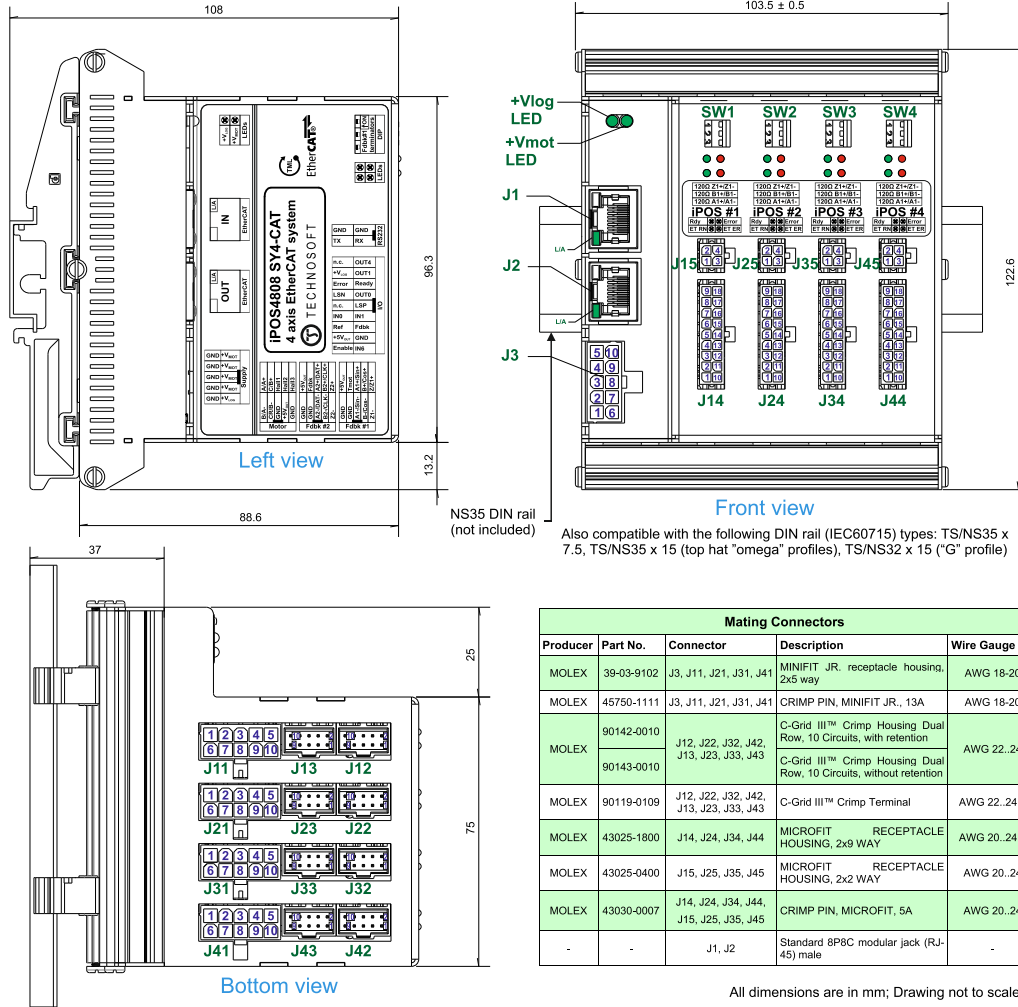


# iPOS4808 SY4-CAT DATASHEET

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Mating Connectors				
Producer	Part No.	Connector	Description	Wire Gauge
MOLEX	39-03-9102	J3, J11, J21, J31, J41	MINIFIT JR receptacle housing, 2x5 way	AWG 18-20
MOLEX	45750-1111	J3, J11, J21, J31, J41	CRIMP PIN, MINIFIT JR., 13A	AWG 18-20
MOLEX	90142-0010	J12, J22, J32, J42, J13, J23, J33, J43	C-Grid III™ Crimp Housing Dual Row, 10 Circuits, with retention	AWG 22..24
	90143-0010	J12, J22, J32, J42, J13, J23, J33, J43	C-Grid III™ Crimp Housing Dual Row, 10 Circuits, without retention	AWG 22..24
MOLEX	90119-0109	J12, J22, J32, J42, J13, J23, J33, J43	C-Grid III™ Crimp Terminal	AWG 22..24
MOLEX	43025-1800	J14, J24, J34, J44	MICROFIT RECEPTACLE HOUSING, 2x9 WAY	AWG 20..24
MOLEX	43025-0400	J15, J25, J35, J45	MICROFIT RECEPTACLE HOUSING, 2x2 WAY	AWG 20..24
MOLEX	43030-0007	J14, J24, J34, J44, J15, J25, J35, J45	CRIMP PIN, MICROFIT, 5A	AWG 20..24
-	-	J1, J2	Standard 8P8C modular jack (RJ-45) male	-

All dimensions are in mm; Drawing not to scale

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

<sup>1</sup> Available starting with F515K firmware version

<sup>2</sup> Sensor used only for step loss detection

<sup>3</sup> For more details, please contact Technosoft

Features
4 axis compact EtherCAT motion system
One supply connector; Motor: 12-50V. Logic: 12-36V
Output current per axis: 8A cont. (BLDC mode); 20A <sub>PEAK</sub>
Feedback Devices per axis (dual-loop support)
1s <sup>1</sup> feedback devices supported:
▪ Incremental encoder interface (single ended or differential)
▪ pulse & direction interface (single ended)
▪ Analogue sin/cos encoder interface (differential 1V <sub>pp</sub> )
▪ Digital Hall sensor interface (single-ended and open collector)

2 <sup>nd</sup> feedback devices supported:
▪ Incremental encoder interface (differential)
▪ pulse & direction interface (differential)
▪ SSI/BiSS-C/EnDAT <sup>1</sup> encoder interface
▪ Integrated termination resistors for the 1 <sup>st</sup> feedback connector of each axis, selectable by DIP switches
▪ TML instruction set for the definition / execution of standalone motion sequences that can be stored in internal E <sup>2</sup> ROM
▪ 6 digital inputs per axis, 12-36V, PNP/NPN programmable: 2 for limit switches, 1 software selectable general-purpose or Enable, 3 general-purpose
▪ 5 digital outputs per axis, 5-36V, 0.5A, NPN open-collector: Ready, Error, 3 general-purpose
▪ 2 analogue inputs per axis: 12-bit, 0-5V: Reference, Feedback or general purpose
▪ RS-232 serial & dual 100Mbps RJ45 EtherCAT® interfaces
▪ EtherCAT® with CAN application protocol over EtherCAT (CoE), File over EtherCAT (FoE) and Ethernet over EtherCAT (EoE)
▪ 16k x 16 SRAM memory for data acquisition
▪ 16k x 16 E <sup>2</sup> ROM 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 per axis
▪ Integrated fan with automatic speed control for thermal protection
▪ Protection to over-current, short-circuit, earth fault, over- / under-voltage, I2t, control error

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Connectors Description			
Port	Name	Type	Description
J1	ECAT IN	I	EtherCAT standard RJ45 Ethernet IN port
J2	ECAT OUT	O	EtherCAT standard RJ45 Ethernet OUT port

Pin	Name	Type	Description
1..5	GND	-	Negative return (ground) of the power supply
J3 6	+V <sub>LOG</sub>	I	Positive terminal of the logic supply input: 9 to 36V <sub>Dc</sub>
7..10	+V <sub>MOT</sub>	I	Positive terminal of the motor supply: 11 to 50V <sub>Dc</sub>

Pin	Name	Type	Description
1	A/A+	O	<b>Phase A</b> for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors
2	C/B+	O	<b>Phase C</b> for 3-ph motors, B+ for 2-ph steppers
3	Hall 1	I	Digital input Hall 1 sensor
4	Hall 2	I	Digital input Hall 2 sensor
5	Hall 3	I	Digital input Hall 3 sensor
6	B/A-	O	<b>Phase B</b> for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors
7	CR/B-	O	<b>Chopping resistor</b> / Phase B- for step motors
8	GND	-	Negative return (ground) of the motor supply
9	+5V <sub>OUT</sub>	O	5V output supply - internally generated
10	GND	-	Negative return (ground) of the motor supply

Pin	Name	Type	Description
1	Z1-	I	Incr. encoder1 Z- diff. input
2	Z1+	I	Incr. encoder1 Z single-ended, or Z+ diff. input
3	B1-/Cos-	I	Incr. encoder1 B- diff. input, or analogue encoder Cos- diff. input
4	B1+/Cos+/Dir	I	Incr. encoder1 B single-ended, or B+ diff. input, or Dir, or analogue encoder Cos+ diff. input
5	A1-/Sin-	I	Incr. encoder1 A- diff. input, or analogue encoder Sin- diff. input
6	A1+/Sin+/Pulse	I	Incr. encoder1 A single-ended, or A+ diff. input, or Pulse, or analogue encoder Sin+ diff. input
7	GND	-	Return ground for sensors supply
8	Temp Mot	I	NTC/PTC input. Used to read an analog temperature value
9	GND	-	Return ground for sensors supply
10	+5V <sub>OUT</sub>	O	5V output supply for I/O usage

Pin	Name	Type	Description
1	Z2-	I	Incr. encoder2 Z- diff. input; has 120Ω resistor between pins 1 and 2
2	Z2+	I	Incr. encoder2 Z+ diff. input ; has 120Ω resistor between pins 1 and 2
3	B2-/Dir-/CLK-/MA-	I/O	Incr. encoder2 B- diff. input, or Dir-, or Clock- for SSI & EnDAT, or Master- for BiSS; has 120Ω resistor between pins 3 and 4
4	B2+/Dir+/C LK+/MA+	I/O	Incr. encoder2 B+ diff. input, or Dir+, or Clock+ for SSI & EnDAT, or Master+ for BiSS; has 120Ω resistor between pins 3 and 4
5	A2-/Pulse-/Data-/SL-	I	Incr. encoder2 A- diff. input, or Pulse-, or Data- for SSI & EnDAT, or Slave- for BiSS; has 120Ω resistor between pins 5 and 6
6	A2+/Pulse+/Data+/SL+	I	Incr. encoder2 A+ diff. input, or Pulse+, or Data+ for SSI & EnDAT, or Slave+ for BiSS; has 120Ω resistor between pins 5 and 6
7	GND	-	Return ground for sensors supply
8	FDBK	I	Analogue input, 12-bit, 0-5V. Used to read an analogue position or speed feedback (as tacho), or used as general purpose analogue input; Also connected to J14/J24/J34/J44 pin12.
9	GND	-	Return ground for sensors supply
10	+5V <sub>OUT</sub>	O	5V output supply for sensors usage

Pin	Name	Type	Description
1	IN5/ Enable	I	12-36V general-purpose digital PNP/NPN input or drive enable input (software selectable)
2	+5V <sub>OUT</sub>	O	5V output supply for I/O usage
3	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
4	IN0	I	12-36V general-purpose digital PNP/NPN input
5	n.c.	-	not connected
6	IN3/LSN	I	12-36V digital PNP/NPN input. Negative limit switch input
7	OUT2/Error	O	5-36V 0.5A, drive Error output, active low, NPN open-collector/TTL pull-up. Also drives the red Error LED.
8	+V <sub>LOG</sub>	I	Positive terminal of the logic supply: 9 to 36V <sub>Dc</sub>
9	n.c.	-	not connected
10	IN6	I	12-36V general-purpose digital PNP/NPN input
11	GND	-	Return ground for I/O pins
12	FDBK	I	Analogue input, 12-bit, 0-5V. Used to read an analogue position or speed feedback (as tacho), or used as general purpose analogue input; Connected also to J4 pin 8.
13	IN1	I	12-36V general-purpose digital PNP/NPN input
14	IN2/LSP	I	12-36V digital PNP/NPN input. Positive limit switch input
15	OUT0	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
16	OUT3/Ready	O	5-36V 0.5A, drive Ready output, active low, NPN open-collector/TTL pull-up. Also drives the green Ready LED.
17	OUT1	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
18	OUT4	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up

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

SW1 (iPOS#1), SW2 (iPOS#2), SW3 (iPOS#3), SW4 (iPOS#4) Configuration selection DIP switch		
Pin	Position	Description
1	down(ON)	Connect an 120Ω resistor between Z1+ and Z1- feedback pins
2	down(ON)	Connect an 120Ω resistor between B1+ and B1- feedback pins
3	down(ON)	Connect an 120Ω resistor between A1+ and A1- feedback pins

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### Electrical characteristics per axis

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

- VLOG = 24 VDC; VMOT = 48VDC
- Supplies start-up / shutdown sequence: -any-
- Load current (sinusoidal amplitude / continuous BLDC, DC, stepper) = 8A

Operating Conditions		Min.	Typ.	Max.	Units
Ambient temperature		0		40 <sup>1,3</sup>	°C
Ambient humidity	Non-condensing	0		90	%Rh
Altitude / pressure <sup>2</sup>	Altitude (vs. sea level)	-0.1	0 ± 2.5	2	Km
	Ambient Pressure	0 <sup>2</sup>	0.75 ± 1	10.0	atm
Storage Conditions		Min.	Typ.	Max.	Units
Ambient temperature		-40		105	°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			
Environmental Characteristics of the multi axis system					
Size (Length x Width x Height)	Without mating connectors	122.6 x 103.5 x 106.9			mm
	With recommended mating connectors.	~4.83 x 4.07 x 4.21			inch
Weight	Without mating connectors	122.6 x 103.5 x 114.5			mm
	With recommended mating connectors.	~4.83 x 4.07 x 4.51			inch
Power dissipation	Idle (no load)	510			g
Efficiency	Operating	13.6			W
		34			%
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) <sup>†</sup>	-1		+45	V
Supply current	No Load on Digital Outputs	+V <sub>LOG</sub> = 9V	1600		mA
		+V <sub>LOG</sub> = 12V	1200		
		+V <sub>LOG</sub> = 24V	600		
		+V <sub>LOG</sub> = 39V	360		
Motor Supply Input (+V <sub>MOT</sub> )		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	11		50	V <sub>DC</sub>
	Absolute maximum values, drive operating but outside guaranteed parameters	9		52	V <sub>DC</sub>
	Absolute maximum values, continuous	-0.6		54	V <sub>DC</sub>
	Absolute maximum values, surge (duration ≤ 10ms) <sup>†</sup>	-1		+57	V
Supply current	Idle		4	20	mA
	Operating	-80	±32	+80	A
	Absolute maximum value, short-circuit condition (duration ≤ 10ms) <sup>†</sup>			100	A
Motor Outputs (A/A+, B/A-, C/B+, BR/B-) per axis		Min.	Typ.	Max.	Units
Nominal output current, continuous <sup>4</sup>	for DC brushed, steppers and BLDC motors with Hall-based trapezoidal control			8	A
	for PMSM motors with FOC sinusoidal control (sinusoidal amplitude value)			8	
	for PMSM motors with FOC sinusoidal control (sinusoidal effective value)			5.66	
Motor output current, peak	maximum 2.5s	-20		+20	A
Short-circuit protection threshold		±22	±26	±30	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
			F <sub>PWM</sub>		

Motor inductance (phase-to-phase)	Recommended value, for current ripple max. ±5% of full range; +V <sub>MOT</sub> = 36 V	20 kHz	330			µH
		40 kHz	150			
Motor electrical time-constant (L/R)	Minimum value, limited by short-circuit protection; +V <sub>MOT</sub> = 36 V	20 kHz	120			µH
		40 kHz	40			
		60 kHz	30			
		80 kHz	15			
		100 kHz	8			
Current measurement	Recommended value for ±5% current measurement error	20 kHz	250			µs
		40 kHz	125			
		60 kHz	100			
		80 kHz	63			
FS = Full Scale accuracy				±4	±8	%FS
Digital Inputs (IN0, IN1, IN2/LSP, IN3/LSN, IN5/Enable, IN6) <sup>5</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	24	36		
	Hysteresis	1.2	2.4	2.8		
	Floating voltage (not connected)	0				
	Absolute maximum, continuous	-10		+39		
Input current	Absolute maximum, surge (duration ≤ 1s) <sup>†</sup>	-20		+40	mA	
	Logic "LOW"; internal 2.7kΩ pull-down to GND		0			
Input frequency	Logic "HIGH"; pulled to +24V		8	10	kHz	
			0	10		
Minimum pulse width		6			µs	
ESD protection	Human body model	±5			kV	
Mode compliance		NPN				
Default state	Input floating (wiring disconnected)	Logic HIGH				
Input voltage	Logic "LOW"		0	2.2	V	
	Logic "HIGH"	6.3	24	36		
	Hysteresis	1.2	2.4	2.8		
	Floating voltage (not connected)	15				
	Absolute maximum, continuous	-10		+39		
Input current	Absolute maximum, surge (duration ≤ 1s) <sup>†</sup>	-20		+40	mA	
	Logic "LOW"; Pulled to GND; Vlog=24V		8	10		
Input frequency	Logic "HIGH"; Internal 2.7kΩ pull-up to +Vlog		0	0	kHz	
			0	10		
Minimum pulse width		6			µs	
ESD protection	Human body model	±5			kV	
Supply Output (+5V) per axis		Min.	Typ.	Max.	Units	
Output voltage	Current sourced = 250mA	4.8	5.15	5.25	V	
Output current		600	650		mA	
Short-circuit		Protected; axis resets				
Over-voltage		NOT protected				
ESD protection	Human body model	±15			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	


<sup>1</sup> Operating temperature at higher temperatures is possible with reduced current and power ratings

<sup>2</sup> iPOS4808 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 maximum ambient temperature can be increased substantially.

<sup>4</sup> @20KHz F<sub>PWM</sub>

<sup>5</sup> The digital inputs are software selectable as PNP or NPN

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Digital Hall Inputs (Hall1, Hall2, Hall3) per axis		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) <sup>†</sup>	-10		+15		
Input current	Logic "LOW"; Pull to GND			5	mA	
	Logic "HIGH"; Internal 1KΩ pull-up to +5	0	0	0		
Minimum pulse width		2			μs	
ESD protection	Human body model	±5			kV	
Encoder2 Inputs (A2+/Data+, A2-/Data-, B2+/Clk+, B2-/Clk-, Z2+, Z2-)		Min.	Typ.	Max.	Units	
Differential mode compliance		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	A2+, B2+, Z2+ A2-, B2-, Z2-		120		Ω	
Input frequency	Differential mode	0		10	MHz	
Minimum pulse width	Differential mode	50			ns	
Digital Outputs (OUT0, OUT1, OUT2/Error, OUT3/ Ready, OUT4)		Min.	Typ.	Max.	Units	
Mode compliance	All outputs (OUT0, OUT1, OUT2/Error, OUT3/Ready)	TTL / open-collector / NPN 24V				
Default state	Not supplied (+V <sub>LOG</sub> floating or to GND)	High-Z (floating)				
	Immediately after power-up	OUT0, OUT1, OUT4	Logic "HIGH"			
		OUT2/Error, OUT3/ Ready	Logic "LOW"			
	Normal operation	OUT0, OUT1, OUT2/Error	Logic "HIGH"			
OUT3/Ready		Logic "LOW"				
Output voltage	Logic "LOW"; output current = 0.5A			0.8	V	
	Logic "HIGH"; output current = 0, no load	OUT2/Error, OUT3/ Ready	2.9	3		3.3
		OUT0, OUT1, OUT4	4	4.5		5
	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	Absolute maximum, surge (duration ≤ 1s) <sup>†</sup>	-1		V <sub>LOG</sub> +1		
	Logic "LOW", sink current			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, OUT1, OUT4			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	±15			kV	


<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.

Encoder1 Inputs (A1/A1+, A1-, B1/B1+, B1-, Z1/Z1+, Z1-)		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+, Z/Z+	Logic "LOW"			1.6	V
	Logic "HIGH"	1.8			
	Floating voltage (not connected)		3.3		
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		5.5	6	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	A1+ to A1-, B1+ to B1-, Z1+ to Z1-		1		kΩ
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			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) <sup>†</sup>	-11		+14	
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) <sup>†</sup>	-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	
ESD protection	Human body model	±1			kV
Analog 0...5V Inputs (REF, FDBK)		Min.	Typ.	Max.	Units
Input voltage	Operational range	0		5	V
	Absolute maximum values, continuous	-12		+18	
	Absolute maximum, surge (duration ≤ 1s) <sup>†</sup>			±36	
Input impedance	To GND		28		kΩ
Resolution			12		bits
Integral linearity				±2.5	mV
Offset error				±24	mV
Gain error				±1%	% FS <sup>3</sup>
Bandwidth (-3Db)	Software selectable	0		1	kHz
ESD protection	Human body model	±5			kV

<sup>1</sup> For full RS-422 compliance, 120Ω termination resistors must be connected across the differential pairs, set SW1/2/3/4 pins 1,2 and 3 to ON.

<sup>2</sup> For many applications, a 120Ω termination resistor should be connected across SIN+ to SIN-, and across COS+ to COS- (set SW1/2/3/4 pins 2 and 3 to ON). Please consult the feedback device datasheet for confirmation.

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

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