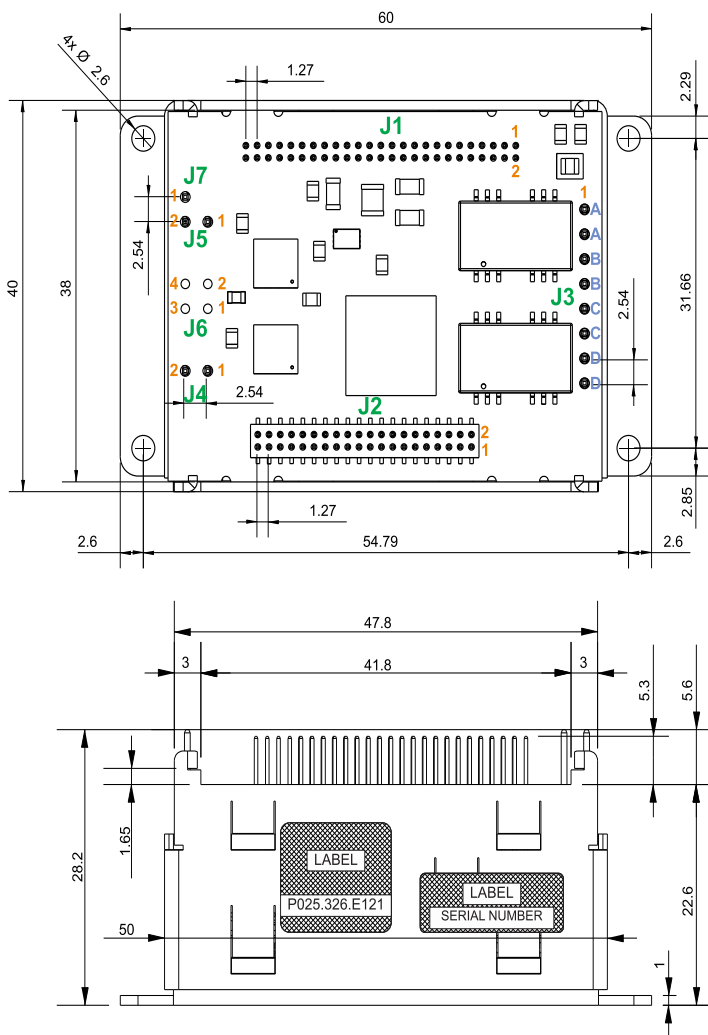




# IMOTIONCUBE CAT STO DATASHEET

P/N: P025.326.E121



All dimensions are in mm.

Motor – sensor configurations					
Sensor	Motor				
	PMSM	BLDC	DC BRUSH	STEP (2-ph)	STEP <sup>3</sup> (3-ph)
Incr. Encoder	Ⓣ		Ⓣ	Ⓣ	
Incr. Encoder + Hall	Ⓣ	Ⓣ			
Analog Sin/Cos encoder	Ⓣ	Ⓣ	Ⓣ	Ⓣ	
SSI <sup>1</sup>	Ⓣ		Ⓣ	Ⓣ	Ⓣ
BiSS-C <sup>1</sup>	Ⓣ		Ⓣ	Ⓣ	Ⓣ
EnDAT <sup>1 2</sup>	Ⓣ		Ⓣ	Ⓣ	Ⓣ
Linear Halls	Ⓣ				
Tacho			Ⓣ		
Open-loop (no sensor)				Ⓣ	Ⓣ

<sup>1</sup> Only with external circuit

<sup>2</sup> Available starting with F515K firmware version

<sup>3</sup> Sensors are used only for step loss detection

Mating connectors			
Connector	Description		
J1	Socket 2x25 pins, 1.27x1.27mm pitch, square 0.4 mm pins		
	If J3&J4 are soldered on motherboard		If J3&J4 are used with mating SSQ connectors
	Harwin	M50-3152542	Harwin M50-3002545
J2	Socket 2x20 pins, 1.27x1.27mm pitch, square 0.4 mm pins		
	If J3&J4 are soldered on motherboard		If J3&J4 are used with mating SSQ connectors
	Harwin	M50-3152042	Harwin M50-3002045
J3	To use full current capabilities of the drive, solder these pins directly to the motherboard without using socket connectors		
	High-current socket 2 pins, 2.54 mm pitch, square 0.635 mm pins -use only if nominal current is < 8A-		SSQ-108-01-T-S
J4	To use full current capabilities of the drive, solder these pins directly to the motherboard without using socket connectors		
	High-current socket 2 pins, 2.54 mm pitch, square 0.635 mm pins -use only if nominal current is < 8A-		SSQ-102-01-T-S
J5+J7	To use full current capabilities of the drive, solder these pins directly to the motherboard without using socket connectors		
J6	High-current socket 2x2 pins, 2.54 mm pitch, square 0.635 mm pins -use only if nominal current is < 8A-		SSQ-102-01-G-D
J6	Connector Header Through Hole 4 position 0.100" (2.54mm)		TSW-102-14-F-D

## 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 (CSP, PVT, S-curve, electronic gearing and cam)
- Motor supply: 12-80V; Logic SELV/ PELV supply: 9-36V; STO SELV/ PELV supply: 18-40V
- Output current: 20A cont. (BLDC mode) \*; 40A<sub>PEAK</sub>, up to 120kHz PWM
- Feedback Devices (dual-loop support)

1<sup>st</sup> feedback devices supported (TTL 5V):

- Incremental encoder interface (single ended or differential)
- Analogue sin/cos encoder interface (differential 1V<sub>pp</sub>) – needs external 120Ω resistors
- Digital Hall sensor interface (single-ended and open collector)
- Linear Hall sensors interface

2<sup>nd</sup> feedback devices supported (LVTTTL 3.3V):

- pulse & direction interface (single ended) for external (master) digital reference
- Incremental encoder interface (single ended)

- pulse & direction interface (single ended) for external digital reference (from master)

- BISS, SSI, EnDAT 2.2 (starting with F514K firmware version) encoder interface capability available only using external circuit

- 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, 0.5A, NPN open-collector: Ready, Error, 2 general-purpose

- 2 analogue inputs: 12-bit, 0-5V: Reference, Feedback or general purpose

- RS-232 serial & dual 100Mbps EtherCAT® interfaces

- 127 h/w addresses selectable by h/w pins configuration

- 16k x 16 SRAM memory for data acquisition

- 16k x16 E<sup>2</sup>ROM to store setup data, TML motion programs, cam tables and other user data

- NTC/PTC analogue Motor Temperature sensor input

- Operating ambient temperature: 0-40°C (over 40°C with derating)

- Programmable protections: short-circuit between motor phases or motor phases to GND, over/under-voltage, over-current, I<sup>2</sup>t, control error

\* With external heat sink

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## Connector description

Pin	Name	Type	Description
1	232RX	I	RS232 data reception
2	Enc1 A+/Sin1+	I	Incr. encoder # A+ diff. input, analogue encoder #1 Sin+ diff. input.
3	232TX	O	RS232 data transmission
4	Enc1 A-/Sin1-	I	Incr. encoder #1 A- diff. input, analogue encoder #1 Sin1- diff. input
5	AxisID 0	I	Axis ID / Address input #0. Analogue input, 0-5V
6	Enc1 B+/Cos1+	I	Incr. encoder # B+ diff. input, analogue encoder #1 Cos+ diff. input.
7	AxisID 1	I	Axis ID / Address input #1. Analogue input, 0-5V
8	ENC1B-/Cos1-	I	Incr. encoder #1 B- diff. input, analogue encoder Cos1- diff. input
9	AxisID 2	I	Axis ID / Address input #2. Analogue input, 0-5V
10	Enc1 Z+	I	Incr. encoder #1 Z+ diff. input.
11	CAN-Hi	-	CAN-Bus positive line (dominant high)
12	Enc1 Z-	I	Incr. encoder Z- diff. input
13	CAN-Lo	-	CAN-Bus negative line (dominant low)
14	Hall1	I/O	Hall 1 sensor 5V digital input
15	Reserved	-	Reserved
16	Hall2	I/O	Hall 2 sensor 5V digital input
17	Reserved	-	Reserved
18	Hall3	I	Hall 3 sensor 5V digital input
19	Ref	I	Analogue input, 12-bit, 0-5V. Used to read an analog position, speed or torque reference, or as general-purpose analogue input
20	Fdbk	I	Analogue input, 12-bit, 0-5V. Used to read an analogue position or speed feedback, or as general-purpose analogue input
21	+Vlog	I	Positive terminal for logic supply 9-36V <sub>DC</sub>
22	+5V <sub>out</sub>	O	5V output supply. Max 300mA for feedback sensors and I/Os
23	IN0	I	12-36V digital input #0, programmable NPN or PNP, general-purpose
24	OUT0	O	24V digital output #0, NPN, general-purpose
25	IN1	I	12-36V digital input #1, programmable NPN or PNP, general-purpose
26	OUT1	O	24V digital output #1, NPN, general-purpose
27	IN2/LSP	I	12-36V digital input #2, programmable NPN or PNP, positive limit switch
28	Out2/ Error	O	24V digital output #2, NPN, drive error
29	In3/LSN	I	12-36V digital input #3, programmable NPN or PNP type, negative limit switch
30	Out3/ Ready	O	24V digital output 3, NPN type, drive ready
31	TMOT	I	Motor temperature sensor input. Analogue input, 0-3.3V
32..34	Reserved	-	Reserved
35	GND	-	Ground
36	GND	-	Ground
37	SIMO	O	Slave In Master Out (for SPI communication)
38	SPI_CLK	O	Serial Clock (for SPI communication)
39	SOMI	I	Slave Out Master In (for SPI communication)
40	Reserved	-	Reserved
41	Enc2 A	I	Incr. encoder #2 A digital input, 0-3.3V
42	SIN2	I	Analogue encoder #2 SIN input, 0-3.3V
43	Enc2 B	I	Incr. encoder #2 B digital input, 0-3.3V
44	COS2	I	Analogue encoder #2 COS input, 0-3.3V
45	Enc2 Z	I	Incr. encoder #2 Z digital input, 0-3.3V
46	+5V <sub>out</sub>	O	5V output supply. Max 300mA for feedback sensors and I/Os
47	SPICS	O	SPI Chip Select
48..50	Reserved	-	Reserved

## Connector Description

Pin	Name	Type	Description
1	Rx0+	I/O	Receive/Transmit positive, ECAT IN port. Connect directly to RJ45 pin3.
2	Tx0+	I/O	Transmit/Receive positive, ECAT IN port. Connect directly to RJ45 pin1.
3	Rx0-	I/O	Receive/Transmit negative, ECAT IN port. Connect directly to RJ45 pin6.
4	Tx0-	I/O	Transmit/Receive negative, ECAT IN port. Connect directly to RJ45 pin2.
5	450	-	GND connection for ECAT IN port. Connect directly to RJ45 pins 4 and 5.
6	Shield0	-	Shield connection for ECAT IN port. Connect directly to RJ45 shield.
7	780	-	GND connection for ECAT IN port. Connect directly to RJ45 pins 7 and 8.
8..11	Reserved	-	Reserved
12	781	-	GND connection for ECAT OUT port. Connect directly to RJ45 pins 7 and 8.
13	Shield1	-	Shield connection for ECAT OUT port. Connect directly to RJ45 shield.
14	451	-	GND connection for ECAT OUT port. Connect directly to RJ45 pins 4 and 5.
15	Tx1-	I/O	Transmit/Receive negative, ECAT OUT port. Connect directly to RJ45 pin2.
16	Rx1+	I/O	Receive/Transmit positive, ECAT OUT port. Connect directly to RJ45 pin3.
17	Tx1+	I/O	Transmit/Receive positive, ECAT OUT port. Connect directly to RJ45 pin1.
18	Rx1-	I/O	Receive/Transmit negative, ECAT OUT port. Connect directly to RJ45 pin6.
19..22	Reserved	-	Reserved
23	ACT0	O	Anode of Link/Activity LED for port IN.
24	ERR	O	Anode of Error LED (EtherCAT status machine).
25	ACT1	O	Anode of Link/Activity LED for port OUT.
26	RUN	O	Anode of Run LED (EtherCAT status machine).
27	+3.3V	O	+3.3V output power supply
28	Sync0	O	Sync0 ECAT signal
29..31	Reserved	-	Reserved
32	SPI_IRQ	O	EtherCAT communication interrupt signal
33	+5V	O	+5V output power supply
34	GND	-	Ground
35..39	Reserved	-	Reserved
40	GND	-	Ground

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
1,2	A/A+	O	Phase A for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors
3,4	B / A-	O	Phase B for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors
5,6	C / B+	O	Phase C for 3-ph motors, B+ for 2-ph steppers
7,8	CR / B-	O	Chopping resistor / Phase B- for step motors

Pin	Name	Type	Description
J4 1,2	+V <sub>MOT</sub>	I	Positive terminal of the motor supply

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Pin	Name	Type	Description
J5	1,2	GND	- Negative return (ground) of the motor supply

Pin	Name	Type	Description
J7	1	Earth	- Earth connection

### Electrical characteristics

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

- Tamb = 0...40°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 <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	2	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
Mechanical Mounting		Min	Typ	Max	Units
Airflow		natural convection <sup>3</sup> , closed box			
Environmental Characteristics		Min	Typ	Max	Units
Size (Length x Width x Height)	Without mating connectors	60 x 40 x 28.2			mm
		~2.36 x 1.58 x 1.11			inch
Weight	Without mating connectors	45			g
Power dissipation	Idle (no load)	3.6			W
	Operating	11			
Efficiency		98			%
Cleaning agents	Dry cleaning is recommended	Only Water- or Alcohol- based			
Protection degree	According to IEC60529, UL508	IP20			
Logic Supply Input (+V <sub>LOG</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		40	V <sub>DC</sub>
	Absolute maximum values, surge (duration ≤ 10ms)	-1		+45	V
Supply current	No Load on Digital Outputs	+V <sub>LOG</sub> = 9V		300	mA
		+V <sub>LOG</sub> = 12V		250	
		+V <sub>LOG</sub> = 24V		150	
		+V <sub>LOG</sub> = 36V		100	
Utilization Category	Acc. to 60947-4-1 (IPEAK ≤ 1.05 * INOM)	DC-1			
Motor Supply Input (+V <sub>MOT</sub> )		Min	Typ	Max	Units
Supply voltage	Nominal values	12	80	90	V <sub>DC</sub>
	Absolute maximum values, drive operating but outside guaranteed parameters	11		94	V <sub>DC</sub>
	Absolute maximum values, surge (duration ≤ 10ms)	-1		95	V
Supply current	Idle		1	5	mA
	Operating	-40	±20	+40	A
	Absolute maximum value, short-circuit condition (duration ≤ 10ms)			45	A
Utilization Category	Acc. to 60947-4-1 (IPEAK ≤ 4.0 * INOM)	DC-3			


Motor Outputs (A/A+, B/A-, C/B+, CR/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 <sub>MOT</sub> = 80 V	F <sub>PWM</sub>			µH	
		20 kHz	330			
		40 kHz	150			
		60 kHz	120			
		80 kHz	80			
	Minimum value, limited by short-circuit protection; +V <sub>MOT</sub> = 80 V	20 kHz	120			µH
		40 kHz	40			
		60 kHz	30			
		80 kHz	15			
		100 kHz	8			
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			
		100 kHz	50			
Current measurement	FS = Full Scale accuracy		±5	±8	%FS	
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)	-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	
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		
	Absolute maximum, surge (duration ≤ 1s)	-11		+14		
Input current	Input voltage 0...+5V	-1	±0.9	+1	mA	
Interpolation Resolution	Depending on software settings			10	bits	
Frequency		0		1	kHz	
ESD protection	Human body model		±1		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)			±36		
Input impedance	To GND		8		kΩ	
Resolution			12		bits	
Integral linearity				±2	bits	
Offset error			±2	±10	bits	
Gain error			±1%	±3%	% FS <sup>4</sup>	
Bandwidth (-3dB)	Software selectable	0		1	kHz	
ESD protection	Human body model		±2		kV	

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

<sup>2</sup> iMOTIONCUBE 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> It is recommended to mount the iMOTIONCUBE on a metallic support using the provided mounting holes, for better reliability and reduced de-rating due to heat dissipation

<sup>4</sup> "FS" stands for "Full Scale"

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Encoder #1 Inputs (A2+, A2-, B2+, B2-, Z2+, Z2-) <sup>1</sup>		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)		4.7		
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 2.2K $\Omega$ pull-up to +5	0	0	0	
Differential mode compliance	For full RS422 compliance, see <sup>2</sup>	TIA/EIA-422-A			
Input voltage, differential mode	Hysteresis	$\pm 0.06$	$\pm 0.1$	$\pm 0.2$	V
	Common-mode range (A+ to GND, etc.)	-7		+7	
Input impedance	A1+, B1+, Z1+ to GND		2.2		k $\Omega$
	A1-, B1-, Z1- to GND		3.6		
Input frequency	Single-ended mode	0		500	kHz
	Differential mode	0		10	
Input voltage, any pin to GND	Absolute maximum, surge (duration $\leq 1s$ ) <sup>†</sup>	-11		+14	V
ESD protection	human body model	$\pm 1$			kV
Encoder #2 Inputs (A2, B2, Z2)		Min	Typ	Max	Units
Single ended mode compliance		TTL / CMOS / Open collector			
Input voltage, single-ended mode	Logic "LOW"			0.8	V
	Logic "HIGH"	2			
Input current, single-ended mode	Logic "LOW"			0.1	mA
	Logic "HIGH"			0.1	
Sin-Cos Encoder Inputs (Sin+, Sin-, Cos+, Cos-) <sup>1</sup>		Min	Typ	Max	Units
Input voltage, differential	Sin+ to Sin-, Cos+ to Cos-	0.8	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 $\leq 1s$ ) <sup>†</sup>	-11		+14	
Input impedance	Differential, Sin+ to Sin-, Cos+ to Cos-		120		$\Omega$
	Common-mode, to GND		2.2		
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	$\pm 2$			kV
Digital Inputs (IN0, IN1, IN2/LSP, IN3/LSN) <sup>3</sup>		Min	Typ	Max	Units
Mode compliance		PNP			
Default state	Input floating (wiring disconnected)	Logic LOW			
Input voltage	Logic "LOW"	-10	0	2.2	V
	Logic "HIGH"	6.3		36	
	Floating voltage (not connected)		0		
	Absolute maximum, continuous	-10		+39	
	Absolute maximum, surge (duration $\leq 1s$ ) <sup>†</sup>	-20		+40	
Input current	Logic "LOW"; pulled to GND		0		mA
	Logic "HIGH"		6	8	

Mode compliance		NPN			
Default state	Input floating (wiring disconnected)	Logic HIGH			
Input voltage	Logic "LOW"	-10		2.2	V
	Logic "HIGH"	6.3		36	
	Floating voltage (not connected)		Vlog-1		
	Absolute maximum, continuous	-10		+36	
	Absolute maximum, surge (duration $\leq 1s$ ) <sup>†</sup>	-20		+40	
Input current	Logic "LOW"; Pulled to GND		6	8	mA
	Logic "HIGH"; Pulled to +24V		0		
Input frequency		0		150	kHz
		3.3			
ESD protection	Human body model	$\pm 15$			kV
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 <sub>LOG</sub> floating or to GND)	High-Z (floating)			
	Immediately after power-up	OUT0, OUT1	Logic "HIGH"		
	Normal operation	OUT0, OUT1, OUT2/Error	Logic "HIGH"		
Output voltage	OUT3/Ready	Logic "LOW"			
	Logic "LOW"; output current = 0.5A			0.8	V
	Logic "HIGH", external load to +V <sub>LOG</sub>		V <sub>LOG</sub>		
Absolute maximum, continuous	-0.5		V <sub>LOG</sub> +0.5		
Output current	Logic "LOW", sink current, continuous			0.5	A
	Logic "HIGH", leakage current; external load to +V <sub>LOG</sub> ; V <sub>OUT</sub> = V <sub>LOG</sub> max = 39V			0.2	
Minimum pulse width		2			$\mu s$
ESD protection	Human body model	$\pm 2$			kV
Encoder#1 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 2.2K $\Omega$ pull-up to +5	0	0	0	
Differential mode compliance	For full RS422 compliance, see <sup>4</sup>	TIA/EIA-422-A			
Input voltage, differential mode	Hysteresis	$\pm 0.06$	$\pm 0.1$	$\pm 0.2$	V
	Common-mode range (A+ to GND, etc.)	-7		+7	
Input impedance, differential	A+ to A-, B+ to B-	4.2	4.7		k $\Omega$
	Z+ to Z-	6.1	7.2		
Input frequency	Single-ended mode, Open-collector / NPN	0		5	MHz
	Differential mode, or Single-ended driven by push-pull (TTL / CMOS)	0		10	
Minimum pulse width	Single-ended mode, Open-collector / NPN	1			$\mu s$
	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 $\leq 1s$ ) <sup>†</sup>	-11		+14	
ESD protection	Human body model	$\pm 2$			kV

<sup>1</sup> Encoder #1 differential input pins do not have internal 120 $\Omega$  termination resistors connected across. Contact Technosoft in case they are needed.

<sup>2</sup> For full RS-422 compliance, 120 $\Omega$  termination resistors must be connected across the differential pairs

<sup>3</sup> The digital inputs are software selectable as PNP or NPN

<sup>4</sup> For full RS-422 compliance, 120 $\Omega$  termination resistors must be connected across the differential pairs, as close as possible to the drive input pins.

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# IMOTIONCUBE CAT STO DATASHEET

P/N: P025.326.E121

Encoder#2 Inputs (A2, B2, Z2)		Min	Typ	Max	Units
Single-ended mode compliance		TTL / CMOS / Open-collector			
Input voltage, single-ended mode A2, B2, Z2	Logic "LOW"			0.8	V
	Logic "HIGH"	2			
Input current, single-ended mode A2, B2, Z2	Logic "LOW"			0.1	mA
	Logic "HIGH"			0.1	
Sin-Cos Encoder Inputs (Sin+, Sin-, Cos+, Cos-) <sup>2</sup>		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) <sup>†</sup>	-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
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 <sup>-10</sup>		hour <sup>-1</sup> (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	
Pulse duration	Ignored high-low-high			5	ms
	Accepted pulse			20	Hz
PWM operation delay	From Enabled low-high transition to PWM operation enabled			30	ms
ESD protection	Human body model	±2			kV

Ethernet Ports		Min.	Typ.	Max.	Units
Standard Compliance	EtherCAT (IEC61158-3/4/5/6-12)				
	Fast Ethernet 100BASE-TX (IEEE802.3u)				
	Auto-negotiation for 100Mbps/s full-duplex				
	Auto-detect MDI/MDI-X				
Power over Ethernet	NOT used by ECAT MX, separate 5V supply	compliant to IEEE802.3af mode A "Mixed DC & Data" NOT compliant to IEEE802.3af mode B "DC on Spares"			
Isolation GND0, GND1	Requirement for motherboard PCB routing	500			V <sub>rms</sub>
		1.5			kV <sub>peak</sub>
Maximum cable length	2-pair UTP Cat5	100	150		m
ESD protection	Human body model	±4			kV
ECAT LED signals		Min.	Typ.	Max.	Units
LED connection		Common anode to 3.3V output			
		Direct, no series resistor			
LED current			8	10	mA
3.3 output voltage		3.15	3.3	3.45	V
3.3 output current				60	mA
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
Supply Output (+5V)		Min	Typ	Max	Units
Output voltage	Current sourced = 500mA	4.8	5	5.2	V
Output current		200	250		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)				

<sup>†</sup> 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.

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