

Electronic control device for single foot pedal 2THE5R



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

Features

- Reliable, light and robust mechanism
- Actuator ergonomics comparable with hydraulic foot pedals
- Easily accessible pedal fixing
- Excellent protection of the electronic part
- Contactless hall effect sensors
- Configurable electronic
- Easily accessible protection boot
- High reliability level compliant with application in safety related parts of control systems up to PLC or d according to ISO 13849

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About this data sheet

This data sheet describes functioning, technical data and ordering codes of the electronic control devices for single foot pedal 2THE5R. This data sheet is illustrated with electronic symbols, sections and unit dimensions drawings.

Related documents

The electronic control devices for single foot pedal 2THE5R is a system component.

- Observe the instructions for the other system components.
- Also observe the instructions in the system documentation from the system manufacturer.

Functional description

Design

Electronic control device type 2THE5R is mainly composed of a control cam (1), a fixation plate (2) containing the electronic card and the contactless sensors, and a body (3) containing the return springs.

General

The design gives the 2THE5R a high level of robustness. The 2THE5R 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 2THE5R differ by integrated electronic functions and the nature of the output signals. The 2THE5R PWM require external regulated power supply for generating PWM signal.

The 2THE5R 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.

The electronic control devices 2THE5R generate low power signals. The control of an electro-hydraulic axis requires to add an external electronic power interface.

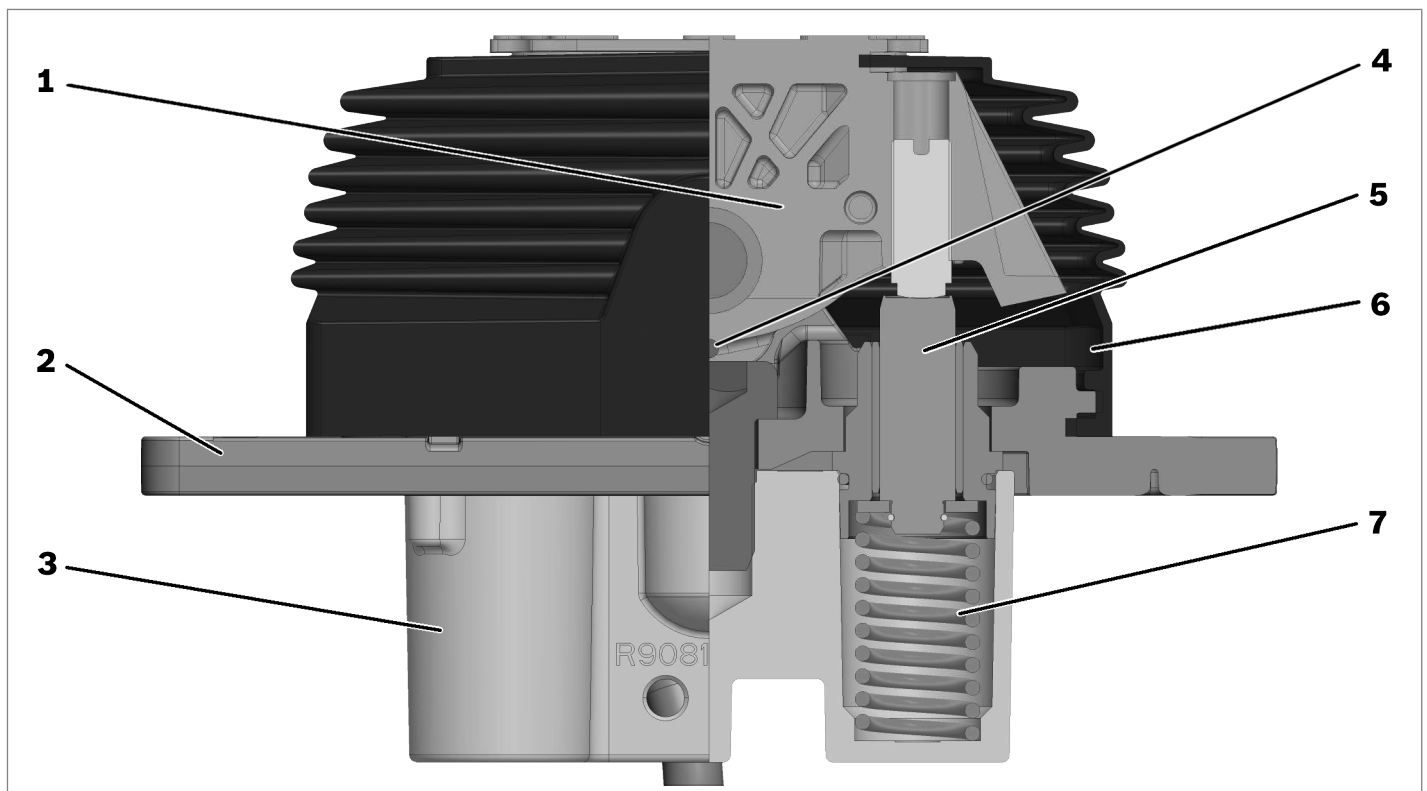
Function principle

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 2THE5R



Features

- ▶ Electromagnetic compatibility (EMC) according to the standards ISO 7637, 11452, 16750.
- ▶ Life expectancy up to 3 millions cycles.
- ▶ 2THE5R is available in version CAN or PWM signal.
- ▶ 1 proportional axis by single foot pedal.

Wiring: block diagram

See pages 9 and 11.

Outputs characteristic curves

See pages 9 and 11.

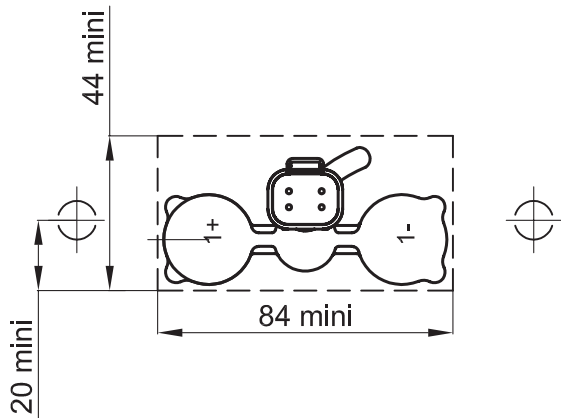
Installation guidelines

- ▶ Mounting flange area: flatness = 0.5 mm.
- ▶ Screw head dimension = Ø16 mm.
- ▶ Tightening torque for the flange fixing screws = 40 Nm maxi.

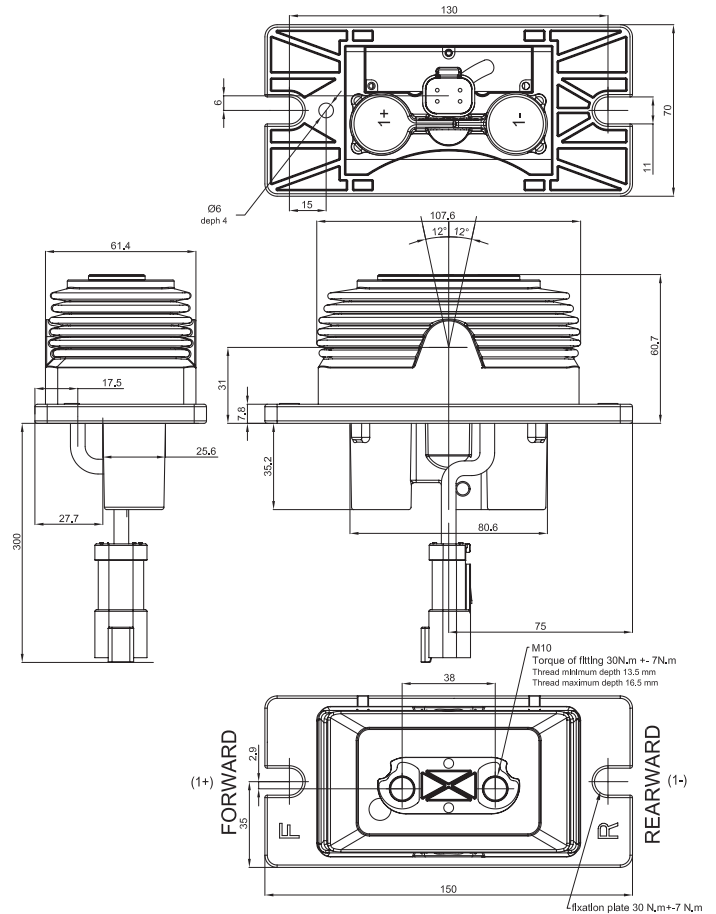
Application

The electronic control devices type 2THE5R can be equipped with pedals adapted to the cabin design for various applications.

Installation hole



Unit dimensions



Type code

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

Axis number

01	1 axis	2
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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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Pedal description

05	Simple pedal support without pedal	RZ
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Series

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

07	DEUTSCH DT connector or Molex ML-XT	05
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08	Further details	*
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Mechanical characteristics

Mechanical			
Life time		3 millions actuation cycles	
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	24 ... 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	0.8

Notice

For applications outside these parameters, please consult us!

Electrical characteristics – signal PWM

Electrical		
Power supply	V	External regulated 5±0.5
Maximum current consumption	mA	34
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	2
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 part4	mA	1 MHz - 400 MHz: 120
Conducted / Radiated emission CISPR25		Class 3
Direct electrostatic discharge	kV	±8
Electrostatic discharge in the air	kV	±15
Further data		Consult us

Notice

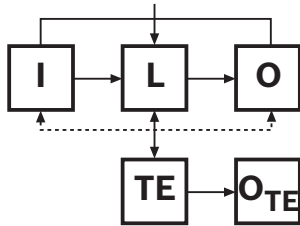
For applications outside these parameters, please consult us!

Information related to standard ISO 13849

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

CAN output 2THED5R

- Meets the architectural category 2 requirements of the standard ISO 13849 (test channel including redundant axis)
- PFHd < 10^{-6}



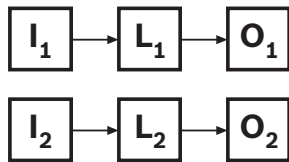
CAN output 2THEC5R

- Meets the architectural category 1 requirements of the standard ISO 13849
- PFHd < 3×10^{-6}



PWM signal output

- Meets the architectural category 3 requirements of the standard ISO 13849
- PFHd < 10^{-6}

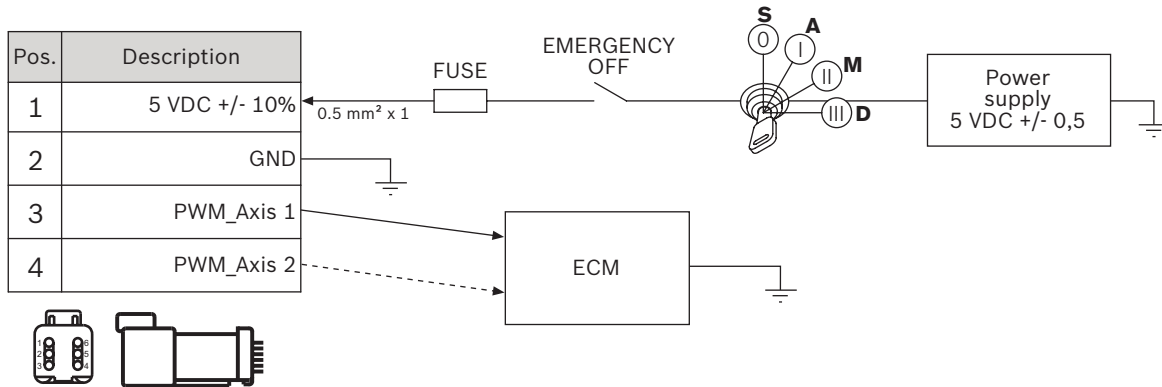


Electrical functions – signal PWM

Notice

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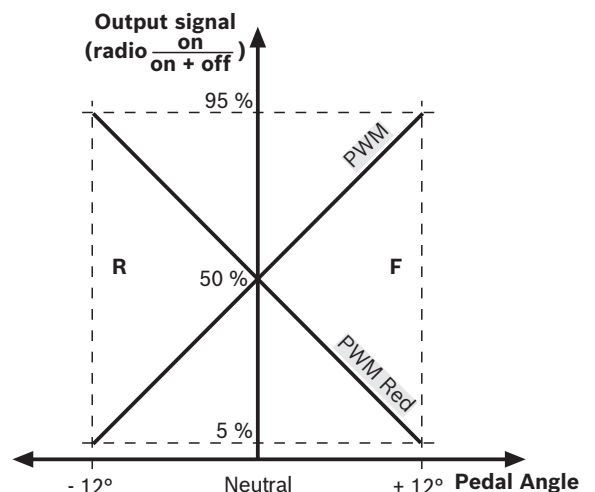
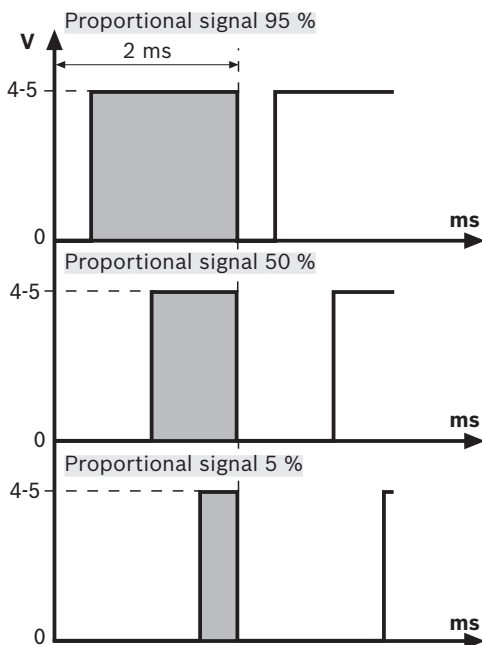
Electrical connection



Output characteristics

The proportional signal (%) is the time ratio between the high state and the signal period.

The 2THE5R 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 ... 34 VDC
Maximum current consumption		mA	150 for 14 V
Proportional signal			
		% of±250	(1 byte encoding)
Neutral		%	0 ¹⁾
Full stroke		%	±100 ¹⁾
Bus speed		KBds	100, 125, 250, 500, 1,000
Protocol (see page 11-12)			2.0A or 2.0B
Protections			
Protection against reverse polarity			Yes on supply side
Protection against short circuit			Connections towards machine protected from 0 to 32 V
Electromagnetic compatibility (EMC)			
Magnetic field according to ISO 11452 part2		V/m	[200 MHz; 2 GHz]; -150
Current injection according to ISO 11452 part4		mA	[50 kHz; 400 MHz]; [100 mA - 300 mA]
Direct electrostatic discharge		kV	±8
Conducted / Radiated emission CISPR25			Class 3
Electrostatic discharge in the air		kV	±15
Further data			Consult us

Notice

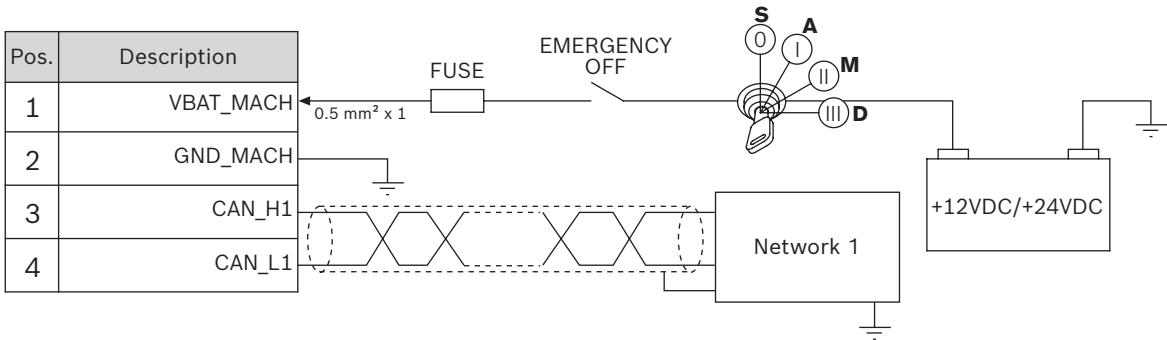
For applications outside these parameters, please consult us!

¹⁾ We recommend a dead band of $\pm 8\%$. The dead band can be set at the transmitter (CAN device) or at the receiver. By default, there is no dead band on the transmitter.

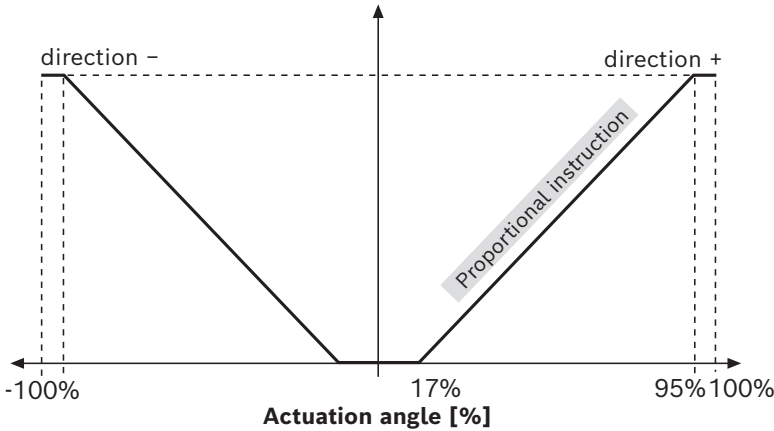
Electrical functions – signal CAN

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	unused	unused	unused	unused	unused	unused	unused	unused	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	unused	unused	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: 125, 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

Object dictionary

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 sends the TxPDO1 and TxPDO2 frames whose identifiers respect the DS300 standard.

The electronic control device 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 as soon as it detects a default.

EMCY identifier comply with the DS300 standard.

The list of error codes is available on request.

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 datasheet)
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 equest. 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: 125, 250, 500, 800, 1000 kBd (kBaud)

Source Address

The source address is the identifier of the electronic control device 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 JUN2011)

The electronic control device 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 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 automatically choose a new address and start again the claiming process.

The frames

► BJM (Basic Joystick Message)

The electronic control device manages BJM frames. The frame 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 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 JUL 2013

The DM1 frame is an information issued by the electronic control device 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 JUL 2013)

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 JUL 2013)

The DM14 to DM16 frames allow the configuration of the electronic control device 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.

Protocole J1939

General	
Source Adress (SA)	Configurable
Name	To be defined by the customer
Address claiming process	[Self Configurable; Master configurable] compliant with SAE J1939-81 JUN2011
Diagnosis Message 1 (DM1)	Compliant with SAE J1939-73 JUL 2013
Diagnosis Message 13 (DM13)	Compliant with SAE J1939-73 JUL 2013
Diagnosis Message 14-16 (DM14-16)	Compliant with SAE J1939-73 JUL 2013 (detail available on datasheet or on request)

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									
Axis 1	Mapping									
	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1		
	SPN2660		SPN2665		SPN2670		SPN2675		Byte 1	
	SPN2660									Byte 2
Axis 2	unused	unused	unused	unused	unused	unused	unused	unused	Byte 3	
	unused	unused	unused	unused	unused	unused	unused	unused	Byte 4	
Limit warning 1 (Detent 1)	SPN 2680		unused	unused	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	
	unused	unused	unused	unused	unused	unused	unused	unused	Byte 8	

SPN = Suspected Parameter Number

Evolved J1939 protocol

General	
Source Address (SA)	Configurable
Name	To be defined by the customer
Address claiming process	[Self Configurable; Master configurable] compliant with SAE J1939-81 JUN2011
Diagnosis Message 1 (DM1)	Compatible with SAE J1939-73 JUL 2013
Diagnosis Message 13 (DM13)	Compatible with SAE J1939-73 JUL 2013
Diagnosis Message 14-16 (DM14-16)	Compatible with SAE J1939-73 JUL 2013 (detail available on datasheet or on request)

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	
	SPN2660		SPN2665		SPN2670		SPN2675		Byte 1
Axis 2	SPN2660								Byte 2
	unused	unused	unused	unused	unused	unused	unused	unused	Byte 3
Limit warning 1 (Detent 1)	unused	unused	unused	unused	unused	unused	unused	unused	Byte 4
	SPN 2680		unused	unused	unused	unused	unused	unused	Byte 5
Counter and checksum	unused	unused	unused	unused	unused	unused	unused	unused	Byte 6
	unused	unused	unused	unused	unused	unused	unused	unused	Byte 7
Counter and checksum	SPN 4206 (Cks)				SPN 4207 (Cnt)				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 explodable 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 11. The fuse used on the power supply is 1.4 A at 12 V or 1 A at 24 V.

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

Recommendations for the definition of CAN frames

We recommend to incorporate an incremental frames counter into the set frames sent by the electronic control device. When processing CAN messages, the machine controller must verify the correct increment of the counter of the device frame and implement a message detection that will stop the movements controlled by the device in case of no message detected.

Startup recommendations (CAN setter...)

Maintenance test: A self test sequence has been defined in order to check the availability of the SIL2 safety functions. To reduce the startup time we can program a “light” self-test. The “light” self test does not exclude the periodic execution of the complete test.

- ▶ Starting with the CANopen protocol: If no adjustment is scheduled on machine, we recommend using the boot option in operational mode.
If you want to configure the electronic control device at each start, the .eds file (compatible with DSP306 standard) can be provided on request.
- ▶ Starting with the J1939 protocol: When starting in J1939 protocol, the electronic control device will wait to have a valid address before transmitting the instructions frames.

Maintenance recommendations**Self test**

The self test must be started automatically at each start or on demand every 10,000 hours of use. The self test sequence takes about 500 ms.

Error code

If the electronic control device is in default, an error code is emitted. The message containing the error code depends on the protocol used.

- ▶ In BRM Std: The error code is included in the 7th bytes of the frame 1.
- ▶ In CANopen: The error code is included in the 3rd and 4th bytes of the EMCY frame.
- ▶ In J1939: The error code is included in the 3rd and 4th bytes of the DM1 frame.

The description of the error codes is available on request.

Reset in case of error

The error codes are classified into 4 categories.

- ▶ Information Error Code
This type of defect does not influence the functioning it disappears when the fault is no longer present.
- ▶ Minor error code
This type of defect notify a malfunction of an electronic control device functionality.
It issues a neutral position signal on the faulty axis regardless of its position. It indicates an inactive status of some component regardless of its status. The operation returns to normal as soon as the axis or component returns to neutral and the fault is no longer detected.
- ▶ A major error code
This type of defect notify a major malfunction of the electronic control device.
It issues neutral position signals on all axes in default whatever their positions.
It indicates an inactive status of all connected components whatever their status. Resetting requires a reboot.
- ▶ Critical error code
Identical description to the “major error code” unless the fault remains present even after reset. To disable this type of defect, a specific CAN message must be sent to the electronic control device.
Contact Bosch Rexroth to receive the error code list and program the machine controller accordingly.

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