

Operating Instructions

June 2007 Edition

The DES (Digital EC Servoamplifier) is a very efficient digital servoamplifier with sinusoidal current commutation for the perfect control of EC (Electronic Commutation) motors.

The EC motors must be equipped with Hall sensors and a digital encoder with line driver. The controller, the monitoring and the complete control algorithms are implemented in a very fast digital signal processor. As with classical, conventional automatic controllers, easy trimming and adjustment of the servoamplifier is possible, with just a few potentiometers.

As an alternative, configuration and commanding also is possible over the PC (RS232 or CAN). This is particularly favourable with series application, as all adjustments and parameters can be quickly reproducibly and numerically set.

The set value specification can be made conventionally with an analogue input (0 ... +5 V or ±10 V), RS232 or CAN bus interface.

The sinusoidal commutation causes minimal torque ripple and low motor noise. The motor chokes integrated in the DES extend the operating range of the DES up to motors with very low inductance.



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The latest edition of these operating instructions, additional documentation and software to the DES 50/5 may be downloaded from the internet under www.maxonmotor.com category «Service & Downloads», Order number 205679.

This document is valid for the Hardware Version 4004.

# 1 Safety Instructions

**Skilled Personnel**

Installation and starting of the equipment shall only be performed by experienced, skilled personnel.

**Statutory Regulations**

The user must ensure that the servoamplifier and the components belonging to it are assembled and connected according to local statutory regulations.

**Load Disconnected**

For primary operation the motor should be free running, i.e. with the load disconnected.

**Additional Safety Equipment**

An electronic apparatus is, in principle, not fail-safe. Machines and apparatus must therefore be fitted with independent monitoring and safety equipment. If the equipment breaks down, if it is operated incorrectly, if the control unit breaks down or if the cables break, etc., it must be ensured that the drive or the complete apparatus is kept in a safe operating mode.

**Repairs**

Repairs may be made by authorised personnel only or by the manufacturer. It is dangerous for the user to open the unit or make repairs to it.

**Danger**

Do ensure that during the installation of the DES 50/5 no apparatus is connected to the electrical supply. After switching on, do not touch any live parts!

**Max. Supply Voltage**

Make sure that the supply voltage is between 12 and 50 VDC. Voltages higher than 53 VDC or of wrong polarity will destroy the unit.

**Short circuit and earth fault**

The DES 50/5 amplifier is not protected against winding short circuits against ground safety earth and/or Gnd!

## 2 Performance Data

### 2.1 Electrical data

Supply voltage $V_{CC}$ (Ripple < 5%) .....	12 - 50 VDC
Max. output voltage.....	$0.9 \cdot V_{CC}$
Max. output current $I_{max}$ .....	15 A
Continuous output current $I_{cont}$ .....	5 A
Switching frequency.....	50 kHz
Max. efficiency .....	92 %
Band width current controller.....	1 kHz
Max. speed (motor with 1 pole pair).....	25 000 rpm
Built-in motor choke per phase.....	160 $\mu$ H / 5 A

### 2.2 Inputs

“Set value” .....	configurable by DIP Switch <b>S9</b> : -10 ... +10 V ( $R_i = 80 \text{ k}\Omega$ ) 0 ... +5 V ( $R_i = 50 \text{ k}\Omega$ )
“Enable”.....	+2.4 ... +50 VDC ( $R_i = 22 \text{ k}\Omega$ )
“Digital 1” (Switch “Monitor n” / “Monitor l”) .....	+2.4 ... +50 VDC ( $R_i = 22 \text{ k}\Omega$ )
“Digital 2” (Switch speed- / current controller).....	+2.4 ... +50 VDC ( $R_i = 50 \text{ k}\Omega$ )
“STOP”.....	+2.4 ... +50 VDC ( $R_i = 22 \text{ k}\Omega$ )
Encoder signals .....	A, A', B, B', I, I' max. 1 MHz
Hall sensor signals.....	Hall sensor 1, Hall sensor 2, Hall sensor 3
CAN ID (CAN identification) .....	configured by DIP Switch <b>S1...7</b> ID = 1 ... 127 (binary coded)

### 2.3 Outputs

Monitor .....	configurable by DIP Switch <b>S10</b> : -10 ... +10 V ( $R_o = 1 \text{ k}\Omega$ , $f_g = 900 \text{ Hz}$ ) 0 ... +5 V ( $R_o = 1 \text{ k}\Omega$ , $f_g = 900 \text{ Hz}$ )
Status reading “Ready”.....	open collector max. 30 VDC ( $I_L < 20 \text{ mA}$ )

### 2.4 Voltage outputs

Encoder supply voltage .....	+5 VDC, max. 100 mA
Hall sensors supply voltage.....	+5 VDC, max. 50 mA

### 2.5 Interfaces

RS232 .....	RxD; TxD (max. 115 200 bit/s)
CAN.....	CAN_H (high); CAN_L (low) (max. 1 Mbit/s)

### 2.6 Trim potentiometers

$n_{max}$ , Offset,  $I_{max}$ , gain

### 2.7 LED indicator

Bi-colour LED .....

READY / ERROR (green = READY, red = ERROR)

### 2.8 Ambient temperature- / Humidity range

Operating .....	-10 ... +45°C
Storage.....	-40 ... +85°C
non condensating .....	20 ... 80 %

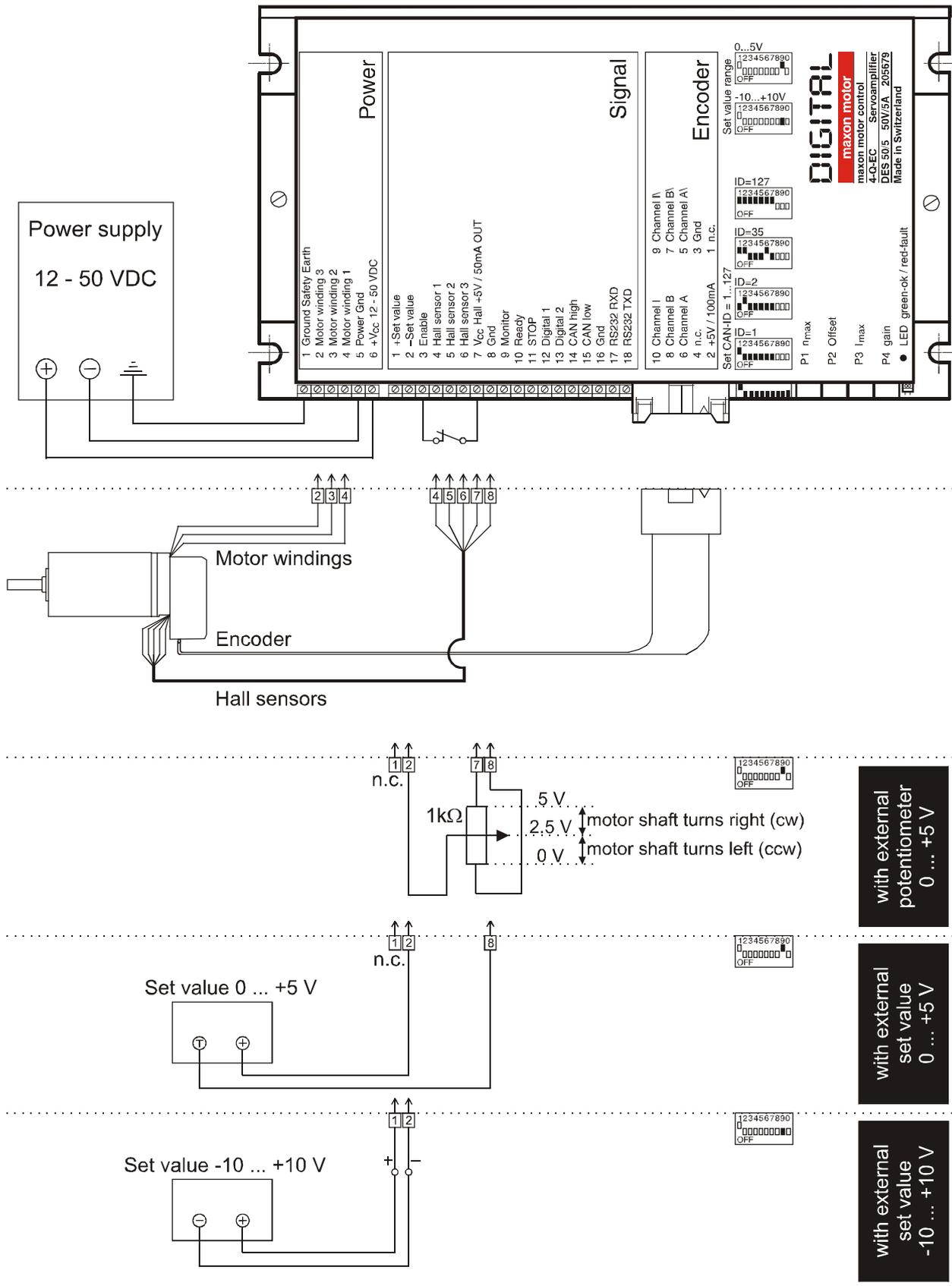
### 2.9 Mechanical data

Weight .....	approx. 410 g
Dimensions .....	see dimension drawing, <a href="#">chapter 9</a>

### 2.10 Connections

PCB clamps .....	Power (6 poles), Signal (18 poles)
Pitch .....	3.5 mm
suitable for wire cross section .....	0.14 ... 1 mm <sup>2</sup> multiple-stranded or 0.14 ... 1.5 mm <sup>2</sup> single wire
Encoder.....	Plug DIN41651 (10 poles) for flat band cable, pitch 1.27 mm, AWG28

### 3 Minimum External Wiring for Different Modes of Operation



## 4 Operating Instructions

### 4.1 Power supply layout

Any available power supply can be used, as long as it meets the minimal requirements set out below.

During set up and adjustment phases, we recommend separating the motor mechanically from the machine to prevent damage due to uncontrolled motion.

#### Power supply requirements

Output voltage	$V_{CC}$ min. 12 VDC; max. 50 VDC
Ripple	< 5 %
Maximum output current	5 A continuous (15 A max.)

The required voltage can be calculated as follows:

#### Known values

- ⇒ Operating torque  $M_B$  [mNm]
- ⇒ Operating speed  $n_B$  [rpm]
- ⇒ Nominal motor voltage  $U_N$  [V]
- ⇒ Motor no-load speed at  $U_N$ ,  $n_0$  [rpm]
- ⇒ Speed/torque gradient of the motor  $\Delta n / \Delta M$  [rpm / mNm]

#### Sought values

- ⇒ Supply voltage  $V_{CC}$  [V]

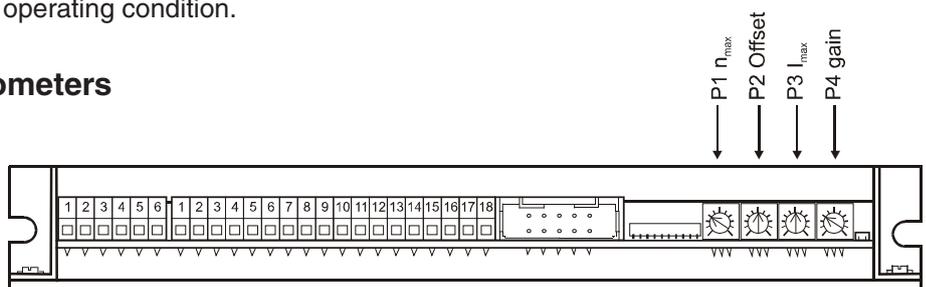
#### Solution

$$V_{CC} = \frac{U_N}{n_0} \cdot \left( n_B + \frac{\Delta n}{\Delta M} \cdot M_B \right) \cdot \frac{1}{0,9} + 2 [V]$$

Choose a power supply capable of supplying this calculated voltage under load. The formula takes a max. PWM cycle of 90 % and a 2 volts max. voltage drop at DES 50/5 into account.

**Consider:** The power supply must be able to buffer the back-fed energy from brake operation e.g. in a condenser. With electronically stabilized power supply units it is to ensure, that the overcurrent protection responds in no operating condition.

### 4.2 Function of the potentiometers



Potentiometer		Function	Turn to the	
			left ↶	right ↷
P1	$n_{max}$	max. speed at max. set value (e.g. external potentiometer fully clockwise; 5 V; 10 V)	slower min. 0 rpm	faster max. 25000 rpm
P2	Offset	Adjustment: $n = 0$ rpm (set value e.g. ext. pot. in centre pos.)	motor turns CCW	motor turns CW
P3	$I_{max}$	current limit	lower $\approx 0$ A	higher $\approx 15$ A
	$I_{cont}$		lower $\approx 0$ A	higher $\approx 5$ A
P4	gain	amplification	lower	higher

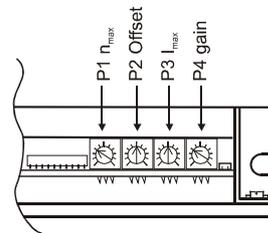
## 4.3 Adjustment of the Potentiometers

### 4.3.1 Pre-adjustment

With the pre-adjustment, the potentiometers are set in a preferred position.

DES units in the original packing are preset.

Pre-adjustment potentiometers		
<b>P1</b>	$n_{\max}$	30 % <sup>1)</sup>
<b>P2</b>	Offset	50 %
<b>P3</b>	$I_{\max}$	50 % <sup>2)</sup>
<b>P4</b>	gain	30 %



1) 30 % are equivalent to  $n_{\max} = \text{approx. } 7500 \text{ rpm}$

2) 50 % are equivalent to  $I_{\text{cont}} = \text{approx. } 2,5 \text{ A}$ ;  $I_{\max} = \text{approx. } 7,5 \text{ A}$

### 4.3.2 Adjustment

#### Digital speed control (see also [5.1.6](#))

1. Give the max. set value (e.g. 10 V) and turn potentiometer **P1**  $n_{\max}$  so far that the required speed is achieved.
2. Set potentiometer **P3**  $I_{\max}$  at the limiting value desired.  
**Important:** The limiting value  $I_{\text{cont}} (=1/3 I_{\max})$  should be below the nominal current (max. continuous current) as shown on the motor data sheet.
3. Increase potentiometer **P4** gain slowly until the amplification is set large enough.  
**Caution:** If the motor vibrates or becomes loud, the amplification is adjusted too high and the potentiometer must be readjusted until the instability of the closed loop of the drive under all loads ceases.
4. Adjust set value to zero, e.g. by short circuiting the set value. Then, with the potentiometer **P2** Offset, set the motor speed to zero.  
Note: Step 4 is not necessary with external set value potentiometer.

#### Digital current control (see also [5.1.6](#))

1. Set potentiometer **P3**  $I_{\max}$  at the limiting value desired.  
**Important:** The limiting value  $I_{\text{cont}} (=1/3 I_{\max})$  should be below the nominal current (max. continuous current) as shown in the motor data sheet.
2. Adjust set value to zero, e.g. by short circuiting the set value. Then, with the potentiometer **P2** Offset, set the motor speed to zero

#### Note

Configured as a current controller, **P1**  $n_{\max}$  and **P4** gain are not activated.

## 5 Functions

### 5.1 Inputs

#### 5.1.1 Set value

Two different versions can be selected to give an analogue set value. Versions are selected by setting the DIP switch **S9** "Set value range". The "Set value" input is protected against overvoltage.

Set value range -10 ... +10 V

Input voltage range	-10 ... +10 V
Input circuit	differential
Input resistance	80 k $\Omega$
Positive set value	(+Set Value) > (-Set Value)
Negative set value	(+Set Value) < (-Set Value)
DIP-Switch <b>S9</b>	OFF 

Set value range 0 ... +5 V

Input voltage range	0 ... +5 V
Input circuit	against Gnd
Input resistance	50 k $\Omega$
Positive set value	(-Set Value) < 2.5 VDC
Negative set value	(-Set Value) > 2.5 VDC
DIP switch <b>S9</b>	ON 
Required external potentiometer	1 k $\Omega$

Set value range 0 ... +5 V is selected, if the set value is given from an external potentiometer.

#### 5.1.2 Enable

If a voltage is given at "Enable", the servoamplifier switches the motor voltage to the winding connections. If the "Enable" input is not switched on or is connected to Gnd, the power stage will be high-impedance (floating) and will be disabled.

The "Enable" input is protected against overvoltage.

	Input resistance	22 k $\Omega$ (+5 V) 10 k $\Omega$ (+24 V)
"Enable"	Minimum input voltage	+2.4 VDC
	Maximum input voltage	+50 VDC
	Switching time	nominal 3 ms (at 5 V)
"Disable"	Minimum input voltage	0 VDC
	Maximum input voltage	+0.8 VDC
	Switching time	nominal 4 ms (at 5 V)

### 5.1.3 Hall sensor 1, Hall sensor 2, Hall sensor 3

On one hand the Hall sensors detect the rotor position during start-up and on the other hand monitor the rotor position during operation. The "Hall sensor" inputs are protected against overvoltage.

Voltage value LOW	max. 0.8 V
Voltage value HIGH	min. 2.4 V
Internal pull-up resistor	2.7 k $\Omega$ against +5 VDC

Suitable for hall effect sensors IC using Schmitt trigger with open collector output.

### 5.1.4 STOP

If a voltage is given at "STOP", the motor speed will be stopped with maximum deceleration (adjusted value at potentiometer **P3 I<sub>max</sub>**) until motor shaft stands still.

If the "STOP" input is not switched on (floating) or is connected to Gnd the motor speed is not influenced.

The "STOP" input is protected against overvoltage.

Input resistance	22 k $\Omega$ (+5 V) 12 k $\Omega$ (+24 V)
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"STOP" disabled

Minimum input voltage	0 VDC
Maximum input voltage	+0.8 VDC

"STOP" enabled

Minimum input voltage	+2.4 VDC
Maximum input voltage	+50 VDC

### 5.1.5 Toggle monitor signal "Digital 1"

If the "Digital 1" input is not switched on (floating) or is connected to Gnd the actual motor speed is given to the "Monitor" output.

If a voltage is given at "Digital 1", the actual motor current is given to the "Monitor" output.

The "Digital 1" input is protected against overvoltage.

Input resistance	22 k $\Omega$ (+5 V) 12 k $\Omega$ (+24 V)
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"Monitor n" enabled

Minimum input voltage	0 VDC
Maximum input voltage	+0.8 VDC

"Monitor l" enabled

Minimum input voltage	+2.4 VDC
Maximum input voltage	+50 VDC

### 5.1.6 Toggle controller mode (speed- / current control) “Digital 2”

If the “Digital 2” input is not switched on (floating) or is connected to a voltage higher than 2.4 VDC the servoamplifier is configured to speed controller mode.

If the “Digital 2” input is connected to Gnd the servoamplifier is configured to current (torque) mode.

The “Digital 2” input is protected against overvoltage.

	Input resistance	50 k $\Omega$ (+5 V) 12 k $\Omega$ (+24 V)
Speed control enabled	Minimum input voltage	+2.4 VDC
	Maximum input voltage	+50 VDC
Current control enabled	Minimum input voltage	+0 VDC
	Maximum input voltage	+0.8 VDC

#### Note

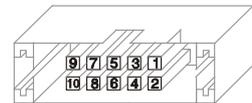
If the controller mode has been changed, a Disable-Enable process (refer to [5.1.2](#)) must be carried out for the activation of the new mode.

### 5.1.7 Encoder

Encoder supply voltage	+5 VDC max. 100 mA
Maximum encoder frequency	1 MHz
Voltage value	TTL Low max. 0.8 V High min. 2.0 V
Line receiver (internal)	EIA standard RS-422

It is recommended to use an encoder with built-in line driver.

Male connector (front view)



### 5.1.8 Pin configuration at “Encoder” input:

1	n.c.	Not connected
2	+5 V	+5 VDC max. 100 mA
3	Gnd	Ground
4	n.c.	Not connected
5	A\	Inverted channel A
6	A	Channel A
7	B\	Inverted Channel B
8	B	Channel B
9	I\	Inverted Channel I
10	I	Channel I

This pin configuration is compatible with the flat cable plugs of the HEDL 55xx encoder (with line driver) and the MR encoders with line driver, type ML and L.

#### Note

The standard encoder adjustment (original packing) refers to a 500-counts per turn encoder. For other encoders the adjustment must be modified with the software (GUI).

## 5.2 Outputs

### 5.2.1 Auxiliary voltage “V<sub>cc</sub> Hall +5 V / 50 mA OUT”

An internal auxiliary voltage of +5 V is provided:

- Powering the hall sensors
- Gating the signals: Enable, Digital 1 and Digital 2
- Reference voltage for external set value potentiometer (1 kΩ)

The output is fuse-protected against overload.

Output voltage	+5 VDC
Max. output current	50 mA

### 5.2.2 “Monitor”

Speed monitor “Monitor n”      “Digital 1” input      0 ... +0.8 VDC (or not connected)

The speed monitor is primarily intended for the qualitative estimation of the dynamics. The absolute speed is determined by the properties of the speed sensors and by the setting of the  $n_{\max}$  potentiometer. The signal is proportional to the speed.

	DIP switch <b>S10</b> ↓ OFF	DIP switch <b>S10</b> ↑ ON
Output voltage range	0 ... +5 VDC	-10 ... +10 VDC
Ripple	max. 0.02 V	max. 0.08 V
Resolution	approx. 0.0125 V (400 Steps)	approx. 0.05 V (400 Steps)
Output resistance R <sub>o</sub>	1 kΩ	1 kΩ
Cutoff frequency f <sub>g</sub>	900 Hz	900 Hz

Example:

-n <sub>max</sub> corresponding to	0 V	-10 V
0 rpm corresponding to	2.5 V	0 V
+n <sub>max</sub> corresponding to	5 V	+10 V

Current monitor “Monitor I”      “Digital 1” input      +2.4 ... +50 VDC

The servoamplifier makes a current actual value available for monitoring purposes. The signal is proportional to the mean value of the motor current.

	DIP switch <b>S10</b> ↓ OFF	DIP switch <b>S10</b> ↑ ON
Output voltage range	0 ... +5 VDC	-10 ... +10 VDC
Ripple	max. 0.02 V	max. 0.08 V
Resolution	approx. 0.0125 V (400 Steps)	approx. 0.0500 V (400 Steps)
Output resistance R <sub>o</sub>	1 kΩ	1 kΩ
Cutoff frequency f <sub>g</sub>	900 Hz	900 Hz
Gradient	≈ 6 A/V	≈ 1.5 A/V

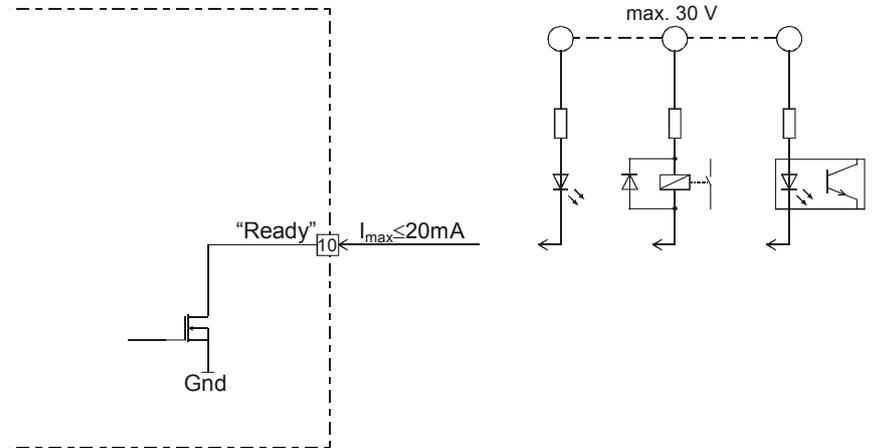
Example:

-15 A corresponding to	0 V	-10 V
0 A corresponding to	2.5 V	0 V
+15 A corresponding to	5 V	+10 V

The “Monitor” output is protected against overload.

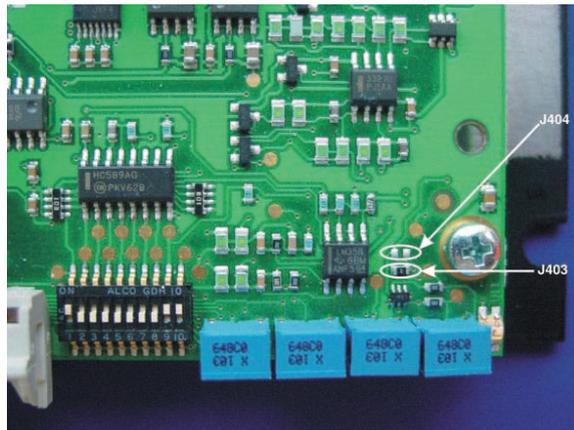
5.2.3 Status reading “Ready”

The “Ready” signal can be used to report the state of operational readiness or a fault condition on a master control unit. The fault condition is stored. In order to reset the fault condition, the servoamplifier must be re-released (Enable). If the cause of the fault situation cannot be eliminated, the error will occur again immediately.



An external additional voltage is required:

Input voltage range	max. 30 VDC
Load current	< 20 mA



**Version 1**  
Standard (pre-adjusted)

Error output	J403 short-circuited (0 Ω) J404 not mounted (open)
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The open collector output is, in normal cases, i.e. no faults, switched to Gnd. In case of a fault, the error output is not conducting (see also 6.2).

**Version 2**  
Special (customized)

Inverted error output	J403 not mounted (open) J404 short-circuited (0 Ω)
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The open collector output is, in normal cases, i.e. no faults, not conducting (high resistance).

In case of a fault, the error output is switched to Gnd (see also 6.2).

## 5.3 Interfaces

### 5.3.1 Serial Interface “RS232 RX”, “RS232 TX”

Maximum input voltage	± 30 V
Maximum output voltage	± 30 V
Maximum bit rate	115 200 bit/s
Data line protection	ESD protected
Internal RS232 driver/receiver	EIA RS232 standard
Baud rate (configurable)	Up to max. 115 200 bit/s

#### Note

- Please bear in mind your PC's serial port maximal baud rate.
- The standard baud rate setting (original packing) is 38 400 bauds. If a different rate is required, the setting must be changed using the software (GUI).

Data bits	8
Parity	none
Stop bit	1
Protocol	none

Connection DES - PC

Servoamplifier DES 50/5	PC Interface (RS232), DIN41652
Signal clamp pin 16 Gnd	Pin 5 Gnd
Signal clamp pin 17 RS232 RxD	Pin 3 TxD
Signal clamp pin 18 RS232 TxD	Pin 2 RxD

### 5.3.2 CAN Interface “CAN high”, “CAN low”

Standard type	CAN high-speed ISO 11898 compatible
Maximum bit rate	1 Mbit/s
Max. number of CAN nodes (fan out)	127
Protocol	CAN 2.0B
CAN frame type	Standard (11 bit identifier)
Identifier setting	by software over CAN or RS232

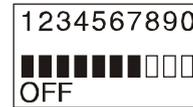
Connection DES – CAN  
bus line CiA DS-102

Servoamplifier DES 50/5	CAN 9-pin D-Sub (DIN41652)
Signal clamp pin 14 CAN high	Pin 7 CAN_H
Signal clamp pin 15 CAN low	Pin 2 CAN_L
Signal clamp pin 16 Gnd	Pin 3 CAN_GND

### 5.3.3 CAN ID (CAN Identification)

The CAN-ID (node address) is set at DIP switch **S1 ... 7**.  
All addresses can be coded from 1 ... 127 using the binary code.

Switch	Binary code	Valence
1	$2^0$	1
2	$2^1$	2
3	$2^2$	4
4	$2^3$	8
5	$2^4$	16
6	$2^5$	32
7	$2^6$	64



If the valences of all switches set at ON are added together, this gives the set CAN-ID (node address).

Examples:

The following table can be used as a guide, but is not comprehensive.

	Switch	1	2	3	4	5	6	7	
	Valence	1	2	4	8	16	32	64	
CAN-ID	Switch setting								Calculation
1		1	0	0	0	0	0	0	1
2		0	1	0	0	0	0	0	2
32		0	0	0	0	0	1	0	32
35		1	1	0	0	0	1	0	1 + 2 + 32
127		1	1	1	1	1	1	1	1 + 2 + 4 + 8 + 16 + 32 + 64

#### Note

- CAN-ID = 0 is invalid and overwritten with CAN-ID = 1.
- DIP switches **S8** to **S10** have no impact on the CAN-ID.

## 5.4 Current limit

Brushless maxon EC motors are particularly well suited for use in servo-drives. Very fast acceleration times and thermal overload protection are required.

The digital servoamplifier DES 50/5 operates with  $I_{\max}$  - and  $I_{\text{cont}}$  -current limitation, which satisfies both requirements.

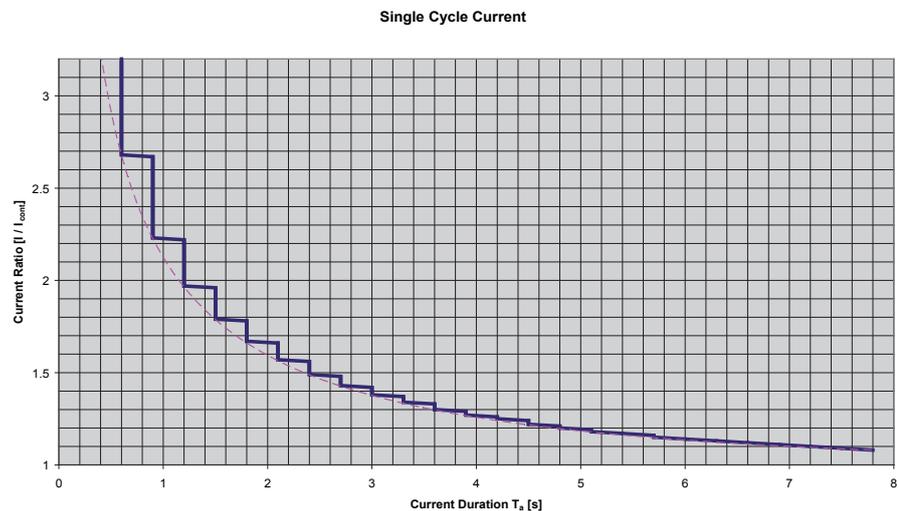
Maximum output current $I_{\max}$	< 15 A
Continuous output current $I_{\text{cont}}$	< 5 A
Ratio $I_{\max} : I_{\text{cont}}$	3:1

The continuous output current  $I_{\text{cont}}$  (0 ... +5 A), adjusted with the potentiometer, is available on an unlimited basis.

A higher current is also permitted for a short time ( $I_{\max} = 3 \cdot I_{\text{cont}}$ ), whereby the length of time is dependent on the previous history of the current path.

### 5.4.1 Single acceleration current

The diagram below shows the relationship between the  $I_{\max} / I_{\text{cont}}$  ratio and the period during which  $I_{\max}$  can be drawn.



A higher current  $I_{\max}$  is permitted for motor acceleration for the period  $T_a$ , after which it is limited to continuous current  $I_{\text{cont}}$ .

#### Example

Max. continuous current  $I_{\text{cont}} = 5 \text{ A}$

Max. output current  $I_{\max} = 15 \text{ A}$

Question:

How long does the DES permit the acceleration current of  $I_{\max} = 15 \text{ A}$ ?

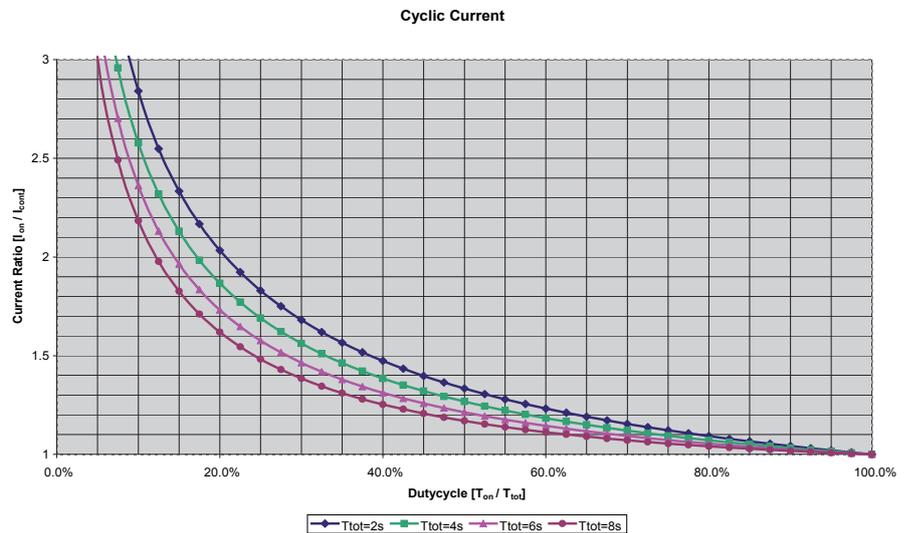
Resolution:

Current ratio  $I_{\max} / I_{\text{cont}} = 15 \text{ A} / 5 \text{ A} = 3$

Period of acceleration  $T_a = 0.6 \text{ s}$  (from diagram)

### 5.4.2 Cyclic operation

The diagram below shows how long the DES can **cyclically** supply a specific output current  $I_{ON}$ . This is based on the assumption that the current between the acceleration processes is zero, otherwise this period is reduced. The diagram shows the relationship between the pulse-width modulation ( $T_{on} / T_{tot}$ ) and the current ratio during the „ON-Time“ to the set max. continuous current ( $I_{on} / I_{cont}$ ).



The diagram shows 4 different curves for the total cycle times  $T_{tot} = 2\text{ s}$ ,  $4\text{ s}$ ,  $6\text{ s}$  und  $8\text{ s}$ .

Example:

Cycle time  $T_{tot} = 4\text{ s}$   
 Max. continuous current  $I_{cont} = 5\text{ A}$

Question:

Potential output current in an operation time by 400 ms.

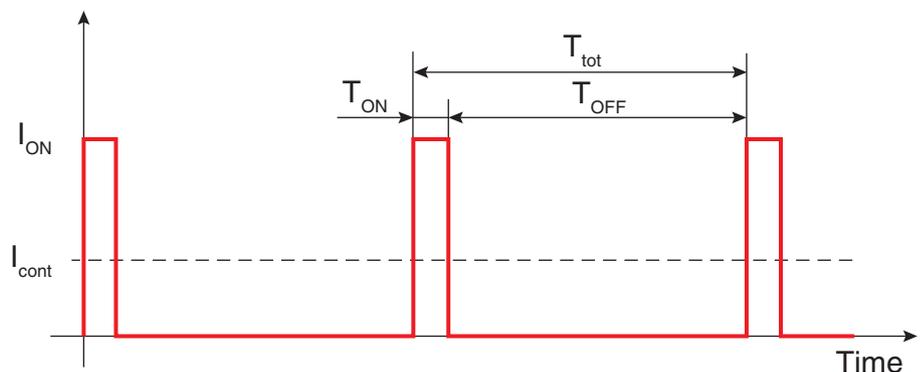
Resolution:

Pulse-width modulation =  $T_{on} / T_{tot} = 400\text{ ms} / 4\text{ s} = 0.1 \rightarrow 10\%$

Current ratio ( $I_{on} / I_{cont}$ ) = 2.6 (from diagram)

**Possible cyclic output current  $I_{ON}$  during  $T_{on}$  =**

$$2.6 \times I_{cont} = 2.6 \times 5\text{ A} = 13\text{ A}$$



## 6 Error Messages

### 6.1 Faultless condition

The green LED shows the operating status (“Enable” or “Disable”) of DES.  
DES in “Disable” status (DES ready): green LED flashes (flash frequency approx. 1 Hz), red LED does not shine.

DES in “Enable” status (power stage of DES is enabled): green LED shines continually, red LED does not shine.

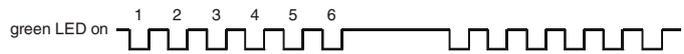
### 6.2 Faulty condition

Error conditions are detected by DES.

The red LED shines continually in the event of error condition.

Depending on error, the green LED flashes at varying intervals.

Example: Error 5



Number of flashing pulses of green LED	possible errors
1	<p>Error 0 =&gt; Hall sensor error</p> <ul style="list-style-type: none"> <li>– Hall sensors incorrectly wired</li> <li>– Hall sensor supply voltage incorrectly wired</li> <li>– damaged Hall sensor in the motor</li> </ul>
2	<p>Error 1 =&gt; Index processing error</p> <ul style="list-style-type: none"> <li>– Encoder without working index channel</li> <li>– System parameter “Encoder Resolution” set incorrectly</li> <li>– Input frequency of encoder signal too high</li> </ul>
3	<p>Error 2 =&gt; Wrong setting of encoder resolution</p> <ul style="list-style-type: none"> <li>– System parameter (“Encoder resolution”) set incorrectly</li> </ul>
4	<p>Error 3 =&gt; Hall sensor 3 not found</p> <ul style="list-style-type: none"> <li>– Hall sensor 3 incorrectly wired</li> <li>– Damaged Hall sensor 3 in the motor</li> <li>– System parameter “Encoder Resolution” set too low</li> </ul>
5	<p>Error 4 =&gt; Over current error</p> <ul style="list-style-type: none"> <li>– Short circuit in the motor winding</li> <li>– Power supply cannot supply enough acceleration current</li> <li>– Gain regulation loop is too high; speed regulation gains must be reduced</li> <li>– System parameter “Acceleration” too high</li> <li>– Damaged power stage</li> </ul>
6	<p>Error 5 =&gt; Over voltage error</p> <ul style="list-style-type: none"> <li>– Power supply voltage too high</li> <li>– Voltage in generation mode too high</li> </ul>
7	<p>Error 6 =&gt; Over speed error</p> <ul style="list-style-type: none"> <li>– Speed in current control mode too high (&gt; 30 000 rpm)</li> </ul>
8	<p>Error 7 =&gt; Supply voltage too low for operation</p> <ul style="list-style-type: none"> <li>– Supply voltage is too low for operation</li> </ul>
9	<p>Error 8 =&gt; Angle detection error</p> <ul style="list-style-type: none"> <li>– The difference of the angle between the encoder and Hall sensors is out of tolerance</li> <li>– Interference on encoder and Hall sensor signals</li> </ul>
12	<p>Error 11 =&gt; Overtemperature</p> <ul style="list-style-type: none"> <li>– The temperature of the power stage is too high</li> </ul>

## 7 EMC-compliant installation

### Power supply (+V<sub>CC</sub> - Power Gnd)

- No shielding normally required.
- Star point-shaped wiring if several amplifiers are supplied by the same power supply.

### Motor cable (> 30 cm)

- Shielded cable highly recommended.
- Connect shielding on both sides:
  - DES 50/5 side: Terminal 1 "Ground Safety Earth" and/or bottom of housing.
  - Motor side: Motor housing or with motor housing mechanical design with low resistive connection.
- Use separate cable.

### Hall sensor cable (> 30 cm)

- Shielded cable highly recommended.
- Connect shielding on both sides:
  - DES 50/5 side: Terminal 1 "Ground Safety Earth" and/or bottom of housing.
  - Motor side: Motor housing or with motor housing mechanical design with low resistive connection.
- Use separate cable.

### Direct connection motor/Hall cable ( $\leq 30$ cm) on DES 50/5

- Shield casing over motor/Hall connection cable
  - Connect shielding on both sides
- or
- Lowest resistive connection of motor housing and "Ground Safety Earth" terminal 1 and/or bottom of DES 50/5 housing
  - Cable design of motor/Hall connection cable as close as possible with aforementioned connection

### Encoder cable

- Encoder with line driver recommended.
- Channel A, A\; channel B, B\; channel I, I\; twisted pair.
- No shielding normally required.
- Use separate cable.

### RS-232

- Twisted pair shielded cable recommended.
- Use separate cable.

**CAN**

- See CiA DS-102 (twisted and / or shielded two-wire circuit closed with the circuit's impedance with common return circuit).
- Closure with impedance through external circuit.
- No galvanic separation on DES 50/5.

**Analogue signals (Set value, Monitor)**

- No shielding normally required
- Use cable shielding with analogue signals with small signal level and electromagnetically harsh environment
- Normally connect shielding on both sides. Place shielding on one side if there are 50/60 Hz interference problems.

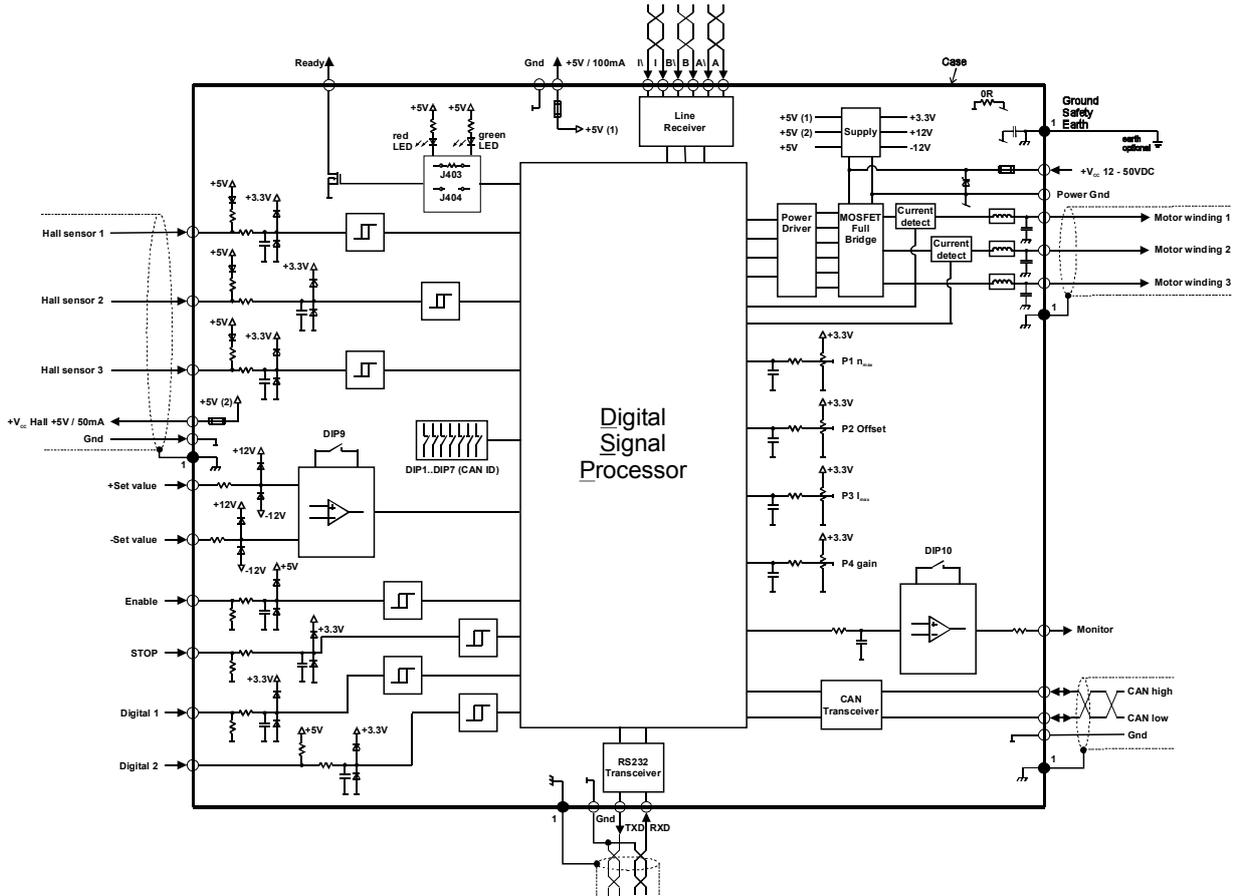
**Digital signals (Enable, Stop, Digital 1, Digital 2, Ready)**

- No shielding necessary.

See also block diagram in [chapter 8](#).

**In practical terms, only the complete equipment, comprising all individual components (motor, amplifier, power supply unit, EMC filter, cabling etc.) can undergo an EMC test to ensure interference-free CE-approved operation.**

### 8 Block Diagram



### 9 Dimension Drawing

Dimensions in [mm]

