

Electronic control device for double foot pedal with dampening 4THE5NR



- Specially designed for the equipment of mobile machines
- Series 4X

Features

- Reliable, light and robust mechanism
- Actuator ergonomics comparable with hydraulic foot devices
- Easily accessible pedals fixing
- Single mounting plate for two pedals
- Excellent protection of the electronic part
- Contactless hall effect sensors
- Configurable electronic
- Easily accessible protection boot
- Easy access to the damping device for maintenance
- High reliability level compliant with application in safety-related parts of control systems up to PLC or d according to ISO 13849
- Outputs on 1 to 2 CAN channels to increase the reliability level of the systems or reduce the load of the bus

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Functional description

Design

Electronic control device type 4THE5NR are mainly composed of a control cam (1), a fixation plate (2) containing the S/S dampers, the electronic card, the contactless sensors, and a body (3) containing the return springs.

General

The ergonomics of the 4THE5NR is similar to a hydraulic device.

The THE5 architecture increases its reliability to match the requirements for integration in safety-related parts of control systems up to PLC or d.

The electronic control devices 4THE5NR differ by integrated electronic functions and the nature of the output signals.

The 4THE5NR PWM require external regulated power supply for generating PWM signal.

The 4THE5NR CAN integrate a power supply regulation and can be then directly supplied from the vehicle battery. They periodically generate frames on the CAN bus which enable dialog with other systems.

For PWM and CAN, the 4THE5NR architecture increases its reliability to match the requirements for integration in safety-related parts of control systems up to PLC or d.

The electronic control devices 4THE5NR generate low power signals. The control of an electro-hydraulic axis requires to add an external electronic power interface.

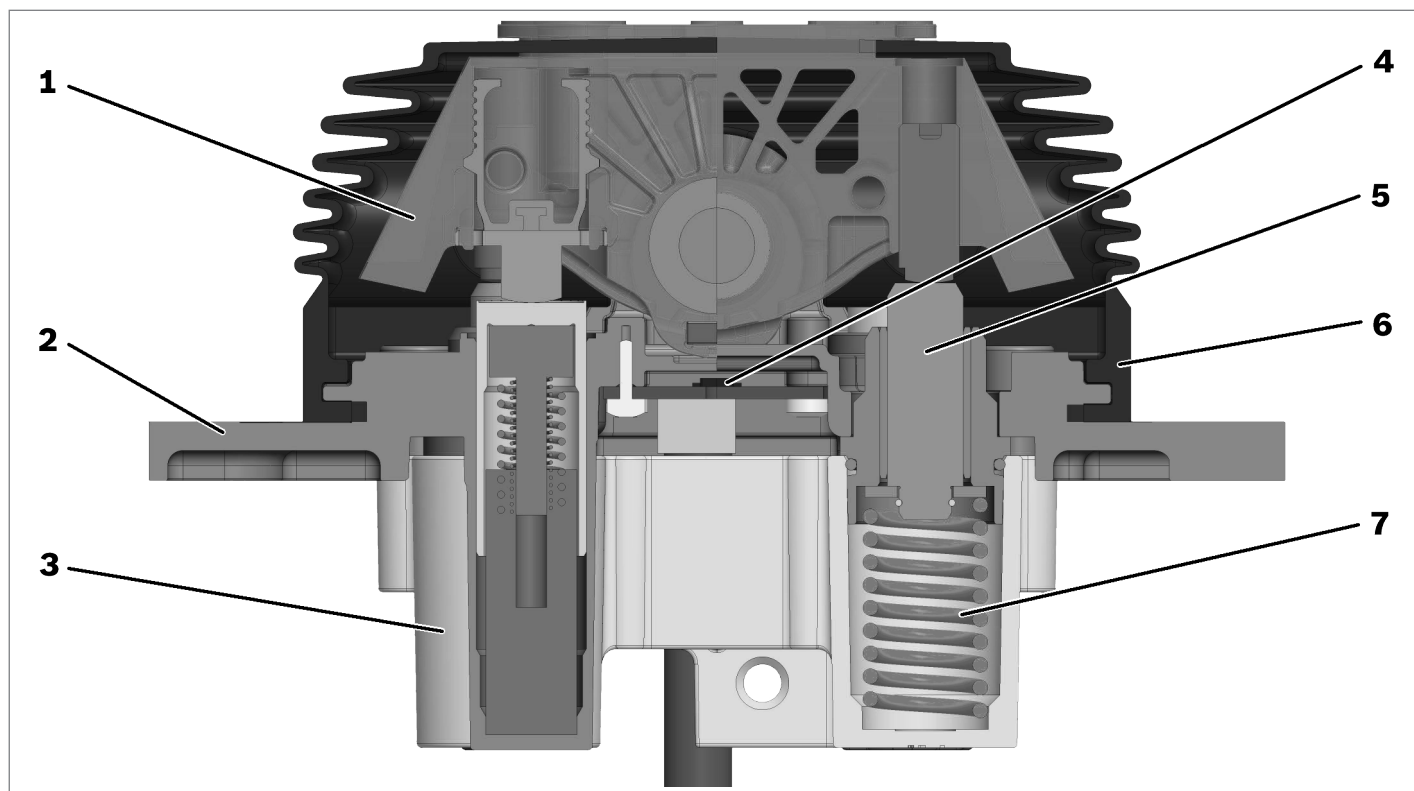
Function principle

When not actuated the operating element is held in neutral position by the return springs (7).

With deflection of the cam (1), the plunger (5) compresses the return spring (7). The magnet attached to the cam (1) moves according to the direction and angle of the maneuver. The signal generated by the sensor (4) is proportional to the inclination of the pedal.

A rubber boot (6) protects the mechanical components of the housing from external contamination.

▼ Cross section 4THE5NR



Features

- ▶ Electromagnetic compatibility (CEM) according to the standards ISO 7637, 11452, 16750.
- ▶ Life expectancy up to 2 millions cycles.
- ▶ 4THE5NR is available in version CAN or PWM signal.
- ▶ 2 redundant proportional axis by single foot pedal.
- ▶ Damping device for the return to neutral of the pedal supports.

Wiring: block diagram

See pages 9 and 11.

Outputs characteristic curves

See pages 9 and 11.

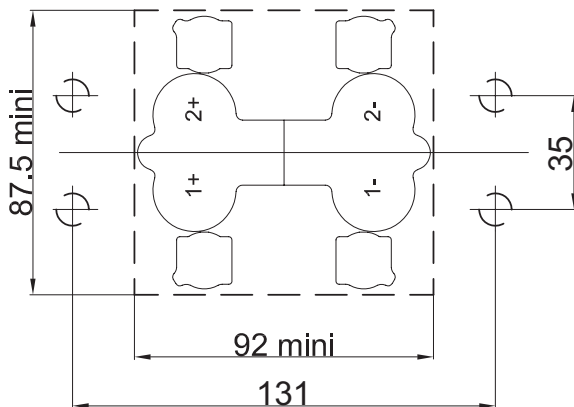
Installation guidelines

- ▶ Mounting flange area: flatness = 0.5 mm.
- ▶ Screw head dimension = $\varnothing$ 16 mm.
- ▶ Tightening torque for the flange fixing screws = 30 Nm maxi.

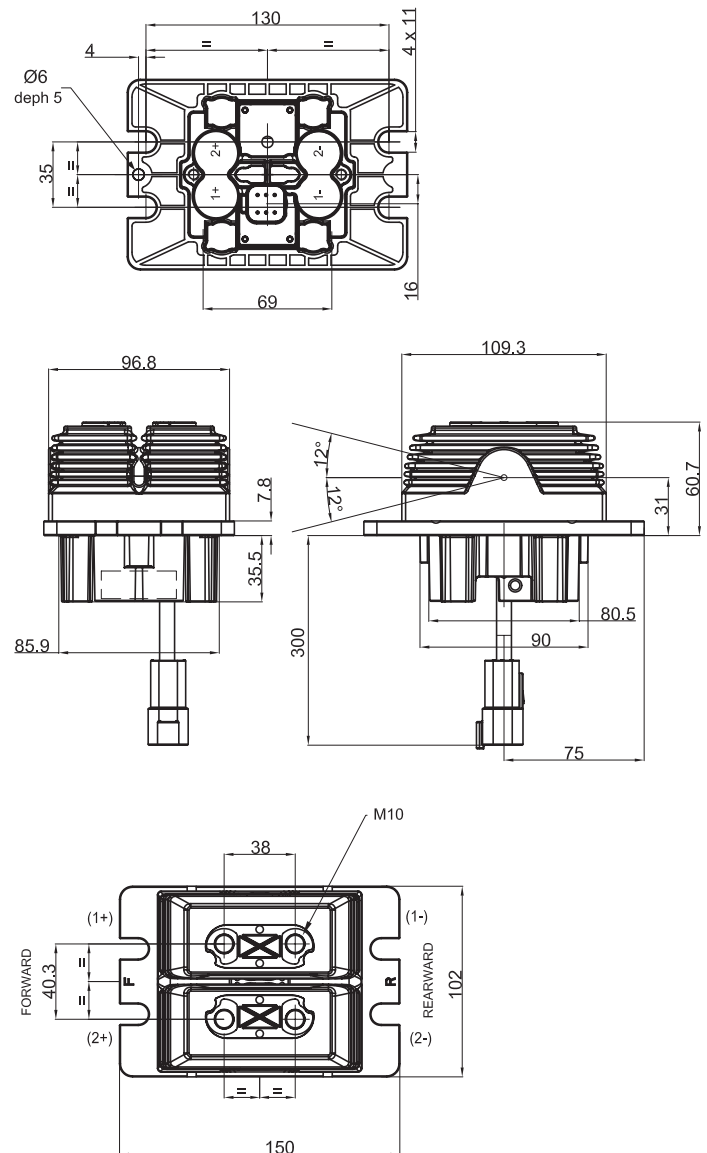
Application

The electronic control device for double foot pedal with dampening type 4THE5NR is mainly dedicated to the travel control of tracked excavators. It can be equipped with pedals adapted to the cabin design. The integrated damping system minimizes the oscillations when pedal equipped with a lever returns to neutral.

Installation hole



Unit dimensions



Ordering code

01	02	03	04	05	06	07		08		09
4	THE		5		RZ	-	4X	/	05	

Axis number

01	2 axis	4
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Product

02	Electronic control device	THE
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Type of output

03	Signal PWM (performance level PLd capable)	SW
	CAN (application in safety-related parts of control systems up to PLd)	D
	CAN (application in safety-related parts of control systems up to PLc)	C

Product

04	THE5	5
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Dampening

05	Without dampening	
	With dampening	N

Pedal description

06	Double pedal support without pedal	RZ
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Series

07	Series 40 to 49: unchanged installation and connection dimensions	4X
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Connectors

08	DEUTSCH DT connector	05
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09	Further details	*
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Mechanical characteristics

Mechanical			
Life time			2 millions actuation cycles ¹⁾
Temperature range			
	Storage, ambient	°C	-40 ... +85
	Operation	°C	-20 ... +85
Resistance to vibrations and shocks			
	Vibration (ISO 16750-3 and CEI 60068-2-64)	Hz	20 ... 2000 (11.2 g RMS)
	Shocks (CEI 60068-2-27)		50 g within 11 ms
Protection level (CEI 60529)			IP67 below the machine's floor IP55 upside the machine's floor
Actuation torque			
	Begin of stroke	Nm	6
	Full stroke	Nm	12
	Maximum permissible at the operating element with an exceptional, one time loading	Nm	200
Actuation angle		degrees	±12
Weight without pedal		kg	1.2

Notice

For applications outside these parameters, please consult us!

Damping effect

The design of the electronic control device for double foot pedal with dampening 4THE5NR can reproduce similar sensations to the maneuver of hydraulic control device. An increase of the actuation's speed adds to the standard actuations force an additional opposite force from the damping device.

The dynamic damping torque is expressed according to the duration of the return to neutral of the pedal support:
24±2 Nm for a return to neutral within 0.2 s.

¹⁾ Endurance performed at full stroke under the sole constraint of the return forces of the device.

Electrical characteristics – signal PWM

Electrical		
Power supply	V	External regulated 5±0.5
Maximum current consumption at 5 V supply	mA	56
Proportional signal		
Proportional signal duty cycle		
Full stroke towards 1+ or 2+	%	95±2.7
Neutral	%	50±2.7
Full stroke towards 1– or 2–	%	5±2.7
PWM Signal frequency	Hz	500±75
High voltage signal	V	4 ... 5
Low voltage signal	V	0 ... 1
Minimum pull up or pull down resistor	kΩ	2
Protections		
Protection against polarity reversal		Outputs protected between 0 and 32 V
Protection against short circuits		Yes
Fuse	A	1
Electromagnetic compatibility (EMC)		
Magnetic field according to ISO 11452 part2	V/m	200 MHz ... 1 GHz: 140
		1 GHz ... 2.7 GHz: 50
Current injection according to ISO 11452 part 4	mA	1 MHz ... 400 MHz: 120
Conducted / Radiated emission CISPR25		150 kHz ... 30 MHz : Class 3
Direct electrostatic discharge	kV	±8
Electrostatic discharge in the air	kV	±15
Further data		Consult us

Notice

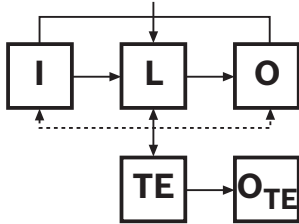
For applications outside these parameters, please consult us!

Informations related to standard ISO 13849

For further information about standard ISO 13849 applied to electronic joysticks, refer to data sheet 90293.

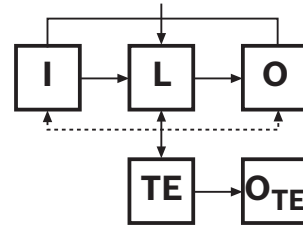
CAN output 4THED5R

- Meets the architectural category 2 requirements of the standard ISO 13849 (test channel including redundant axis)
- Diagnostic coverage (DC) = High



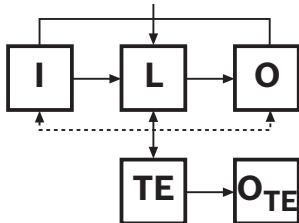
CAN output 4THEC5R

- Meets the architectural category 1 requirements of the standard ISO 13849
- Diagnostic coverage (DC) = Medium



PWM signal output

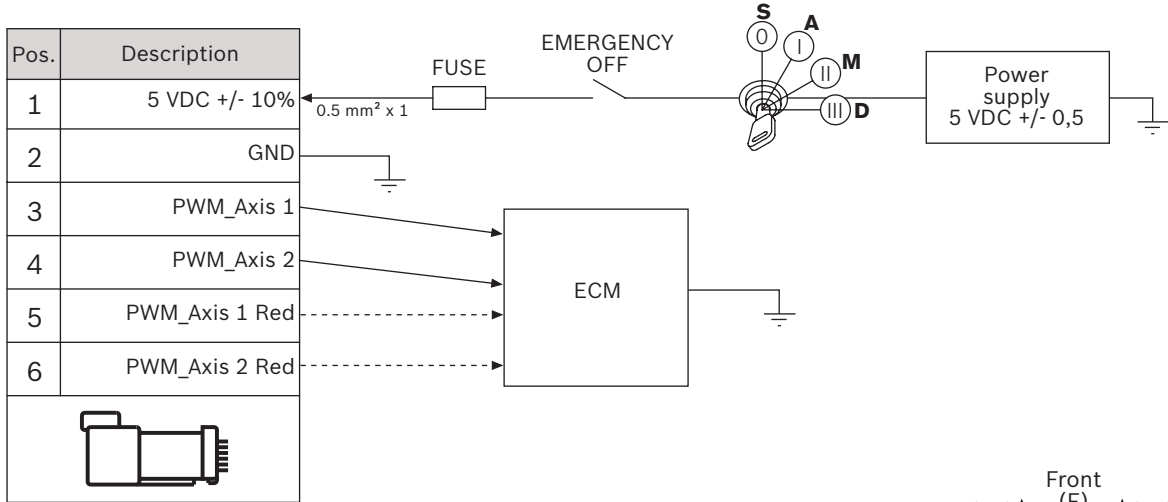
- Meets the architectural category 3 requirements of the standard ISO 13849



Electrical functions – signal PWM

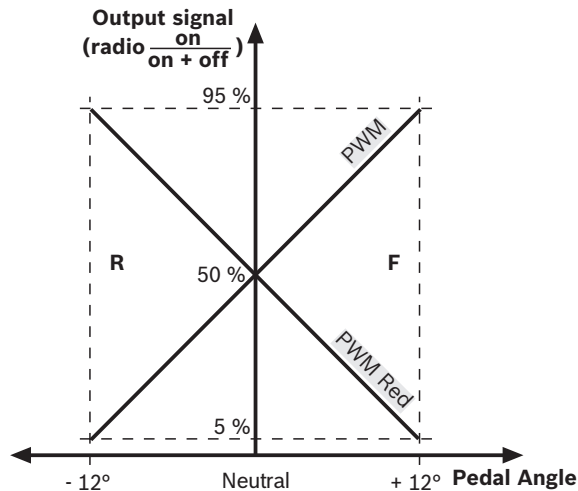
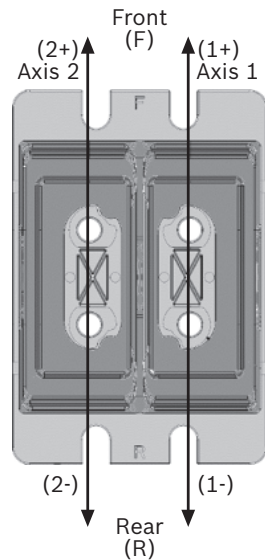
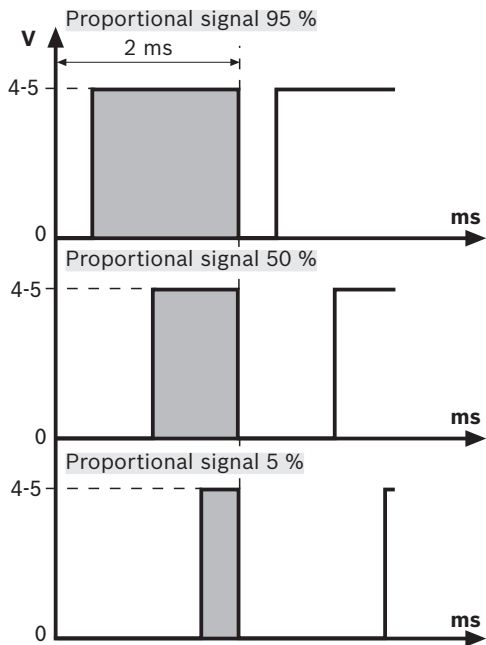
Notice
For applications outside these parameters, please consult us!

Electrical connection



Output characteristics

The proportional signal (%) is the time ratio between the high state and the signal period.
The 4THE5NR delivers two redundant PWM signals opposite on each of its two axes: PWM and PWM Red (redundant).



Electrical characteristics – signal CAN

Electrical		
Power supply	V	7 ... 36 VDC
Maximum current consumption at 14 V supply	mA	55
Proportional signal	0 ... 255 digits (1 byte encoding)	
Neutral	%	0
Full stroke	%	±100
Bus speed	KBds	250, 500, 1000
Protocol CAN (see protocol chapters)	2.0 A or 2.0 B	
Protections		
Protection against reverse polarity	V	36 for 60 seconds
Protection against short circuit	Connections towards machine protected from 0 to 32 V	
Electromagnetic compatibility (EMC)		
“Load dump” pulse protection according to ISO 16750-2	Pulse 5b, $U_s = 202\text{ V}$, $U_s^* = 58\text{ V}$, $R_i = 2\ \Omega$, $t_d = 100\text{ ms}$, 5 pulses, 1 minute interval between two pulses	
Magnetic field according to ISO 11452 part 2	V/m	200 MHz ... 2.7 GHz : 150
Current injection according to ISO 11452 part 4	mA	50 kHz ... 400 MHz : 100 ... 300
Conducted / Radiated emission CISPR25	Class 2 / Class 3	
Direct electrostatic discharge	kV	±8
Electrostatic discharge in the air	kV	±15
Further data	Consult us	

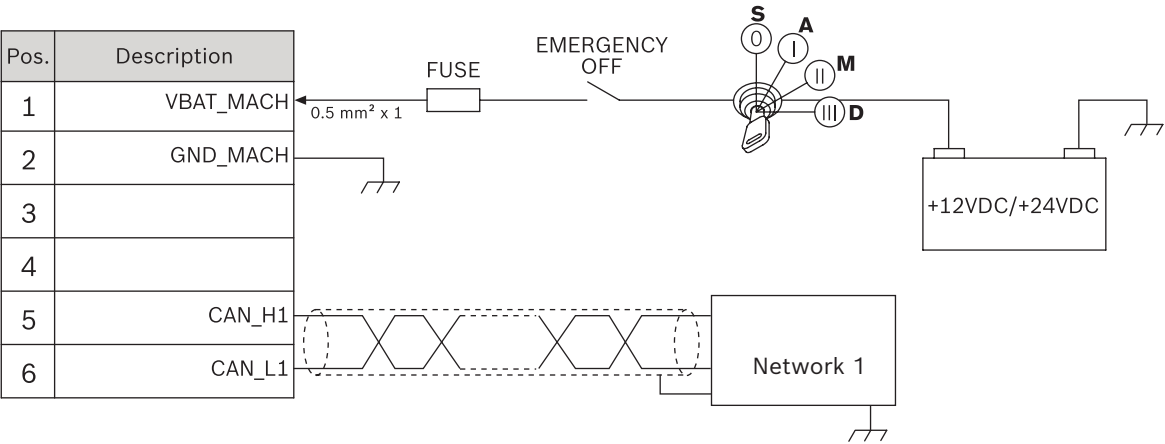
Notice

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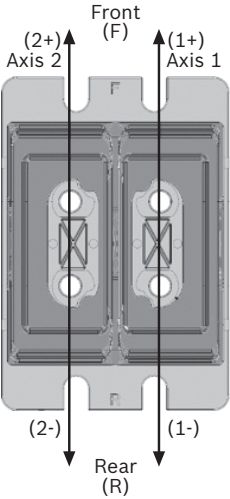
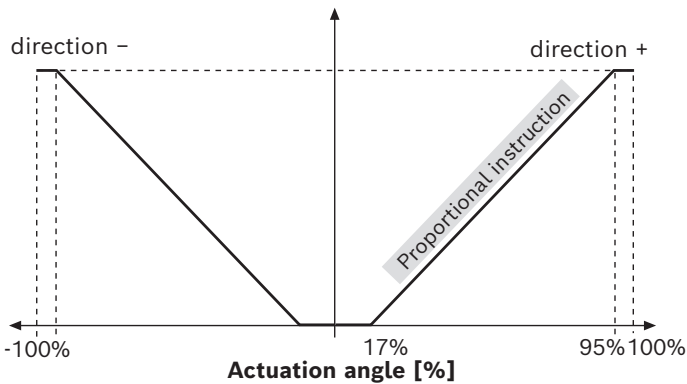
Electrical functions –signal CAN

Notice
For applications outside these parameters, please consult us!

Electrical connection to single CAN network



Output characteristic



Protocol Bosch Rexroth standard

Predefined protocol with periodic transmission of frames. The identifier of the frame is configurable.

Telegram 1									
ID:	Configurable on 11 bits								
Transmission rate:	Every 20 ms								
DLC:	8 bytes								
	Mapping								
	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	
Axis 1	0..250								Byte 1
Axis 2	0..250								Byte 2
Axis 3	unused	unused	unused	unused	unused	unused	unused	unused	Byte 3
Axis 4	unused	unused	unused	unused	unused	unused	unused	unused	Byte 4
Direction (Dir)	unused	unused	unused	unused	2-	2+	1-	1+	Byte 5
	unused	unused	unused	unused	unused	unused	unused	unused	Byte 6
Error (Err)	Error codes are available on request								Byte 7
Incremental counter (Inc)	Cyclic counter 0..255								Byte 8

Additional information:

- Physical layer: Standard 2.0A
- Identifier 11 bits
- BUS speed: 250, 500, 1000 kBd (kBaud)
- The list of errors to be managed by machine controller can be found the instruction manual 29696-B.

CANopen protocol

The CANopen protocol is based on the use of the object dictionary that contains a list of objects accessible via the configuration tools.

CANopen and eds file (electronic data sheet) are available on request.

Service Data Object (SDO)

Allows access to objects defined in the object dictionary (Read / Write).

Fully compatible with the tool «vector CANsetter» (software for configuring a CANopen component).

The «multi packet» (transmit objects larger than 4 bytes) is not managed by the electronic control device.

Network management

According to DS300 standard, CANopen defines four operating status:

- Initialization: component initialization on the network
- Pre-operational: component configuration on the network.
- Operational: normal function of the component on the network
- Stop: Suspension of the frame transmissions to the network (to temporarily reduce the bus load).

The operating status are accessible via NMT frame (Network Management)

A special option offered to customers can boot directly into the operational status (without using NMT frame to move from the pre-operational to operational status).

TxPDO

The TxPDOs frames convey the status of internal axis information, rollers, rockers and push buttons. They may also contain frame counters, error codes and other objects of the dictionary.

The electronic control device 4THE5NR sends the TxPDO1 and TxPDO2 frames, whose identifiers respect the DS300 standard.

The electronic control device 4THE5NR proposes following frames transmission modes:

- Synch 0: Transmission on reception of synchronization frames when internal status changes
- Synch X (1 – 10): Transmission after reception of X synchronization frames.

Asynchronous:

- Periodic transmission (configurable periodicity with a resolution of 10 ms).
- Periodic transmission (configurable periodicity) or on status change.

The content of TxPDOs frames is fully configurable during production or when using on machine.

EMCY

The EMCY frame (emergency) is emitted by the electronic control device 4THE5NR as soon as it detects a default. EMCY identifier comply with the DS300 standard.

The list of errors to be managed by machine controller can be found in the instruction manual the 29696-B.

General	
Node ID	Configurable
SDO	Multipacket transfert no supported (Object dictionary available on request)
NMT	Compliant with DS301 (Configurable initial state: Pre-operationnal or Operationnal)
Emergency frame (EMCY)	Compliant with DS301 (error code are available on request)
Error Control Services	Configurable: Node guarding, heartbeat
Device profile	DS401 (Object dictionary and eds file available on request)

Frame1 TxPDO									
COD ID	0x180 + node ID								
Transmission rate:	Every XX ms; On Synch Y; Every XXX ms or on change (not exceed 10 ms)								
DLC	8 bytes								
Area to be filled with the items contained in the object dictionary available on request. See section describing the specifics of the CANopen standard.	Mapping								
	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	
									Byte 1
									Byte 2
									Byte 3
									Byte 4
									Byte 5
									Byte 6
									Byte 7
									Byte 8

Frame 2 (TxPDO)								
COD ID	0x280 + node ID							
Transmission rate:	Every XX ms; On Synch Y; Every XXX ms or on change (not exceed 10 ms)							
DLC	8 bytes							
Area to be filled with the items contained in the object dictionary available on request. See section describing the specifics of the CANopen standard.	Mapping							
	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1
								Byte 1
								Byte 2
								Byte 3
								Byte 4
								Byte 5
								Byte 6
								Byte 7
								Byte 8

J1939 protocol

- Physical layer: Standard CAN 2.0B
- Identifier 29 bits
- BUS speed: 250, 500, 1000 kBd (kBaud)

Source Address

The source address is the identifier of the electronic control device 4THE5NR on the CAN J1939 network. It is configurable from 2-253 based on the needs expressed by the customer.

Address claiming process (SAE J1939-81 MAR 2017)

The electronic control device 4THE5NR can be configured in “master configurable mode”, or in “self configurable mode”.

- Master configurable mode:
In case of conflict and priority loss during the claiming process, the electronic control device 4THE5NR stops any frame transmission until the master node allocate a new address.
- Self configurable mode:
In case of conflict and priority loss during the claiming process, the electronic control device 4THE5NR automatically choose a new address and start again the claiming process.

The frames

- BJM (Basic Joystick Message)
The electronic control device 4THE5NR manages BJM frames. The frames transmission occurs when status changes or periodically each 100 ms. The periodicity in case of status change can be configured (10 ms or 20 ms)
The electronic control device 4THE5NR proposes two frames contents. The first content complies with the SAE J1939-71 standard and the second is a customization integrating counters and redundancy checks.
- DM1 (diagnostic message 1) according to SAE J1939-73 JAN 2019
The DM1 frame is an information issued by the electronic control device 4THE5NR when an internal default is detected. It is reissued every second until the fault disappears. The DM1 frame that contains the list of errors to be managed by machine controller can be found in the instruction manual 29696-B.
- DM13 (diagnostic message 13) according to SAE J1939-73 JAN 2019
The DM13 frame allows the control of the BUS load by validating or stopping the frame transmission on the CAN bus.
- DM14 to DM16 (diagnostic message 14 to 16) according to SAE J1939-73 JAN 2019
The DM14 to DM16 frames allow the configuration of the electronic control device 4THE5NR by using the J1939 protocol.
The list of objects (or parameters) accessible by means of the DM14 DM16 frames is available on request. The exchange mechanism includes the expression of a request by using the frame DM14, the acquittal of the request using the DM15 frame and the transmission of the required data by the DM16 frame.

J1939 protocol

General									
Source Address (SA)	Configurable								
Name	Defined in standard SAE J1939-81 MAR 2017								
Address claiming process	[Self Configurable; Master configurable] compliant with SAE J1939-81 MAR 2017								
Telegram 1									
Type	Basic Joystick Message 1 (BJM1)								
Parameter group number (PGN)	0x00FDD6								
Transmission rate	Every 100 ms or on change (not exceed 20 ms)								
DLC	8 bytes								
	Mapping								
	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	
Axis 1	SPN2660		SPN2665		SPN2670		SPN2675		Octet 1
	SPN2660								Octet 2
Axis 2	SPN2661		SPN2666		SPN2671		SPN2676		Octet 3
	SPN2661								Octet 4
Limit warning 1 (Detent 1)	SPN 2680		SPN 2681		unused	unused	unused	unused	Octet 5
	unused	unused	unused	unused	unused	unused	unused	unused	Octet 6
	unused	unused	unused	unused	unused	unused	unused	unused	Octet 7
	unused	unused	unused	unused	unused	unused	unused	unused	Octet 8

SPN = Suspected Parameter Number

Enhanced J1939 protocol

General									
Source Address (SA)	Configurable								
Name	Defined in standard SAE J1939-81 MAR 2017								
Address claiming process	[Self Configurable; Master configurable] compliant with SAE J1939-81 MAR 2017								
Telegram 1									
Type	Basic Joystick Message 1 (BJM1)								
Parameter group number (PGN)	0x00FDD6								
Transmission rate	Every 100 ms or on change (mini period 20 ms or 10 ms)								
DLC	8 bytes								
Axis 1	Mapping								
	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	
	SPN 2680		SPN2665		SPN2670		SPN2675		Byte 1
	SPN2660								Byte 2
	SPN 2680		SPN2666		SPN2671		SPN2676		Byte 3
	SPN2661								Byte 4
	SPN 2680		SPN 2681		unused	unused	unused	unused	Byte 5
	unused	unused	unused	unused	unused	unused	unused	unused	Byte 6
	unused	unused	unused	unused	unused	unused	unused	unused	Byte 7
Counter and checksum	SPN 4207 (Checksum)				SPN 4206 (Counter)				Byte 8

SPN = Suspected Parameter Number

Guidelines

Operating precautions

Safety measures

- ▶ Provide a fully accessible device to the operator for disabling the electronic control device signal.
- ▶ Provide at the receiver (Machine Controller), a «time out» device compatible with the controlled functions.
- ▶ Signal cables and power cables must be rooted separately and away from each other.
- ▶ In case of electric welding operations on the machine, unplug the power supply battery as well as all plugs connecting the electronics.
- ▶ Ensure adequate distance between electronics and any radio installations in order to limit the magnetic field seen by the electronic control device.
- ▶ Do not use electronic control devices close to a magnetic field source of frequency lower than 50 Hz and amplitude greater than 0.6 mT.
- ▶ Do not use in explosive environment.
- ▶ Do not direct the jet of a pressure washing unit directly at the unit.
- ▶ Equip other inductances of the machine with freewheel diodes to avoid the generation of parasites.

Wiring recommendations

The wiring diagram on the machine is described on page 10. The fuse used on the power supply is 1.4 A at 12 V or 1 A at 24 V (pages 9 & 11).

Disposal



Spring pre-stressed components!

Risk of injury due to parts ejected during disassembly of the device into its individual parts.

- ▶ Loosen screwed and spring loaded parts slowly and keep secured until the compression spring is relieved.

Careless disposal of the device, material can result in environmental pollution.

Observe the points below when disposing of any device:

1. Dispose of the device and the packaging material in accordance with the national regulations in your country.
2. Disassemble the device into its individual parts and recycle them.
3. For example, separate the parts into:
 - Castings
 - Steel
 - Aluminium
 - Non-ferrous metal
 - Electronic waste
 - Plastic
 - Seals

Related documentation

Further information about installation, commissioning and operation can be found in the instruction manual 29698-01-B.

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