 60 / 90 / 94) with mating connector on both ends	**6127481**
	**ZBS AK-080-3.0-1s** Cable harness for HY-TTC 50 / 60 / 90 / 94 3 m flying lead with mating connector on one end	**6081986**
	**ZBS AK-080-3.0-1s-TTC77** Cable harness for HY-TTC 77 3 m flying lead with mating connector on one end	**6139188**

Cable harnesses for controllers

	Type	Part no.
	**ZBS AK-060-3.0-1s** HY-TTC 200 cable harness 60 pole 3 m flying lead **Note:** For full connection, both **ZBS AK-060-3.0-1s** and **ZBS AK-094-3.0-1s** are required.	**6081989**
	**ZBS AK-094-3.0-1s** HY-TTC 200 cable harness 94 pole 3 m flying lead **Note:** For full connection, both **ZBS AK-060-3.0-1s** and **ZBS AK-094-3.0-1s** are required.	**6081990**
	**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_{Bat} 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_{Bat} and K15 as well as a switch for K15 provide additional functionality. A useful accessory for commissioning and service.	**61499787**

5

Cable harnesses for I/O expansion modules

Type	Part no.
ZBS AK-048-3.0-1s HY-TTC 30X cable harness 48 pole 3 m flying lead	**6148656**
ZBS AK-080-3.0-1s Cable harness for HY-TTC 36X / 48X / 48XS	**6081986**

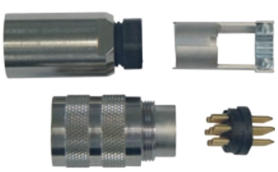
PCAN-Dongle

Type	Part no.
ZBS PCAN-USB	**on request**

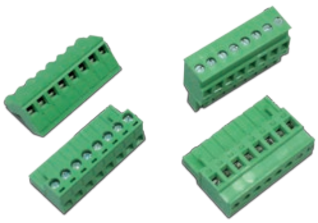
Cable harnesses for displays

Type	Part no.
	
ZBS AKV-015-1.0-2s HY-eVision² 10.4 Cable harness for power supply with USB	**6137851**
	
ZBS AKV-034-1.0-2s HY-eVision² 7.0 Cable harness for power supply with USB and camera connection	**6137854**
	
ZBS AKP-030-1.0-2s HY-eVision² 10.4 Programming cable harness	**922240**
	
ZBS AKP-034-1.0-2s HY-eVision² 7.0 Programming cable harness (2 CAN)	**922277**
ZBS AKP-034-1.0-2s-4CAN HY-eVision² 7.0 Programming cable harness (4 CAN)	**6158297**
	
ZBS AK-034-3.0-1s HY-eVision² 7.0 Cable harness 34 pole 3 m flying lead	**6127483**

Connectors

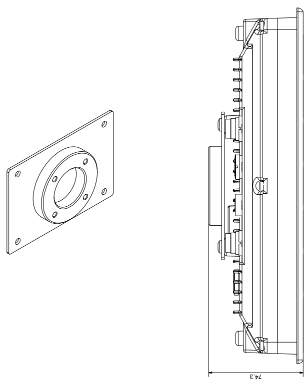
	Type	Part no.
	**ZBS AS-028** HY-TTC 50 series, connection kit 28 pole **Note:** The complete order includes: **ZBS AS-028** and **ZBS AS-052**	**6082667**
	**ZBS AS-052** HY-TTC 50 series, connection kit 52 pole **Note:** The complete order includes: **ZBS AS-028** and **ZBS AS-052**	**6082668**
	**ZBS AS-060** HY-TTC 200 and HY-Vision connection kit 60 pole **Note:** The complete order includes: **ZBS AS-060** and **ZBS AS-094**	**6091033**
	**ZBS AS-094** HY-TTC 200 and HY-Vision connection kit 94 pole **Note:** The complete order includes: **ZBS AS-060** and **ZBS AS-094**	**6091034**
	**ZBS AS-034** HY-eVision² 7.0 connection kit Pins are supplied	**6114948**
	**ZBS AS-030** HY-eVision² 10.4 connector	**6158298**
	**ZBS AS-048** HY-TTC 30 series, connection kit	**6158445**

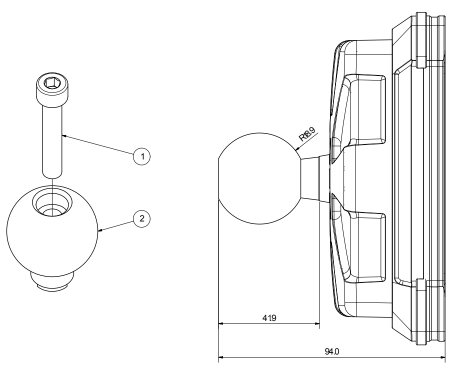
Connectors



Type	Part no.
ZBS MTB-AS-43 ECU connection block plug terminal for ZBS MTB-RACK Height 43	**on request**
ZBS MTB-AS-63 ECU connection block plug terminal for ZBS MTB-RACK Height 63	**on request**
ZBS RTB-AS-43 ECU connection block plug terminal for ZBS RTB-RACK Height 43	**on request**
ZBS RTB-AS-63 ECU connection block plug terminal for ZBS RTB-RACK Height 63	**on request**
ZBS-AS-058 HY-TTC 500 series, connection kit 58 pole	**6158449**
ZBS-AS-096 HY-TTC 500 series, connection kit 96 pole	**6158450**

Installation accessories





Type	Part no.
ZBS RM-10.4 RAM-Mount; mounting bracket for HY-eVision² 10.4	**6137801**
ZBS RM-07.0 RAM-Mount; mounting bracket for HY-eVision² 7.0	**6137777**

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 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

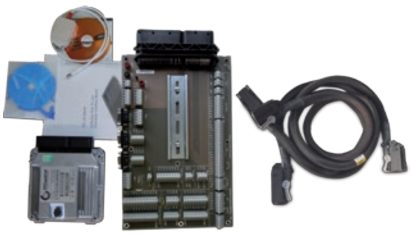
Starter kit for I/O expansions

- 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®

Type	Part no.
HY-TTC 50 CODESYS® Starter kit	**on request**
HY-TTC 60 CODESYS® Starter kit	**922197**
HY-TTC 90 CODESYS® Starter kit	**922169**
HY-TTC 94 CODESYS® Starter kit	**923617**
HY-TTC 200 CODESYS® Starter kit	**921138**
HY-TTC 540 CODESYS® Starter kit	**924366**
HY-TTC 580 CODESYS® Starter kit	**924149**

Starter kits for C programming



Type	Part no.
HY-TTC 50 C Starter kit	**on request**
HY-TTC 60 C Starter kit	**924181**
HY-TTC 90 C Starter kit	**on request**
HY-TTC 94 C Starter kit	**924178**
HY-TTC 200 C Starter kit	**924177**
HY-TTC 540 C Starter kit	**924365**
HY-TTC 580 C Starter kit	**924105**
HY-TTC 30-H C Starter kit	**924146**
HY-TTC 30S-H C Starter kit	**924150**

Starter kits for I/O expansions

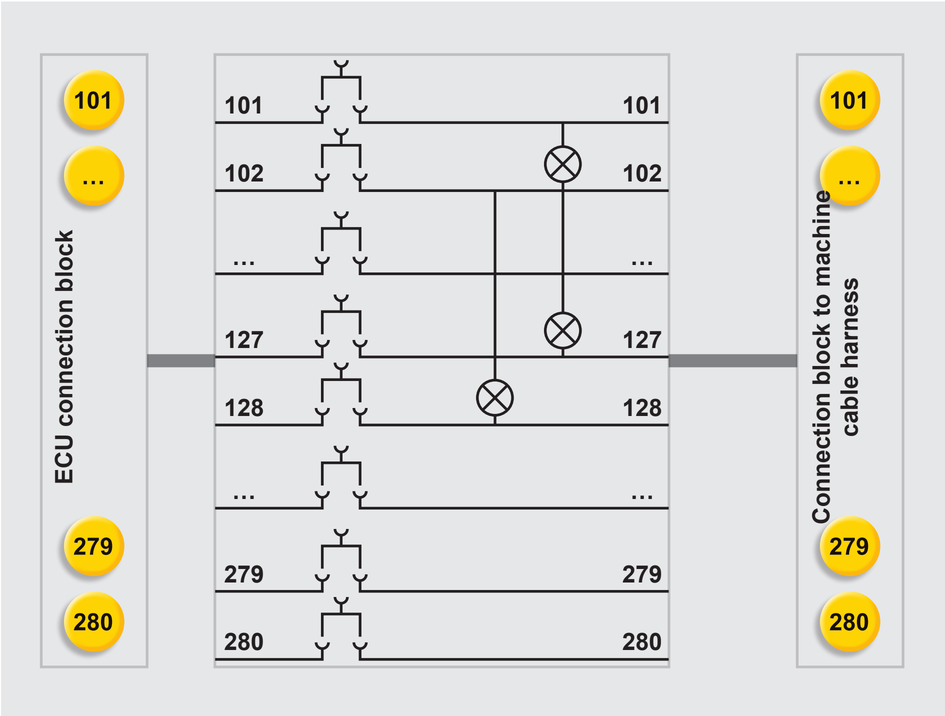
Type	Part no.
HY-TTC 30X-H-Starter kit	**924142**
HY-TTC 30XS-H-Starter kit	**924148**

JTAG adapters

	Type	Part no.
	**ZBS JTAG-01** TTC50FAM JTAG Adapter Board For HY-TTC 50 / 60 / 90 / 94 / 77	**6158299**
	**ZBS JTAG-02** JTAG Adapter Board For HY-TTC 200	**6158358**
	**ZBS JTAG-03** JTAG Adapter For HY-TTC 30x	**6158443**
	**ZBS JTAG-04** JTAG Adapter For HY-TTC 540 / 580	**6158360**

Break-Out Box (BOB)

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)

	Type	Part no.
	**ZBS BOB-K-080** Break-Out Box in carry case for HY-TTC 50 / 60 / 90 / 94 / 36X / 48X / 48XS	**6127439**
	**ZBS BOB-K-048** Break-Out Box in carry case for HY-TTC 30X series	**6156290**
	**ZBS BOB-TESTKIT-00-000** Test cables to supplement the Break-Out Boxes, consisting of cables and jumper plugs in 2 mm and 4 mm technology.	**on request**

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.

Manual Controller Test Rig Chassis (19" Rack)

ZBS MTB-RACK-43-VKG-A0-00-000
ZBS MTB-RACK-63-VKG-A0-00-000

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

Ambient conditions	
Power supply	230 V AC ±10%
Power consumption	max. 250 VA
Supply U_{Bat}	max. 90 A
Power dissipation	max. 960 W
Dimensions and weight	
Dimensions	450 x 550 x 280 mm (Rack 43) 450 x 817 x 280 mm (Rack 63)
Weight	approx. 17 kg (Rack 43) approx. 28 kg (Rack 63)

Model code

ZBS MTB-RACK – 43 – VKG – AO – 00 – 000

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

ZBS MTB-RACK – 63 – VKG – AO – 00 – 000

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

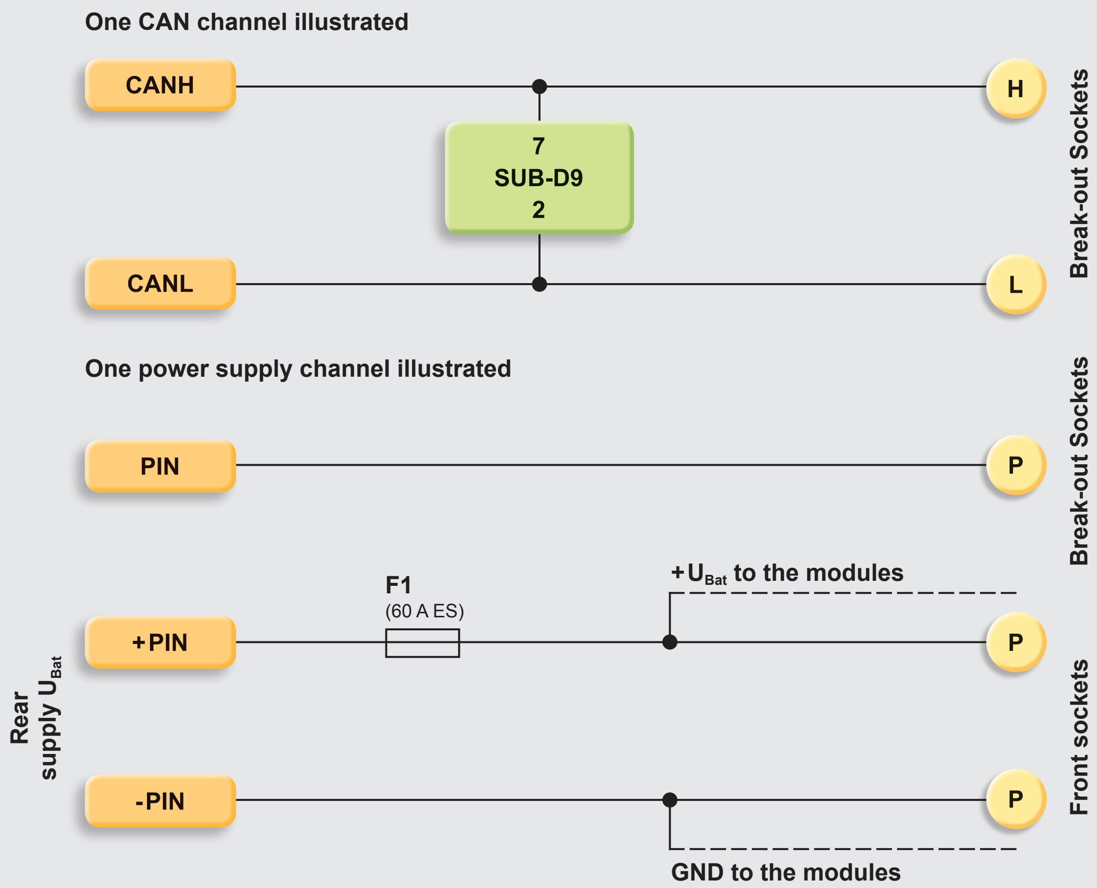
	0	1	2	3	4	5
2	Input or switch	Input or switch	Input or switch	Input or switch	Input or switch	Input, switch or CAN
	200 201 202 203	210 211 212 213	220 221 222 223	230 231 232 233	240 241 242 243	250 251 252 253
1	Input, switch or output	Input, switch or output	Input, switch or output	Input, switch or output	Input, switch or output	2x CAN 1x RS232 1x LIN
	100 101 102 103	110 111 112 113	120 121 122 123	130 131 132 133	140 141 142 143	150 151 152 153
0	Input, switch or output	Input, switch or output	Input, switch or output	Input, switch or output	Fuse Power-out	supply-pins
	000 001 002 003	010 011 012 013	020 021 022 023	030 031 032 033	040 041 042 043	050 051 052 053

ZBS MTB-RACK-63-VKG-A0-00-000

	0	1	2	3	4	5
7	Input or switch	Input or switch	Input or switch	Input or switch	Input or switch	Input, switch or CAN
	700 701 702 703	710 711 712 714	720 721 722 723	730 731 732 733	740 741 742 743	750 751 752 753
6	Input or switch	Input or switch	Input or switch	Input or switch	Input or switch	Input, switch or CAN
	600 601 602 603	610 611 612 613	620 621 622 623	630 631 632 633	640 641 642 643	650 651 652 653
5	Input, switch or output	Input, switch or output	Input, switch or output	Input, switch or output	Input, switch or output	Input, switch or CAN
	500 501 502 503	510 511 512 513	520 521 522 523	530 531 532 533	540 541 542 543	550 551 552 553
4	Input, switch or output	Input, switch or output	Input, switch or output	Input, switch or output	Input, switch or output	2x CAN 1x RS232 1x LIN
	400 401 402 403	410 411 412 413	420 421 422 423	430 431 432 433	440 441 442 443	450 451 452 453
3	Input, switch or output	Input, switch or output	Input, switch or output	Input, switch or output	Fuse Power-out	supply-pins
	300 301 302 303	310 311 312 313	320 321 322 323	330 331 332 333	340 341 342 343	350 351 352 353

Block circuit diagram

ZBS MTB-RACK-43-VKG-A0-00-000 / ZBS MTB-RACK-63-VKG-A0-00-000



Overview

Controller	Rack 4.3	Rack 6.3	MTB IN	MTB INSW	MTB OUT	Blind covers	Cable harness
HYTTC 50	1 x		4 x	2 x	6 x	3 x	ZBS AK-080-3.0-1s
HY-TTC 60	1 x		6 x	2 x	6 x	1 x	ZBS AK-080-3.0-1s
HY-TTC 90/94	1 x		6 x	2 x	6 x	1 x	ZBS AK-080-3.0-1s
HY-TTC 77		1 x	8 x	2 x	7 x	8 x	ZBS AK-080-3.0-1s-TTC77
HY-TTC 200		1 x	7 x	2 x	9 x	7 x	ZBS AK-154-3.0-1s-TTC200
HY-TTC 30X-H	1 x		4 x		4 x	7 x	ZBS AK-048-3.0-1s
HY-TTC 30X-I	1 x		7 x		1 x	7 x	ZBS AK-048-3.0-1s
HY-TTC 30X-O	1 x		4 x		4 x	7 x	ZBS AK-048-3.0-1s
HY-TTC 36X	1 x		5 x	2 x	3 x	5 x	ZBS AK-080-3.0-1s
HY-TTC 48X/48XS	1 x		6 x	2 x	4 x	3 x	ZBS AK-080-3.0-1s
HY-TTC 540		1 x	13 x		11 x	3 x	ZBS AK-154-3.0-1s
HY-TTC 580		1 x	11 x		13 x	3 x	ZBS AK-154-3.0-1s
HY-TTC 30-H	1 x		4 x		4 x	7 x	ZBS AK-048-3.0-1s
HY-TTC 30S-H	1 x		4 x		4 x	7 x	ZBS AK-048-3.0-1s
HY-TTC 30XS-H	1 x		4 x		4 x	7 x	ZBS AK-048-3.0-1s
HY-TTC 30XS-I	1 x		7 x		1 x	7 x	ZBS AK-048-3.0-1s

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.

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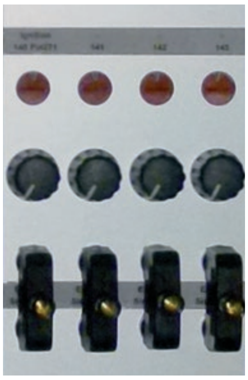


Universal Input Module for Manual Controller Test Rig
ZBS MTB-IN-00-000

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

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

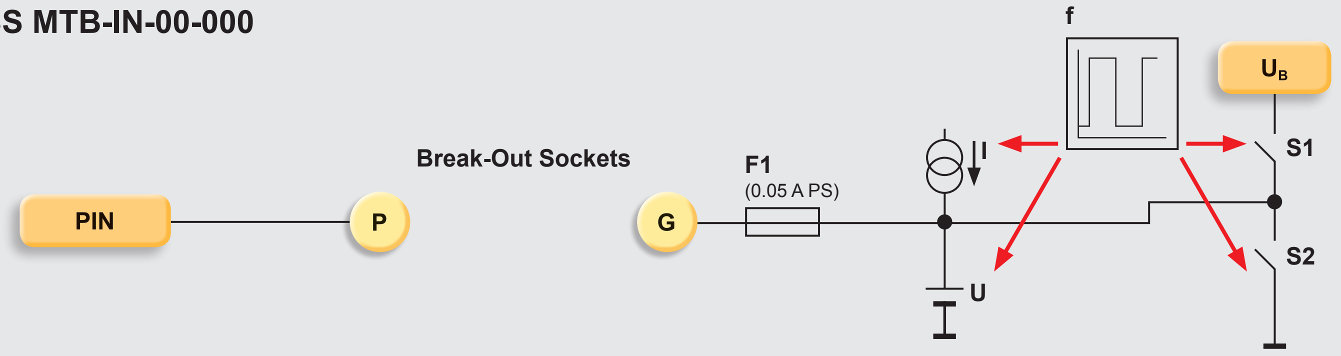
Functions	
Functions	0: switch low-side active (switching to GND)[1)] 1: switch high-side active (switching to $+U_{Bat}$)[1)] 2: rpm 1 Hz – 6.5 kHz low-side active[1)] 3: rpm 1 Hz – 6.5 kHz high-side active[1)] 4: current source 0..25 mA 5: voltage 0..5 V[1)] 6: voltage 0..16 V[1)] 7: voltage 0..32 V[1)] 8: dual voltage 0..5 V, slave-slot inverted[1)] 9: dual voltage 0.5..4.5 V, slave-slot inverted[1)] 10: dual voltage 0.5..4.5 V master, slave-slot 0.5..2.5 V (following)[1)] 11: dual current 0..25 mA, slave-slot inverted 12: dual rpm +/-1 Hz..2.0 kHz low-side active, slave signal with 90 °, phase shift (direction dependent)[1)] 13: dual rpm +/-1 Hz..2.0 kHz high-side active, slave signal with 90 °, phase shift (direction dependent)[1)] 14: dual switch master = HS, slave = HS inverted (switching to $+U_{Bat}$)[1)] 15: dual switch master = LS, slave = LS inverted (switching to GND)[1)]
Dimensions	
Dimensions	71 x 129 x 210 mm
Weight	285 g

Note: [1)] All voltages are limited to the rear voltage supply (Power Logic).

5

Block circuit diagram

ZBS MTB-IN-00-000



Model code

ZBS MTB – IN – 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.

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.

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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.

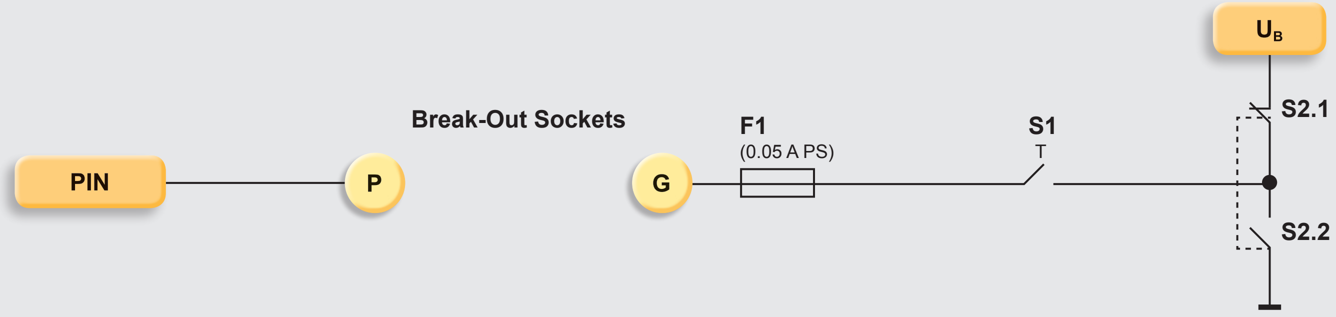
Technical data

Functions	
Functions	0: switch low-side active (switching to GND) 1: switch high-side active (switching to rear voltage supply [Power Logic Slot O])
Dimensions	
Dimensions	71 x 129 x 210 mm
Weight	250 g

5

Block circuit diagram

ZBS MTB-INSW-00-000



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
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Note

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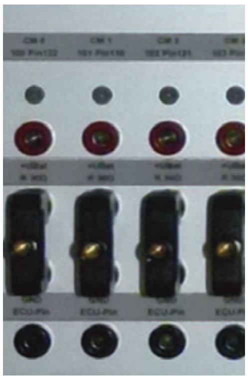


Universal Output Module for Manual Controller Test Rig
ZBS MTB-OUT-00-000

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.

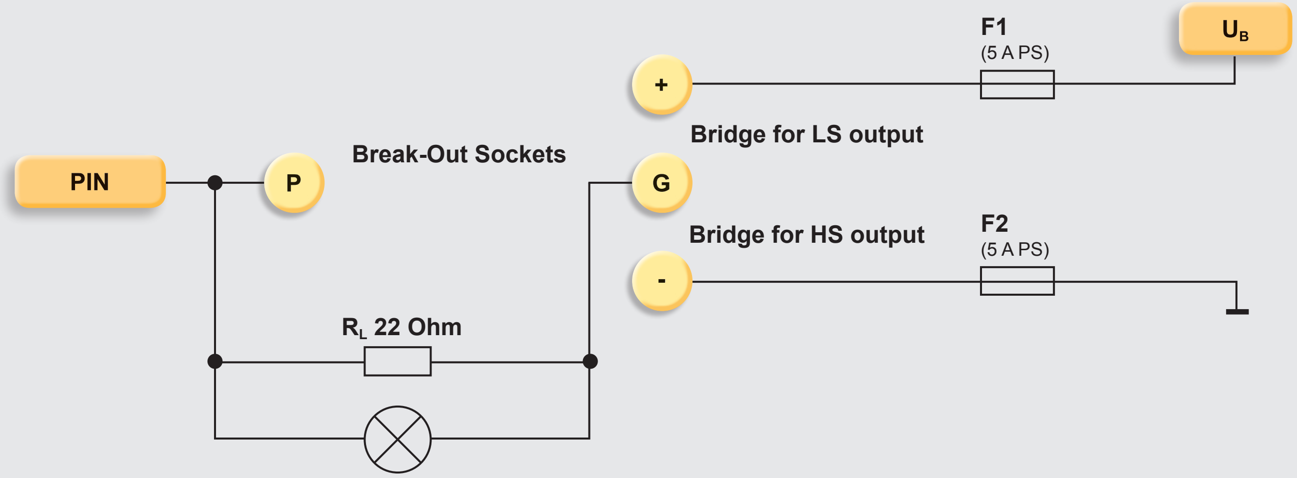
The real-time signal level can be measured at the Break-Out Plug. This jumper plug connects the pin of the controller with the electronics of the module. When disconnected, external actuator can also be directly connected to the controller.

Technical data

Functions	
Functions	1: Low side load (resistance 22 Ω to GND): jumper plug between R and GND 2: High-side load (resistance 22 Ω to $+U_{Bat}$): jumper plug between R and $+U_{Bat}$
Resistive load	22 Ω
Electronic fuse element 5 A for U_{Bat} and GND	
LED for status monitoring; ON for U_{out} > 9V	
Dimensions	
Dimensions	71 x 129 x 210 mm
Weight	270 g

Block circuit diagram for a slot (PIN)

ZBS MTB-OUT-00-000



Model code

ZBS MTB – OUT – 00 – 000

Equipment options
00 = standard

Modification number
000 = standard

Note
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Accessories
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Note

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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

Ambient conditions	
Power supply	230 V AC ±10 %
Power consumption	max. 250 VA
Supply U_{Bat}	90 A nominal current, 90 A peak current
Power dissipation	max. 960 W
Dimensions and weight	
Dimensions	450 x 550 x 280 mm (Rack 43) 450 x 817 x 280 mm (Rack 63)
Weight	approx. 17 kg (Rack 43) approx. 28 kg (Rack 63)

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

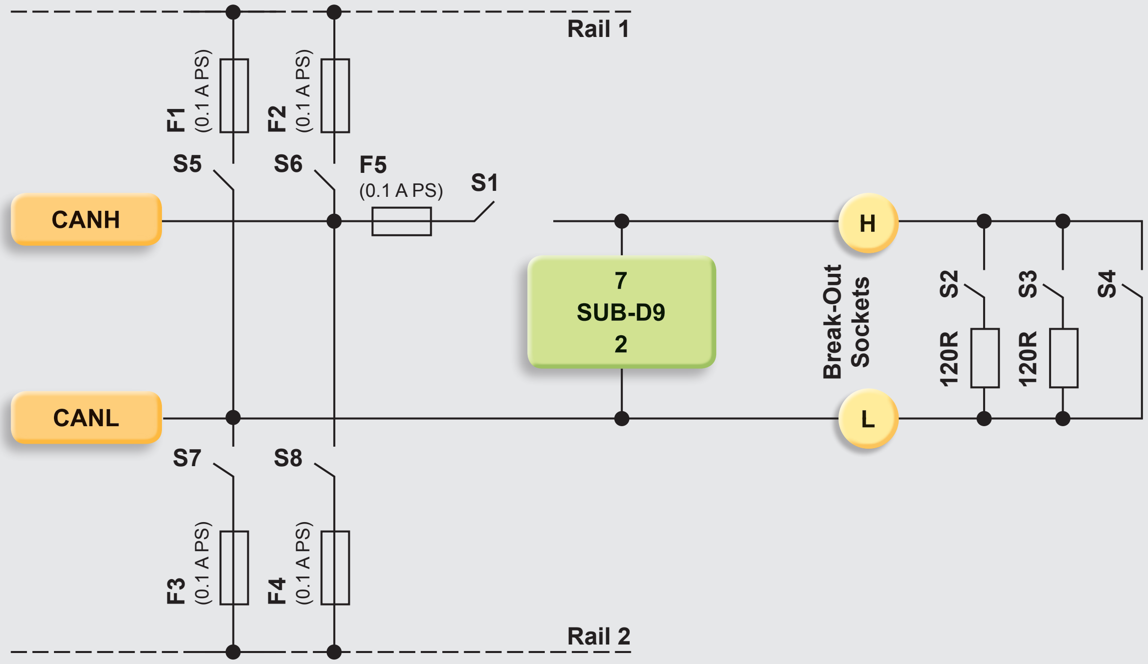
The sensor supply simulation module allows the sensor power supply supplied by the ECU to be tested. It is thus possible to measure the real-time voltage as well as the current. In addition different error signals can be switched.

Block circuit diagram

ZBS RTB-RACK-43-VGKS-A0-00-000
ZBS RTB-RACK-63-VGKS-A0-00-000

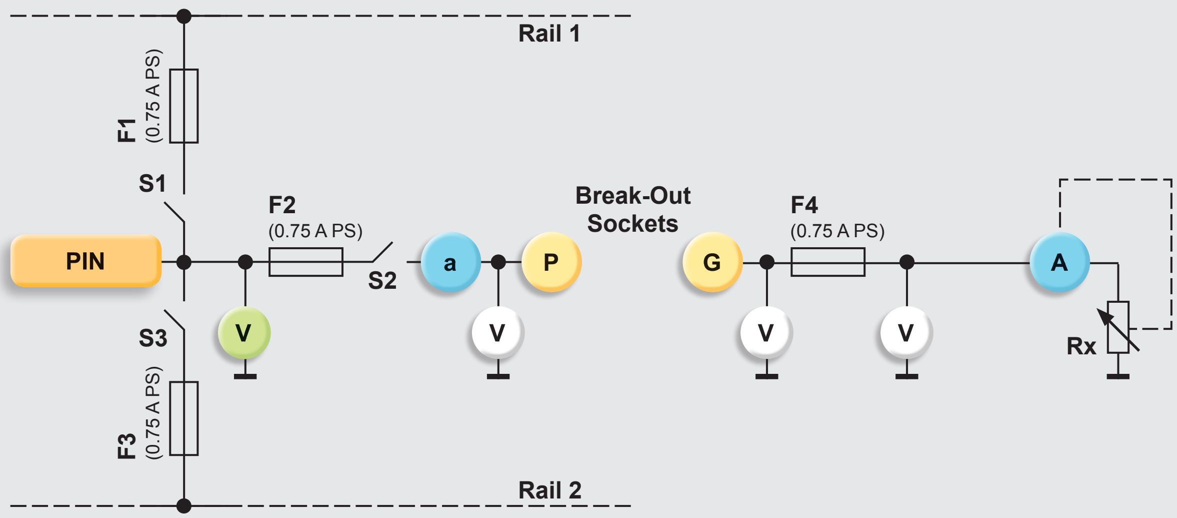
Communication module, permanently installed in RACK

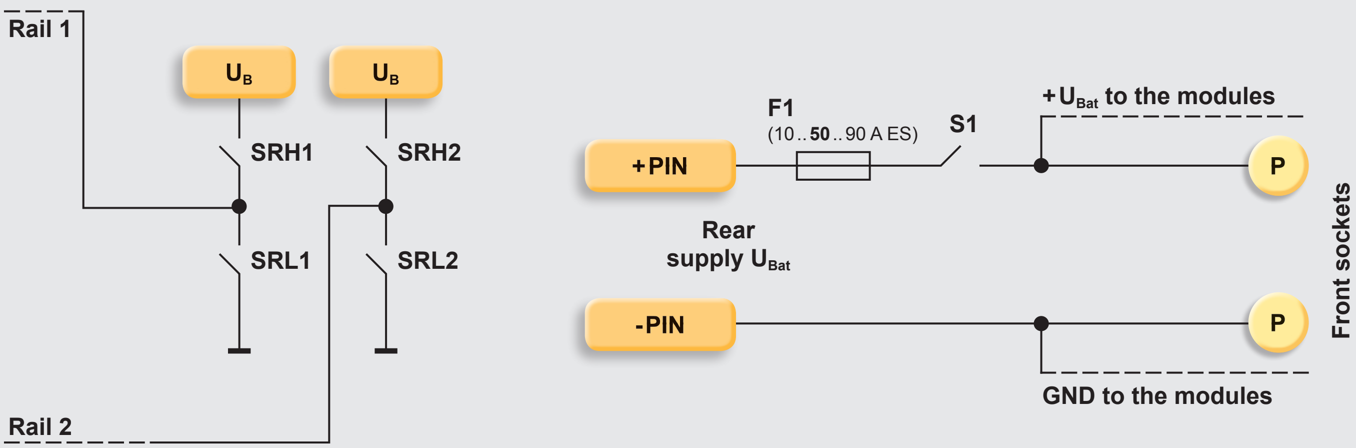
One CAN channel illustrated



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

	0				1				2				3				4				5			
2	Input or Output				Input or Output				Input or Output				Input or Output				Input or Output				Sensor Supply Simulation			
	200	201	202	203	210	211	212	213	220	221	222	223	230	231	232	233	240	241	242	243	250	251	252	253
1	Input or Output				Input or Output				Input or Output				Input or Output				Input or Output				2x CAN 1x RS232 1x LIN			
	100	101	102	103	110	111	112	113	120	121	122	123	130	131	132	133	140	141	142	143	150	151	152	153
0	Input or Output				Input or Output				Input or Output				Input or Output				Fuse Power-out				supply-pins			
	000	001	002	003	010	011	012	013	020	021	022	023	030	031	032	033	040	041	042	043	050	051	052	053

ZBS RTB-RACK-63-VGKS-A0-00-000

	0				1				2				3				4				5			
7	Input or Output				Input or Output				Input or Output				Input or Output				Input or Output				Input or CAN			
	700	701	702	703	710	711	712	714	720	721	722	723	730	731	732	733	740	741	742	743	750	751	752	753
6	Input or Output				Input or Output				Input or Output				Input or Output				Input or Output				Input or CAN			
	600	601	602	603	610	611	612	613	620	621	622	623	630	631	632	633	640	641	642	643	650	651	652	653
5	Input or Output				Input or Output				Input or Output				Input or Output				Input or Output				Sensor Supply Simulation			
	500	501	502	503	510	511	512	513	520	521	522	523	530	531	532	533	540	541	542	543	550	551	552	553
4	Input or Output				Input or Output				Input or Output				Input or Output				Input or Output				2x CAN 1x RS232 1x LIN			
	400	401	402	403	410	411	412	413	420	421	422	423	430	431	432	433	440	441	442	443	450	451	452	453
3	Input or Output				Input or Output				Input or Output				Input or Output				Fuse Power-out				supply-pins			
	300	301	302	303	310	311	312	313	320	321	322	323	330	331	332	333	340	341	342	343	350	351	352	353

Overview

Controller	Rack 4.3	Rack 6.3	RTB IN	RTB OUT	Blind covers	Cable harness
HYTTC 50	1 x		6 x	6 x	2 x	ZBS AK-080-3.0-1s
HY-TTC 60	1 x		8 x	6 x		ZBS AK-080-3.0-1s
HY-TTC 90/94	1 x		8 x	6 x		ZBS AK-080-3.0-1s
HY-TTC 77		1 x	10 x	7 x	9 x	ZBS AK-080-3.0-1s-TTC77
HY-TTC 200		1 x	9 x	9 x	8 x	ZBS AK-154-3.0-1s-TTC200
HY-TTC 30X-H	1 x		4 x	4 x	6 x	ZBS AK-048-3.0-1s
HY-TTC 30X-I	1 x		7 x	1 x	6 x	ZBS AK-048-3.0-1s
HY-TTC 30X-O	1 x		4 x	4 x	6 x	ZBS AK-048-3.0-1s
HY-TTC 36X	1 x		7 x	3 x	4 x	ZBS AK-080-3.0-1s
HY-TTC 48X/48XS	1 x		8 x	4 x	2 x	ZBS AK-080-3.0-1s
HY-TTC 540		1 x	13 x	11 x	2 x	ZBS AK-154-3.0-1s
HY-TTC 580		1 x	11 x	13 x	2 x	ZBS AK-154-3.0-1s
HY-TTC 30-H	1 x		4 x	4 x	6 x	ZBS AK-048-3.0-1s
HY-TTC 30S-H	1 x		4 x	4 x	6 x	ZBS AK-048-3.0-1s
HY-TTC 30XS-H	1 x		4 x	4 x	6 x	ZBS AK-048-3.0-1s
HY-TTC 30XS-I	1 x		7 x	1 x	6 x	ZBS AK-048-3.0-1s

Note

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Subject to technical modifications.

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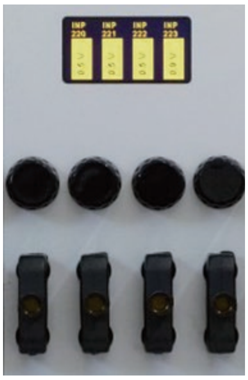


Universal Input Module for RTB
ZBS RTB-IN-00-000

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.

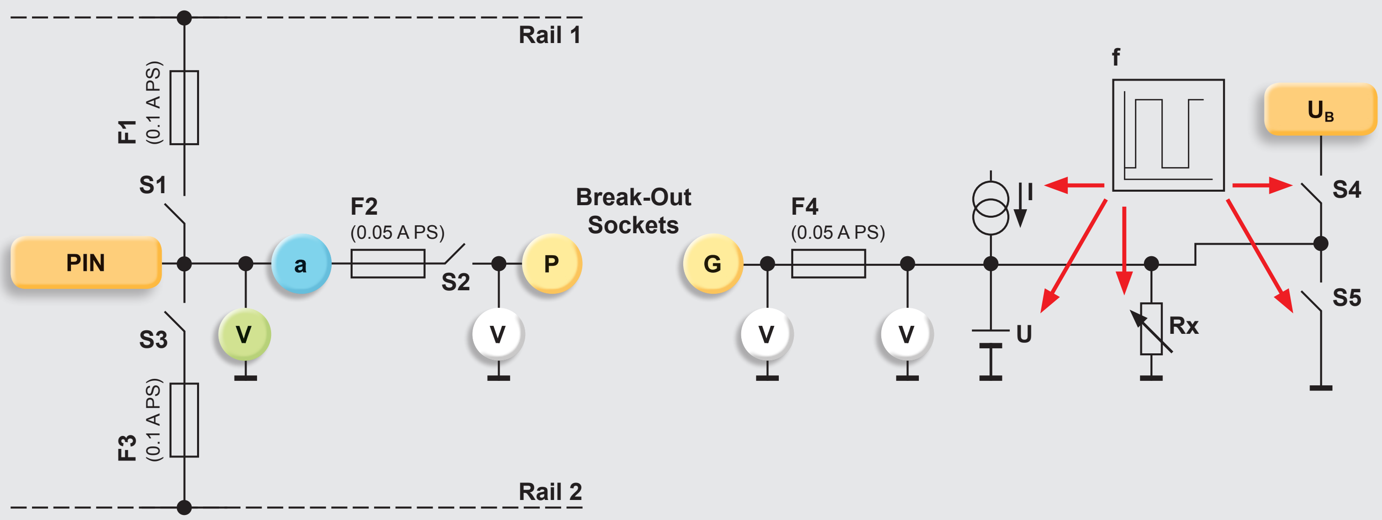
When disconnected, external signals or actuators can also be directly connected to a controller pin.

Technical data

Functions	
Voltage source	0 .. 36.0 V
Current source	0 .. 25.5 mA
Resistance	38 Ω .. 50 kΩ
High-side switch to $+U_B$	
Low-side switch to GND	
High-side rpm	1 .. 24,000 min^{-1}, 0.1 .. 24,000 min^{-1} for remote control
Low-side rpm	1 .. 24,000 min^{-1}, 0.1 .. 24,000 min^{-1} for remote control
High-side-PWM	0.1 .. 99.9 % for 1 .. 24,000 Hz, 0.1 .. 24,000 min^{-1} for remote control
Low-side PWM	0.1 .. 99.9 % bei 1 .. 24,000 Hz, 0.1 .. 24,000 min^{-1} for remote control
Bosch-ABS sensor	1 .. 550 Hz
Short circuit to Rail1 or Rail2	
Wirebreak	
“Master-slave” mode	Dual Switch Master = HS, Slave = HS following Dual Switch Master = HS, Slave = HS inverted Dual Switch Master = LS, Slave = LS following Dual Switch Master = LS, Slave = LS inverted Dual Switch Master = HS, Slave = LS following Dual Switch Master = HS, Slave = LS inverted Dual Switch Master = LS, Slave = HS following Dual Switch Master = LS, Slave = HS inverted Dual Voltage Slave-Slot following (factor = 0.5) Dual Voltage Slave-Slot inverted Dual Current Slave-Slot following (factor = 0.5) Dual Current Slave-Slot inverted Incremental encoder HS 1 .. .. 24,000 min^{-1}, 0.1 .. 24,000 min^{-1} for remote control Incremental encoder LS 1 .. 24,000 min^{-1}, 0.1 .. 24,000 min^{-1} for remote control Incremental encoder Voltage 1 .. 4,000 Hz, 0.1 .. 4,000 Hz for remote control **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_{Bat}.
Dimensions and weight	
Dimensions	71 x 129 x 210 mm
Weight	290 g

Block circuit diagram

ZBS RTB-IN-00-000



Model code

ZBS RTB – IN – 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.

Note

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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 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.

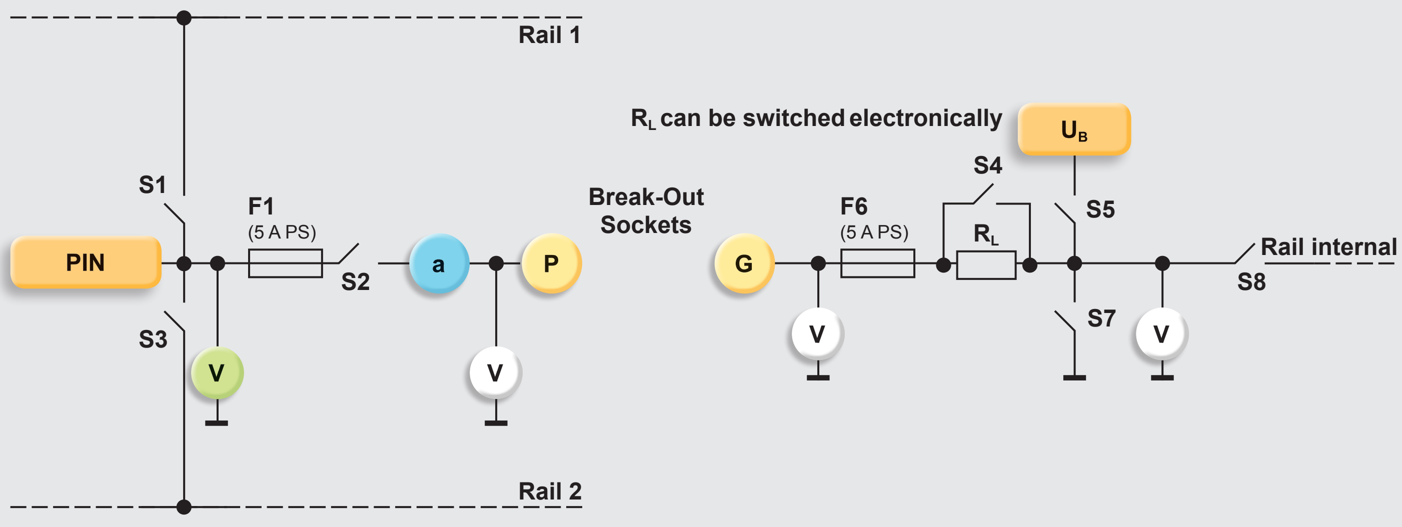
Technical data

Functions	
HS output with electronic load (2.5 .. 30 Ω); maximum 2.3 A and 40 W at <35 °C heat sink temperature	
LS output with electronic load (2.5 .. 30 Ω); maximum 2.3 A and 40 W at <35 °C heat sink temperature	
HS output with ext. load, max. 5 A	
LS output with ext. load, max. 5 A	
Connection to Rail1 or Rail2 or to internal rail	
Wirebreak	
Dimensions and weight	
Dimensions	71 x 129 x 210 mm
Weight	390 g

5

Block circuit diagram

ZBS RTB-OUT-00-000



Model code

ZBS RTB – OUT – 00 – 000

Equipment options
00 = standard

Modification number
000 = standard

Note
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Accessories
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Note

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Additional communication module for RTB
ZBS RTB-CAN-00-000

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.

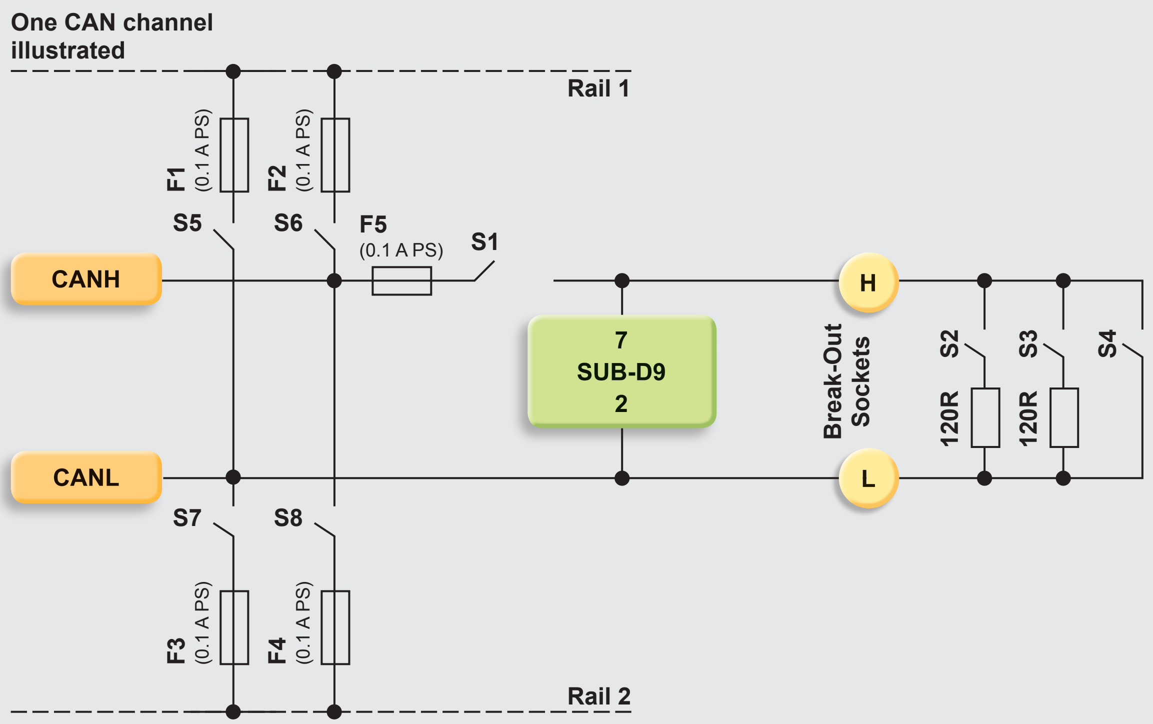
The module can only be operated via a slot on the right-hand rack side.

Technical data

Functions	
Switchable termination (120 or 60 Ohm)	
Voltage source 0 .. 10.0 V for remote control	
Short-circuit simulation of each CAN line (U_{Bat}, GND and CAN-H / CAN-L)	
Wirebreak simulation	
Dimensions and weight	
Dimensions	71 x 129 x 210 mm
Weight	290 g

Block circuit diagram

ZBS RTB-CAN-00-000



Model code

ZBS RTB – CAN – 00 – 000

Equipment options
00 = standard

Modification number
000 = standard

Note
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Accessories
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Note

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Accessories for MTB/RTB

Type	Part no.
ZBS MTB-MBP-314 Blind cover, (3 HE 14 TE 2.5 mm)	**on request**
ZBS MTB-BS-TTCxx-43 xx: 50 / 60 / 77 / 90 / 94 / 200 / 30X-H / 30X-I / 30X-O / 30X-P / 36X / 37X / 48X / 48XS Labelling kit for front and rear for ZBS MTB-Rack Height 43	**on request**
ZBS MTB-BS-TTCxx-63 xx: 50 / 60 / 77 / 90 / 94 / 200 / 30X-H / 30X-I / 30X-O / 30X-P / 36X / 37X / 48X / 48XS Labelling kit for front and rear for ZBS MTB-Rack Height 63	**on request**
ZBS MTB-BS-BLANK unmarked (can be labelled)	**on request**
ZBS RTB-RACK-MOUNT-43 19" mounting kit for mounting the ZBS RTB/MTB-RACK Height 43 in a 19"control box	**on request**
ZBS RTB-RACK-MOUNT-63 19" mounting kit for mounting the ZBS RTB/MTB-RACK Height 63 in a 19"control box	**on request**

5

E 18.500.2/11.14

5.3 Sensors

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

Functional Safety PL d, Cat 2 SIL 2	HDA 4700	HDA 8700	HLS 100	HLS 200	HLT 1000
					
Measured variable	Pressure	Pressure	Position	Position	Position / distance
Accuracy (max. error)	0.5	0.5			0.5
Measurement principle	Thin-film strain gauge	Thin-film strain gauge	Hall sensors	IR-light barriers	Magneto-striction
Number of outputs	2	1	1	2	1
Output	Analogue	Analogue	PWM	P-switch outputs	Analogue
CANopen	✓				✓
Available as individual units	✓				✓
OEM product for large volume production		✓	✓	✓	
PL d	✓	✓	✓	✓	✓
Category	3	2	2	2	2
SIL 2		✓	✓		✓
Diagnostics-capable	✓	✓	✓	✓	✓

Note:
Not all feature combinations are possible. For precise information, please consult the relevant data sheet.

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Electronic pressure transmitters	HDA 4800	HDA 4700	HDA 4400	HDA 4300	HDA 4100	HDA 3800	HDA 7400	HDA 8700	HDA 8400	HDA 9000
Accuracy (max. error)	0.25	0.5	1.0	1.0	1.0	0.3	1.0	0.5	1.0	1.0
Low pressure (up to 40 bar)	✓	✓	✓	✓	✓	✓				✓
High pressure (from 40 bar)	✓	✓	✓			✓	✓	✓	✓	✓
Relative pressure	✓	✓	✓	✓		✓	✓	✓	✓	✓
Absolute pressure					✓					
Number of switching outputs	2	2	2	2	2	2	4	2	2	2
Analogue output	✓	✓	✓	✓		✓	✓			
Available as individual units	✓	✓	✓	✓	✓	✓	✓			
OEM product for large volume production							✓	✓	✓	✓
Flush membrane		✓	✓	✓			✓			
CANopen Version		✓					✓			
ECE type authorisation (approved for road vehicles)								✓	✓	
Approval for potentially explosive atmospheres		✓	✓	✓	✓					
Approvals for shipping		✓	✓	✓	✓					
UL Approval	✓	✓	✓	✓	✓		✓	✓	✓	
Increased functional safety		✓						✓		

Note:
Not all feature combinations are possible. For precise information, please consult the relevant data sheet.

Electronic pressure switches

Electronic pressure switches 	EDS 3400	EDS 3300	EDS 3100	EDS 300	EDS 8000	EDS 601	EDS 1700	EDS 4400	EDS 4300	EDS 4100	EDS 820	EDS 810	EDS 710	EDS 410
Accuracy (max. error)	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Low pressure (up to 40 bar)		✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓
High pressure (from 40 bar)	✓			✓	✓	✓	✓	✓			✓	✓	✓	✓
Relative pressure	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Absolute pressure			✓							✓				
Number of switching outputs	2	2	2	2	2	2	4	2	2	2	2	2	1	2
Analogue output	✓	✓	✓	✓		✓	✓							
Digital display	✓	✓	✓	✓	✓	✓	✓							
Programmable	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Factory-set (not field-adjustable)								✓	✓	✓		✓	✓	✓
DESINA-compliant	✓	✓	✓											
VDMA Menu Navigation	✓	✓	✓		✓									
Available as individual units	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
OEM product for large volume production								✓	✓	✓		✓	✓	✓
Flush membrane	✓	✓												
IO Link Interface	✓	✓	✓								✓			
ECE type authorisation (approved for road vehicles)												✓		
Approval for potentially explosive atmospheres								✓	✓	✓				
Approvals for shipping				✓										
UL Approval	✓	✓	✓		✓							✓		

Note:
Not all feature combinations are possible. For precise information, please consult the relevant data sheet.

Temperature transmitters

Electronic temperature transmitters	ETS 4100 		ETS 4500 		ETS 7000 	HTT 8000 
Accuracy % (max. error)	0.8		2.0		2.0	3.0
Temperature range -25 .. +100 °C	✓		✓		✓	✓
Pressure resistant to 125 bar		✓		✓	✓	✓
Pressure resistant to 600 bar	✓		✓			
Probe length in mm	6	50-350	10.7	50-350	10	16
Analogue output	✓		✓		✓	✓
Available as individual units	✓		✓		✓	
OEM product for large volume production						✓
Approval for potentially explosive atmospheres			✓			
Protection class	IP 65		IP 65		IP 67	IP 67

Note: Not all feature combinations are possible. For precise information, please consult the relevant data sheet.

Temperature switches

Electronic temperature switches	ETS 3200 	ETS 3800 	ETS 320 	ETS 380 	ETS 1700 	HTS 8000 
Accuracy (max. error)	1 °C	1 °C	1 °C	1 °C	1 °C	3 %
Pressure resistant to 600 bar	✓		✓			
Integrated probe	✓		✓			✓
Separate probe		✓		✓	✓	
Number of switching outputs	2	2	2	2	4	2
Analogue output	✓	✓	✓	✓	✓	
Digital display	✓	✓	✓	✓	✓	
Programmable	✓	✓	✓	✓	✓	
In-Tank	✓					
Factory-set (not field-adjustable)						✓
VDMA Menu Navigation	✓	✓				
Available as individual units	✓	✓	✓	✓	✓	
OEM product for large volume production						✓
IO Link Interface	✓	✓				
UL Approval	✓	✓				

Note: Not all feature combinations are possible. For precise information, please consult the relevant data sheet.

Sensors for distance and position

Sensors for distance and position	HLT 1000-R2	HLT 2100-R1	HLT 2500-F1	HLT 2500-L2	HLS 528	IES 2010 / 2015 / 2020	IWE 40	HLS 100	HLS 200
									
Measurement range in mm	50 to 2,500	50 to 4,000	50 to 4,000	50 to 4,000	up to 6,000				
For cylinder installation	✓	✓							
Number of switching outputs					2	2		1 (PWM)	2
Analogue output	✓	✓	✓	✓	✓		✓		
CANopen Version	✓	✓	✓	✓					
Device Net		✓	✓	✓					
Profibus		✓	✓	✓					
EtherCAT		✓	✓	✓					
SSI		✓	✓	✓					
Available as individual units	✓	✓	✓	✓	✓				
OEM product for large volume production						✓	✓	✓	✓
Increased functional safety	✓							✓	✓

Note: Not all feature combinations are possible. For precise information, please consult the relevant data sheet.

Level sensors

	ENS 3000	HNS 526	HNT 1000	HNS 3000
				
Measurement principle	capacitive	ultrasound-based	magnetostrictive	magnetostrictive
Measuring range	250 to 730	280 to 6,400	250 to 2,500	250 to 2,500
With temperature probe	✓			✓
Mechanical connection	Screw connection	M30x1	G 3/4	G 3/4
Electrical connection	M12x1	M12x1	M12x1 cable outlet	M12x1
Number of switching outputs	1, 2 + 4	1 + 2		1, 2 + 4
Analogue output	✓	✓	✓	✓
CANopen Version			✓	
VDMA Menu Navigation	✓	✓		✓
IO Link Interface	✓			✓
UL Approval	✓			
Target Applications	Industry	Industry	Industry, mobile	Industry, mobile

Note: Not all feature combinations are possible. For precise information, please consult the relevant data sheet.

Flow rate transmitters / Flow switches

Flow rate transmitters, flow switches	EVS 3110 	EVS 3100 	HFS 2100 	HFS 2500 	HFT 2100 	HFT 2500 
Accuracy (max. error) in %	2	2	10	5	10	3
Measurement principle	Turbine	Turbine	Float principle	Float principle	Float principle	Float principle
Pressure-resistant	✓	✓	✓	✓	✓	✓
Water-based media	✓			✓		✓
Oil / viscous fluids		✓	✓		✓	
Direction of flow optional	✓	✓				
Installation position optional	✓	✓	✓	✓	✓	✓
Max. number of switching contacts			2	2		
Analogue output	✓	✓			✓	✓
Display			✓	✓		
ATEX approval			✓	✓		

Note: Not all feature combinations are possible. For precise information, please consult the relevant data sheet.

Speed sensors

Speed sensors	HSS 110 	HSS 120 	HSS 130 	HSS 210 	HSS 220 
Flange	✓	✓	✓		
Screw-in thread				✓	✓
Probe length in mm	18.4	30, 35, 45	16, 32	0 .. 50 adjustable	0 .. 48 adjustable
Oil / viscous fluids	✓	✓	✓	✓	✓
Salt water	✓	✓	✓		✓
Cleaning agent, salt spray	✓	✓			
Direction of rotation detection	✓	✓	✓	✓	✓
Available as individual units	✓	✓	✓	✓	✓
Outputs	1 NPN 1 PWM analogue	2 NPN	2 NPN	2 Push-Pull	2 NPN
IP class	IP 67 IP 6K9K	IP 67 IP 69K	IP 67 IP 69K	IP 67	IP 68

Note: Not all feature combinations are possible. For precise information, please consult the relevant data sheet.

Sensors for potentially explosive atmospheres	HDA 4700	HDA 4400	HDA 4300	HDA 4100	EDS 4400	EDS 4300	EDS 4100	ETS 4500	HFS 2500	HFS 2100
										
Measured variable	Pressure	Pressure	Pressure	Pressure	Pressure	Pressure	Pressure	Temp.	Flow	Flow
Accuracy	0.5	1.0	1.0	1.0	1.0	1.0	1.0	2.0	5, 10	10
Available as individual units	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
OEM product for large volume production					✓	✓	✓			
Flush membrane	✓	✓	✓							
ATEX Intrinsically safe	✓	✓	✓	✓	✓	✓	✓		✓	✓
Flush membrane ATEX-Intrinsically safe	✓	✓	✓							
CSA Intrinsically safe	✓		✓	✓						
IECEx Intrinsically safe	✓	✓	✓	✓						
Flush membrane IECEx Intrinsically safe	✓	✓	✓							
ATEX, IECEx, CSA, flameproof enclosure	✓				✓			✓		
Flush membrane ATEX, IECEx, CSA, flameproof enclosure	✓									

Note: Not all feature combinations are possible. For precise information, please consult the relevant data sheet.

Condition monitoring products

	CMU 1000 	CSI B 2 	HLB 1300 	AS 1000 	AS 3000 	EY 1356 
	Condition Monitoring Unit	Interface module				
Measurement channels	32					
Measurement inputs	8 HSI / SMART 8 analogue sensors 4 digital signals					
Outputs	2 analogue signals 4 relays					
Interface	Ethernet RS 232 USB					
Visualization	CMWIN					
Sensor			Oil condition sensor	AquaSensor	AquaSensor	Contamination switch
Measured variable			rel. humidity temperature dielectric constants	Saturation level or temperature	Saturation level or temperature	Particles
Output				Analogue HSI 2 switch output	1 analogue 2 switch output I/O Link	switching signal

Service unit

	HMG 500 	HMG 510 	HMG 3010 	HDA 4748-H 	ETS 4148-H 	EVS 3108-H 
Portable data recorder	✓	✓	✓			
Number of measurement inputs	2	2	10			
Interface		USB	USB RS 232			
Measurement inputs	HSI	HSI	HSI Analogue Frequency			
Connection to CAN bus			✓			
Visualization		CMWIN	HMGWIN CMWIN			
Automatic sensor detection, HSI				✓	✓	✓
Measured variable				Pressure	Temp.	Flow rate

Monitoring and display units

	HDA 5500 
Monitoring and display unit	✓
Inputs	3 analogue
Outputs	Analogue 4 relays
Accuracy	0.5

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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



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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

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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:

Subject	Contents
	Hardware training courses
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-eVison² ● Communication options in the application

	Programming training courses
Programming the 16-bit controllers in C	● Installation and setup of the development environment ● Configuring the controller ● Utilizing the IO driver in C ● Utilizing the communication interfaces in C ● Compiling and transferring the application ● Debug options
Programming the 32-bit controllers in C	● Installation and setup of the development environment ● Configuring the controller ● Utilizing the IO driver in C ● Utilizing the communication interfaces in C ● Compiling and transferring the application ● Debug options

	Advanced training courses
Principles of the communication protocols	● Range of communication interfaces on the market ● CAN and its higher protocols ● Serial communication interfaces (RS, LIN, USB) ● Secure communication options
CANopen IO expansions and their integration	● Integration of the IO expansion in a network ● Parameterization of the IO expansion ● Utilizing the inputs and outputs ● What lies behind the object directory?
Using TTC tools	● Working with the TTC-Downloader ● Use of the TTControl Service Tools (Remote Assistance)
Functional safety – Principles	● The “new” standard DIN EN ISO 13849 and its impact ● Liability consequences ● Procedure for a risk analysis ● Implementing the requirements using HYDAC Electronic products

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**

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