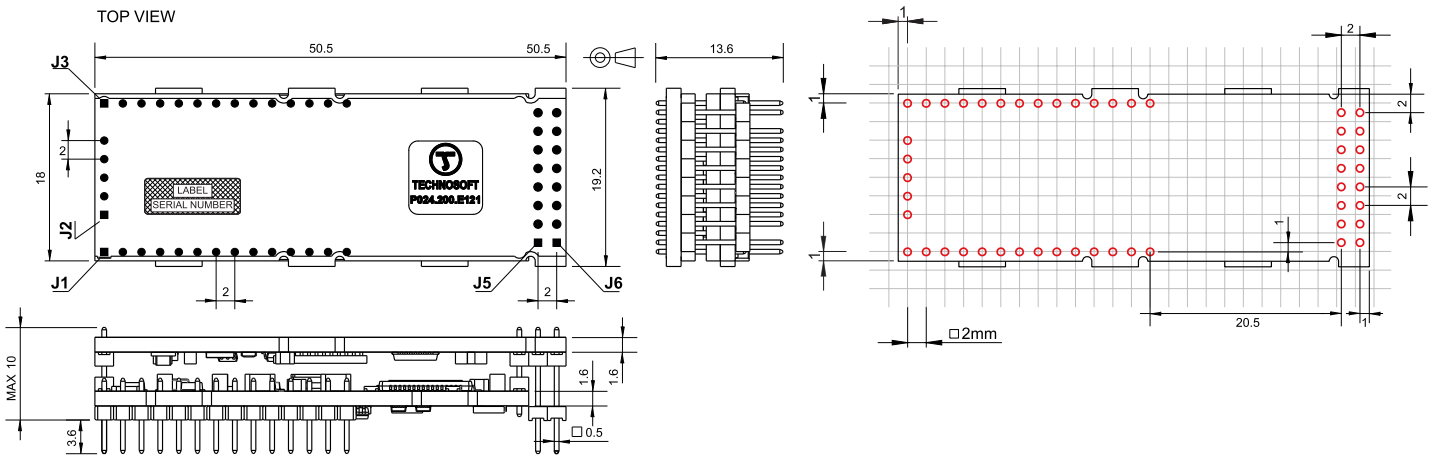


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Top view; Pins facing downward; All dimensions are in mm; Header pitch is 2 mm.; Drawing not to scale; Tolerance ± 0.1 mm (unless otherwise noted)

Motor – sensor configurations						
Sensor \ Motor	PMSM	BLDC	DC BRUSH	STEP (2-ph)	STEP (3-ph)	
Incr. Encoder	Ⓢ		Ⓢ	Ⓢ		
Incr. Encoder + Digital Hall	Ⓢ	Ⓢ				
Digital halls only	Ⓢ					
Linear Halls	Ⓢ					
Tacho			Ⓢ			
Open-loop (no sensor)				Ⓢ	Ⓢ	
Open-loop (with step loss detection using incr. enc.)				Ⓢ	Ⓢ	
Open-loop (with incr. enc on load.)				Ⓢ	Ⓢ	

- Incremental encoder interface (single-ended, open collector and differential)
- Linear Hall sensors interface
- 5 digital inputs, 5-24V, NPN: Enable, 2 for limit switches, 2 general-purpose
- 2 digital outputs, 5-24V, 0.5A, NPN open-collector
- 2 drive state LEDs having the function of Error and Ready.
- 1 analogue input: 12-bit, 0-5V or ± 10 V : Reference/Feedback or general purpose
- RS-232 serial & dual 100Mbps EtherCAT® interfaces
- 2K × 16 SRAM for data acquisition
- 4K × 16 E²ROM to store TML motion programs and data
- Operating ambient temperature: 0-40°C
- Hardware Protections: short-circuit between motor phases and from motor phases to GND, over-voltage, under-voltage, over-temperature and I²t

Mating Connectors				
Ref	Producer	Part No.	Description	
J1, J3	Through-hole	Samtec SQT-114-01-L-S	14-pin single-row 2.0mm-pitch vertical through-hole socket, accepting 0.5mm square pin	
	SMD	Samtec SMM-114-02-L-S	14-pin single-row 2.0mm-pitch vertical SMD socket, accepting 0.5mm square pin	
J2	Through-hole	Samtec SQT-105-01-L-S	5-pin single-row 2.0mm-pitch vertical through-hole socket, accepting 0.5mm square pin	
	SMD	Samtec SMM-105-02-L-S	5-pin single-row 2.0mm-pitch vertical SMD socket, accepting 0.5mm square pin	
J4, J5	Through-hole	Samtec SQT-108-01-L-S	8-pin single-row 2.0mm-pitch vertical through-hole socket, accepting 0.5mm square pin	
		Harwin M22-7130842	8-pin single-row 2.0mm-pitch vertical through-hole socket, accepting 0.5mm square pin	
	SMD	Samtec SMM-108-02-L-S	8-pin single-row 2.0mm-pitch vertical SMD socket, accepting 0.5mm square pin	
		Fischer BLY 5 SMD 08	8-pin single-row 2.0mm-pitch vertical SMD socket, accepting 0.5mm square pin	

- **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
- Motor supply: 7-30V. Logic supply: 7-40V
- Output current: 0.9A cont. (BLDC mode); 0.9A_{PEAK}, up to 120kHz PWM
- Digital Hall sensor interface (single-ended and open collector)

Pin	Name	Type	Description
1	GND	-	Return ground
2	+V _{MOT}	I	Positive terminal of the motor supply: 7 to 30V _{DC}
3	+V _{LOG}	I	Positive terminal of the logic supply: 7 to 40V _{DC}
4	OUT0	O	5-24V 0.5A general-purpose digital output, NPN open-collector / TTL pull-up
5	OUT1	O	5-24V 0.5A general-purpose digital output, NPN open-collector / TTL pull-up
6	IN0	I	5-24V digital NPN input
7	IN1	I	5-24V digital NPN input
8	IN2 / LSP	I	5-24V digital NPN input Positive limit switch input
9	IN3 / LSN	I	5-24V digital NPN input Negative limit switch input
10	IN4 / Enable	I	5-24V digital NPN input Drive enable input
11	232RX	I	RS-232 Data Reception
12	232TX	O	RS-232 Data Transmission
13	Reserved	I/O	Reserved. Do not connect.
14	Reserved	I/O	Reserved. Do not connect.

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

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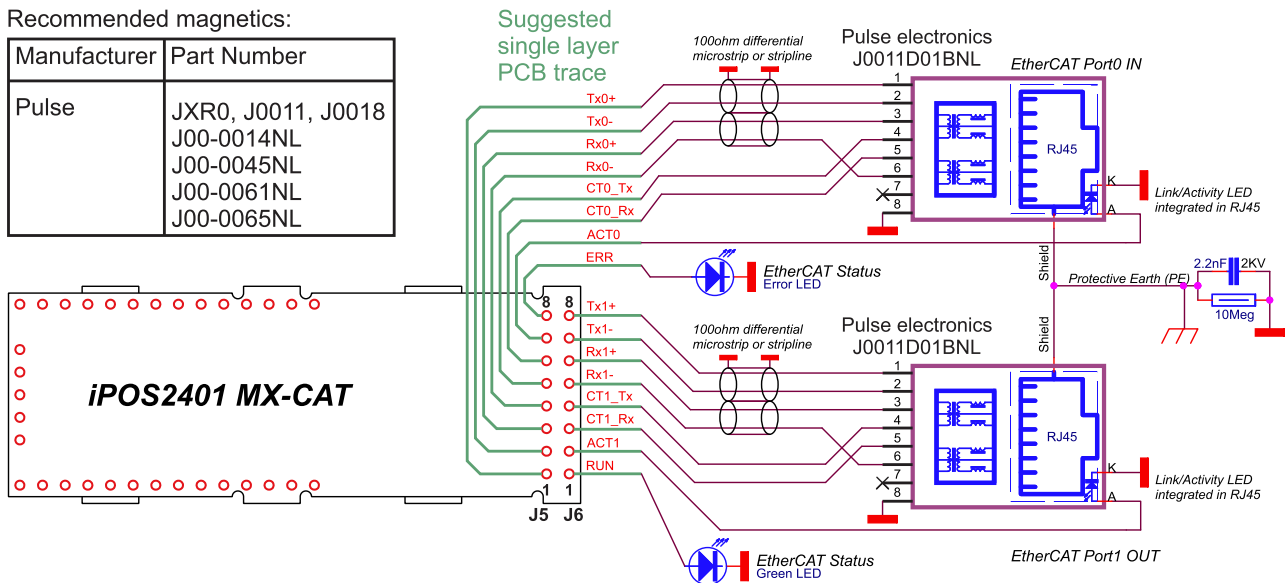
Pin	Name	Type	Description
1	GND	-	Return ground
2	A / A+	I	Incr. encoder A single-ended, or A+ diff. input
3	A-	I	Incr. encoder A- diff. input, or linear Hall 3 input
4	B / B+	I	Incr. encoder B single-ended, or B+ diff. input
5	B-	I	Incr. encoder B- diff. input, or linear Hall 2 input
6	Z / Z+	I	Incr. encoder Z (index) single-ended, or Z+ diff. input
7	Z-	I	Incr. encoder Z- differential input, or linear Hall 1 input
8	Hall 1	I	Digital input Hall 1 sensor
9	Hall 2	I	Digital input Hall 2 sensor
10	Hall 3	I	Digital input Hall 3 sensor
11	REF/FDBK	I	Analogue input, 12-bit, 0-5V or ±10V (software selectable) . Used to read an analog position, speed or torque reference or feedback; can be used as general purpose analogue input
12	+5V _{OUT}	O	5V output supply
13	reserved	-	Reserved – do not connect
14	GND	-	Return ground

Pin	Name	Type	Description
1	TX0+	I/O	Transmit/Receive positive, IN port. Connect to magnetics primary. Magnetics secondary corresponds to pin 1 or RJ45.
2	TX0-	I/O	Transmit/Receive negative, IN port. Connect to magnetics. After magnetics circuit, it corresponds to pin 2 or RJ45.
3	RX0+	I/O	Receive/Transmit positive, IN port. Connect to magnetics primary. Magnetics secondary corresponds to pin 3 or RJ45.
4	RX0-	I/O	Receive/Transmit negative, IN port. Connect to magnetics primary. Magnetics secondary corresponds to pin 6 or RJ45.
5	CT0_Tx	I/O	Return for center tap of magnetics primary that is also connected to pins 1,2 of J5
6	CT0_Rx	I/O	Return for center tap of magnetics primary that is also connected to pins 3,4 of J5
7	ACT0	O	Anode of Link/Activity LED for port IN.
8	ERR	O	Anode of Error LED (EtherCAT status machine).

Pin	Name	Type	Description
1	RUN	O	Anode of Run LED (EtherCAT status machine).
2	ACT1	O	Anode of Link/Activity LED for port OUT.
3	CT1_Rx	I/O	Return for center tap of magnetics primary that is also connected to pins 5,6 of J6
4	CT1_Tx	I/O	Return for center tap of magnetics primary that is also connected to pins 7,8 of J6
5	RX1-	I/O	Receive/Transmit negative, OUT port. Connect to magnetics. After magnetics circuit, it corresponds to pin 6 or RJ45.
6	RX1+	I/O	Receive/Transmit positive, OUT port. Connect to magnetics. After magnetics circuit, it corresponds to pin 3 or RJ45.
7	TX1-	I/O	Transmit/Receive negative, OUT port. Connect to magnetics. After magnetics circuit, it corresponds to pin 2 or RJ45.
8	TX1+	I/O	Transmit/Receive positive, OUT port. Connect to magnetics. After magnetics circuit, it corresponds to pin 1 or RJ45.

Recommended magnetics:

Manufacturer	Part Number
Pulse	JXR0, J0011, J0018 J00-0014NL J00-0045NL J00-0061NL J00-0065NL



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Electrical characteristics

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

- Tamb = 0..40°C, VLOG = 24 VDC; VMOT = 24VDC
- Supplies start-up / shutdown sequence: -any-
- Load current (sinusoidal amplitude / continuous BLDC, DC, stepper) = 0.9A

Operating Conditions		Min.	Typ.	Max.	Units
Ambient temperature		0		+40	°C
Ambient humidity	Non-condensing	0		90	%Rh
Altitude / pressure ¹	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	°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 ² , closed box			
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	20			mm
Insertion force	Using recommended mating connectors		t.b.d.		Kg
Extraction force			t.b.d.		
Environmental Characteristics		Min.	Typ.	Max.	Units
Size (Length x Width x Height)	Global size	50.5 x 19.2 x 13.6			mm
		~1.99 x 0.76 x 0.54			inch
Weight		<20			g
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	6	24	39	V _{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	5.7		40	V _{DC}
	Absolute maximum values, continuous	-0.6		42	V _{DC}
	Absolute maximum values, surge (duration ≤ 10ms) [†]	-1		+45	V
Supply current	+V _{LOG} = 12V	110	140	460	mA
	+V _{LOG} = 24V	60	70	230	
Motor Supply Input (+V _{MOT})		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	6.5	24	28	V _{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	4.8		29	V _{DC}
	Absolute maximum values, continuous	-0.6		30	
	Absolute maximum values, surge (duration ≤ 10ms) [†]	-1		32	V
Supply current	Idle		10	25	mA
	Operating	-0.9	±0.9	+0.9	
	Absolute maximum value, short-circuit condition (duration ≤ 10ms) [†]			4	
Supply Output (+5V)		Min.	Typ.	Max.	Units
Output voltage	Current sourced = 350mA	4.9	5	5.2	V
Output current		350	500	540	mA
Short-circuit	Yes / Drive resets at event				
Over-voltage	NOT protected				
ESD protection	Human body model	±15			kV


Motor Outputs (A/A+, B/A-, C/B+, CR/B-)		Min.	Typ.	Max.	Units
Nominal output current, continuous ³	for DC brushed, steppers and BLDC motors with Hall-based trapezoidal control			0.9	A
	for PMSM motors with FOC sinusoidal control (sinusoidal amplitude value)			0.9	
	for PMSM motors with FOC sinusoidal control (sinusoidal effective value)			0.64	
Motor output current, peak		-0.9		+0.9	A
Short-circuit protection threshold			±1.3		A
Short-circuit protection delay		5	10		µs
On-state voltage drop	Nominal output current; including typical mating connector contact resistance		±50	±100	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} = 24 V	F _{PWM}			µH
		20 kHz	160		
		40 kHz	80		
		60 kHz	60		
		80 kHz	40		
	Minimum value, limited by short-circuit protection; +V _{MOT} = 24 V	20 kHz	60		µH
		60 kHz	20		
		40 kHz	15		
		80 kHz	8		
		100 kHz	4		
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		±4	±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"	2	5		
	Floating voltage (not connected)		4.4		
	Absolute maximum, surge (duration ≤ 1s) [†]	-10		+15	
Input current	Logic "LOW"; Pull to GND			1.2	mA
	Logic "HIGH"; Internal 4.7KΩ pull-up to +5	0	0	0	
Minimum pulse width		2			µs
ESD protection	Human body model	±5			kV
Analog 0..5V/ ±10V Input (REF/FDBK)		Min.	Typ.	Max.	Units
Input voltage	Operational range	0..5V mode	0	5	V
		±10V mode	-10	+10	
	Absolute maximum values, continuous		-12	+18	
	Absolute maximum, surge (duration ≤ 1s) [†]			±36	
Input impedance	To +1.47V		41		KΩ
Resolution			12		bits
Integral linearity				±2	bits
Offset error			±2	±10	bits
Gain error			±1%	±3%	% FS ⁴
Bandwidth (-3dB)	Software selectable	0		1	kHz
ESD protection	Human body model	±5			kV

¹ iPOS2401 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.

² 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

³ @20kHz F_{PWM}

⁴ "FS" stands for "Full Scale"

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Digital Inputs (IN0, IN1, IN2/LSP, IN3/LSN, IN4/Enable)		Min.	Typ.	Max.	Units
Mode compliance		TTL / CMOS / LVTTTL (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	
Input current	Absolute maximum, surge (duration ≤ 1s) [†]	-20		+40	mA
	Logic "LOW"; ulled to GND		0.6	1	
	Logic "HIGH"; Internal 4.7KΩ pull-up to +3.3	0	0	0	
	Logic "HIGH"; Pulled to +5V		0.15	0.2	
Input frequency		0		150	kHz
Minimum pulse		3.3			μs
ESD protection	Human body model	±5			kV
Digital Outputs (OUT0, OUT1)		Min.	Typ.	Max.	Units
Mode compliance	All outputs (OUT0, OUT1)	TTL / CMOS / Open-collector / NPN 24V			
Default state	Not supplied (+V _{LOG} floating or to GND)	High-Z (floating)			
	Immediately after power-up	Logic "HIGH"			
Output voltage	Normal operation	Logic "HIGH"			
	Logic "LOW"; output current = 0.5A		0.2	0.8	V
	Logic "HIGH"; output current = 0, no load	4	4.5	5	
	Logic "HIGH", external load to +V _{LOG}		V _{LOG}		V
	Absolute maximum, continuous	-0.5		V _{LOG} +0.5	
Absolute maximum, surge (duration ≤ 1s) [†]	-1		V _{LOG} +1		
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			4	mA
Minimum pulse width	Logic "HIGH", leakage current; external load to +V _{LOG} ; V _{OUT} = V _{LOG} max = 40V		0.1	0.2	mA
		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
Input voltage	Absolute maximum values, continuous	-7		+7	V
	Absolute maximum, surge (duration ≤ 1s) [†]	-11		+14	
Input current	Input voltage 0...+5V	-1	±0.7	+1	mA
Interpolation Resolution	Depending on software settings	9		13	bits
Frequency		0		4	kHz
ESD protection	Human body model	±15			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			
	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	0	2.5	3	mA
	Logic "HIGH"; Internal 2.2KΩ pull-up to +5	0	0	0	

Differential mode compliance		TIA/EIA-422-A		
Input voltage, differential mode	For full RS422 compliance, see [†]			
	Hysteresis	±0.06	±0.1	±0.2
Input impedance, differential	Common-mode range (A+ to GND, etc.)	-7		+7
	A+ to A-, B+ to B-, Z+ to Z-	2.7	2.8	
Input frequency	Single-ended mode, Open-collector / NPN	0		500
	Differential mode, or Single-ended driven by push-pull (TTL / CMOS)	0		12
Minimum pulse width	Single-ended mode, Open-collector / NPN	1		
	Differential mode, or Single-ended driven by push-pull (TTL / CMOS)	20		
Input voltage, any pin to GND	Absolute maximum values, continuous	-7		+7
	Absolute maximum, surge (duration ≤ 1s) [†]	-11		+14
ESD protection	Human body model	±1		


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

Ethernet Ports		Min.	Typ.	Max.	Units
Standard Compliance	CoE, 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				
Magnetics requirements	Standard 100BASE-TX MDI/MDI-X				
	Primary inductance @8mA bias	350			μH
	Turns ratio (primary:secondary)	1CT:1			
	Symmetry (for MDI/MDI-X)	Symmetrical, RX=TX			
	CMRR 1-50MHz	30			dB
Maximum cable length	Isolation@1 minute	2.25			kV
ESD protection	Human body model	t.b.d.			kV

LED signals		Min.	Typ.	Max.	Units
LED connection		Common cathode to GND			
		Direct, no series resistor			
Red color LED (ERR) current	V _F (min) = 1.5V V _F (max) = 3.0V	1	5	7	mA
Green color LED (RUN) current	V _F (min) = 1.7V V _F (max) = 3.0V	4	17	24	mA
Yellow color LED (ACT) current	V _F (min) = 1.7V V _F (max) = 3.0V	4	17	24	mA

[†] 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.

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.

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