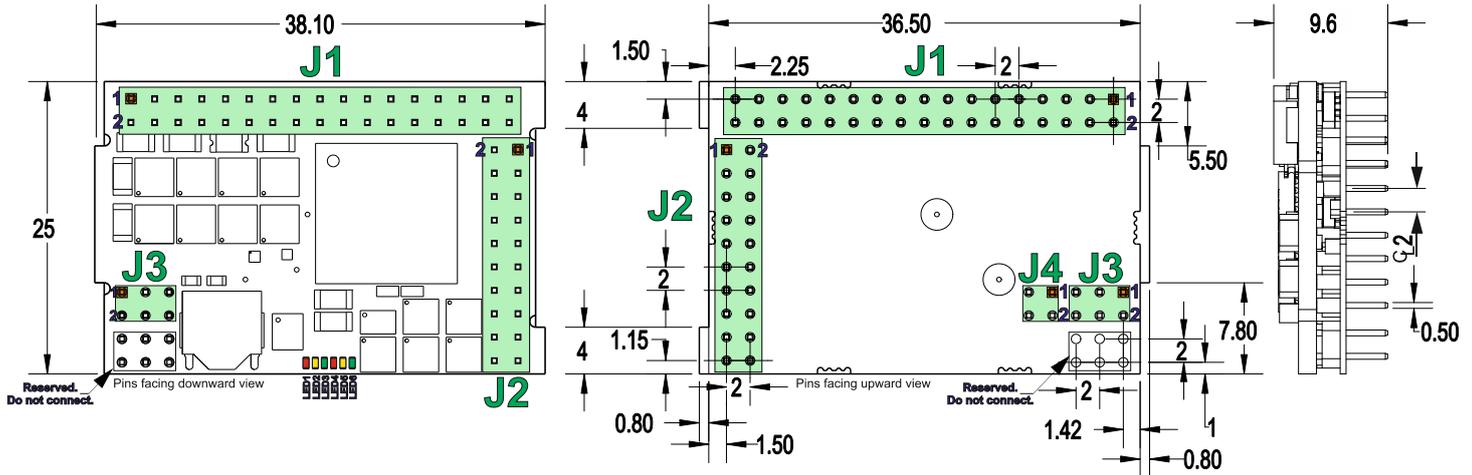


# Micro 4804 MZ-CAT-STO DATASHEET P/N: P020.003.E122



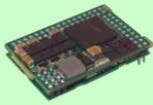
All dimensions are in mm. Drawing not to scale.

Motor – sensor configurations					
Sensor	Motor				
	PMSM	BLDC	DC BRUSH	STEP (2-ph)	STEP (3-ph)
Incr. Encoder	Ⓢ		Ⓢ	Ⓢ	
Incr. Encoder + Dig. Hall	Ⓢ	Ⓢ			
Linear Halls	Ⓢ				
Digital Hall control only	Ⓢ				
BISS / SSI / EnDAT / TAMAGAWA / Nikon / Sanyo Denki / Panasonic	Ⓢ	Ⓢ	Ⓢ	Ⓢ	
Tacho			Ⓢ		
Open-loop (no sensor)				Ⓢ	Ⓢ

Mating Connectors			
Producer	Part No.	Connector	Description
Samtec	SQW-117-01-F-D(-VS)	J1	2x17, 2.0mm THT (SMD) socket
	CLT-117-02-F-D		2x17, 2.0mm SMD pass-through socket
	SQW-110-01-F-D(-VS)	J2	2x10, 2.0mm THT (SMD) socket
	CLT-110-02-F-D		2x10, 2.0mm SMD pass-through socket
	SQW-103-01-F-D(-VS)	J3	2x3, 2.0mm THT (SMD) socket
	CLT-103-02-F-D		2x3, 2.0mm SMD pass-through socket
	SQW-102-01-F-D(-VS)	J4	2x2, 2.0mm THT (SMD) socket
	CLT-102-02-F-D		2x2, 2.0mm SMD pass-through socket

- **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 features, including CSP, CSV, CST, PVT, S-curve, electronic gearing, camming, and more.
  - Motor supply: 48V nominal
    - Motor output current:
      - Nominal: 4.5A<sub>RMS</sub> / 6.3A amplitude for PMSM motors
      - 5.5A for DC / BLDC / Step motors
      - Peak: 11.3A<sub>RMS</sub> / 16A amplitude
  - Logic supply: 24V nominal, 48V max
  - Feedback Options:
    - 1 x Hall sensor interface (digital or linear)
      - Feedback#1 and Feedback#2 can be:
        - Incremental encoder A / B (index Z only for Feedback 1): differential or single-ended;
        - Absolute encoder: differential or single-ended. Supported protocols: SSI, BiSS, EnDAT, Tamagawa, Panasonic, Nikon, Sanyo Denki.
    - 1 x analogue input, 12-bit, software selectable: 0-5V or ±10V; Reference, Feedback or General purpose
    - 3 x digital inputs: 2 for limit switches + one general-purpose, NPN, pull-up on-board to +5V. Pull to GND to activate.
  - 3 x configurable I/Os, each software selectable as:
    - Digital input, NPN, with pull-up on-board to +5V. Pull to GND to activate;
    - Digital output, NPN (open-collector), with pull-up on-board to +5V. Sink current: 1 x 1.5A to drive inductive loads (such as mechanical brake), 2 x 50mA.
  - Commissioning (set-up) possible through RS232, USB, FoE (file-over-EtherCAT) or EoE (Ethernet-over-EtherCAT)
  - EtherCAT connection to standard RJ45: requires external magnetics (may be integrated into RJ45)
    - 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.
  - 24Kwords E<sup>2</sup>ROM to store setup data, TML motion programs, cam tables and other user data
  - 16Kwords SRAM memory for data acquisition
  - Operating ambient temperature: 0-40°C (over 40°C with de-rating)
  - Programmable protections: any short-circuit between motor phases, GND and/or supply, over/under-voltage, over-current, I<sup>2</sup>t drive & motor, control error
  - 3 AxisID inputs, for hardware-based address setting
  - >98% voltage efficiency, >98% power efficiency

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# Micro 4804 MZ-CAT-STO DATASHEET P/N: P020.003.E122

Pin	Name	Type	Description
1	+Vlog	I	Positive terminal of the logic supply input: 6 to 48 V <sub>DC</sub>
2	A/A+	O	Phase A for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors
3	GND	-	Ground return for logic supply
4	B/A-	O	Phase B for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors
5	GND	-	Ground return for motor supply & shield for motor windings cable
6	C/B+	O	Phase C for 3-ph motors, B+ for 2-ph steppers
7	+Vmot	I	Positive terminal of the motor supply: 7 to 48 VDC
8	Cr/B-	O	Chopping resistor / Phase B- for 2-ph steppers
9	BFS	-	Boot Fail-Safe: Connect to GND to reprogram firmware in the improbable case when a power loss occurs during a firmware update and the normal firmware recovery fails
10	ID2	I	AxisID2 selection pin. See AxisID register settings table.
11	TX1-	I/O	Transmit/Receive negative, OUT port. Connect to magnetics PHY TX1 or directly to nearby RX0-
12	RX1-	I/O	Receive/Transmit negative, OUT port. Connect to magnetics PHY RX1 or directly to nearby TX0-
13	TX1+	I/O	Transmit/Receive positive, OUT port. Connect to magnetics PHY TX1 or directly to nearby RX0+
14	RX1+	I/O	Receive/Transmit positive, OUT port. Connect to magnetics PHY RX1 or directly to nearby TX0+
15	GND1*	-	Ground shield & center-tap for ECAT magnetics port 1
16	GND0*	-	Ground shield & center-tap for ECAT magnetics port 0
17	TX0-	I/O	Transmit/Receive negative, IN port. Connect to magnetics PHY TX0 or directly to nearby RX1-
18	RX0-	I/O	Receive/Transmit negative, IN port. Connect to magnetics PHY RX0 or directly to nearby TX1-
19	TX0+	I/O	Transmit/Receive positive, IN port. Connect to magnetics PHY TX0 or directly to nearby RX1+
20	RX0+	I/O	Receive/Transmit positive, IN port. Connect to magnetics PHY RX0 or directly to nearby TX1+
21	ID0	I	AxisID0 selection pin. See AxisID register settings table.
22	ID1	I	AxisID1 selection pin. See AxisID register settings table.
23	232TX	O	RS-232 Data Transmission.
24	232RX	I	RS-232 Data Reception.
25	...	Rsvd.	Reserved. Do not connect.
26			
27	IN2/LSP	I	5-48V digital NPN input. Positive limit switch input
28	IN3/LSN	I	5-48V digital NPN input. Negative limit switch input
29	IN5	I	5-48V digital general-purpose NPN input
30	I/O0	I/O	5-48V 1.5A NPN (sink) general-purpose digital programmable output OUT0 or input IN0
31	I/O1	I/O	5-48V 50mA NPN (sink) general-purpose digital programmable output OUT1 or input IN1
32	I/O4	I/O	5-48V 50mA NPN (sink) general-purpose digital programmable output OUT4 or input IN4
33	GND	-	Ground return and shield
34	AnalogIn	I	Analog input (range software selectable 0-5V or ±10V)

\* GND0, GND1, and all other GND pins are internally connected within the drive. However, it is strongly recommended to reserve GND0 and GND1 exclusively for EtherCAT-related functions, and avoid using them for any other purposes.

Pin	Name	Type	Description
1	ECAT ACT0	O	Shows the state of the physical link and activity for ECAT IN port. Active high, LV-TTL.
2	ECAT ACT1	O	Shows the state of the physical link and activity for ECAT OUT port. Active high, LV-TTL.
3	TML RDY	O	Lit after power-on when the drive initialization ends. Turned off when an error occurs. Active high, LV-TTL.
4	TML ERR	O	Turned on when the drive detects an error condition. Active high, LV-TTL.
5	ECAT RUN	O	EtherCAT® RUN indicator. Active high, LV-TTL.
6	ECAT ERR	O	EtherCAT® ERROR indicator. Active high, LV-TTL.

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

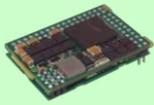
Pin	Name	Type	Description
1	+V USB	I	USB 5V detect input
2	GND	-	Ground return for USB
3	Hall1	I	Digital Hall, or Linear Hall sensor 1
4	Hall2	I	Digital Hall, or Linear Hall sensor 2
5	Hall3	I	Digital Hall, or Linear Hall sensor 3
6	GND	-	Ground return and shield
7	+5V	O	Supply for all feedback sensors
8	GND	-	Ground return and shield
9	EncA1+/EncA1/Dt1+/Dt1	I	Encoder 1 A+/Data+ diff. input or single-ended input
10	EncA1-/Dt1-	I	Encoder 1 A-/Data- diff. input. Leave open for single-ended; Add externally 120Ω to pin 9 for differential
11	EncB1+/EncB1/Clk1+/Clk1	I	Encoder 1 B+/Clock+ diff. input or single-ended input
12	EncB1-/Clk1-	I	Encoder 1 B-/Clock- diff. input. Leave open for single-ended; Add externally 120Ω to pin 11 for differential
13	EncA2+/EncA2/Dt2+/Dt2	I	Encoder 2 A+/Data+ diff. input or single-ended input
14	EncA2-/Dt2-	I	Encoder 2 A-/Data- diff. input. Leave open for single-ended; Add externally 120Ω to pin 13 for differential
15	EncB2+/EncB2/Clk2+/Clk2	I/O	Encoder 2 B+/Clock+ diff. input or single-ended input
16	EncB2-/Clk2-	I	Encoder 2 B-/Clock- diff. input. Leave open for single-ended; Add externally 120Ω to pin 15 for differential
17	Z1+	I	Encoder 1 Z+ diff. input or single-ended input
18	Z1-	I	Encoder 1 Z- diff. input. Leave open for single-ended; Add externally 120Ω to pin 17 for differential
19	USB DM	I/O	USB data-
20	USB DP	I/O	USB data+

No.	Name	Color	Description
LED1	TML ERR	RED	Turned on when the drive detects an error condition.
LED2	ECAT ACT1	YELLOW	Shows the state of the physical link and activity for ECAT OUT port.
LED3	TML RDY	GREEN	Lit after power-on when the drive initialization ends. Turned off when an error occurs.
LED4	ECAT ERR	RED	EtherCAT® ERROR indicator.
LED5	ECAT ACT0	YELLOW	Shows the state of the physical link and activity for ECAT IN port.
LED6	ECAT RUN	GREEN	EtherCAT® RUN indicator.

AxisID register									
MSB	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LSB
ID2			ID1			ID0			
Nominal[V]	Minimum[V]	Maximum[V]	IDx* Bits	IDx* Value					
0.000	0.00	0.53	000	0					
1.06	0.53	1.41	001	1					
1.76	1.41	2.01	010	2					
2.25	2.01	2.43	011	3					
2.60	2.43	2.75	100	4					
2.89	2.75	3.01	101	5					
3.13	3.01	3.22	110	6					
3.32	3.22	3.30	111	7					

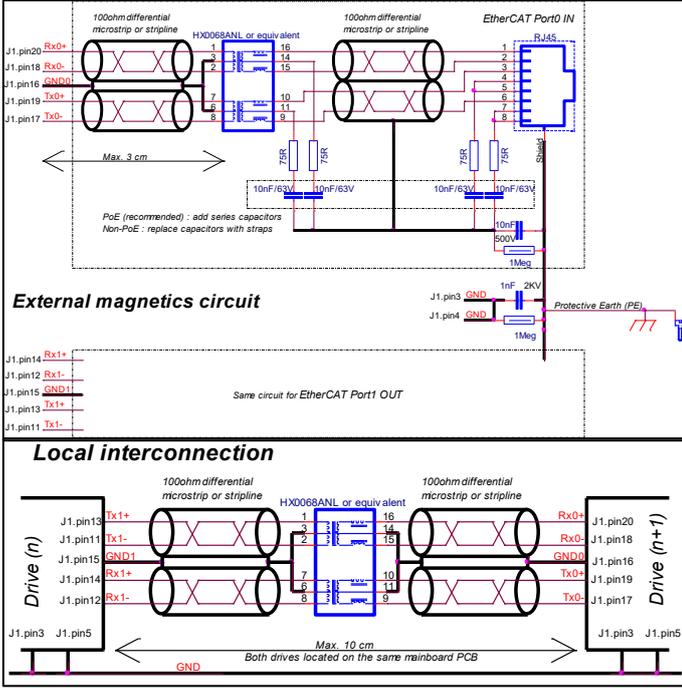
**Remarks:**  
 1.  $AxisID = (64 * ID2\_Value) + (8 * ID1\_Value) + ID0\_Value$   
 2. If all "IDx" pins are left not connected or connected to GND, the AxisID value is 255 and the EtherCAT register called "configured station alias" will be 0.  
 3. Bit 8 (MSB of ID2) is ignored, and always considered as "0"  
 \* where "x" can be 0, 1 or 2

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## Electrical characteristics

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

- $V_{LOG} = 24$  VDC;  $V_{MOT} = 48$  VDC;  $F_{PWM} = 20$  KHz
- Ambient temperature = 25°C (typical values) / 0°C...40°C (min/max values)
- Supplies start-up / shutdown sequence: -any-
- Load current = nominal

Operating Conditions		Min.	Typ.	Max.	Units	
Ambient temperature		0		40 <sup>1,2</sup>	°C	
Ambient humidity		Non-condensing		90	%Rh	
Altitude / pressure <sup>3</sup>		Altitude (vs. sea level)	-0.1	0 + 2.5 <sup>3</sup>	Km	
		Ambient Pressure	0 <sup>2</sup>	0.75 + 1	10.0	atm
Storage Conditions		Min.	Typ.	Max.	Units	
Ambient temperature		-40		100	°C	
Ambient humidity		Non-condensing		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	
Environmental Characteristics		Min.	Typ.	Max.	Units	
Size (Length x Width x Height)		38.1 x 25 x 9.6			mm	
Weight		~1.5 x 1 x 0.4			inch	
		12			g	
Cleaning agents		Dry cleaning is recommended			Only Water- or Alcohol- based	
Protection degree		According to IEC60529			IP20	
Power dissipation		Idle ( $I_{MOT} = 0A$ )	1	1.2	W	
		Full power ( $I_{MOT} = nominal$ )	2.0	2.4		
Power efficiency		Full power ( $I_{MOT} = nominal$ )	98.7		%	
		$f_{PWM} = 20KHz$	98.3			
		$f_{PWM} = 100KHz$	91.4			
Voltage efficiency		Idle ( $I_{MOT} = 0A$ )	55		%	
		Full power ( $I_{MOT} = nominal$ )		100		
Surface temperature <sup>2</sup>					°C	
Mechanical Mounting		Min.	Typ.	Max.	Units	
Airflow		natural convection <sup>2</sup> , closed box				
Spacing required for horizontal mounting <sup>2</sup>		Between adjacent drives	10		mm	
		Between drives and nearby walls	10		mm	
		Space needed for drive removal	20		mm	
		Between drives and roof-top	30		mm	
Insertion force		Using recommended mating connectors			40	N
Extraction force		8			N	

Logic Supply Input (+V <sub>LOG</sub> )		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	6	24	48	V <sub>DC</sub>
	Absolute maximum values, drive operating but outside guaranteed parameters	4.9		57	V <sub>DC</sub>
	Absolute maximum values, continuous	-0.5		58	V <sub>DC</sub>
Supply current	+V <sub>LOG</sub> = 12V		90	150	mA
	+V <sub>LOG</sub> = 24V		60	90	
	+V <sub>LOG</sub> = 48V		45	60	
Utilization category	Acc. to 60947-4-1 ( $I_{PEAK} \leq 1.05 \cdot I_{NOM}$ )	DC-1			
Motor Supply Input (+V <sub>MOT</sub> )		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	7		48	V <sub>DC</sub>
	Absolute maximum values, drive operating but outside guaranteed parameters	6		57	V <sub>DC</sub>
	Absolute maximum values, continuous	-0.5		58	V <sub>DC</sub>
Supply current	Idle		0.3		mA
	Operating	-16	±7	+16	
Voltage measurement error				±0.15	V
Utilization category	Acc. to 60947-4-1 ( $I_{PEAK} \leq 4.0 \cdot I_{NOM}$ )	DC-3			
Supply Output (+5V)		Min.	Typ.	Max.	Units
Output voltage	Current sourced = 400mA	5.05	5.2	5.25	V
Output current	Output voltage $\geq 4.85V$			1,200	mA
Short-circuit to GND protection		Yes / Drive resets at event			
Over-voltage protection		NOT protected			
ESD protection	Human body model	±1			KV
Motor Outputs (A/A+, B/A-, C/B+, CR/B-)		Min.	Typ.	Max.	Units
Nominal current*	PMSM motors sinusoidal amplitude			±6.3	A
	PMSM motors sinusoidal RMS			4.5	A <sub>RMS</sub>
	DC/BLDC/STEP motors continuous			5.5	A
Peak current	maximum 4 seconds	-16		+16	A
Short-circuit protection threshold			±25	±28	A
Short-circuit protection delay		2.6		3.5	µs
On-state voltage drop	Nominal output current; including typical mating connector contact resistance		50	70	mV
Off-state leakage current			0.3	1	mA
Current measurement	Accuracy (FS = Full Scale)		±1	±1.5	%FS
	Noise (current $\leq 2A$ )		±4	±6	mA
	Noise (current $\geq 2A$ )		±30	±50	mA
Offset drift (compensated @ AxisOn)				±0.16	mA/°C
Motor inductance (phase-to-phase)	Recommended value to avoid spurious short-circuit protection, triggered by ripple	Fast loop <sup>3</sup> V <sub>MOT</sub>			µH
		50µs 48V		133	
		100µs 48V		266	
		50µs 24V		66	
Motor electrical time-constant (L/R)	Recommended value for ±5% current measurement error	F <sub>PWM</sub> = 20 kHz		330	µs
		F <sub>PWM</sub> = 40 kHz		170	
		F <sub>PWM</sub> = 60 kHz		140	
		F <sub>PWM</sub> = 80 kHz		80	
		F <sub>PWM</sub> = 100 kHz		66	
Hall Inputs (Hall1, Hall2, Hall3)		Min.	Typ.	Max.	Units
Mode compliance	TTL / CMOS / Open-collector (NPN sink), or analog (linear)	0...5V			
Default state	Input floating (Wiring disconnected)	4.5	4.8	5.2	V
Input voltage	Digital	Logic "LOW"		1.5	
		Logic "HIGH"	3	2.5	
	Hysteresis		0.5		
Analog		0	0.5...4.5	4.95	
Input current	Logic "LOW"; Pull to GND		2.4		mA
Logic "HIGH"; Internal 2.2K $\Omega$ pull-up to +5			0		
Minimum pulse width			66		µs
ESD protection - Human body model			±15		kV
Analog Input (REF/ FDBK)		Min.	Typ.	Max.	Units
Input voltage	Operational range	0...5, -10...+10			V
	Absolute maximum values, continuous	-22		+26	
	Absolute maximum values, surge (duration $\leq 1s$ )			±38	
Input impedance	To 1.44V		20		k $\Omega$
Bandwidth (-3dB)	Software selectable	0		5.3	kHz
Resolution			12		bits
Integral linearity				±1	bits
Offset error	Range -10V ... +10V		±10	±30	mV
	Range 0 ... +5V		±15	±40	
Gain error	Range -10V ... +10V		±30	±50	mV
	Range 0 ... +5V		±25	±40	
ESD protection	Human body model	±1.5			kV

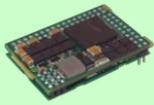
<sup>1</sup> Operating temperature at higher temperatures is possible with reduced current and power ratings  
<sup>2</sup> In case of forced cooling (conduction or ventilation): a) the ambient temperature requirements may be extended substantially as long as the drive (PCB) temperature is kept below 85 °C; b) the spacing requirements can be dropped down to zero; c) the surface temperature will decrease accordingly

<sup>3</sup> Micro 4804 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>4</sup> For current values  $>4A_{RMS}$ , pins J1/2...8 may need to be soldered instead of socketed, for long-term reliability – check socket manufacturer specifications.

<sup>5</sup> Fast loop period of 50µs is not possible with all feedback device types.

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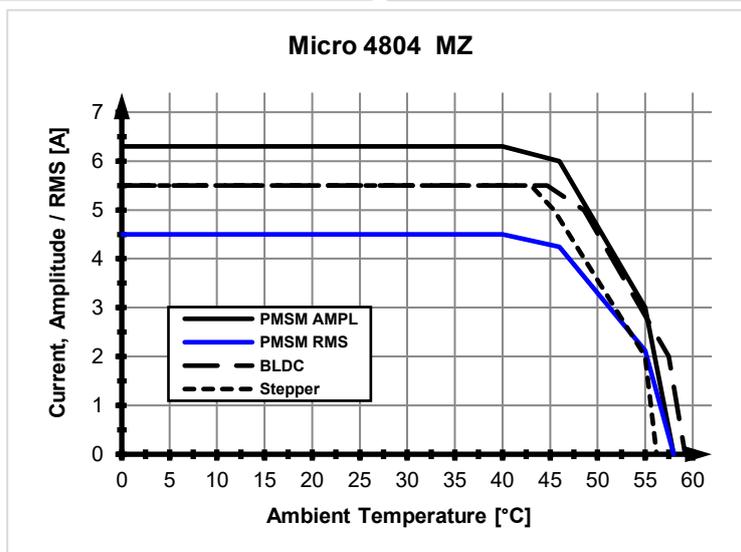
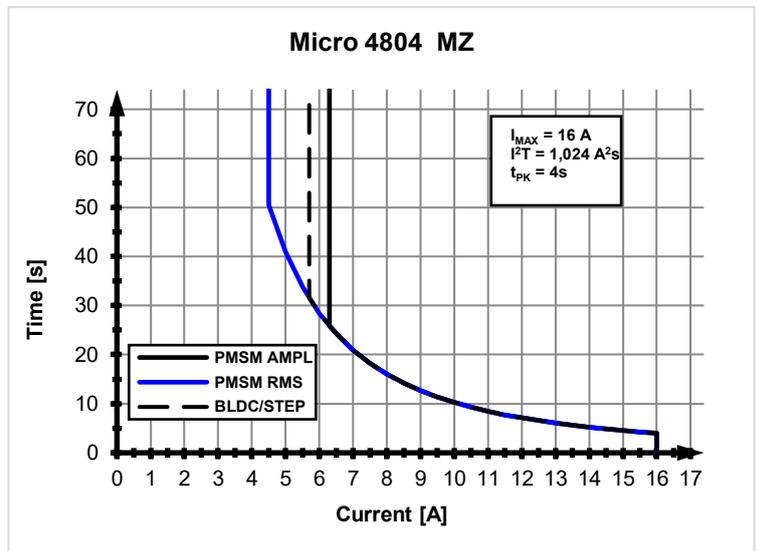
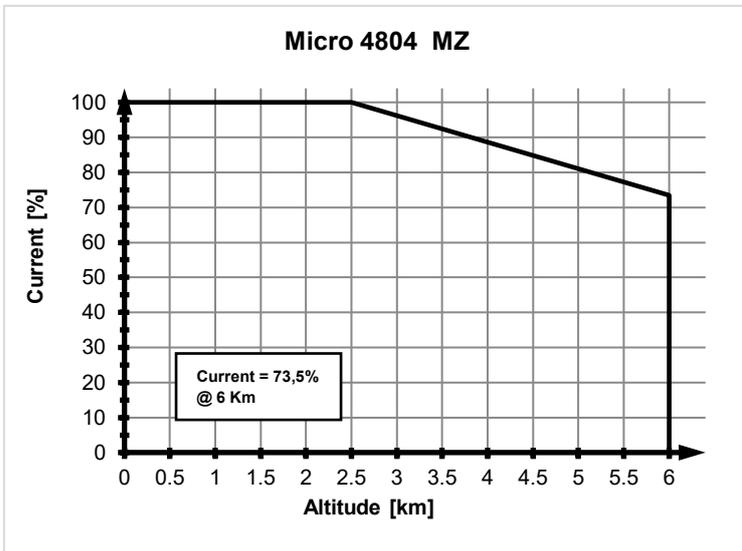
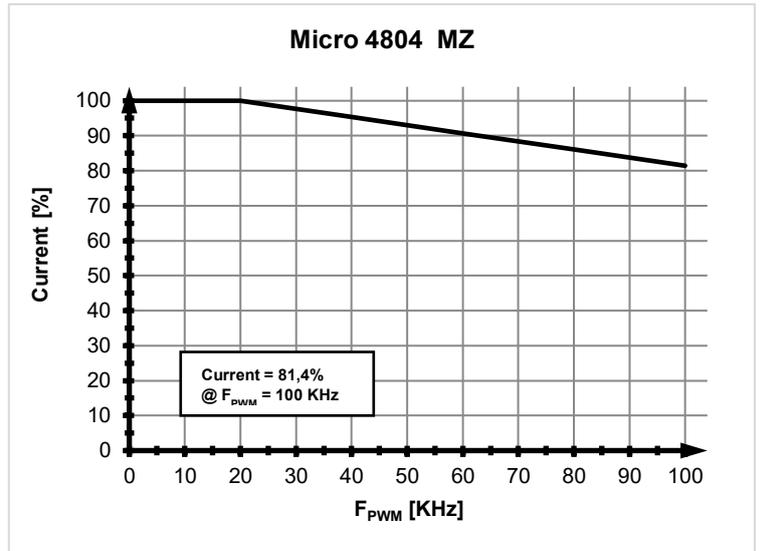
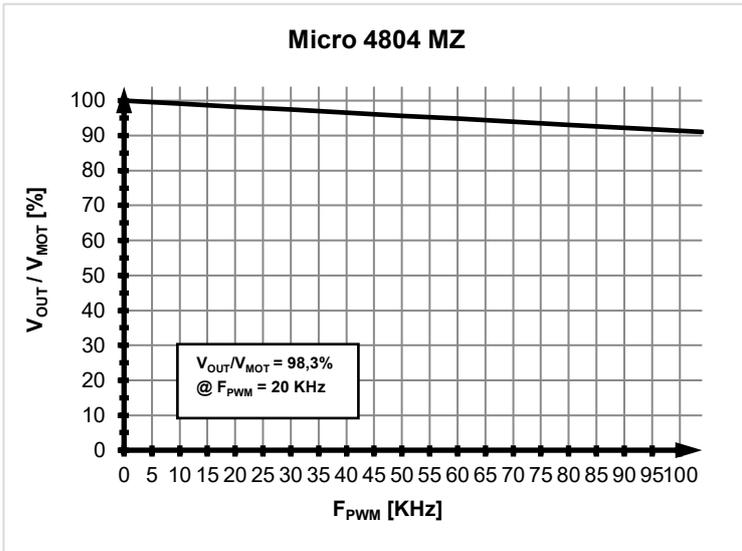
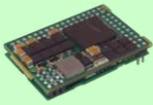
Digital Inputs (IN0, IN1, IN2/LSP, IN3/LSN, IN4, IN5)		Min.	Typ.	Max.	Units	
Mode compliance		NPN (sink)				
Default state		Logic HIGH				
Input voltage	Logic "LOW"		1.4	1.8	V	
	Logic "HIGH"		3.1	2.5		
	Hysteresis		0.9	1.1		
	Logic "LOW"	IN0, IN1, IN4, IN5		1.4		1.6
	Logic "HIGH"	IN2/LSP, IN3/LSN		4		3.5
	Hysteresis			0.6		
	Floating voltage (not connected)			4.7		
Input current	Absolute maximum, continuous	IN2/LSP, IN3/LSN, IN5	-2	+80	mA	
		IN0, IN1, IN4	-0.5	V <sub>LOG</sub> +0.5		
Input frequency	Logic "LOW"; Pulled to GND		6.5	8	kHz	
	Logic "HIGH"; Pulled to +24V		0.2	0.4		
Minimum pulse		0		500	μs	
ESD protection - Human body model		±2			kV	
Digital Outputs (OUT0, OUT1, OUT4)		Min.	Typ.	Max.	Units	
Mode compliance		NPN (sink) 24V				
Load type		Resistive, Inductive				
Default state		High-Z (floating)				
Immediately after power-up		Logic "HIGH"				
Output voltage	Logic "LOW"; output current = 1.5A for OUT0/ 0.05A for OUT1, OUT4			0.4	V	
	Logic "HIGH"; output current = 0, no load	4	4.7	5.2		
	Logic "HIGH", external load to +V <sub>LOG</sub>		V <sub>LOG</sub>			
	Absolute maximum, continuous (free-wheeling diodes to +V <sub>LOG</sub> to GND)	-0.5		V <sub>LOG</sub> +0.5		
Output current	Absolute maximum, surge (duration ≤ 1s) †	-1		V <sub>LOG</sub> +1	A	
	Logic "LOW", sink current, short duration, duty cycle <=1%	5s max		0.1		
		0.5s max		0.15		
	Logic "LOW", sink current, continuous; V <sub>OUT</sub> ≤ 0.4V	OUT1, OUT4				0.05
		OUT0				1.5
	Logic "HIGH", source current; external load to GND; V <sub>OUT</sub> ≥ 2.0V					5
	Logic "HIGH", leakage current; external load to +V <sub>LOG</sub> ; V <sub>OUT</sub> = V <sub>LOG</sub> max = 40V	V <sub>LOG</sub> =24V	0.18	0.2		
	V <sub>LOG</sub> =48V	0.42	0.45			
Minimum pulse width		0.5			μs	
ESD protection - Human body model		±25			kV	
Encoder Inputs (A1+, A1-, B1+, B1-, Z1+, Z1-, A2+, A2-, B2+, B2-) <sup>1</sup>		Min.	Typ.	Max.	Units	
Single-ended mode compliance	Leave A1-, B1-, Z1-, A2-, B2- floating	TTL / CMOS / Open-collector floating (NPN sink)				
Single-ended threshold	A1+, B1+, Z1+, A2+, B2+	1.3	1.4	1.5	V	
Single-ended input current	Input pulled to GND against on-board 2.2 kΩ pull-up to +5V		2.4	2.7	mA	
Differential mode compliance	For full RS422 compliance, see <sup>1</sup>	TIA/EIA-422-A				
Input voltage	Hysteresis	±0.03	±0.05	±0.2	V	
	Differential mode	-15		+15		
	Common-mode range (A+ to GND, etc.)	-7		+12		
Input impedance, differential	Common-mode (A1+ to GND, etc.)		2.2		kΩ	
	Differential (A1+ to A1-, etc.)		4.4			
Input frequency	Differential mode	0		15	MHz	
Minimum pulse width	Differential mode	33			ns	
ESD protection	Human body model	±30			kV	
RS-232		Min.	Typ.	Max.	Units	
Compliance		TIA/EIA-232-C				
Bit rate	Default	9600			Baud	
	Software selectable	9600		115200		
Output voltage		±5	±5.7		V	
Short-circuit	232TX to GND	Guaranteed				
Input voltage	Absolute maximum, continuous	-30		+30	V	
ESD protection	Human body model	±15			kV	
BFS input		Min.	Typ.	Max.	Units	
Polarity		Active Low (0=fail-safe boot, 1=normal)				
Default state	BFS floating	High				
Voltage	Logic low (active)		0	1.1	V	
	Logic high (inactive)	2.0	3.3		V	
	Abs. max., continuous	-0.5		3.8	V	
Current	Logic low (2.2kΩ pull to +3.3V)		1.5	1.6	mA	
	Logic high		0		mA	
ESD protection	Human body model	±250			V	

LED outputs		Min.	Typ.	Max.	Units	
Polarity	Active high (high=LED lit)					
	Common cathode to GND					
	Voltage	I <sub>OH</sub> ≤ 0.9mA	2.9	3.3		V
		I <sub>OH</sub> ≤ 1.5mA	2.4			V
Current	I <sub>OL</sub> ≤ 2.0mA		0	0.4	V	
	Abs. max., continuous	-0.5		3.8	V	
	Sink (I <sub>OL</sub> ) current larger than source (I <sub>OH</sub> ) current	-2.0		+1.5	mA	
Short-circuit protection		NOT protected				
ESD protection	Human body model	±250			V	
EtherCAT®		Min.	Typ.	Max.	Units	
Compliance		IEEE802.3, IEC61158				
Software protocols compatibility		CoE, FoE, EoE, IEC61800-7-301				
		Required, external				
Magnetics	Turns ratio	1:1				
	Inductance	350			μH	
	Common mode rejection	-30			dB	
	Center tap	to J1 pins 15, 16				
Transmission line	According to TIA/EIA-568-5-A	5	5e	6	Category	
		UTP	FTP	STP	Shield	
Auto	swap + / - inside a pair	Yes (MLT3 encoding)				
	swap Rx / Tx pairs	Yes (auto-MDI/MDIX)				
	Swap port0(IN) / port1(OUT)	NO (EtherCAT requirement)				
Configured Station Alias (using AxisID)	0 + 255					
ESD protection	Human body model	±5			kV	
Absolute encoder interface:		Min	Typ.	Max	Units	
SSI, BiSS-C, EnDAT, Tamagawa, Nikon, Sanyo Denki						
Single-ended mode		Not recommended, reduced robustness & speed				
Differential mode compliance	For full RS422 compliance, see <sup>1</sup>	TIA/EIA-422-A				
Output voltage	Differential; 50Ω differential load	1.5	3.3		V	
	Common-mode, referenced to GND	1	1.7	3		
CLOCK frequency	Nikon, Sanyo Denki	2.5, 4			MHz	
	Panasonic, Tamagawa	2.5				
	All others	1, 2, 3, 4				
Output Short-circuit protection	Common-mode voltage ±15V	Yes, protected				
DATA format	Software selectable	Binary / Gray				
		Single-turn / Multi-turn				
		Counting direction				
		CRC type				
DATA resolution	Including CRC, flags, ...			64	Bits	
	If total resolution >31 bits, some bits must be ignored by software setting to achieve a max. 31 bits resolution					
AxisID inputs		Min.	Typ.	Max.	Units	
Default state	ID1, ID1, ID2 floating	Configured Station Alias = 0, AxisID=255				
Internal pull-down to GND		95	100	105	kΩ	
ESD protection	Human body model	±250			V	
Safe Torque Off (STO) Inputs		Min.	Typ.	Max.	Units	
Safety Integrity Level		SIL 3				
Performance Level		PL e				
Safety Category		Cat 3				
Reaction time				30	ms	
Ignored diagnostic pulses	Duration			5	ms	
	Repetition rate			20	Hz	
MTTFd			377		years	
DC			90		%	
PFH			8E-10		hours	
Lifetime			20		years	
V <sub>LOG</sub>	External power supply	SELV or PELV				
Pollution Degree	Cabinet / Housing	IP54			-	
					2	
STO wiring	Bundling / Grouping	Separate wiring for STO1, STO2				
	Shielding	Separate shield for STO1, STO2				
Compatibility	Each STO channels has separate + and - terminals	PNP (source) or NPN (sink), depending on user connection				
Isolation		Each STO channel is opto-isolated				
Voltage, STOx+ to STOx-	Inactive (torque off)		0	5.6	V	
	Active (motor driven)	18	24		V	
	Abs. maximum, continuous	-70		+70	V	
Voltage	Isolation, STO1 to STO2	±2			kV	
	Isolation, STOx to GND	±2			kV	
Current	STOx+ - STOx- = 24V	3			5	
ESD protection	Human body model	±30			kV	

† 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.

<sup>1</sup> Full RS-422 compatibility, as well as noise rejection improvement requires an external 120Ω resistor connected across each signal pair (A1+/A1-, B1+/B1-, Z1+/Z1-, A2+/A2-, B2+/B2-)

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