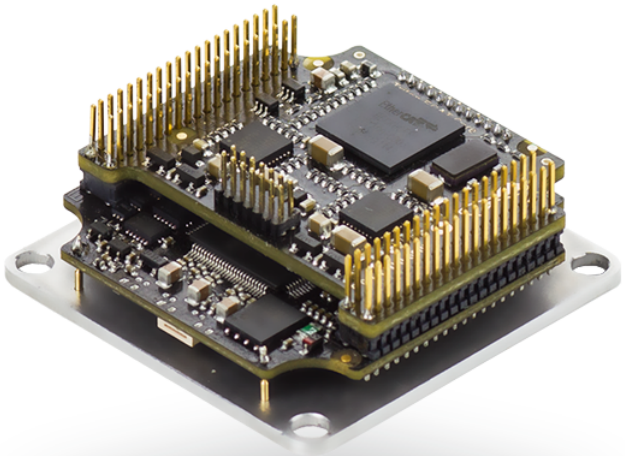
Triton Core Product Manual



Edition 05/29/2017

For the most up to date information visit the online manual.

INGENIA-CAT S.L.

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INGENIA
passion for motion

1 Table of Contents

2 General Information

2.1 Manual revision history

Revision	Release Date	Changes	PDF
v1	February 2017	Preliminary draft.	Download[1]
v2	May 2017	Improved PDF export format.	

For the most up to date information use the online Product Manual[2]. The PDF manual is generated only after major changes.

Please refer to product hardware revisions (see page 12) for information on previous hardware revisions and changes.

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[1] http://doc.ingeniamc.com/download/attachments/58654728/Triton%20Core%20Product%20Manual%20v1.pdf?api=v2&modificationDate=1487976169754&version=1
[2] http://doc.ingeniamc.com/triton/manuals/triton-core-product-manual

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3 Safety Information

3.1 About this manual

Read carefully this chapter to raise your awareness of potential risks and hazards when working with the Triton Servo Drive.

To ensure maximum safety in operating the Triton Servo Drive, it is essential to follow the procedures included in this guide. This information is provided to protect users and their working area when using the Triton Servo Drive, as well as other hardware that may be connected to it. Please read this chapter carefully before starting the installation process.

3.2 Warnings

The following statements should be considered to avoid serious injury to those individuals performing the procedures and/or damage to the equipment:

- To prevent the formation of electric arcs, as well as dangers to personnel and electrical contacts, never connect/disconnect the Triton Servo Drive while the power supply is on.
- Disconnect the Triton Servo Drive from all power sources before proceeding with any possible wiring change.
- After turning off the power and disconnecting the equipment power source, wait at least 10 seconds before touching any parts of the controller that are electrically charged or hot.

3.3 Precautions

The following statements should be considered to avoid serious injury to those individuals performing the procedures and/or damage to the equipment:

- The Triton Servo Drive components temperature may exceed 100 ºC during operation.
- Some components become electrically charged during and after operation.
- The power supply connected to this controller should comply with the parameters specified in this document.
- When connecting the Triton Servo Drive to an approved power source, do so through a line that is separate from any possible dangerous voltages, using the necessary insulation in accordance with safety standards.
- High-performance motion control equipment can move rapidly with very high forces. Unexpected motion may occur especially during product commissioning. Keep clear of any operational machinery and never touch them while they are working.
- Do not make any connections to any internal circuitry. Only connections to designated connectors are allowed.
- All service and maintenance must be performed by qualified personnel.
- Before turning on the Triton Servo Drive, check that all safety precautions have been followed, as well as the installation procedures.

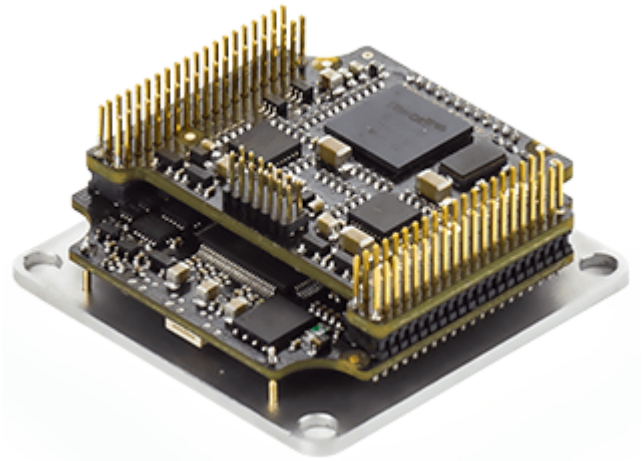
4 Product Description

The Triton Core Servo Drive is an ultra-compact solution designed to be integrated in a motherboard or backplane as a component. It provides top performance, advanced networking and built-in safety, as well as a fully featured motion controller. The Triton can control multiple motor types and supports almost any feedback sensor including absolute serial encoders.

Its incredibly compact design includes multiple communication ports carrying **CANopen protocol**[5], and thus enabling a wide choice of interfacing methods. Its small form factor, its capability to operate up to 110 ºC and the bunch of features that come packed with it makes Triton a valid OEM for critical-size applications.

The Triton Servo Drive has been designed with efficiency in mind. It incorporates cutting-edge MOSFET technology as well as optimised control algorithms to provide the perfect trade-off between EMI and performance.

Triton Servo Drive is provided with several general purpose inputs and outputs designed for 3.3 V TTL logic. By using these inputs and outputs it is possible to implement alarm signals, connect digital sensors, activate external devices (LEDs, actuators, solenoids, etc.). Some of the digital and analog inputs can also be used as command / target sources.



4.1 Triton part numbering

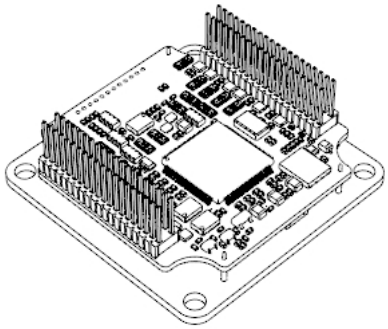
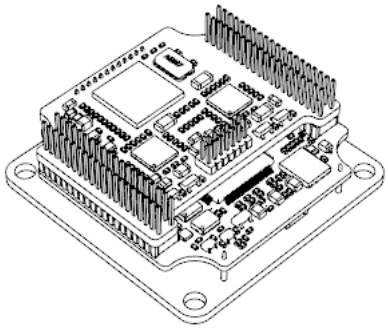
[5] http://doc.ingeniamc.com/display/EMCL/CANopen+protocol

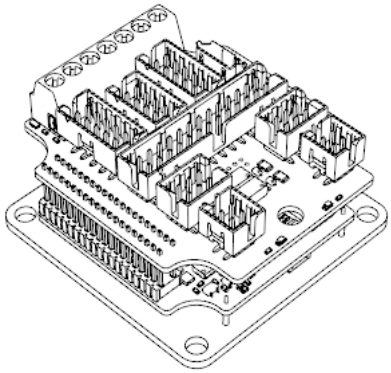
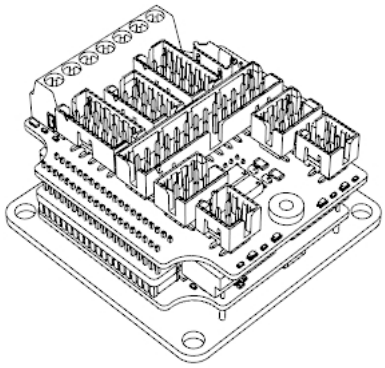
TRI-x/xx-y-P

Power rating:
7/48 = 6.3 A cont. / 8.5 A peak @ 48 Vdc nominal
4/48 = 5 A cont. / 5 A peak @ 48 Vdc nominal
1/48 = 1 A cont. / 1 A peak @ 48 Vdc nominal

Communication interfaces:
C = CAN / USB / UART
E = EtherCAT / USB / UART

Connectors:
C = Connector board with terminal blocks (Triton Go)
P = Pin headers (Triton Core)

Product	Ordering part number	Status	Image
Triton Core	TRI-7/48-C-P	ACTIVE	
	TRI-4/48-C-P	ACTIVE	
	TRI-1/48-C-P	ACTIVE	
	TRI-7/48-E-P	ACTIVE	
	TRI-4/48-E-P	ACTIVE	
	TRI-1/48-E-P	ACTIVE	

Triton Go[6]	TRI-7/48-C-C	ACTIVE	
	TRI-4/48-C-C	ACTIVE	
	TRI-1/48-C-C	ACTIVE	
	TRI-7/48-E-C	ACTIVE	
	TRI-4/48-E-C	ACTIVE	
	TRI-1/48-E-C	ACTIVE	

4.2 Specifications

A list of features of the Triton Core Servo Drive is shown next. For further details, please check the Operational characteristics (see page 14) section below.

Electrical and power specifications			
Part number →	**TRI-1/48-y-P**	**TRI-4/48-y-P**	**TRI-7/48-y-P**
Power supply voltage	+8 V_{DC} to +48 V_{DC}		
Transient peak voltage	65 V_{DC}		
Internal DC bus capacitance	20 µF		
Minimum motor inductance	200 µH (Triton still can control motors with lower inductances. Check the **Knowledge Base**[7] from Ingenia)		

[6] http://doc.ingeniamc.com/display/TR/Triton+Go+Product+Manual
[7] http://doc.ingeniamc.com/display/KB/Motor+inductance+effects+on+servo+drives

Nominal phase continuous current (BLDC mode)	0.67 A_{RMS}	3.33 A_{RMS} (with heatsink)	5.6 A_{RMS} (with heatsink)
Nominal phase continuous current (DC mode)	1 A_{DC}	5 A_{DC} (with heatsink)	6.3 A_{DC} (with heatsink)
Maximum phase peak current	1 A_{DC} (continuous)	5 A_{DC} (continuous, with heatsink)	8.5 A_{DC} (5 s, with heatsink)
Current sense range	± 1.02 A	± 5.10 A	± 12.7 A
Current sense resolution	1.99 mA/ count	9.96 mA/count	24.8 mA/count
Shunt braking transistor	Output for external shunt braking transistor activation.		
Cold plate	1.5 mm aluminum sheet 6082-T6.		
Power connectors	Pin headers mm pitch		
Standby power consumption	≤ 2.5 W (EtherCAT version TRI-x/48-E-P) ≤ 1.5 W (CAN version TRI-x/48-C-P)		
Efficiency	>96% at the rated power and current		
Motion control specifications			
Part number →	**TRI-1/48-y-P**	**TRI-4/48-y-P**	**TRI-7/48-y-P**
Supported motor types	• Rotary brushless (trapezoidal and sinusoidal) • Linear brushless (trapezoidal and sinusoidal) • DC brushed • Rotary voice coil • Linear voice coil		
Power stage PWM frequency	20 kHz (default) 80 kHz (alternative PWM frequency, configurable[8])		
Current sensing	Precision current sense on phases A, B. (Phase C is generated digitally) Accuracy is ± 1% full scale. 10 bit ADC resolution.		

[8] http://doc.ingeniamc.com/display/EMCL/0x2020+-+Enable+alternative+frequency+PWM

Sensors for commutation (brushless motors)	• Digital Halls (Trapezoidal) • Analog Halls (Sinusoidal / Trapezoidal) • Quad. Incremental encoder (Sinusoidal / Trapezoidal) • PWM encoder (Sinusoidal / Trapezoidal) • Analog potentiometer (Sinusoidal / Trapezoidal) • Sin-Cos encoder (Sinusoidal / Trapezoidal) • Absolute encoder SSI (over SPI) (Sinusoidal / Trapezoidal)
Sensors for servo loops	• Digital Halls • Analog Halls • Quad. Incremental encoder • PWM encoder • Analog potentiometer • Sin-Cos encoder • Absolute encoder SSI (over SPI) • DC tachometer
Supported target sources	• Network communication – USB • Network communication – CANopen • Network communication – UART (3.3 V levels) • Network communication – EtherCAT • Standalone (execution from internal EEPROM memory) • Analog inputs • Step and Direction (Pulse and Direction) • PWM command • Encoder Following / Electronic Gearing

Inputs/outputs and protections			
Part number →	**TRI-1/48-y-P**	**TRI-4/48-y-P**	**TRI-7/48-y-P**
Inputs and outputs	General purpose: • 4 x non-isolated single-ended digital inputs. 3.3 V levels, 5.5 V tolerant • 2 x non-isolated high speed differential digital inputs. 3.3 V levels, 5.5 V tolerant • 2 x single-ended analog inputs. 12 bits, 0 V to 3.3 V range, 5.5 V tolerant • 6 x push-pull digital outputs. 3.3 V levels, 5.5 V tolerant. Dedicated: • 1 x non-isolated Torque OFF dedicated digital input. 3.3 V levels, 5.5 V tolerant • 6 x push-push LED outputs. See Signalling LEDs (see page 31) and Operational characteristics (see page 14) sections for more details. Output supplies: • 1 x 5 V output supply for powering external circuitry (up to 200 mA) • 1 x 3.3 V output supply for powering external circuitry (up to 50 mA)		

Protections	• User configurable:
	  • DC bus over-voltage
	  • DC bus under-voltage
	  • Drive over-temperature
	  • Drive under-temperature
	  • Over-current
	  • Overload (I^2t)
	• Short-circuit protections:
	  • Phase to DC bus
	  • Phase to phase
	  • Phase to GND
	• Mechanical limits for homing functions
	• Hall sequence/combination error
	• Encoder broken wire input (for use along external circuitry)
	• ESD protections in all inputs, outputs, feedbacks and communications
	• EMI protections (noise filters) in all inputs and feedbacks
	• High power transient voltage suppressor for short braking (600 W peak TVS diode)
	• Can drive an external power braking resistor in case of re-injection by means of an external switched element.		

Motor brake	Motor brake output (by means of an external switched element) through digital outputs.	
Communications		
Part number →	**TRI-x/48-C-P**	**TRI-x/48-E-P**
USB	USB 2.0. The board can be supplied from USB for configuration purposes but will not power the motor.	
Serial	UART (3.3 V levels, by default: 115200 bps, 8 data bits, no parity, 1 stop bit, no flux control)	
CANopen	Available at 3.3 V levels, non-isolated. RX and TX pins shall be connected to external CAN transceiver (default baud rate is 1 Mbps). CiA-301, CiA-303, CiA-305, CiA-306 and CiA-402 compliant.	-
EtherCAT	-	Available (magnetics are not included)
Environmental and mechanical specifications		
Part number →	**TRI-x/48-C-P**	**TRI-x/48-E-P**
Cold plate temperature	• -40 ºC to +85 ºC full current (with appropriate heatsink) • +85 ºC to +110 ºC derated current	
Maximum humidity	5% - 85% non-condensing	
Horizontal dimensions	43 mm x 43 mm	
Body height	8.64 mm	
Pin length	7.24 mm	
Weight	22 g	26

4.3 Hardware revisions

Hardware revision	Individual board references	Description and changes
1.0.0 August 2016	i039-01H1-1.0.0 i039-01H2-1.0.0	First product release.

1.1.0 November 2016	i039-01H1-1.1.0 i039-01H2-1.0.0	Changed product current range naming (current resolution and range is exactly the same as before) • TRI-0.5/48 becomes TRI-1/48 • TRI-2/48 becomes TRI-4/48 • TRI-8/48 becomes TRI-7/48 Features added: • Analog Halls feedback • Analog (Sin-Cos) encoder feedback

Identifying the hardware revision

Hardware revision is screen printed on the board.

4.4 Absolute maximum ratings

The following information represent the environmental and electrical limits of Triton Core. Notice this does not represent an operational conditions limit, but a limit before **permanent damage or destruction.** References to pin names and pin group names can be found in the Pinout (see page 25) section.

Over operating free-air temperature range unless otherwise noted.

Parameter		MIN	MAX	UNIT
$V_{BUS(CONT)}$, $V_{LOGIC(CONT)}$	V_BUS or V_LOGIC to GND_P in continuous mode	-0.3	54	V
$V_{BUS(TRANS)}$,$V_{LOGIC(TRANS)}$	V_BUS or V_LOGIC to GND_P in transient mode	-0.3	65	V
V_{USB}	USB_SUPPLY to GND_D	-0.3	5.5	V
$V_{PE(GND)}$	PE to GND_P	-250	250	V
$V_{PE(BUS)}$	PE to V_BUS	-250	250	V
$V_{3.3VPINS}$	3.3 V tolerant signal pins to GND_D *1	-0.3	3.5	V
V_{5VPINS}	5 V tolerant signal pins to GND_D *2	-5.5	5.5	V
$V_{ECAT(LED)}$	LED_ECAT_LINKx to GND_D	-0.5	6.5	V
$V_{ECAT(BUS)}$	PHY0_x or PHY1_x to GND_D	-0.5	3.7	V
V_{GND}	GND_P to GND_D *3	0	0	V

$I_{PH(MAX)}$	Phase current short-circuit protection threshold *[4]	-13	13	A
T_{OTP}	Power stage built-in Over-Temperature Protection (Hardware) *[5]	—	150	ºC
$T_{STORAGE}$	Maximum storage temperature	-40	125	ºC

Note 1: +3.3V_D, +3.3V_REF_OUT, ABS_ENCODER_x, #ABS_ENCODER_CS, USB_DATAx, SHUNT_DRIVE_OUT, UART_x, CAN_TTL_x

Note 2: +5V_D, INPUT_x, HS_INPUT_x, ANALOG_IN_x, ENCODER_x, OUTPUT_x, LED_x, #BROKEN_WIRE_IN, #TORQUE_OFF_IN, MOTOR_TEMP_IN, HALL_x

Note 3: GND_P and GND_D are internally connected on a single point. Please keep these nets separated on the interface board to prevent noise problems.

Note 4: Absolute maximum current for all part numbers

Note 5: Absolute maximum junction temperature

4.5 Operational characteristics

The following information represent the recommended operation limits of Triton Core, among which its response will remain between known boundaries. References to pin names and pin group names can be found in the Pinout (see page 25) section.

For all the following characteristics T_A = 25 ºC, V_{BUS} = 48 V, f_{SW} = 20 kHz, 1.2 ºC/W heatsink attached, unless otherwise noted.

4.5.1 Input supply

Parameter		Conditions / Comments	MIN	TYP	MAX	UNIT
V_{BUS}	Power supply voltage range	Supply to power systems through pin V_BUS	8	—	48	V
V_{LOGIC}	Logic supply voltage range	Supply to logic systems through pin V_LOGIC	8	—	48	V
V_{USB}	USB supply voltage range	Supply to logic systems through pin	4.5	—	5.5	V
$I_{USB(CAN)}$	USB supply current (TRI-x/48-C-P)	USB_SUPPLY = 5 V Note that the ECAT version cannot be powered by USB only.	—	300	500	mA
C_{BUS}	Internal DC bus capacitance		16	20	24	µF

$P_{STB(CAN)}$	Standby power consumption (TRI-x/48-C-P)	Power stage disabled	—	—	1.5	W
$P_{STB(ECAT)}$	Standby power consumption (TRI-x/48-E-P)	Power stage disabled	—	—	2.5	W

4.5.2 Output supplies and voltage reference

Parameter		Conditions / Comments	MIN	TYP	MAX	UNIT
V_{5V}	+5V_D output voltage		4.75	5	5.25	V
$V_{3.3V}$	+3.3V_D output voltage		3.23	3.3	3.37	V
$V_{3.3V\ REF}$	+3.3V_REF_OUT output voltage	Specified at full temperature range / Typical error at 25ºC is ±0.2%.	3.28	3.3	3.32	V
I_{5V}	+5V_D output current *[1]		0	—	200	mA
$I_{3.3V}$	+3.3V_D output current *[1]		0	—	50	mA
$I_{3.3VREF}$	+3.3V_REF_OUT output current *[1]		0	—	10	mA

Note 1: Can withstand continuous short-circuit. Rearms after cool down time < 10 s.

4.5.3 Output stage

Parameter		Conditions / Comments	MIN	TYP	MAX	UNIT
$I_{DC(TRI-1)}$	Continuous phase current in DC mode (TRI-1/48-y-P)	no heatsink required. Limited by ADC range.	-1	—	1	A_{DC}
$I_{TRA(TRI-1)}$	Continuous phase current in Trapezoidal mode (TRI-1/48-y-P)	no heatsink required. Limited by ADC range.	—	—	0.67	A_{RMS}
$I_{SIN(TRI-1)}$	Continuous phase current in Sinusoidal mode (TRI-1/48-y-P)	no heatsink required. Limited by ADC range.	—	—	0.71	A_{RMS}
$I_{DC(TRI-4)}$	Continuous phase current in DC mode (TRI-4/48-y-P)	Limited by ADC range.	-5	—	5	A_{DC}

$I_{TRA(TRI-4)}$	Continuous phase current in Trapezoidal mode (TRI-4/48-y-P)	Limited by ADC range.	—	—	3.33	A_{RMS}
$I_{SIN(TRI-4)}$	Continuous phase current in Sinusoidal mode (TRI-4/48-y-P)	Limited by ADC range.	—	—	3.54	A_{RMS}
$I_{DC(TRI-7)}$	Continuous phase current in DC mode (TRI-7/48-y-P)		-6.3	—	6.3	A_{DC}
$I_{TRA(TRI-7)}$	Continuous phase current in Trapezoidal mode (TRI-7/48-y-P)		—	—	5.6	A_{RMS}
$I_{SIN(TRI-7)}$	Continuous phase current in Sinusoidal mode (TRI-7/48-y-P)		—	—	5.6	A_{RMS}
$I_{PK(TRI-1)}$	Peak phase current (TRI-1/48-y-P)	Peak time = continuous. No heatsink required. Limited by ADC range.	-1	—	1	A_{DC}
$I_{PK(TRI-4)}$	Peak phase current (TRI-4/48-y-P)	Peak time = continuous. Limited by ADC range.	-5	—	5	A_{DC}
$I_{PK(TRI-7)}$	Peak phase current (TRI-7/48-y-P)	Peak time = 5 s	-8.5	—	8.5	A_{DC}
η_{NOM}	Efficiency	Phase current = 7 A_{RMS}	—	—	97	%

4.5.4 System monitoring

Parameter		Conditions / Comments	MIN	TYP	MAX	UNIT
$I_{RANGE(TRI-1)}$	Phase current sensing range (TRI-1/48-y-P)		-1.02	—	1.02	A
$I_{RANGE(TRI-4)}$	Phase current sensing range (TRI-4/48-y-P)		-5.1	—	5.1	A
$I_{RANGE(TRI-7)}$	Phase current sensing range (TRI-7/48-y-P)		-12.7	—	12.7	A
$I_{SENSE(TRI-1)}$	Phase current sensing sensitivity (TRI-1/48-y-P)		—	1.99	—	mA/ count
$I_{SENSE(TRI-4)}$	Phase current sensing sensitivity (TRI-4/48-y-P)		—	9.96	—	mA/ count
$I_{SENSE(TRI-7)}$	Phase current sensing sensitivity (TRI-7/48-y-P)		—	24.8	—	mA/ count

I_{ERR}	Phase current sensing tolerance (all part numbers)		—	±1	±2	%
V_{MON}	DC bus voltage reading range		0	—	73.6	V
V_{ERR}	DC bus voltage reading tolerance		—	±1	±3	%
T_{ERR}	Board temperature reading tolerance		—	—	±5	%

4.5.5 Protections

Parameter		Conditions / Comments	MIN	TYP	MAX	UNIT
V_{USER}	User-configurable over / under voltage protection limits		6	—	65	V
T_{USER}	User-configurable over / under temperature protection limits	Board temperature	-40	—	110	ºC
$V_{ESD(AIR)}$	Air discharge ESD protection voltage rating on all pins *[1]	As in IEC 61000-4-2 Standard	—	—	±30	kV
$V_{ESD(CONTACT)}$	Contact discharge ESD protection voltage rating on all pins *[1]	As in IEC 61000-4-2 Standard	—	—	±30	kV
$P_{ESD(POWER)}$	Power and Logic supplies ESD protection peak pulse power *[2]	T_A = 25 ºC, 10/1000 µs waveform	—	—	600	W
$P_{ESD(SIGNAL)}$	All signal pins ESD protection peak pulse power *[3]	T_A = 25 ºC, 8/20µs waveform	—	—	130	W

Note 1: Except CAN_TTL_x (Air and Contact discharge = ±8 kV) and PHY0_x or PHY1_x (Air discharge = ±16 kV, Contact discharge = ±10 kV), as per IEC 61000-4-2 Standard. Also, Power and Logic supplies use unidirectional ESD protections (Air and Contact discharge = +30 kV).

Note 2: Power supply and Logic supply have independent ESD protections.

Note 3: Except pins in Note 1. Pins 3.3 V_D, USB_SUP rate 260 W and pin 5V_D rate 520 W, under the same conditions.

4.5.6 Inputs

Parameter		Conditions / Comments	MIN	TYP	MAX	UNIT
$V_{IH(3.3)}$	High-level input voltage (3.3 V tolerant inputs)	INPUT_x, HS_INPUT_x, #BROKEN_WIRE_IN, UART_RX, CAN_TTL_RX and ABS_ENCODER_SDI pins	2.5	—	—	V
$V_{IL(3.3)}$	Low-level input voltage (3.3 V tolerant inputs)	INPUT_x, HS_INPUT_x, #BROKEN_WIRE_IN, UART_RX, CAN_TTL_RX and ABS_ENCODER_SDI pins	—	—	0.6	V
$V_{IH(5)}$	High-level input voltage (5 V tolerant inputs)	HALL_x and #TORQUE_OFF_IN pins	3.6	—	—	V
$V_{IL(5)}$	Low-level input voltage (5 V tolerant inputs)	HALL_x and #TORQUE_OFF_IN pins	—	—	0.8	V
$V_{IH(ECAT)}$	High-level input voltage (EtherCAT interface)	PHY0_RXDx and PHY1_RXDx pins	2	—	—	V
$V_{IL(ECAT)}$	Low-level input voltage (5 V tolerant inputs)	PHY0_RXDx and PHY1_RXDx pins	—	—	0.8	V
V_{ANALOG}	Analog inputs voltage range	ANALOG_IN_x and MOTOR_TEMP_IN	0	—	3.3	V
B_{ANALOG}	Analog inputs resolution	ANALOG_IN_x and MOTOR_TEMP_IN	—	12	—	bit
R_{TERM}	Differential encoder termination resistor	ENCODER_x+ to ENCODER_x-	—	220	—	Ω
$I_{IN(3.3V)}$	3.3 V tolerant pins input current	INPUT_x, HS_INPUT_x, #BROKEN_WIRE_IN, UART_RX, CAN_TTL_RX and ABS_ENCODER_SDI pins	-5	—	5	mA
$I_{IN(5V)}$	5 V tolerant pins input current	HALL_x and #TORQUE_OFF_IN pins	-3.2	—	3.2	mA

4.5.7 Outputs

Parameter		Conditions / Comments	MIN	TYP	MAX	UNIT
V_{OH}	High-level voltage on output pins *[1]	I_{OUTPUT} = 50 µA	2.3	—	—	V
V_{OL}	Low-level voltage on output pins *[1]	I_{OUTPUT} = -50 µA	—	—	0.5	V
IOUT(3.3V)	Output current on 3.3 V tolerant pins *[2]		-5	—	5	mA
IOUT(5V)	Output current on 5 V tolerant pins *[3]		-2	—	2	mA
$V_{OH(ECAT)}$	High-level voltage on PHY0_TXDx and PHY1_TXDx pins		2.4	—	—	V
$V_{OL(ECAT)}$	Low-level voltage on PHY0_TXDx and PHY1_TXDx pins		—	—	0.4	V
$V_{OH(ECAT\_LED)}$	High-level voltage on LED_ECAT_LINKx pins	I_{ECAT_LED} = 50 µA	3.2	—	—	V
$V_{OL(ECAT\_LED)}$	Low-level voltage on LED_ECAT_LINKx pins	I_{ECAT_LED} = -50 µA	—	—	0.1	V
I_{ECAT_LED}	LED_ECAT_LINKx pins output current		-8	—	8	mA

Note 1: Applies to pins OUTPUT_x, SHUNT_DRIVE_OUT, UART_TX, CAN_TTL_TX, #ABS_ENCODER_CS, ABS_ENCODER_SDO, ABS_ENCODER_SCK, LED_CAN_RUN / LED_ECAT_RUN, LED_CAN_ERROR / LED_ECAT_ERROR, LED_FAULT/#OK

Note 2: Applies to pins SHUNT_DRIVE_OUT, UART_TX, CAN_TTL_TX, ABS_ENCODER_x, #ABS_ENCODER_CS, USB_DATAx

Note 3: Applies to pins OUTPUT_x, LED_CAN_RUN / LED_ECAT_RUN, LED_CAN_ERROR / LED_ECAT_ERROR, LED_FAULT/#OK

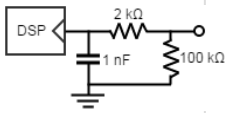
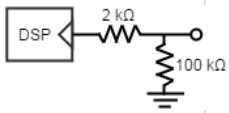
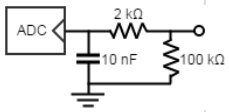
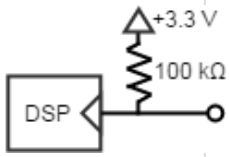
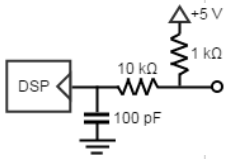
4.5.8 Motion

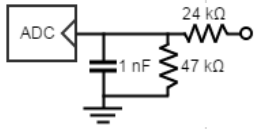
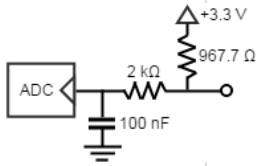
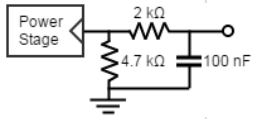
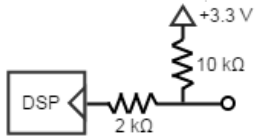
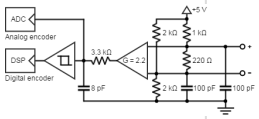
Parameter		Conditions / Comments	MIN	TYP	MAX	UNIT
f_{SW}	Default power stage switching frequency		—	20	—	kHz

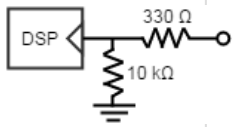
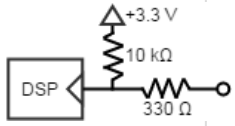
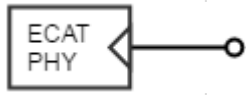
$f_{SW(RANGE)}$	Power stage switching frequency configurable range *[1]		20	—	80	kHz
f_{TORQUE}	Torque loop refresh frequency		—	10	—	kHz
f_{SERVO}	Position / velocity loops refresh frequency		—	1	—	kHz
f_{ERR}	Frequency tolerance	Over operating temperature range	—	—	±150	ppm
D_{MAX}	Maximum DC Bus utilisation (duty)		—	95	—	%

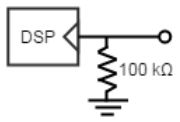
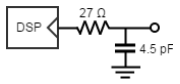
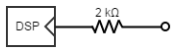
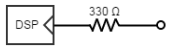
Note 1: Switching frequencies different from default are provided only under demand.

4.6 Equivalent circuits

Equivalent circuit	Function	Associated pins	f_C (-3dB)	Max. sample rate
	Digital inputs.	INPUT_x	80 kHz	1 ksps
	High speed digital Inputs.	HS_INPUT_x	-	20 Msps
	Analog inputs.	ANALOG_IN_x	8 kHz	10 ksps
	Absolute encoder (SPI) chip select.	#ABS_ENCODER_CS	-	-
	Digital hall inputs *[1]	HALL_x	159 kHz	10 ksps

	Analog hall inputs *[1]	HALL_x	10 kHz	10 ksps
	Motor temperature input *[2]	MOTOR_TEMP_IN	0.8 kHz	10 ksps
	Torque Off input.	#TORQUE_OFF_IN	-	-
	Encoder broken wire protection input.	#BROKEN_WIRE_IN	-	1 ksps
	Analog and digital encoder inputs. *[3]	ENCODER_x	6 MHz (Firmware glitch filter up to 30 MHz)	10 ksps

Equivalent circuit	Function	Associated pins		Max. baud rate
	UART and CAN interface.	UART_RX UART_TX CAN_TTL_RX	-	1 Mbps
	CAN transmitter line.	CAN_TTL_TX	-	1 Mbps
	EtherCAT interface.	PHY0_x and PHY1_x LED_ECAT_LINKx	-	100 Mbps (PHY0_x and PHY1_x)

	Absolute encoder (SPI) interface.	ABS_ENCODER_SDI ABS_ENCODER_SDO ABS_ENCODER_SCK	-	2 Mbps (SSI encoder max. 1 kHz)
	USB interface. Includes ESD protections.	USB_DATA+ USB_DATA-	-	12 Mbps
Equivalent circuit	**Function**	**Associated pins**	**-**	**Max. output frequency**
	Digital & LED outputs. Active high at 3.3V.	OUTPUT_x LED_CAN_RUN / LED_ECAT_RUN LED_CAN_ERROR / LED_ECAT_ERROR LED_FAULT/#OK	-	1 kHz (only OUTPUT_x pins)
	Shunt braking transistor output. Use a logic level power MOSFET to connect an external braking resistor *[4]	SHUNT_DRIVE_OUT	-	20 kHz

Note 1: Digital halls and Analog halls share the same input pins. The pull-up resistor is only enabled when Digital halls are selected as feedback source.

Note 2: The 967.7 Ω pull-up resistor can be set to 30 kΩ to improve sensing a PTC thermistor of a higher nominal resistance. Contact Ingenia Support[9] for more info.

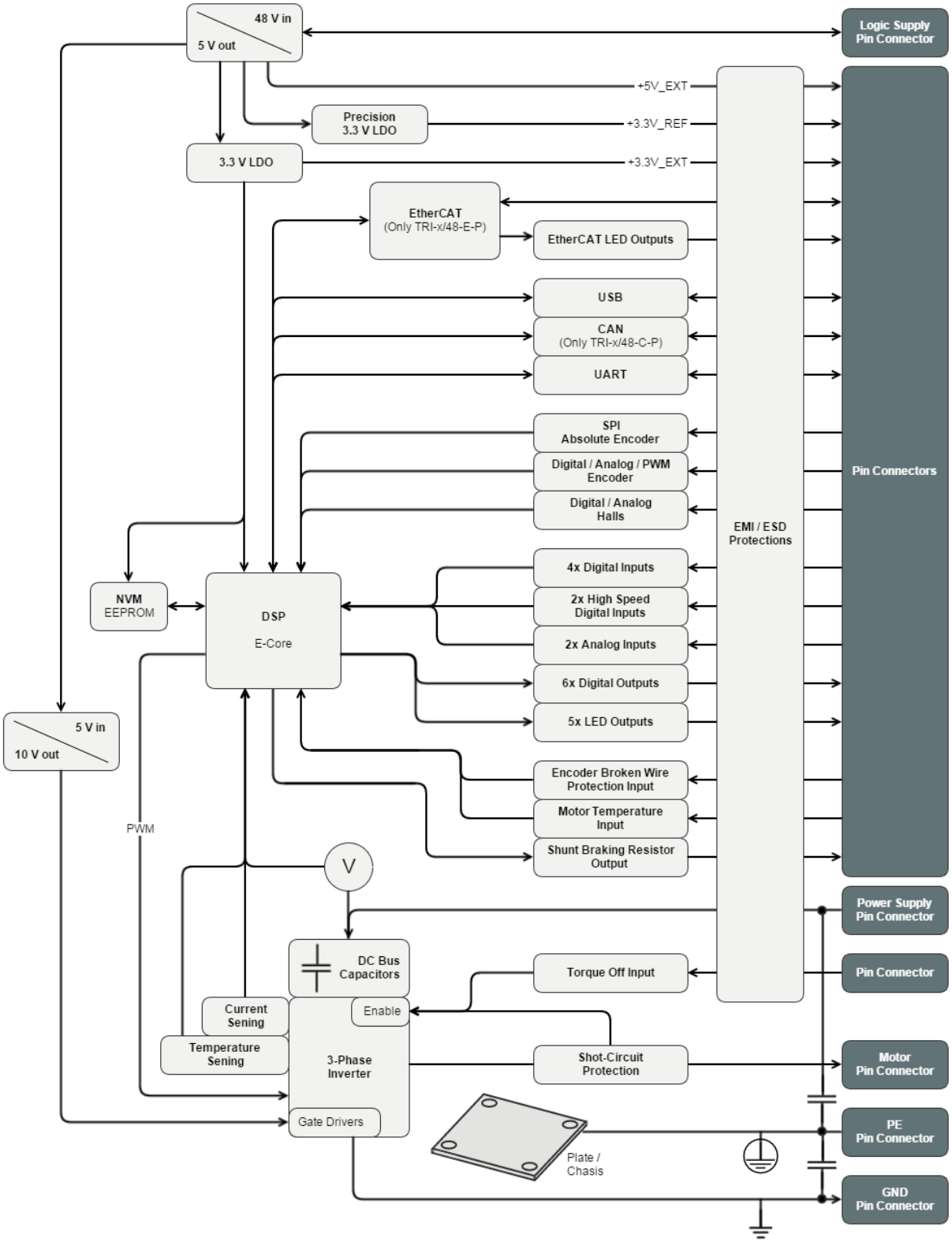
Note 3: Analog and Digital encoder share the same input pins. In any case, differential encoders use both positive and negative terminals, while single-ended encoders only use the positive terminal. See the **Pinout** (see page 25) section for more information.

Note 4: It is recommended to set the braking resistor PWM duty to 100 %. In this case, the switching frequency depends on the characteristics of the re-injection or braking action itself.

4.7 Architecture

This diagram represent the main hardware elements of Triton Core, and how they relate to each other.

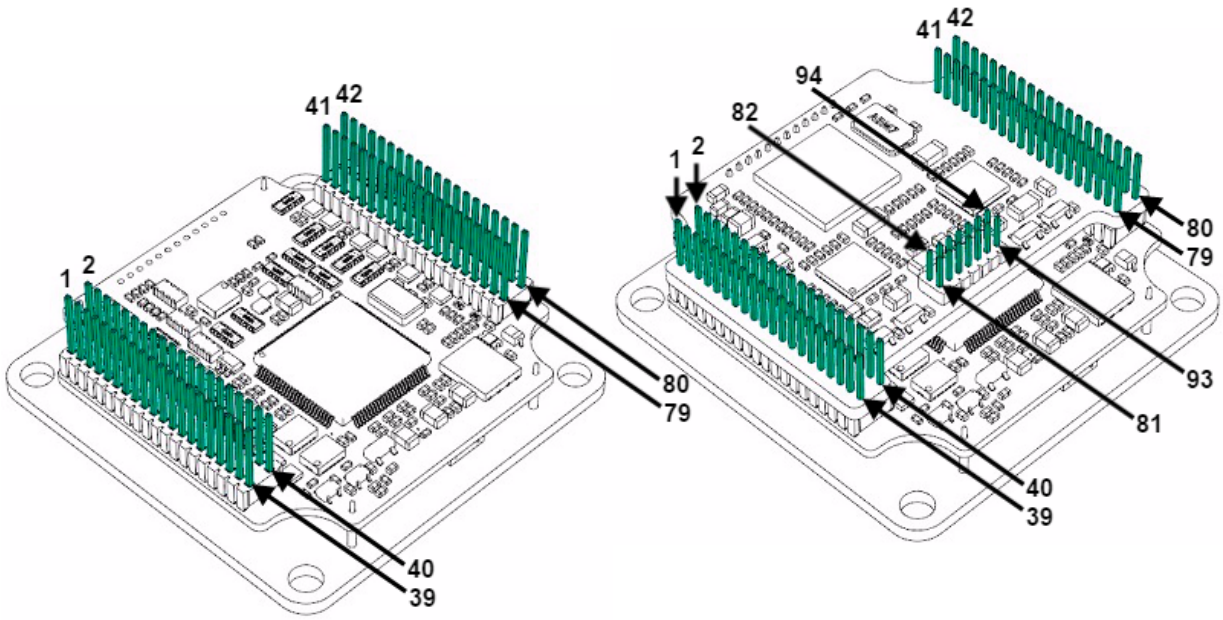
[9] http://ingeniamc.com/support/triton


48 V in
5 V out
Logic Supply Pin Connector
+5V_EXT
Precision 3.3 V LDO
+3.3V_REF
3.3 V LDO
+3.3V_EXT
EtherCAT (Only TRI-x/48-E-P)
EtherCAT LED Outputs
USB
CAN (Only TRI-x/48-C-P)
UART
SPI Absolute Encoder
Digital / Analog / PWM Encoder
Digital / Analog Halls
EMI / ESD Protections
Pin Connectors
4x Digital Inputs
2x High Speed Digital Inputs
2x Analog Inputs
NVM EEPROM
DSP E-Core
6x Digital Outputs
5x LED Outputs
5 V in
10 V out
Encoder Broken Wire Protection Input
Motor Temperature Input
Shunt Braking Resistor Output
PWM
V
Power Supply Pin Connector
DC Bus Capacitors
Torque Off Input
Pin Connector
Current Sening
Enable
Temperature Sening
3-Phase Inverter
Shot-Circuit Protection
Motor Pin Connector
Gate Drivers
PE Pin Connector
Plate / Chasis
GND Pin Connector

5 Pinout

The following diagram and pinout table defines the functionality of each pin in Triton Core Servo Drive. For further information, see **Operational characteristics** in Product Description (see page 6) section.

> **Pinout change from previous version**
>
> Note that the pin numbering is different from the first version of the Triton Core datasheet. Find the latest datasheet available **here**[10].



Triton Core with CAN (TRI-x/xx-C-P)

Triton Core with EtherCAT (TRI-x/xx-E-P

Pin	Name	Type	Group	Function
1	V_LOGIC	Power	Supply input	Logic circuits supply positive (can be directly tied to V_BUS pins)
2, 3, 4	V_BUS	Power		Power supply positive. Check Product Description (see page 6) section for more detail
5, 6, 7, 8	GND_P	Power		Power supply negative (Ground)

[10] http://ingeniamc.com/uploads/media/default/0001/01/4c83d7ac4a45382fd22cc82fc76750fa924ce036.pdf

9, 10, 11, 12	PE	Power	Motor power	Protective Earth (Internally connected to driver mounting plate / chassis)
13, 14, 15, 16	PHASE_C	Power		Motor phase C for 3-phase motors (do not connect for DC motors or voice coils)
17, 18, 19, 20	PHASE_B	Power		Motor phase B for 3-phase motors, negative for DC motors and voice coils
21, 22, 23, 24	PHASE_A	Power		Motor phase A for 3-phase motors, positive for DC motors and voice coils
25	SHUNT_DRIVE_OUT	Output	-	Digital output for driving a power braking resistor by means of an external switched element or over-voltage notification
26	NC	-	-	Do not connect
27	#BROKEN_WIRE_IN	Input	-	Notification digital input for an external encoder broken wire detector
28	GND_D	Power	Motor temperature	Reference 0 V for external circuitry
29	MOTOR_TEMP_IN	Input		Analog input for a motor temperature sensor (PTC thermistor kind is preferred)
30	HALL_1	Input	Digital Halls	Digital hall 1 sensor input
31	HALL_2	Input		Digital hall 2 sensor input
32	HALL_3	Input		Digital hall 3 sensor input
33	GND_D	Power	Feedbacks supply	Reference 0 V for external circuitry
34	+5V_D	Power		+5 V supply for external circuitry. Check Product Description (see page 6) section for more detail
35	ENCODER_A+	Input	Incremental encoder	A channel input for a single ended digital encoder. A+ terminal for a differential digital encoder
36	ENCODER_A-	Input		A- terminal for a differential digital encoder
37	ENCODER_Z+	Input		Index channel input for a single ended digital encoder. Positive Index terminal for a differential digital encoder
38	ENCODER_Z-	Input		Negative Index terminal for a differential digital encoder

39	ENCODER_B+	Input		B channel input for a single ended digital encoder. B+ terminal for a differential digital encoder
40	ENCODER_B-	Input		B- terminal for a differential digital encoder
41	OUTPUT_6	Output	Outputs	Digital output 6
42	OUTPUT_5	Output		Digital output 5
43	OUTPUT_4	Output		Digital output 4
44	OUTPUT_3	Output		Digital output 3
45	GND_D	Power	I/Os supply	Reference 0 V for external circuitry
46	+5V_D	Power		+5 V supply for external circuitry. Check Product Description (see page 6) section for more detail
47	OUTPUT_2	Output	Outputs	Digital output 2
48	OUTPUT_1	Output		Digital output 1
49	ANALOG_IN_2	Input	Analog inputs	Analog input 2
50	ANALOG_IN_1	Input		Analog input 1
51	HS_INPUT_2	Input	Digital inputs	High speed digital input 2
52	HS_INPUT_1	Input		High speed digital input 1
53	INPUT_4	Input		Digital input 4
54	INPUT_3	Input		Digital input 3
55	+3.3V_D	Power	I/Os supply	+3.3 V supply for external circuitry. Check Product Description (see page 6) section for more detail
56	+3.3V_REF_OUT	Output	-	Precise 3.3 V reference output for calibrating or supplying external ultra-low power analog circuitry. Check Product Description (see page 6) section for more detail

57	INPUT_2	Input	Digital Inputs	Digital input 2
58	INPUT_1	Input		Digital input 1
59	UART_TX	Output	UART	Transmit terminal for UART stream in 3.3 V TTL levels
60	UART_RX	Input		Receive terminal for UART stream in 3.3 V TTL levels
61	#ABS_ENCODER_CS	Output	Absolute encoder	Absolute encoder SPI Chip Select output terminal
62	GND_D	Power		Reference 0 V for external circuitry
63	ABS_ENCODER_SDO	Output		Absolute encoder SPI Serial Data Output stream terminal
64	ABS_ENCODER_SCK	Output		Absolute encoder SPI Clock stream terminal
65	ABS_ENCODER_SDI	Input		Absolute encoder SPI Serial Data Input stream terminal
66	NC	-	-	Do not connect
67	LED_CAN_RUN	Output	CAN	Dedicated digital output for CAN RUN (see page 31) LED signalling (CAN version TRI-x/48-C-P only)
	LED_ECAT_RUN	Output	EtherCAT	Dedicated digital output for EtherCAT RUN (see page 31) LED signalling (EtherCAT version TRI-x/48-E-P only)
68	CAN_TTL_RX	Input	CAN	Receive terminal for CAN stream in 3.3 V TTL levels
69	LED_CAN_ERROR	Output		Dedicated digital output for CAN ERROR (see page 31) LED signalling (CAN version TRI-x/48-C-P only)
	LED_ECAT_ERROR	Output	EtherCAT	Dedicated digital output for EtherCAT ERROR (see page 31) LED signalling(EtherCAT version TRI-x/48-E-P only)
70	CAN_TTL_TX	Output	CAN	Transmit terminal for CAN stream in 3.3 V TTL levels
71	LED_FAULT/#OK	Output	-	Dedicated digital output for Drive Status (see page 31) LED signalling
72	GND_D	Power	CAN	Reference 0 V for external circuitry

73	USB_DATA+	Bidirectional	USB	Positive terminal for USB data stream.
74	USB_SUPPLY	Power		USB +5 V bus terminal. Internal Logic circuitry can be supplied from this pin
75	USB_DATA-	Bidirectional		Negative terminal for USB data stream.
76	#TORQUE_OFF_IN	Input	STO	Digital input to disable the power stage of the drive
77	GND_D	Power	USB	Reference 0 V for external circuitry
78	+5V_D	Power	STO	+5 V supply for external circuitry. Check Product Description (see page 6) section for more detail
79	NC	-	-	Do not connect
80	NC	-	-	Do not connect
Following pins only in EtherCAT version (TRI-x/48-E-P)				
81	LED_ECAT_LINK0	Output	EtherCAT	Dedicated digital output for EtherCAT LINK 0 (see page 31) LED signalling
82	LED_ECAT_LINK1	Output		Dedicated digital output for EtherCAT LINK 1 (see page 31) LED signalling
83	GND_D	Power		Reference 0 V for external circuitry
84	GND_D	Power		Reference 0 V for external circuitry
85	PHY1_RXD+	Input		Positive terminal for the Receiver of the EtherCAT Port 1
86	PHY1_TXD+	Output		Positive terminal for the Transmitter of the EtherCAT Port 1
87	PHY1_RXD-	Input		Negative terminal for the Receiver of the EtherCAT Port 1
88	PHY1_TXD-	Output		Negative terminal for the Transmitter of the EtherCAT Port 1
89	GND_D	Power		Reference 0 V for external circuitry
90	GND_D	Power		Reference 0 V for external circuitry
91	PHY0_TXD+	Output		Positive terminal for the Transmitter of the EtherCAT Port 0
92	PHY0_RXD+	Input		Positive terminal for the Receiver of the EtherCAT Port 0

93	PHY0_TXD-	Output		Negative terminal for the Transmitter of the EtherCAT Port 0
94	PHY0_RXD-	Input		Negative terminal for the Receiver of the EtherCAT Port 0

6 Signalling LEDs

Triton Core Servo Drive does not include any signalling LED, but has some dedicated pins to drive external LEDs. With the use of **5 dedicated LED outputs** and some additional signals, the following status LEDs can be drived.

- Supply and operation: 1 dedicated LED output for FAULT indication plus 2 additional pins for indicating the basic operation status.
- CANopen communication: 2 dedicated LED outputs for CANopen status (shared with EtherCAT).
- EtherCAT communication: 4 dedicated LED outputs for EtherCAT status (2 signals shared with CANopen).

See the Pinout (see page 25) section for identification of these pins.

6.1 Power and operation signalling LED outputs

Three signals are intended for application-based purposes and for driving LEDs indicating the drive status. Specifically, the **+3.3V_D** signal can be used to power low-power external electronics and for driving a POWER LED; the **LED_FAULT/#OK** signal can be used as a "health" notification signal, dricing a FAULT LED; and the **SHUNT_DRIVE_OUT** signal can be used to drive a power MOSFET that switches a shunt braking power resistor and also a SHUNT LED.

> **Suggested LED colors**
>
> Suggested colors for the mentioned LEDs are: **green** for POWER LED (+3.3V_D pin), **red** for FAULT LED (LED_FAULT/#OK pin) **blue** for SHUNT LED (SHUNT_DRIVE_OUT pin). These are the colors used in **Triton Go**[11].

Next table shows the meaning of each signal:

LED signal	Meaning
+3.3V_D	The internal logic power supply is working.
LED_FAULT/ #OK	An error event has occurred and the drive is trapped in the **Fault state**. Find more about the Fault state in the **E-Core documentation**[12] page.
SHUNT_DRIV E_OUT	The DC bus voltage (power supply) is greater than the maximum voltage configured by the user. **Configuration required** This signal will only work if the shunt braking resistor output is configured as active.

[11] http://doc.ingeniamc.com/display/TR/Triton+Go+Product+Manual
[12] http://doc.ingeniamc.com/display/EMCL/Error+management

6.2 CAN signalling LED outputs (only TRI-x/48-C-P)

Two LED signal outputs provide information about the CANopen communication status, according to CiA 303-3 recommendations[13].

LED_CAN_ERROR and **LED_CAN_RUN** signals (used for EtherCAT operation in the Triton Core part number TRI-x/48-E-P), are intended to drive a red ERROR **LED** and a **green RUN LED**, respectively.

ERROR LED indicates the status of the CAN physical layer and errors due to missed CAN messages (sync, guard or heartbeat). Next table the meaning of the ERROR LED states:

ERROR LED state*	Concept	**Description**
Off	No error	Device is in working condition.
Single flash	Warning limit reached	At least one of the error counters of the CAN controller has reached or exceeded the warning level (too many error frames).
Double flash	Error control event	A guard event (NMT-slave or NMT-master) or a heartbeat event (heartbeat consumer) has occurred.
Triple flash	Sync error	The sync message has not been received within the configured communication cycle period time out.
On	Bus off	The CAN controller is bus off.

RUN LED indicates the status of the CANopen network state machine. Next table shows the meaning of the RUN LED states:

RUN LED state*	Concept	**Description**
Off	Off	The device is switched off
Blinking	Pre-operational	The device is in state PREOPERATIONAL
Single flash	Stopped	The device is in state STOPPED
On	Operational	The device is in state OPERATIONAL

*See a detailed description of the states in the next table:

[13] http://www.can-cia.org/

* Possible LED states	Description
ON	The LED is always on
OFF	The LED is always off
Single flash	One short flash (~200 ms) followed by a long off phase (~1000 ms)
Double flash	Sequence of 2 short flashes (~200 ms), separated by an off phase (~200 ms). The sequence is finished by a long off phase (~1000 ms)
Triple flash	Sequence of 3 short flashes (~200 ms), separated by an off phase (~200 ms). The sequence is finished by a long off phase (~1000 ms)
Blinking	On and off with a frequency of ~2.5 Hz: ON for ~200 ms followed by off for ~200 ms.

Note that the specified timings can vary in up to ±20%.

6.3 EtherCAT signalling LED outputs (only TRI-x/48-E-P)

Four EtherCAT LED signals provide information regarding communication status according to EtherCAT[14] specification.

LED_ECAT_RUN and **LED_ECAT_ERROR** signals (used for CAN operation in the Triton Core part number TRI-x/48-C-P), are intended to drive a **red ERROR LED** and a **green RUN LED**, respectively. The signalling fits the following states table, which indicates the status of the EtherCAT state machine:

RUN LED state	EtherCAT slave status		ERROR LED state	EtherCAT slave status
Off	INIT		Off	No error
Blinking	PRE-OPERATIONAL		Blinking	Invalid configuration
Single Flash	SAFE-OPERATIONAL		Single flash	Local error
On	OPERATIONAL		Double flash	Watchdog timeout
			On	Application controller failure

For high severity errors inside the Triton Servo Drive, an special LED state has been developed:

Status	Signalling	RUN LED state	ERROR LED state
Internal error	Interleaved blink	Blinking (Initial status: OFF)	Blinking (Initial status: ON)

[14] https://www.ethercat.org/default.htm

LED_ECAT_LINK0 and **LED_ECAT_LINK1** signals are intended to drive **YELLOW** **Link 0** and **Link 1** LEDs, typically integrated in the RJ45 connector housing to indicate the state of the physical link activity on each port. Signalling fits the following states table:

Link LED state	EtherCAT slave status
Off	Port closed
Flickering	Port opened (activity on port)
On	Port opened (no activity on port)

7 Product Dimensions

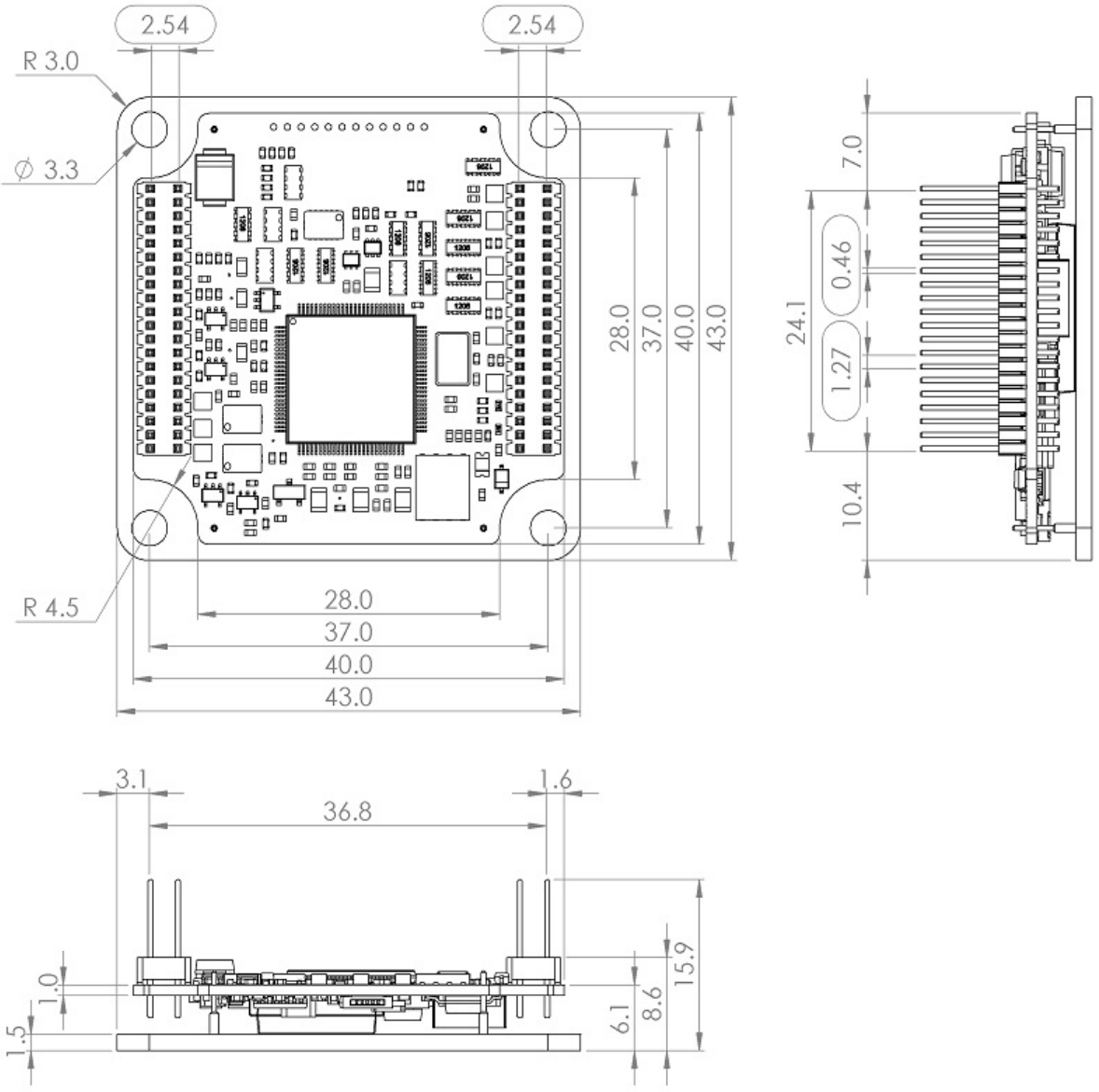
Triton Core Servo Drive has a **43 mm x 43 mm footprint**, and the maximum height depends on the Triton part number. All Triton variants are provided with 4 x Ø 3.3 mm holes in a 37 mm x 37 mm square for **M3 screws** mounting.

Thermal dissipation required

To reach its power specifications, all Triton Core variants must be mounted over a **metallic chassis or heatsink**, and a thermal interface material must be placed and compressed in between.

7.1 Triton Core with CAN (TRI-x/48-C-P)

Next figure shows mechanical dimensions in **mm**. All tolerances are **≤ ±0.2 mm**.



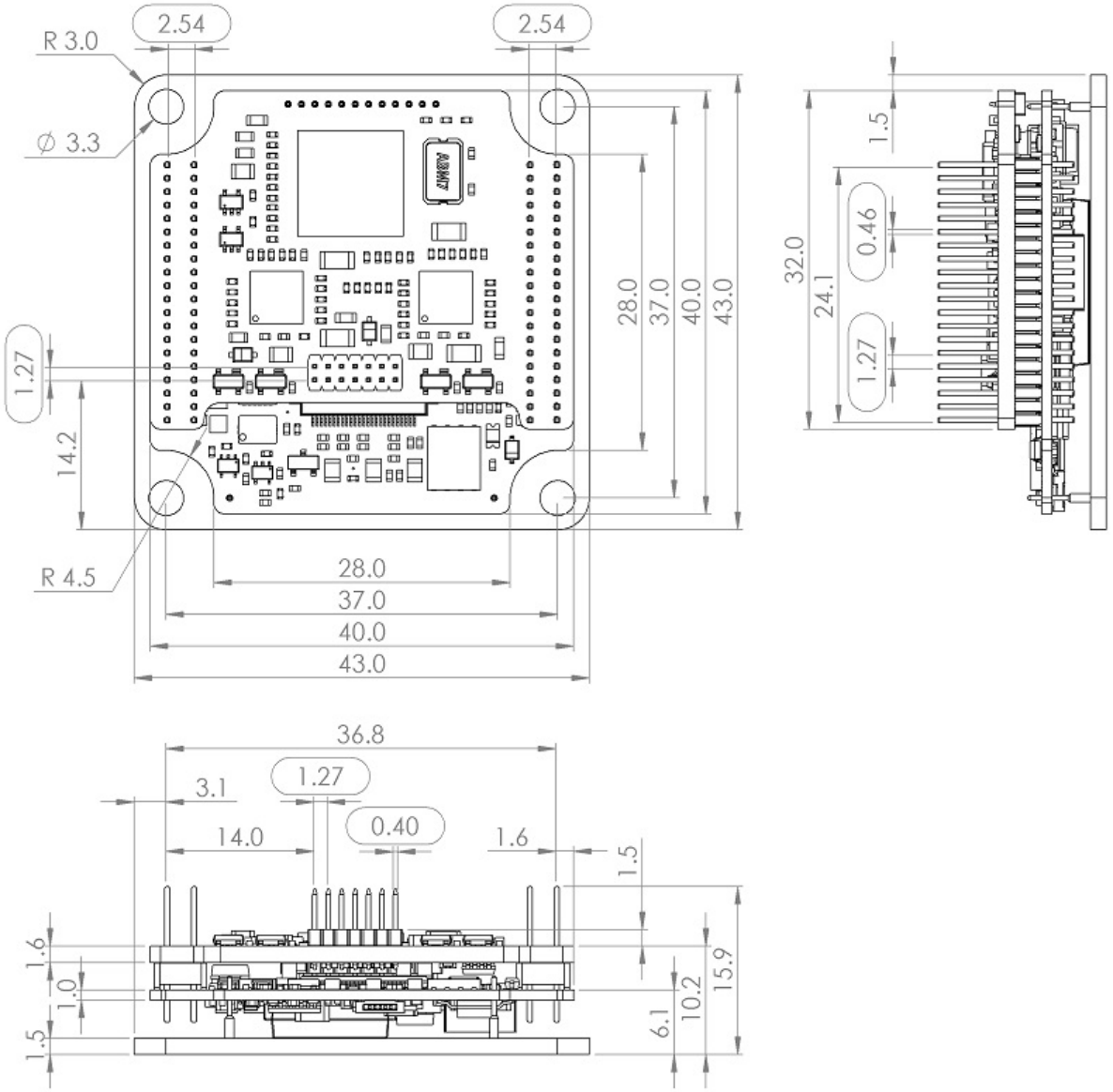
3D Model

For further detail, download the STEP 3D model and PDF 3D[15] for the Triton Core TRI-x/xx-C-P. Note that the model is simplified: it does not show all the internal components, but does show the major volumes.

7.2 Triton Core with EtherCAT (TRI-x/48-E-P)

Next figure shows mechanical dimensions in **mm**. All tolerances are **≤ ±0.2 mm**.

[15] http://ingeniamc.com/support/triton



3D Model

For further detail, download the STEP 3D model and PDF 3D[16] for the Triton Core TRI-x/xx-E-P. Note that the model is simplified: it does not show all the internal components, but does show the major volumes.

[16] http://ingeniamc.com/support/triton

8 Application Software

8.1 Configuration

To connect, configure, tune your motor or upgrade the firmware of the Triton Core, install Ingenia **Motion Lab**[17] suite. The software package includes USB drivers.

> **Keep the firmware updated**
>
> Before configuring your drive for a new application make sure you have upgraded to the latest firmware revision.

8.2 Applications

If you want to make your own application to communicate with the Jupiter and develop standalone or multiaxis systems you can use the multi-platform library **MCLIB**[18]**.**

8.3 Arduino

To start an Arduino based project easily, connect using the serial UART pins of the Jupiter and use our Arduino Library **Ardulib**[19].

[17] http://ingeniamc.com/software#motionlab
[18] http://ingeniamc.com/software#mclib
[19] http://ingeniamc.com/software#ardulib

9 Service

We are committed to quality customer service. In order to serve in the most effective way, please open a ticket on our service desk at www.ingeniamc.com/support or contact your local sales representative for assistance.

If you are unaware of your local sales representative, please contact the Customer Support.

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