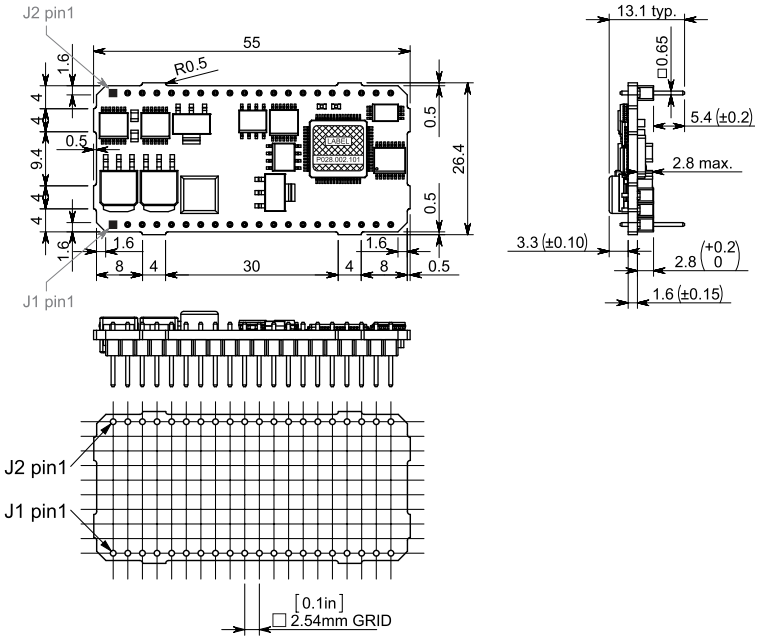


Motor – sensor configurations					
Sensor \ Motor	PMSM	BLDC	DC BRUSH	STEP (2-ph)	STEP (3-ph)
Incr. Encoder	●		●	●	
Incr. Encoder + Hall	●	●			
Analog Sin/Cos encoder	●				
Linear Halls	●				
Digital Halls	●				
Tacho			●		
Open-loop (no sensor)				●	●

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: 4A cont. (BLDC mode); $10A_{PEAK}$, 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 $1V_{pp}$)
- 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 × 16 SRAM for data acquisition
- 4K × 16 E^2ROM 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^2t
- Firmware: F508M+ or F523E+

Connector description

	Pin	Name	Type	Description
J1	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	$+V_{MOT}$	I	Positive terminal of the motor supply: 9 to $36V_{DC}$
	7	$+V_{LOG}$	I	Positive terminal of the logic supply: 7 to $36V_{DC}$
	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
J2	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	$+5V_{OUT}$	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

Electrical characteristics

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

- Tamb = 0…40ºC, 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[1]		0		+40	ºC
Ambient humidity	Non-condensing	0		90	%Rh
Altitude / pressure[2]	Altitude (vs. sea level)	-0.1	0 ÷ 2.5	[2]	Km
	Ambient Pressure	0 [2]	0.75 ÷ 1	10.0	atm
Storage Conditions		**Min.**	**Typ.**	**Max.**	**Units**
Ambient temperature		-40		+85	ºC
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[3], 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 connectors; without retainer		20	36	N
Extraction force		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		
Efficiency			98		%
Cleaning agents	Dry cleaning is recommended	Only Water- or Alcohol- based			
Protection degree	According to IEC60529, UL508	IP00			-
Logic Supply Input (+V_{LOG})		**Min.**	**Typ.**	**Max.**	**Units**
Supply voltage	Nominal values	7		36	V_{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	4.9		40	V_{DC}
	Absolute maximum values, continuous	-0.7		42	V_{DC}
	Absolute maximum values, surge (duration ≤ 10ms) †	-1		+45	V
Supply current	+V_{LOG} = 7V		125	300	mA
	+V_{LOG} = 12V		80	200	
	+V_{LOG} = 24V		50	125	
	+V_{LOG} = 40V		40	100	
Motor Supply Input (+V_{MOT})		**Min.**	**Typ.**	**Max.**	**Units**
Supply voltage	Nominal values	9		36	V_{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	8.5		40	V_{DC}
	Absolute maximum values, continuous	-0.7		42	V_{DC}
	Absolute maximum values, surge (duration ≤ 10ms) †	-1		+45	V
Supply current	Idle		1	5	mA
	Operating	-10	±4	+10	A
	Absolute maximum value, short-circuit condition (duration ≤ 10ms) †			15	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				4	A
	for PMSM motors with FOC sinusoidal control (sinusoidal amplitude value)				4	
	for PMSM motors with FOC sinusoidal control (sinusoidal effective value)				2.82	
Motor output current, peak	maximum 2.5s		-10		+10	A
Short-circuit protection threshold	measurement range			±13	±15	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_{MOT} = 36 V	F_{PWM}				µH
		20 kHz	250			
		40 kHz	120			
		60 kHz	100			
		80 kHz	60			
		100 kHz	45			
	Minimum value, limited by short-circuit protection; +V_{MOT} = 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 measure-ment error	20 kHz	250			µs
		40 kHz	125			
		60 kHz	100			
		80 kHz	63			
		100 kHz	50			
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 / LVTTL (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	
	Absolute maximum, surge (duration ≤ 1S) †		-20		+40	
Input current	Logic "LOW"; ulled to GND			0.6	1	mA
	Logic "HIGH"; Internal 4.7KΩ pull-up to +3.3		0	0	0	
	Logic "HIGH"; Pulled to +5V			0.15	0.2	
	Logic "HIGH"; Pulled to +24V			2	2.5	
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 + LVTTL (3.3V)			
Default state	Not supplied (+V_{LOG} 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"			

[1] Operating temperature can be extended up to **+65ºC** with reduced current and power ratings.
[2] 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.
[3] 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

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	V
		OUT0	4	4.5	5	V
	Logic "HIGH", external load to +V_{LOG}			V_{LOG}		V
	Absolute maximum, continuous		-0.5		V_{LOG}+0.5	V
	Absolute maximum, surge (duration ≤ 1S) †		-1		V_{LOG}+1	V
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_{OUT} >= 2.0V	OUT2/Error OUT3/ Ready			2	mA
		OUT0			4	mA
	Logic "HIGH", leakage current; external load to +V_{LOG}; V_{OUT} = V_{LOG} 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		V
	Floating voltage (not connected)			4.4		V
	Absolute maximum, surge (duration ≤ 1S) †		-10		+15	V
Input current	Logic "LOW"; Pull to GND				1.2	mA
	Logic "HIGH"; Internal 4.7KΩ pull-up to +5		0	0	0	mA
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			V
	Floating voltage (not connected)			4.5		V
Input voltage, single-ended mode Z/Z+	Logic "LOW"				1.2	V
	Logic "HIGH"		1.4			V
	Floating voltage (not connected)			4.7		V
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	mA
Differential mode compliance	For full RS422 compliance, see [1]		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	V
Input impedance, differential	A+ to A-, B+ to B-		4.2	4.7		KΩ
	Z+ to Z-		6.1	7.2		KΩ
Input frequency	Single-ended mode, Open-collector / NPN		0		500	KHz
	Differential mode, or Single-ended driven by push-pull (TTL / CMOS)		0		10	MHz
Minimum pulse width	Single-ended mode, Open-collector / NPN		1			µS
	Differential mode, or Single-ended driven by push-pull (TTL / CMOS)		50			nS

Input voltage, any pin to GND	Absolute maximum values, continuous	-7		+7	V
	Absolute maximum, surge (duration ≤ 1S) †	-11		+14	V
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	V
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_{PP}
Input voltage, any pin to GND	Operational range	-1	2.5	4	V
	Absolute maximum values, continuous	-7		+7	V
	Absolute maximum, surge (duration ≤ 1S) †	-11		+14	V
Input impedance	Differential, Sin+ to Sin-, Cos+ to Cos- [2]	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	V
	Absolute maximum, surge (duration ≤ 1S) †			±36	V
Input impedance	To GND		30		KΩ
Resolution			12		bits
Integral linearity				±2	bits
Offset error			±2	±10	bits
Gain error			±1%	±3%	% FS [3]
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
	Torelance			±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	m
	500Kbps			100	m
	≤ 250Kbps			250	m
Resistor	Between CAN-Hi, CAN-Lo	none on-board			
Node addressing	Strapping option (AxisID0,1,2)	1 ÷ 127 (CANopen); 1-195 & 255 (TMLCAN)			-
ESD protection	Human body model	±15			KV

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

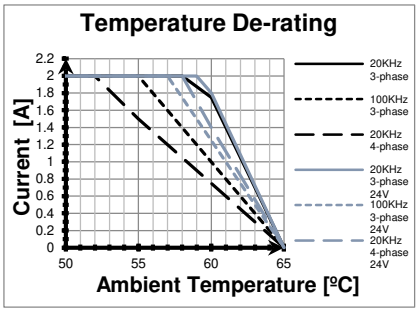
[2] For many applications, an 120Ω termination resistor should be connected across SIN+ to SIN-, and across COS+ to COS-. Please consult the feedback device datasheet for confirmation.

[3] "FS" stands for "Full Scale"

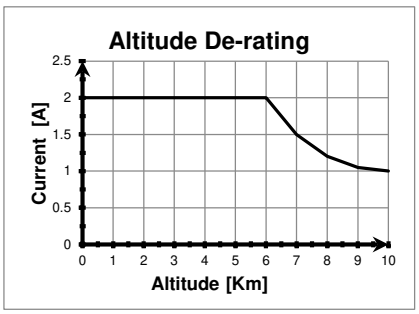
Supply Output (+5V)		Min.	Typ.	Max.	Units
Output voltage	Current sourced = 250mA	4.8	5	5.2	V
Output current		250	350		mA
Short-circuit		NOT protected			
Over-voltage		NOT protected			
ESD protection	Human body model	±1			KV

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)			

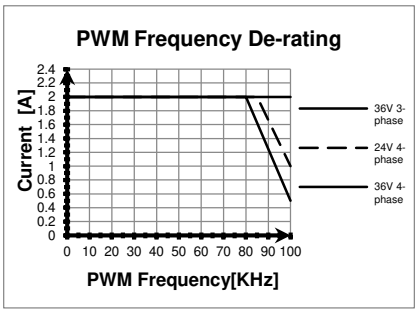
† Stresses beyond values listed under "absolute maximum ratings" may cause permanent damage to the device. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.



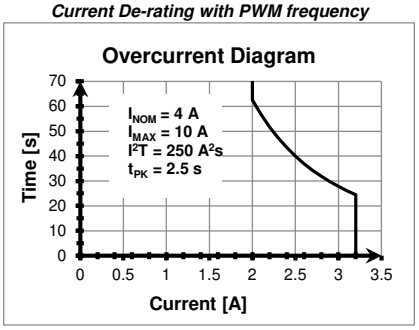
De-rating with ambient temperature



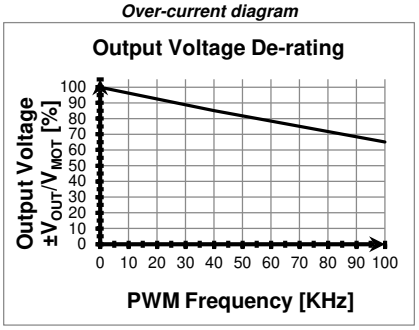
De-rating with altitude



Current De-rating with PWM frequency



Over-current diagram



Output Voltage De-rating with PWM frequency[1]

[1] V_{OUT} – the output voltage, V_{MOT} – the motor supply voltage