

Motor – sensor configurations					
Sensor \ Motor	PMSM	BLDC	DC BRUSH	STEP (2-ph)	STEP (3-ph)
Incr. Encoder	Y		Y	Y	
Incr. Encoder + Hall	Y	Y			
Analog Sin/Cos encoder	Y				
Linear Halls	Y				
Digital Halls	Y				
Tacho			Y		
Open-loop (no sensor)				Y	Y

Connectors type			
Ref.	Producer	On-board connector	Mating connector
J1, J2	Fischer Elektronik	SL 11 112 020 G	BL 5 20
-	-	Standard header square pin 0.635 x 0.635 mm; 2.54 mm pitch	Standard socket for square pin 0.635 x 0.635 mm; 2.54 mm pitch

Features	
▪	Motor supply: 9-36V. Optional logic supply: 7-36V
▪	Output current: 2A cont. (BLDC mode); 3.2A <sub>PEAK</sub> , up to 100KHz PWM
▪	Digital Hall sensor interface (single-ended and open collector)
▪	Incremental encoder interface (single-ended, open collector and differential)
▪	Linear Hall sensors interface
▪	Analogue sin/cos encoder interface (differential 1V <sub>pp</sub> )
▪	5 digital inputs, 5-36V, NPN: Enable, 2 for limit switches, 2 general-purpose
▪	3 digital outputs, 5-36V, 0.5A, NPN O.C.: Ready, Error, 1 general-purpose
▪	1 analogue input: 12-bit, 0-5V: Reference or general purpose
▪	RS-232 serial & CAN-bus 2.0B interfaces with h/w selectable addresses
▪	TMLCAN and CANopen (CiA 301v4.2 and 402v3.0) protocols
▪	2K x 16 SRAM for data acquisition
▪	4K x 16 E <sup>2</sup> ROM to store TML motion programs and data
▪	Operating ambient temperature: 0-40°C (over 40°C with derating)
▪	Hardware Protections: short-circuit between motor phases and from motor phases to GND, over-voltage, under-voltage and I <sup>2</sup> t
▪	Firmware: F509M+ or F524E+

Connector description			
Pin	Name	Type	Description
1-2	B / A-	O	Phase B for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors
3-4	CR / B-	O	Chopping resistor / Phase B- for step motors
5-6	+V <sub>MOT</sub>	I	Positive terminal of the motor supply: 9 to 36V <sub>DC</sub>
7	+V <sub>LOG</sub>	I	Positive terminal of the logic supply: 7 to 36V <sub>DC</sub>
8	OUT3 / Ready	O	5-36V 0.5A drive ready output, active low, NPN open-collector/TTL pull-up. Also drives the green LED.
9	OUT2 / Error	O	5-36V 0.5A drive error output, active low, NPN open-collector/TTL pull-up. Also drives the red LED
10	Hall 1	I	Digital input Hall 1 sensor
11	Hall 2	I	Digital input Hall 2 sensor
12	Hall 3	I	Digital input Hall 3 sensor
13	OUT0	O	5-36V 0.5A general-purpose digital output, NPN open-collector / TTL pull-up

14	REF	I	Analogue input, 12-bit, 0-5V. Used to read an analog position, speed or torque reference, or used as general purpose analogue input
15	Z / Z+	I	Incr. encoder Z (index) single-ended, or Z+ diff. input
16	Z- / LH3	I	Incr. encoder Z- differential input, or linear Hall 3 input
17	A / A+ / Sin+	I	Incr. encoder A single-ended, or A+ diff. input, or analogue encoder Sin+ diff. input
18	A- / Sin- / LH1	I	Incr. encoder A- diff. input, or analogue encoder Sin- diff. input, or linear Hall 1 input
19	B / B+ / Cos+	I	Incr. encoder B single-ended, or B+ diff. input, or analogue encoder Cos+ diff. input
20	B- / Cos- / LH2	I	Incr. encoder B- diff. input, or analogue encoder Cos- diff. input, or linear Hall 2 input

Pin	Name	Type	Description
1-2	A / A+	O	Phase A for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors
3-4	C / B+	O	Phase C for 3-ph motors, B+ for 2-ph steppers
5-6	GND	-	Negative return (ground) of the motor supply
7	IN0	I	5-36V digital input General-purpose
8	IN1	I	5-36V digital input
9	IN2 / LSP	I	5-36V digital input Positive limit switch input
10	IN3 / LSN	I	5-36V digital input Negative limit switch input
11	IN4 / Enable	I	5-36V digital input Drive enable input
12	GND	-	Return ground
13	+5V <sub>OUT</sub>	O	5V output supply
14	AxisID 2	I	Axis ID/Address input. 7 states: floating, strap to GND or +5V, resistor 4K7 or 22K to GND or +5V
15	AxisID 1	I	Axis ID/Address input. 7 states: floating, strap to GND or +5V, resistor 4K7 or 22K to GND or +5V
16	AxisID 0	I	Axis ID/Address input. 7 states: floating, strap to GND or +5V, resistor 4K7 or 22K to GND or +5V
17	Can-Lo	I/O	CAN-Bus negative line (dominant low)
18	Can-Hi	I/O	CAN-Bus positive line (dominant high)
19	232TX	O	RS-232 Data Transmission
20	232RX	I	RS-232 Data Reception

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### Electrical characteristics

All parameters measured under the following conditions (unless otherwise specified):

- Tamb = 0...40°C, VLOG = 24 VDC; VMOT = 36VDC
- Supplies start-up / shutdown sequence: -any-
- Load current (sinusoidal amplitude / continuous BLDC, DC, stepper) = 2A


Operating Conditions		Min.	Typ.	Max.	Units
Ambient temperature <sup>1</sup>		0		+40	°C
Ambient humidity	Non-condensing	0		90	%Rh
Altitude / pressure <sup>2</sup>	Altitude (vs. sea level)	-0.1	0 ÷ 2.5		Km
	Ambient Pressure	0 <sup>2</sup>	0.75 ÷ 1	10.0	atm
Storage Conditions		Min.	Typ.	Max.	Units
Ambient temperature		-40		+85	°C
Ambient humidity	Non-condensing	0		100	%Rh
Ambient Pressure		0		10.0	atm
ESD capability (Human body model)	Not powered; applies to any accessible part			±0.5	kV
	Original packaging			±15	kV
Mechanical Mounting		Min.	Typ.	Max.	Units
Airflow		natural convection <sup>3</sup> , closed box			
Spacing required for vertical mounting	Between adjacent drives	30			mm
	Between drives and nearby walls	30			mm
	Between drives and roof-top	20			mm
Spacing required for horizontal mounting	Between adjacent drives	4			mm
	Between drives and nearby walls	5			mm
	Space needed for drive removal	10			mm
	Between drives and roof-top	15			mm
Insertion force	Using recommended mating		20	36	N
Extraction force	connectors; without retainer	5	10		N
Environmental Characteristics		Min.	Typ.	Max.	Units
Size ( Length x Width x Height )	Global size	55 x 26.4 x 13.1			mm
		~2.2 x 1 x 0.5			inch
Weight		8			g
Power dissipation	Idle (no load)		1		W
	Operating		3		W
Efficiency			98		%
Cleaning agents	Dry cleaning is recommended	Only Water- or Alcohol- based			
Protection degree	According to IEC60529, UL508	IP00			-
Logic Supply Input (+V <sub>LOG</sub> )		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	7		36	V <sub>DC</sub>
	Absolute maximum values, drive operating but outside guaranteed parameters	4.9		40	V <sub>DC</sub>
	Absolute maximum values, continuous	-0.7		42	V <sub>DC</sub>
	Absolute maximum values, surge (duration ≤ 10ms) <sup>†</sup>	-1		+45	V
Supply current	+V <sub>LOG</sub> = 7V		125	300	mA
	+V <sub>LOG</sub> = 12V		80	200	
	+V <sub>LOG</sub> = 24V		50	125	
	+V <sub>LOG</sub> = 40V		40	100	
Motor Supply Input (+V <sub>MOT</sub> )		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	9		36	V <sub>DC</sub>
	Absolute maximum values, drive operating but outside guaranteed parameters	8.5		40	V <sub>DC</sub>
	Absolute maximum values, continuous	-0.7		42	V <sub>DC</sub>
	Absolute maximum values, surge (duration ≤ 10ms) <sup>†</sup>	-1		+45	V
Supply current	Idle		1	5	mA
	Operating	-3.2	±2	+3.2	A
Supply current	Absolute maximum value, short-circuit condition (duration ≤ 10ms) <sup>†</sup>			5	A

Motor Outputs (A/A+, B/A-, C/B+, BR/B-)		Min.	Typ.	Max.	Units
Nominal output current, continuous	for DC brushed, steppers and BLDC motors with Hall-based trapezoidal control			2	A
	for PMSM motors with FOC sinusoidal control (sinusoidal amplitude value)			2	
	for PMSM motors with FOC sinusoidal control (sinusoidal effective value)			1.41	
Motor output current, peak	maximum 24s	-3.2		+3.2	A
Short-circuit protection threshold	measurement range		±4.3	±5	A
Short-circuit protection delay		5	10		µs
On-state voltage drop	Nominal output current; including typical mating connector contact resistance		±0.3	±0.5	V
Off-state leakage current			±0.5	±1	mA
Motor inductance (phase-to-phase)	Recommended value, for current ripple max. ±5% of full range; +V <sub>MOT</sub> = 36 V	F <sub>PWM</sub>			µH
		20 kHz	250		
		40 kHz	120		
		60 kHz	100		
		80 kHz	60		
		100 kHz	45		
	Minimum value, limited by short-circuit protection; +V <sub>MOT</sub> = 36 V	20 kHz	75		µH
		40 kHz	25		
		60 kHz	20		
		80 kHz	10		
		100 kHz	5		
Motor electrical time-constant (L/R)	Recommended value for ±5% current measurement error	20 kHz	250		µs
		40 kHz	125		
		60 kHz	100		
		80 kHz	63		
Current measurement	FS = Full Scale accuracy		±4	±8	%FS
Digital Inputs (IN0, IN1, IN2/LSP, IN3/LSN, IN4/Enable)		Min.	Typ.	Max.	Units
Mode compliance		TTL / CMOS / LVTTTL (3.3V) / Open-collector / NPN / 24V outputs			
Default state	Input floating (wiring disconnected)	Logic HIGH			
Input voltage	Logic "LOW"		0	0.8	V
	Logic "HIGH"	2	5÷24		
	Floating voltage (not connected)		3		
	Absolute maximum, continuous	-10		+30	
Input current	Absolute maximum, surge (duration ≤ 1S) <sup>†</sup>	-20		+40	mA
	Logic "LOW"; ulled to GND		0.6	1	
	Logic "HIGH"; Internal 4.7KΩ pull-up to +3.3	0	0	0	
	Logic "HIGH"; Pulled to +5V		0.15	0.2	
Input frequency		0		150	kHz
Minimum pulse		3.3			µs
ESD protection	Human body model	±5			kV
Digital Outputs (OUT0, OUT2/Error, OUT3/ Ready)		Min.	Typ.	Max.	Units
Mode compliance	All outputs (OUT0, OUT2/Error, OUT3/Ready)	TTL / CMOS / Open-collector / NPN 24V			
	Ready, Error	Same as above + LVTTTL (3.3V)			
Default state	Not supplied (+V <sub>LOG</sub> floating or to GND)	High-Z (floating)			
	Immediately after power-up	OUT0	Logic "HIGH"		
		OUT2/Error, OUT3/ Ready	Logic "LOW"		
	Normal operation	OUT0, OUT2/Error	Logic "HIGH"		
		OUT3/Ready	Logic "LOW"		

<sup>1</sup> Operating temperature can be extended up to +65°C with reduced current and power ratings.

<sup>2</sup> iPOS360x can be operated in vacuum (no altitude restriction), but at altitudes over 2,500m, current and power rating are reduced due to thermal dissipation efficiency.

<sup>3</sup> In case of forced cooling (conduction or ventilation) the spacing requirements may drop substantially down to zero as long as the ambient temperature is kept below the maximum operating limit

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Output voltage	Logic "LOW"; output current = 0.5A			0.2	0.8	V
	Logic "HIGH"; output current = 0, no load	OUT2/Error, OUT3/ Ready	2.9	3	3.3	
		OUT0	4	4.5	5	
	Logic "HIGH", external load to +V <sub>LOG</sub>			V <sub>LOG</sub>		V
	Absolute maximum, continuous		-0.5		V <sub>LOG</sub> +0.5	
	Absolute maximum, surge (duration ≤ 1S) †		-1		V <sub>LOG</sub> +1	
Output current	Logic "LOW", sink current, continuous				0.5	A
	Logic "LOW", sink current, pulse ≤ 5 sec.				1	A
	Logic "HIGH", source current; external load to GND; V <sub>OUT</sub> ≥ 2.0V	OUT2/Error OUT3/ Ready			2	mA
		OUT0			4	mA
	Logic "HIGH", leakage current; external load to +V <sub>LOG</sub> ; V <sub>OUT</sub> = V <sub>LOG</sub> max = 40V			0.1	0.2	mA
Minimum pulse width			2			µs
ESD protection	Human body model		±5			kV
Digital Hall Inputs (Hall1, Hall2, Hall3)			Min.	Typ.	Max.	Units
Mode compliance			TTL / CMOS / Open-collector			
Default state	Input floating (wiring disconnected)		Logic HIGH			
Input voltage	Logic "LOW"			0	0.8	V
	Logic "HIGH"		2	5		
	Floating voltage (not connected)			4.4		
	Absolute maximum, surge (duration ≤ 1S) †		-10		+15	
Input current	Logic "LOW"; Pull to GND				1.2	mA
	Logic "HIGH"; Internal 4.7KΩ pull-up to +5		0	0	0	
Minimum pulse width			2			µs
ESD protection	Human body model		±5			kV
Encoder Inputs (A/A+, A-, B/B+, B-, Z/Z+, Z)			Min.	Typ.	Max.	Units
Single-ended mode compliance	Leave negative inputs disconnected		TTL / CMOS / Open-collector			
Input voltage, single-ended mode A/A+, B/B+	Logic "LOW"				1.6	V
	Logic "HIGH"		1.8			
	Floating voltage (not connected)			4.5		
Input voltage, single-ended mode Z/Z+	Logic "LOW"				1.2	V
	Logic "HIGH"		1.4			
	Floating voltage (not connected)			4.7		
Input current, single-ended mode A/A+, B/B+, Z/Z+	Logic "LOW"; Pull to GND			2.5	3	mA
	Logic "HIGH"; Internal 2.2KΩ pull-up to +5		0	0	0	
Differential mode compliance	For full RS422 compliance, see <sup>1</sup>		TIA/EIA-422-A			
Input voltage, differential mode	Hysteresis		±0.06	±0.1	±0.2	V
	Common-mode range (A+ to GND, etc.)		-7		+7	
Input impedance, differential	A+ to A-, B+ to B-		4.2	4.7		kΩ
	Z+ to Z-		6.1	7.2		
Input frequency	Single-ended mode, Open-collector / NPN		0		500	kHz
	Differential mode, or Single-ended driven by push-pull (TTL / CMOS)		0		10	
Minimum pulse width	Single-ended mode, Open-collector / NPN		1			µs
	Differential mode, or Single-ended driven by push-pull (TTL / CMOS)		50			

Input voltage, any pin to GND	Absolute maximum values, continuous	-7		+7	V
	Absolute maximum, surge (duration ≤ 1S) †	-11		+14	
ESD protection	Human body model	±1			kV
Linear Hall Inputs (LH1, LH2, LH3)		Min.	Typ.	Max.	Units
Input voltage	Operational range	0	0.5÷4.5	4.9	V
	Absolute maximum values, continuous	-7		+7	V
	Absolute maximum, surge (duration ≤ 1S) †	-11		+14	
Input current	Input voltage 0...+5V	-1	±0.9	+1	mA
Interpolation Resolution	Depending on software settings			11	bits
Frequency		0		1	kHz
ESD protection	Human body model	±1			kV
Sin-Cos Encoder Inputs (Sin+, Sin-, Cos+, Cos-)		Min.	Typ.	Max.	Units
Input voltage, differential	Sin+ to Sin-, Cos+ to Cos-		1	1.25	V <sub>PP</sub>
Input voltage, any pin to GND	Operational range	-1	2.5	4	V
	Absolute maximum values, continuous	-7		+7	
	Absolute maximum, surge (duration ≤ 1S) †	-11		+14	
Input impedance	Differential, Sin+ to Sin-, Cos+ to Cos- <sup>2</sup>	4.2	4.7		kΩ
	Common-mode, to GND		2.2		kΩ
Resolution with interpolation	Software selectable, for one sine/cosine period	2		10	bits
Frequency	Sin-Cos interpolation	0		450	kHz
	Quadrature, no interpolation	0		10	MHz
ESD protection	Human body model	±1			kV
Analog 0...5V Inputs (REF)		Min.	Typ.	Max.	Units
Input voltage	Operational range	0		4.95	V
	Absolute maximum values, continuous	-12		+18	
	Absolute maximum, surge (duration ≤ 1S) †			±36	
Input impedance	To GND		30		kΩ
Resolution			12		bits
Integral linearity				±2	bits
Offset error			±2	±10	bits
Gain error			±1%	±3%	% FS <sup>3</sup>
Bandwidth (-3dB)	Software selectable	0		1	kHz
ESD protection	Human body model	±5			kV
Axis ID Inputs (AxisID 0, AxisID 1, AxisID 2)		Min.	Typ.	Max.	Units
External connections	7 levels	Not connected; Strap to GND; Strap to +5V; 4.7KΩ to GND; 4.7KΩ to +5V; 22KΩ to GND; 22KΩ to +5V;			
Pin current	Use to size PCB tracks			±0.5	mA
4.7KΩ/22KΩ resistor	Power rating	3			mW
	Tolerance			±5	%
ESD protection	Human body model	±5			kV
RS-232		Min.	Typ.	Max.	Units
Compliance		TIA/EIA-232-C			
Bit rate	Software selectable	9600		115200	Baud
Short-circuit	232TX short to GND	Guaranteed			
ESD protection	Human body model	±2			kV
CAN-Bus		Min.	Typ.	Max.	Units
Compliance		ISO11898, CiA-301v4.2 & 402v3.0			
Bit rate	Software selectable	125		1000	Kbps
Bus length	1Mbps			25	m
	800Kbps			50	
	500Kbps			100	
	≤ 250Kbps			250	
Resistor	Between CAN-Hi, CAN-Lo	none on-board			
Node addressing	Strapping option (AxisID0,1,2)	1 ÷ 127 (CANopen); 1-195 & 255 (TLMCAN)			
ESD protection	Human body model	±15			kV

<sup>1</sup> For full RS-422 compliance, 120Ω termination resistors must be connected across the differential pairs, as close as possible to the drive input pins.

<sup>2</sup> For many applications, an 120Ω termination resistor should be connected across SIN+ to SIN-, and across COS+ to COS-. Please consult the feedback device datasheet for confirmation.

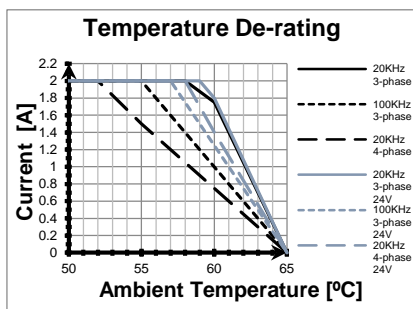
<sup>3</sup> "FS" stands for "Full Scale"

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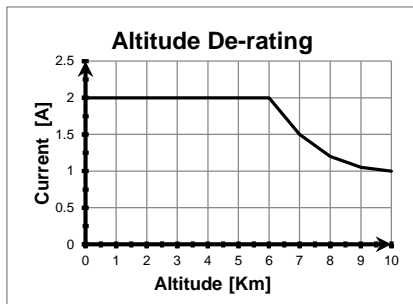


Supply Output (+5V)		Min.	Typ.	Max.	Units
Output voltage	Current sourced = 250mA	4.8	5	5.2	V
Output current		250	350		mA
Short-circuit		NOT protected			
Over-voltage		NOT protected			
ESD protection	Human body model	±1			kV
Conformity		Min.	Typ.	Max.	Units
EU Declaration		2014/30/EU (EMC), 2014/35/EU (LVD), 2011/65/EU (RoHS), 1907/2006/EC (REACH), 93/68/EEC (CE Marking Directive), EC 428/2009 (non dual-use item, output frequency limited to 590Hz)			

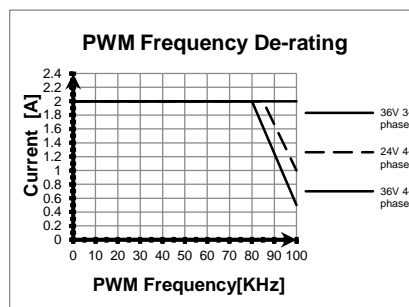
† Stresses beyond values listed under "absolute maximum ratings" may cause permanent damage to the device. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.



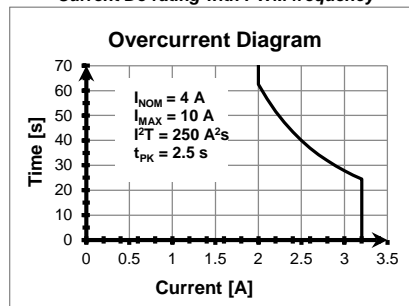
De-rating with ambient temperature



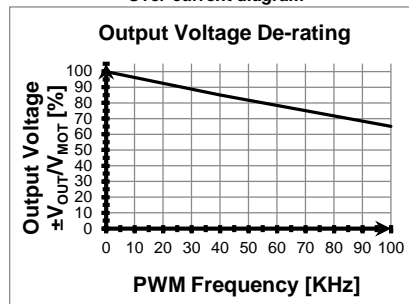
De-rating with altitude



Current De-rating with PWM frequency



Over-current diagram

Output Voltage De-rating with PWM frequency<sup>1</sup>

<sup>1</sup>  $V_{OUT}$  – the output voltage,  $V_{MOT}$  – the motor supply voltage

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