

Motor – sensor configurations						
Sensor	Motor	PMSM	BLDC	DC BRUSH	STEP (2-ph)	STEP (3-ph)
Incr. Encoder		☑		☑	☑	
Incr. Encoder + Hall		☑	☑			
Analog Sin/Cos encoder		☑	☑	☑	☑	
SSI		☑	☑	☑	☑	
BISS-C		☑	☑	☑	☑	
Tacho				☑		
Open-loop (no sensor)					☑	☑

- Features**
- Motion controller and drive in a single compact unit based on MotionChip™ technology
 - Universal solution for control of rotary and linear brushless, brushed and 2 or 3-phase step motors
 - Advanced motion control capabilities (PVT, S-curve, electronic cam)
 - Motor supply: 11-80V; Logic SELV/ PELV supply: 9-36V; STO SELV/ PELV supply: 18-40V
 - Output current: 20A cont. (BLDC mode); 40A_{PEAK}, up to 60kHz PWM
 - Feedback Devices (dual-loop support)
- 1st feedback devices supported:
- Incremental encoder interface (differential)
 - Analogue sin/cos encoder interface (differential 1V_{pp})
 - Digital Hall sensor interface (single-ended and open collector)

- 2nd feedback devices supported:
- Incremental encoder interface (differential)
 - BISS / SSI encoder interface
 - pulse & direction interface (differential) for external (master) digital reference
 - STO: 2 safe torque-off inputs, safety integrity level (SIL3/Cat3/PLe) acc. to EN61800-5-1; -2/ EN61508-3; -4/ EN ISO 13849-1.
 - 4 digital inputs, 12-36V, PNP/NPN programmable: 2 for limit switches, 2 general-purpose
 - 4 digital outputs, 5-36V, NPN open-collector: Ready, Error, OUT1 0.5A and OUT0 2A
 - 2 analogue inputs: 12 bit, +/-10V and 0-5V: Reference and Feedback (for Tacho) or general purpose
 - RS-232 serial & dual 100Mbps RJ45 EtherCAT® interfaces
 - EtherCAT® with CAN application protocol over EtherCAT (CoE)
 - 127 h/w addresses selectable by DIN switch
 - 16k x 16 SRAM memory for data acquisition
 - 16k x16 E²ROM memory to store setup data, TML motion programs, cam tables and other user data
 - Operating ambient temperature: 0-40°C (over 40°C with derating)
 - NTC/PTC analogue Motor Temperature sensor input
 - Protections: short-circuit between motor phases and from motor phases to GND, over/under-voltage, over-current, I²t, control error, over temperature, communication error

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Mating Connectors			
Ref	Producer	Part No.	Description
J1	Camden	CTBA9208/4FL	Supply input, 4x5.08 female counter part for cable
J2	Camden	CTBA9208/5FL	Motor power, 5x5.08 female counter part for cable
J3,J4		generic 15-pin High Density D-Sub male	Feedback #1 +Hall & #2
J9		generic RJ10-4/4 phone plug	RS232
J5		generic 15-pin D-Sub male, DB15	I/O ; Analog
J8	MOLEX	43025-0400	MICROFIT RECEPTACLE HOUSING, 2x2 WAY
J8	MOLEX	43030-0007	CRIMP PIN, MICROFIT, 5A
J6,J7	-		Standard 8P8C modular jack (RJ-45) male

Connector Description			
Pin	Name	Type	Description
1	GND	-	Negative return (ground) of the power supply
2	+V _{MOT}	I	Positive terminal of the motor supply: 12 to 80V _{DC} .
3	+V _{LOG}	I	Positive terminal of the logic supply input: 12 to 36V _{DC}
4	Earth	-	Earth connection

Pin	Name	Type	Description
1	A/A+	O	Phase A for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors
2	B/A-	O	Phase B for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors
3	C/B+	O	Phase C for 3-ph motors, B+ for 2-ph steppers
4	CR / B-	O	Chopping Resistor output/ Phase B- for step motors
5	Earth	-	Earth connection

Pin	Name	Type	Description
1	STO1+	I	Safe Torque Off input 1, positive input (opto-isolated, 18+40V)
2	STO2+	I	Safe Torque Off input 2, positive input (opto-isolated, 18+40V)
3	STO1-	I	Safe Torque Off input 1, negative return (opto-isolated, 0V)
4	STO2-	I	Safe Torque Off input 2, negative return (opto-isolated, 0V)

Apply between both STO1+, STO2+ and STO1-, STO2- 24V DC from SELV/ PELV power supply for motor PWM output operation


Pin	Name	Type	Description
1	+5V _{OUT}	O	5V output supply for I/O usage
2	Hall 1	I	Digital input Hall 1 sensor
3	Hall 2	I	Digital input Hall 2 sensor
4	B1+/Cos+	I	Incr. encoder1 B+ diff. input, or analogue encoder Cos+ diff. input
5	A1+/Sin+	I	Incr. encoder1 A+ diff. input, or analogue encoder Sin+ diff. input
6...8	n.c.		Not connected
9	Z1+	I	Incr. encoder1 Z+ diff. input
10	Z1-	I	Incr. encoder1 Z- diff. input
11	GND	-	Return ground for sensors supply
12	Temp Mot	I	Analogue input, 12-bit, 0-3.3V. Used to read an analog temperature value
13	Hall 3	I	Digital input Hall 3 sensor
14	B1-/Cos-	I	Incr. encoder1 B- diff. input, or analogue encoder Cos- diff. input
15	A1-/Sin-	I	Incr. encoder1 A- diff. input, or analogue encoder Sin- diff. input

Pin	Name	Type	Description
1	+5V _{OUT}	O	5V output supply for I/O usage
2	Data+/SL+	I	Data+ for SSI, or Slave+ for BiSS C; has 120Ω resistor between pins 2 and 3
3	Data-/SL-	I	Data- for SSI, or Slave- for BiSS C; has 120Ω resistor between pins 2 and 3
4	B2+/Dir+	I	Incr. encoder2 B+ diff. input, or Dir+; has 120Ω resistor between pins 4 and 14
5	A2+/Pulse+	I	Incr. encoder2 A+ diff. input, or Pulse+; has 120Ω resistor between pins 5 and 15
6	+V _{LOG}	I	Positive terminal of the logic supply input: 9 to 36V _{DC}
7	CLK+/MA+	O	Clock+ for SSI, or Master+ for BiSS C
8	CLK-/MA-	O	Clock- for SSI, or Master- for BiSS C
9	Z2+	I	Incr. encoder2 Z+ diff. input
10	Z2-	I	Incr. encoder2 Z- diff. input
11	GND	-	Return ground for sensors supply
12	FDBK	I	Analogue input, 12-bit, 0-5V. Used to read an analog position or speed feedback (as tacho), or used as general-purpose analog input
13	n.c.	-	
14	B2-/Dir-	I	Incr. encoder2 B- diff. input, or Dir-; has 120Ω resistor between pins 4 and 14
15	A2-/Pulse-	I	Incr. encoder2 A- diff. input, or Pulse-; has 120Ω resistor between pins 5 and 15

Port	Name	Type	Description
J6	ECAT IN	I	EtherCAT standard RJ45 Ethernet IN port
J7	ECAT OUT	O	EtherCAT standard RJ45 Ethernet OUT port

Pin	Name	Type	Description
1	GND	-	Return ground for RS-232 pins
2	232TX	O	RS-232 Data Transmission
3	232RX	I	RS-232 Data Reception
4	GND	-	Return ground for RS-232 pins

Pin	Name	Type	Description
1	GND	-	Return ground for I/O pins
2	IN2/LSP	I	12-36V digital PNP/NPN input. Positive limit switch input
3	OUT2/Error	O	5-36V 0.5A, drive Error output, active low, NPN open-collector/TTL pull-up. Also drives the red LED
4	OUT3/Ready	O	5-36V 0.5A, drive Ready output, active low, NPN open-collector/TTL pull-up. Also drives the green LED.
5	OUT0	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
6	OUT1	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
7	+5V _{OUT}	O	5V output supply for I/O usage
8	+V _{LOG}	I	Positive terminal of the logic supply input: 12 to 36V _{DC}
9	IN3/LSN	I	12-36V digital PNP/NPN input. Negative limit switch input
10	IN0	I	12-36V general-purpose digital PNP/NPN input
11	IN1	I	12-36V general-purpose digital PNP/NPN input
12	REF10+	I	Analogue input, 11-bit, positive +/-10V input. Used to read an analog position, speed or torque reference.
13	REF10-	I	Analogue input, 11-bit, negative +/-10V input. Used to read an analog position, speed or torque reference. Connected to GND when REF5 is used.
14	REFSEL	I	Analogue selection, floating for +/-10V input, GND connected when REF5+ is used.
15	REF5	I	Analogue input, 12-bit, 0-5V input. Used to read an analog position, speed or torque reference.

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Pin	Name	Type	Description
1	Reserved	-	Leave switch off (UP position)
2	ID-Bit6	-	
3	ID-Bit5	-	
4	ID-Bit4	-	Hardware AxisID selection switches
5	ID-Bit3	-	They represent the first 7 LSB bits of an 8 bit
6	ID-Bit2	-	Axis ID number.
7	ID-Bit1	-	
8	ID-Bit0	-	

Electrical characteristics

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

- Tamb = 24°C, VLOG = 24 VDC; VMOT = 80VDC
- Supplies start-up / shutdown sequence: any
- Load current (sinusoidal amplitude / continuous BLDC, DC, stepper) = 20A

Operating Conditions		Min.	Typ.	Max.	Units
Ambient temperature ¹		0		+40	°C
Ambient humidity	Non-condensing	0		90	%Rh
Altitude / pressure ²	Altitude (vs. sea level)	-0.1	0 ± 2	2	km
	Ambient Pressure	0 ²	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
Mechanical Mounting		Min.	Typ.	Max.	Units
Airflow		natural convection ³ , closed box			
Environmental Characteristics		Min.	Typ.	Max.	Units
Size (Length x Width x Height)	Without mating connectors	139 x 94.2 x 24.5			mm
		~5.47 x 3.7 x 0.97			inch
Weight	Without mating connectors	240			g
Power dissipation	Idle (no load)	3.6			W
	Operating	11			W
Efficiency		98			%
Cleaning agents	Dry cleaning is recommended	Only Water- or Alcohol- based			
Protection degree	According to IEC60529, UL508	IP20			-
Logic Supply Input (+V _{LOG})		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	12	24	36	V _{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	8	24	40	V _{DC}
	Absolute maximum values, surge (duration ≤ 10ms) [†]	-1		+45	V
Supply current	No Load on Digital Outputs	+V _{LOG} = 12V	250		mA
		+V _{LOG} = 24V	150		
		+V _{LOG} = 36V	100		
Motor Supply Input (+V _{MOT})		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	12	80	90	V _{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	11		94	V _{DC}
	Absolute maximum values, surge (duration ≤ 10ms) ⁴	-1		95	V
Supply current	Idle		1	5	mA
	Operating	-40	±20	+40	
	Absolute maximum value, short-circuit condition (duration ≤ 10ms) ¹			45	

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			20	A
	for PMSM motors with FOC sinusoidal control (sinusoidal amplitude value)			20	
	for PMSM motors with FOC sinusoidal control (sinusoidal effective value)			14.2	
Motor output current, peak	maximum 10s	-40		+40	A
Short-circuit protection threshold				±45	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} = 80 V	F _{PWM}			µH
		20 kHz	330		
	40 kHz	150			
	60 kHz	120			
Minimum value, limited by short-circuit protection; +V _{MOT} = 80 V	20 kHz	120		µH	
	40 kHz	40			
	60 kHz	30			
Motor electrical time-constant (L/R)	Recommended value for ±5% current measurement error	20 kHz	250		µs
		40 kHz	125		
	60 kHz	100			
Current measurement	FS = Full Scale accuracy		±5	±8	%FS
Digital Inputs (IN0, IN1, IN2/LSP, IN3/LSN) ⁵		Min.	Typ.	Max.	Units
Mode compliance		PNP			
Default state	Input floating (wiring disconnected)	Logic LOW			
Input voltage	Logic "LOW"	-36	0	2.4	V
	Logic "HIGH"	7.5	24	36	
	Hysteresis	1.2	2.4	2.8	
	Floating voltage (not connected)		0		
	Absolute maximum, continuous	-36		+39	
	Absolute maximum, surge (duration ≤ 1s) [†]	-50		+50	
Input current	Logic "LOW"; pulled to GND		0		mA
	Logic "HIGH"; pulled to +24V		9	10	
Mode compliance		NPN			
Default state	Input floating (wiring disconnected)	Logic HIGH			
Input voltage	Logic "LOW"	-36	0	2.2	V
	Logic "HIGH"	7.5		36	
	Hysteresis	1.2	2.4	2.8	
	Floating voltage (not connected)		23		
	Absolute maximum, continuous	-36		+39	
	Absolute maximum, surge (duration ≤ 1s) [†]	-50		+50	
Input current	Logic "LOW"; Pulled to GND		9	10	mA
	Logic "HIGH"; Pulled to +24V			0.4	
Input frequency		0		150	kHz
Minimum pulse		3.3			µs
ESD protection	Human body model	±2			kV

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


² iPOS8020 BX-CAT 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 It is recommended to mount the iPOS8020 BX-CAN on a metallic support using the provided mounting holes, for better reliability and reduced de-rating due to heat dissipation

⁴ 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.

⁵ The digital inputs are software selectable as PNP or NPN

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Digital Outputs (OUT0, OUT1, OUT2/Error, OUT3/ Ready)		Min.	Typ.	Max.	Units
Mode compliance	All outputs (OUT0, OUT1, OUT2/Error, OUT3/Ready)	NPN 24V			
Default state	Not supplied (+V _{LOG} floating)	High-Z (floating)			
	Immediately after power-up	Logic "HIGH"			
	Normal operation	Logic "HIGH"			
Output voltage	Logic "LOW"; output current = 2A for OUT0/ 0.5A for the other digital outputs			0.8	V
	Logic "HIGH"; output current = 0, no load	2.9	3	3.3	
	Logic "HIGH", external load to +V _{LOG}	4	4.5	5	
	Absolute maximum, continuous	-0.5		V _{LOG} +0.5	
	Absolute maximum, surge (duration ≤ 1s) ¹	-1		V _{LOG} +1	
Output current	Logic "LOW", sink current, continuous			0.5	A
				2	A
	Logic "HIGH", source current; external load to GND; V _{OUT} ≥ 2.0V			2.5	mA
				7	mA
	Logic "HIGH", leakage current; external load to +V _{LOG} ; V _{OUT} = V _{LOG} max = 40V		0.05	0.7	mA
Minimum pulse width		0.5			μs
ESD protection	Human body model	±15			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"	1.8			
	Floating voltage (not connected)		4.5		
	Absolute maximum, surge (duration ≤ 1s) ¹	-10		+15	
Input current	Logic "LOW"; Pull to GND		5	3	mA
	Logic "HIGH"; Internal 1KΩ pull-up to +5	0	0	0	
Minimum pulse width		2			μs
ESD protection	Human body model	±5			kV
Encoder Inputs (A+, A-, B+, B-, Z+, Z-, A2+, A2-, B2+, B2-, Z2+, Z2-) ²		Min.	Typ.	Max.	Units
Differential mode compliance	For full RS422 compliance, see ²	TIA/EIA-422-A			
Input voltage	Hysteresis	±0.06	±0.1	±0.2	V
	Differential mode	-14		+14	
	Common-mode range (A+ to GND, etc.)	-11		+14	
Input impedance, differential	A+, A2+, B+, B2+, Z+, Z2+		2.2		kΩ
	A-, A2-, B-, B2-, Z-, Z2-		1.6		
Input frequency	Differential mode			10	MHz
Minimum pulse width	Differential mode		50		ns

Sin-Cos Encoder Inputs (Sin+, Sin-, Cos+, Cos-) ²		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	
	Absolute maximum, surge (duration ≤ 1s) ¹	-11		+14	
Input impedance	Differential, Sin+ to Sin-, Cos+ to Cos-	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	±2			kV
Analog 0...5V Inputs (REF, FDBK)		Min.	Typ.	Max.	Units
Input voltage	Operational range	0		4.95	V
	Absolute maximum values, continuous	-12		+18	
	Absolute maximum, surge (duration ≤ 1s) ¹			±36	
Input impedance	To GND		8		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	±2			kV
Analog ±10V Input (Ref)		Min.	Typ.	Max.	Units
Differential voltage range			±10		V
Common-mode voltage range	Referenced to GND	-12	0...10	+50	V
Input impedance	Differential		40		kΩ
Common-mode impedance	Referenced to GND		20		kΩ
Resolution			12		bits
Integral linearity				0.036	%FS ²
Offset error	Common-mode voltage = 0...10 V		±0.2	±0.5	%FS ²
Gain error	Common-mode voltage = 0...10 V		±10	±12	%FS ²
Bandwidth (-3dB)	Depending on software settings		1.5		kHz
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
EtherCAT®		Min.	Typ.	Max.	Units
Compliance	IEEE802.3, IEC61158				
Transmission line specification	According to TIA/EIA-568-5-A	Cat. 5e.UTP			
J5, J6 pinout	EtherCAT® supports MDI/MDI-X auto-crossover	TIA/EIA-568-A or TIA/EIA-568-B			
Software protocols compatibility		CoE, CiA402, IEC61800-7-301			
Node addressing	By hardware DIP switch	1 + 127			-
	By software	1 + 255			
MAC addressing		none			-
ESD protection	Human body model	±15			kV

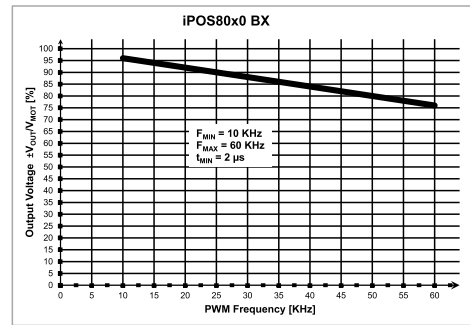
¹ Stresses beyond values listed under "absolute maximum ratings" may cause permanent damage to the device. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

² All differential input pins have internal 120Ω termination resistors connected across

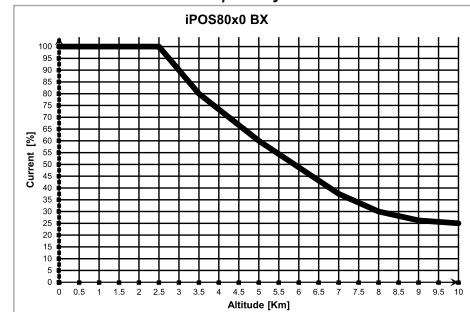
³ "FS" stands for "Full Scale"

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Safe torque OFF (STO1+, STO1-; STO2+, STO2+)		Min.	Typ.	Max.	Units
Safety function	According to EN61800-5-2	STO (Safe Torque OFF)			
EN 61800-5-1/-2 and EN 61508-5-3/-4 Classification	Safety Integrity Level	safety integrity level 3 (SIL3)			
	PFHd (Probability of Failures per Hour - dangerous)	8×10^{-10}	hour ⁻¹ (0.8 FIT)		
EN13849-1 Classification	Performance Level	Cat3/PLe			
	MTTFd (meantime to dangerous failure)	377			years
Mode compliance		PNP			
Default state	Input floating (wiring disconnected)	Logic LOW			
Input voltage	Logic "LOW" (PWM operation disabled)	-20		5.6	V
	Logic "HIGH" (PWM operation enabled)	18		36	
	Absolute maximum, continuous	-20		+40	
Input current	Logic "LOW"; pulled to GND		0		mA
	Logic "HIGH", pulled to +Vlog		5	13	
Repetitive test pulses (high-low-high)	Ignored high-low-high			5	ms
				20	Hz
Fault reaction time	From internal fault detection to register DER bit 14 =1 and OUT2/Error high-to-low			30	ms
PWM operation delay	From external STO low-high transition to PWM operation enabled			30	ms
ESD protection	Human body model	±2			kV
BiSS/SSI Encoder Interface		Min.	Typ.	Max.	Units
Differential mode (CLOCK, DATA) ¹	For full RS422 compliance, see ¹	TIA/EIA-422			
CLOCK Output voltage	Differential; 50Ω differential load	2.0	2.5	5.0	V
	Common-mode, referenced to GND	2.3	2.5	2.7	
CLOCK frequency	Software selectable	1000, 2000, 3000			kHz
DATA Input hysteresis	Differential mode	±0.1	±0.2	±0.5	V
Data input impedance	Termination resistor on-board		120		Ω
DATA Input common mode range	Referenced to GND	-7		+12	
	Absolute maximum, surge (duration ≤ 1s) [†]	-25		+25	
DATA format	Software selectable	Binary / Gray			
		Single-turn / Multi-turn			
		Counting direction			
DATA resolution	Single-turn			56	Bits
	Multi-turn and single-turn			56	
If total resolution >31 bits, some bits must be ignored by software setting to achieve a max 31 bits resolution					
Supply Output (+5V)		Min.	Typ.	Max.	Units
Output voltage	Current sourced = 250mA	4.8	5	5.2	V
Output current		350	400		mA
Short-circuit		NOT protected			
Over-voltage		NOT protected			
ESD protection	Human body model	±2			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)			



iPOS8020 BX-CAT Output Voltage De-rating with PWM frequency 1



iPOS8020 BX-CAT De-rating with altitude



CAUTION!
FOR PWM FREQUENCIES LESS THAN 20 KHZ, CORRELATE THE PWM FREQUENCY WITH THE MOTOR PARAMETERS IN ORDER TO AVOID POSSIBLE MOTOR DAMAGE.

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

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