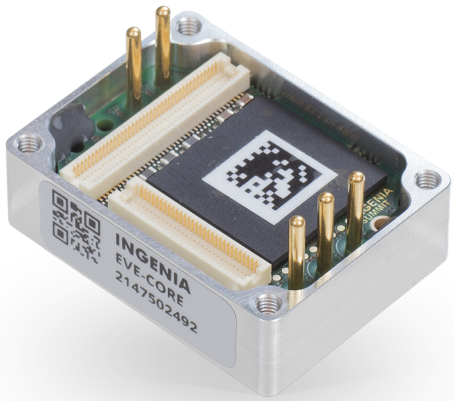
Everest CORE - Product Manual



Edition 06/14/2019

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

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携手慧摩森 创建灵巧之运动

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	2019-4-12	Initial version	Export as pdf

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

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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 Everest CORE Servo Drive.

To ensure maximum safety in operating the Everest CORE 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 Everest CORE 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 Everest CORE Servo Drive while the power supply is on.
- Disconnect the Everest 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 Everest Servo CORE 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 Everest Servo CORE 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 Everest Servo CORE Drive, check that all safety precautions have been followed, as well as the installation procedures.

4. Product Description

Everest CORE is a high power, highly-integrated, digital servo drive intended to be plugged or soldered to an application-specific daughter board. The drive features best-in-class energy efficiency thanks to its state of the art power stage, and can be easily configured with Ingenia's free-to-download software MotionLab 3.

Everest CORE can be interfaced by means of its proprietary **Motion Control Bus** protocol.

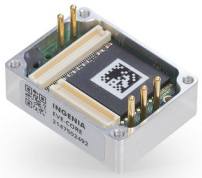
Main features:

- Ultra-small footprint
- 80 V_{DC}, 30 A_{RMS} continuous
- Up to 99% efficiency
- Up to 75 kHz current loop, 25 kHz servo loops
- 10 kHz ~ 100 kHz PWM frequency
- 16 bit ADC with VGA for current sensing
- Supports Halls, Quadrature encoder, SSI and BiSS-C
- Up to 4 simultaneous feedback sources
- Full voltage, current and temperature protections

Typical applications:

- Collaborative robot joints
- Robotic exoskeletons
- Wearable robots
- AGVs
- UAVs
- Industrial highly integrated servomotors
- Smart motors
- Battery-powered and e-Mobility
- Low inductance motors

4.1. Part numbering

Product	Ordering part number	Status	Image
Everest CORE Pluggable servo drive with communication through proprietary **M**otion **C**ontrol **B**us protocol.	EVE-CORE	PRE-PROD.	

For applications requiring a pluggable drive enabled with EtherCAT or CANopen, please see Everest NET.

For applications requiring a ready-to-go product, also enabled enabled with EtherCAT or CANopen, please see Everest XCR.

4.2. Specifications

Part number →	**EVE-CORE**
Electrical and power specifications	
Minimum DC bus supply voltage	8 V_{DC}
Maximum DC bus supply voltage	80 V_{DC} (continuous) 85 V_{DC} (peak 100 ms)
Recommended power supply voltage range	12 V_{DC} ~ 72 V_{DC} This voltage range ensures a safety margin including power supply tolerances and regulation during acceleration and braking.
Internal drive DC bus capacitance	6 µF
Logic supply voltage	4.9 V_{DC} ~ 5.1 V_{DC}
Nominal phase continuous current (RMS)	30 A
Maximum phase peak current (RMS)	60 A @ 3 sec Active current limiting based on power stage and motor temperature.
Efficiency	Up to 99% @ 20 kHz, 80 V, 30 A
Bus voltage utilisation	> 97% @ 20 kHz, 80 V, voltage mode, no load
Motion control specifications	
Standby logic supply consumption	≤ 1 W Measured with commutation turned OFF.
Supported motor types	• Rotary brushless (SVPWM and Trapezoidal) • Rotary brushed (DC)
Power stage PWM frequency (configurable)	10 kHz, 20 kHz (default), 50 kHz & 100 kHz
Current sensing	16 bit ADC resolution. Accuracy is ±2% full scale.
Current sense resolution (configurable)	Current gain is configurable in 4 ranges: • 2.475 mA/count • 1.352 mA/count • 0.570 mA/count • 0.379 mA/count

Current sense ranges (configurable)	Current ranges for the 4 configurable current gains: • ±81.1 A • ±44.3 A • ±18.7 A • ±12.4 A
Max. Current loop frequency	75 kHz
Max. servo loops frequency (position & velocity)	25 kHz @ 75 kHz current loop

Feedbacks	• Digital Halls
	• Quadrature / Incremental encoder
	• Absolute Encoder: up to 2 at the same time, combining any of the following:
	  • BiSS-C (up to 2 in daisy chain topology)
	  • SSI
	*Only a specific subset of absolute encoders are supported. Contact Ingenia for further information.

Supported target sources	Network communication (Motion Control Bus)
Control modes	• Cyclic Synchronous Position • Cyclic Synchronous Velocity • Cyclic Synchronous Current • Profile Position (trapezoidal & s-curves) • Profile Velocity • Interpolated Position (P, PT, PVT) • Homing
Inputs/outputs and protections	
General purpose Inputs and outputs	4 x non-isolated single-ended digital inputs - 3.3 V logic level. Can be configured as: • General purpose • Positive or negative homing switch • Positive or negative limit switch • Quick stop input 4 x non-isolated single-ended digital outputs - 3.3 V logic level, 3 mA max. sink / source current. Can be configured as: • General purpose • Operation enabled event flag • External shunt braking resistor driving signal 1 x ±3.3 V ,16-bit, differential analog input for load cells or torque sensors. Can be read by the Master to close a torque loop.
Shunt braking resistor output	Configurable over any of the digital outputs (see above). Enabling this function would require an external transistor or power driver.

Motor brake output	Dedicated, PWM capable, 3.3 V digital output for driving a mechanical brake. Turn-on and turn-off times are configurable. Enabling this function would require an external transistor or power driver.
Safe Torque OFF inputs	2 x dedicated, non-isolated STO digital inputs (3.3 V and 5 V tolerant).
Motor temperature input	1 x dedicated, 5 V, 12-bit, single-ended analog input for measuring motor temperature.

Protections	• Hardcoded / hardwired Drive protections:
	  • Automatic current derating on voltage, current and temperature
	  • Short-circuit Phase to DC bus
	  • Short-circuit Phase to Phase
	  • Short-circuit Phase to GND
	• Configurable protections:
	  • DC bus over-voltage
	  • DC bus under-voltage
	  • Drive over-temperature
	  • Drive under-temperature
	  • Motor over-temperature (requires external sensor)
	  • Current overload (I^2t). Configurable up to Drive limits
	  • Voltage mode over-current (with a closed current loop, protection effectiveness depends on the PID).
	• Motion Control protections:
	  • Halls sequence / combination error (Pending implementation)
	  • Limit switches
	  • Position following error
	  • Velocity / Position out of limits

Communications	
MCB	Proprietary Motion Control Bus protocol based on SPI.
Environmental conditions	
Aluminium case	Yes (connectors side open)
PE isolation	> 300 MΩ @ 1000 V
Case temperature	Operation: • -40 ºC to +60 ºC at full current • +60 ºC to +85 ºC with derated current For further information, see Thermal Specifications below. Storage: • -40 ºC to +100 ºC
Maximum humidity	5% ~ 85% non-condensing

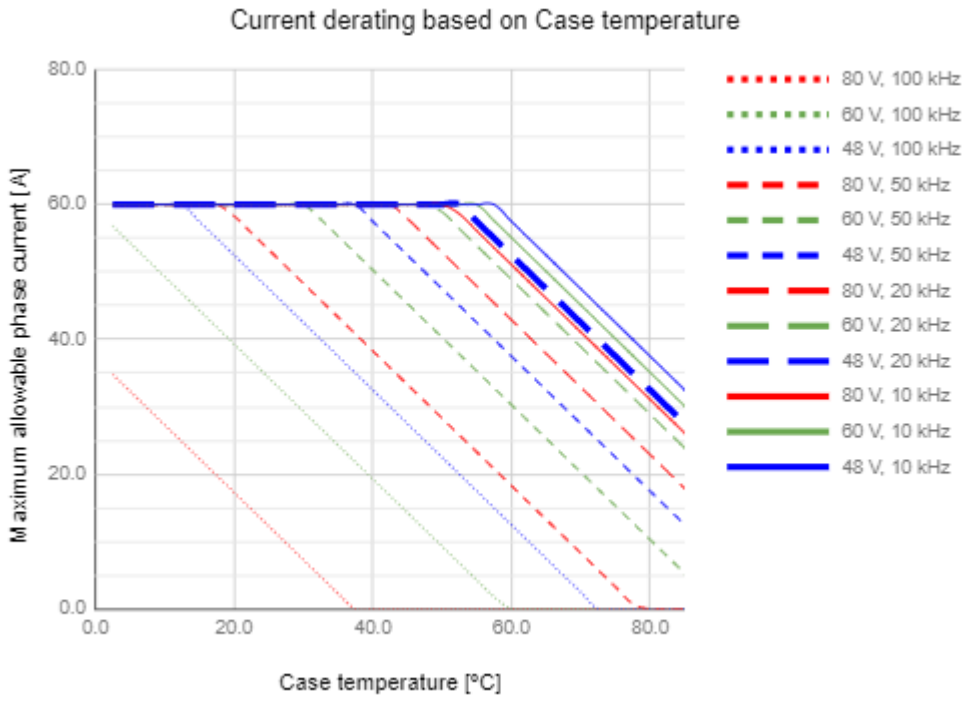
Mechanical specifications	
Horizontal dimensions	34.5 mm x 26 mm
Height	10.4 mm (case) 17 mm (including full length of the power pins)
Weight	16 gr
Certifications	
Certifications	CE, RoHS STO SIL3 (certification pending)

4.3. Thermal specifications

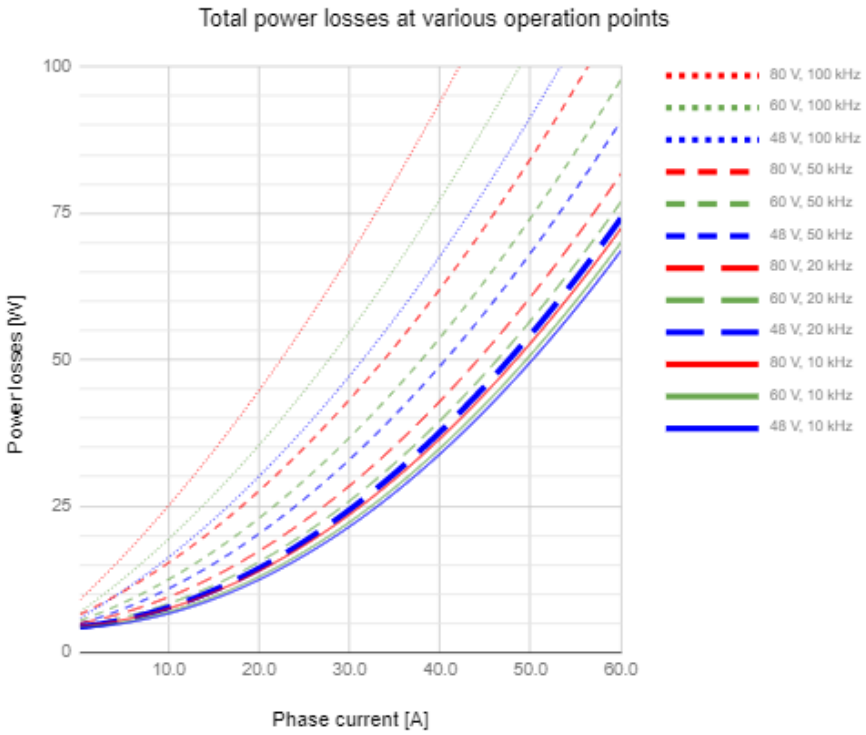
Thermal performance of Everest CORE is specified as function of the **temperature measured in its aluminium case**, the **DC bus voltage** and the **PWM commutation frequency**. This 3 parameters could ultimately determine the maximum continuous current the Everest CORE can output, provided that an **active derating** algorithm will be continuously protecting it from thermal over-stress. Notice that PWM commutation frequency cannot be changed dynamically, but pre-selected to match the application needs: most probably 10 kHz will be selected for highest current at a given temperature (be aware that selecting this frequency may cause audible noise), but 100 kHz will be preferred to control a low inductance motor.

The following figure show the maximum phase current at different case temperatures and DC bus voltages. Here **current is expressed in RMS**. To obtain the equivalent current in amplitude just multiply it by √2 .

To ensure a proper performance of Everest CORE, the **case temperature must be held always below 85 ºC ($T_{c\text{-}max}$ = 85 ºC).**



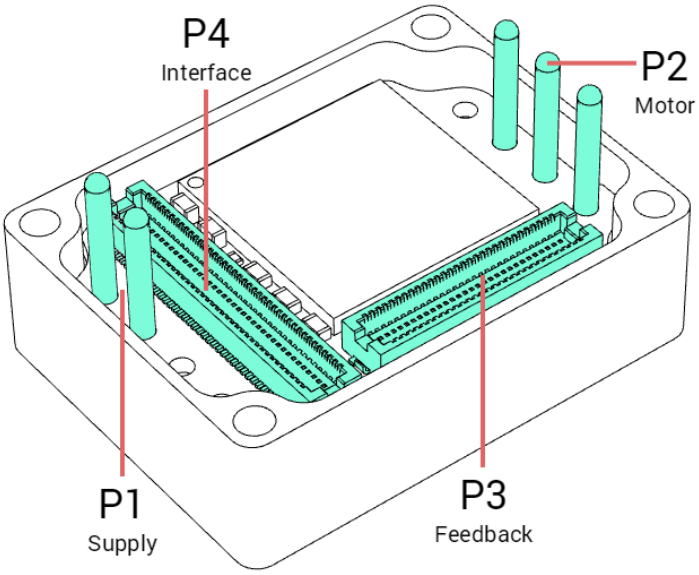
Following figure show the theoretical **power losses** at different operating points.



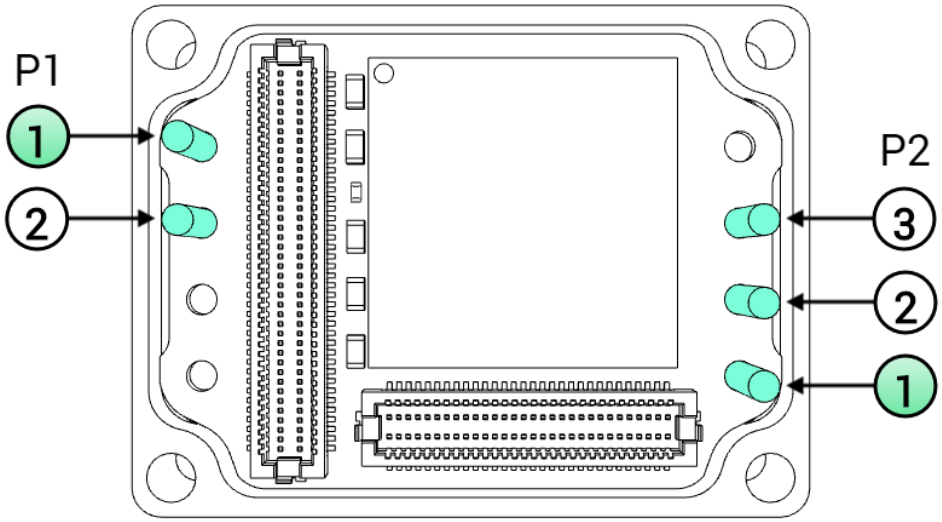
Take a look to the Thermal Dissipation section below to learn how to dimension a heatsink to allow Everest CORE reaching a target current under an specific ambient temperature.

5. Pinout

5.1. Connectors Overview



5.2. P1 and P2 Power pins



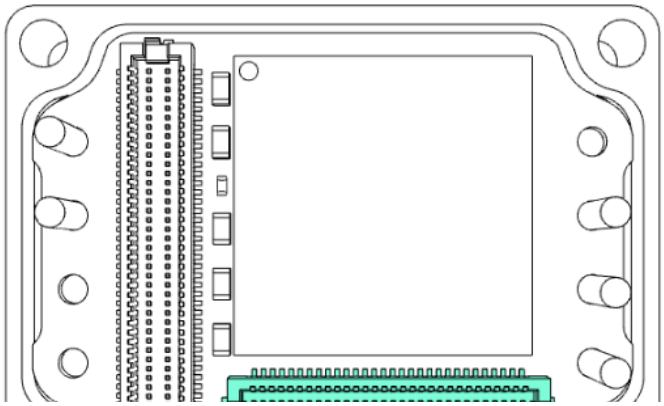
P1 Supply Power pins			
Pin	**Name**	**Type**	**Function**
1	POW_SUP	Power	Power supply positive (DC bus).
2	GND_P		Power supply negative (Power Ground).
Chassis	PE		Protective Earth connected to driver housing and fixing M2.5 threads.

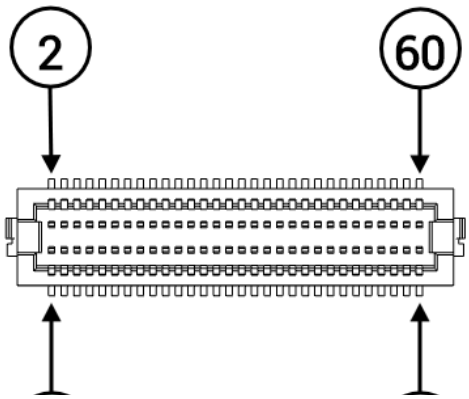
P2 Motor Power pins			
Pin	**Name**	**Type**	**Function**
1	PH_A	Power	Motor phase A for 3-phase motors, positive for DC motors.
2	PH_B		Motor phase B for 3-phase motors, negative for DC motors.
3	PH_C		Motor phase C for 3-phase motors (do not connect for DC motors).
Chassis	PE		Protective Earth connected to driver housing and fixing M2.5 threads.

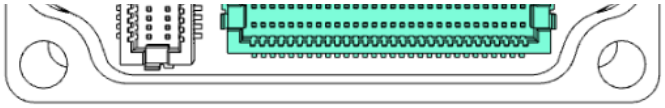
Everest CORE connector	**Recommended mating contact**	**Description**
	Up to 11.2 A_{RMS} rated motors	
Ø 1.52 mm, 4 mm pitch, gold plated power pins.		Beryllium copper TH pin receptacle. Gold plated.
	Mill-Max 9372-0-15-15-23-27-10-0	
	> 11.2 A_{RMS} rated motors	
	Direct solder to PCB. TH pad with min. hole Ø 1.63 mm. Ensure PCB track are wide enough to withstand the target current.	

5.3. P3 Feedback connector

The pinout of the Feedback connector is exactly the same for for Everest CORE (EVE_CORE) and **Everest NET** (EVE_NET) although **the position of the connector is different**.







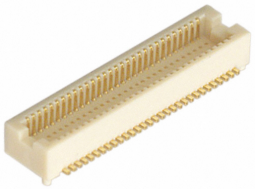
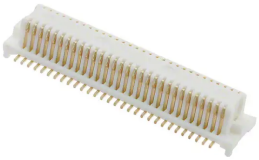
P3 Feedback connector							
#	**Signal name**	**Description**	**Type**	**#**	**Signal name**	**Description**	**Type**
1	GND_A	Analog Ground. Do not connect to GND_D directly, use a ferrite bead or 1 Ω resistor in between.	Power	**2**	GND_A	Analog Ground. Do not connect to GND_D directly, use a ferrite bead or 1 Ω resistor in between.	Power
3	DNC	Reserved. Do not connect (leave floating).	-	**4**	AN1_P	Analog input for torque sensing.	16 bit differential analog input
5	DNC			**6**	AN1_N		
7	DNC			**8**	DNC	Reserved. Do not connect (leave floating).	-
9	DNC			**10**	DNC		
11	DNC			**12**	DNC		
13	MOTOR_TEMP	Motor temperature sensor input. 0 V to 5 V level high impedance input.	12 bit single-ended analog input	**14**	DNC		
15	GND_D	Digital signal Ground.	Power	**16**	NC	Internally not connected. Recommended to leave them unconnected.	
17	HALL_1	Digital hall 1.	Input	**18**	NC		
19	HALL_2	Digital hall 2.		**20**	GND_A	Analog Ground. Do not connect to GND_D directly, use a ferrite bead or 1 Ω resistor in between.	Power
21	HALL_3	Digital hall 3.		**22**	GND_D	Digital signal Ground.	
23	CLL	Reserved. Must be tied or pulled-down to GND_D.	-	**24**	DIG_ENC_1A	Digital encoder 1 A.	Input
25	CHL	Reserved. Must be tied or pulled-up to 3.3 V.		**26**	DIG_ENC_1B	Digital encoder 1 B.	

27	CLL	Reserved. Must be tied or pulled-down to GND_D.		**28**	DIG_ENC_1Z	Digital encoder 1 Index.	
29	CHL	Reserved. Must be tied or pulled-up to 3.3 V.		**30**	DIG_ENC_2A	Digital encoder 2 A.	
31	DNC	Reserved. Do not connect (leave floating).		**32**	DIG_ENC_2B	Digital encoder 2 B.	
33	DNC			**34**	DIG_ENC_2Z	Digital encoder 2 Index.	
35	DNC			**36**	GND_D	Digital signal Ground.	Power
37	DNC			**38**	ABSENC1_CLK	Clock output for Absolute Encoder 1.	Output
39	DNC			**40**	ABSENC1_DATA	Data input for Absolute Encoder 1 (supports SSI or up to 2 BiSS-C encoders connected in daisy chain topology).	Input
41	DNC			**42**	DNC	Reserved. Do not connect (leave floating).	-
43	DNC			**44**	GND_D	Digital signal Ground.	Power
45	DNC			**46**	DNC	Reserved. Do not connect (leave floating).	-
47	DNC			**48**	DNC		
49	DNC			**50**	DNC		
51	DNC			**52**	DNC		
53	DNC			**54**	DNC		
55	DNC			**56**	DNC		
57	DNC			**58**	DNC		
59	GND_D	Digital signal Ground.	Power	**60**	GND_D	Digital signal Ground.	Power

Notes and naming conventions:

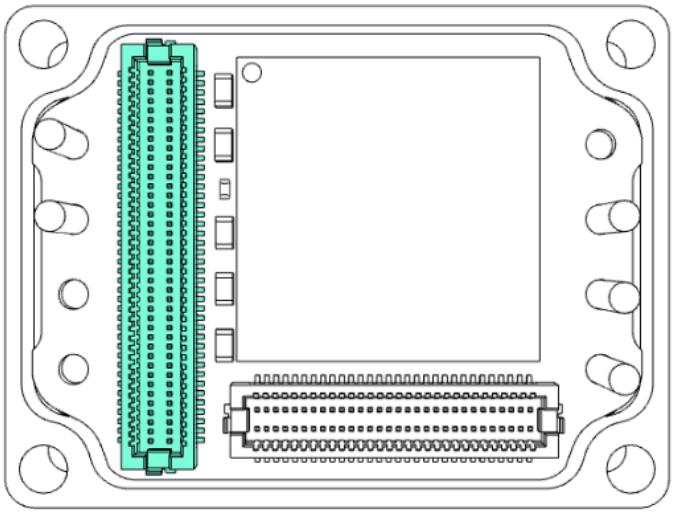
- All pins are tolerant to 3.3 V unless otherwise noted.
- "_P" and "_N" indicates positive and negative of differential signals
- "\" Indicates inverted (active low) signal

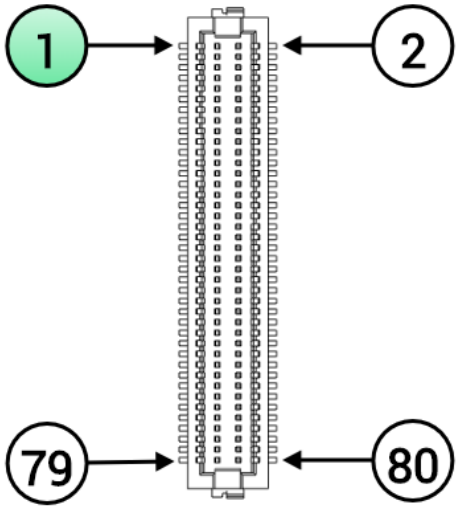
- "NC" means Not Connected. Pins marked with NC can be tied to GND or 3.3 V, but best practice is to leave them unconnected.
- "DNC" means Do Not Connect. Pins marked with DNC must not be tied to any driving voltage, including GND or 3.3 V.
- "CLL" means Connect to Low Level. Pins marked with CLL must be tied or pulled-down to 0 V.
- "CHL" means Connect to High Level. Pins marked with CHL must be tied or pulled-up to 3.3 V.

Manufacturer	Everest CORE connector	Required mating connector	Description
Hirose Electric			60-pin mezzanine stacking board connector. 0.5 mm pitch. Center strip, gold-plated surface mount contacts. 3 mm stacking height.
	DF12(3.0)-60DP-0.5V(86)	DF12(3.0)-60DS-0.5V(86)	

5.4. P4 Everest CORE Interface connector

Although using the same physical connector as Everest NET (EVE-NET), position and pinout is different in Everest CORE (EVE-CORE).





P4 Everest CORE Interface connector							
#	**Signal name**	**Description**	**Type**	**#**	**Signal name**	**Description**	**Type**
1	GND_D	Digital signal Ground.	Power	**2**	GND_D	Digital signal Ground.	Power

3	5V_D	5 V, 300 mA continuous logic supply input. Must be low ripple and ensure ±2% regulation tolerance or less. It is advised to connect all four 5V_D pins. It is recommended to provide at least 500 mA input current if pins 9 or 10 (3.3V_D) are used to drive external circuits.	Power input	**4**	5V_D	5 V, 300 mA continuous logic supply input. Must be low ripple and ensure ±2% regulation tolerance or less. It is recommended to connect all four 5V_D pins. It is advised to provide at least 500 mA input current if pins 9 or 10 (3.3V_D) are used to drive external circuits.	Power input
5	5V_D			**6**	5V_D		
7	GND_D	Digital signal Ground.	Power	**8**	GND_D	Digital signal Ground.	Power
9	3.3V_D	3.3 V, 250 mA max. output to supply peripherals. An excessive current demand on this pin could cause failure or even permanent damage to the Everest CORE.	Power output	**10**	3.3V_D	3.3 V, 250 mA max. output to supply peripherals. An excessive current demand on this pin could cause failure or even permanent damage to the Everest CORE.	Power output
11	GND_D	Digital signal Ground.	Power	**12**	GND_D	Digital signal Ground.	Power
13	GND_D			**14**	MCB_SPI_MISO	Motion Control Bus, Master input Slave output	Output
15	GND_D			**16**	MCB_SPI_MOSI	Motion Control Bus, Master output Slave input	Input
17	GND_D			**18**	\MCB_SPI_CS	Motion Control Bus, Chip Select output	
19	GND_D			**20**	MCB_SPI_CLK	Motion Control Bus, Clock output	
21	GND_D			**22**	MCB_SYNC0	Motion Control Bus, synchronization signal 0	
23	GND_D			**24**	MCB_SYNC1	Motion Control Bus, synchronization signal 1	Output
25	GND_D			**26**	MCB_IRQ	Motion Control Bus, interrupt request output	
27	GND_D			**28**	DNC	Reserved. Do not connect (leave floating).	-
29	NC	Internally not connected. Recommended to leave them unconnected.	-	**30**	GND_D	Digital signal Ground.	Power
31	NC			**32**	GND_D		

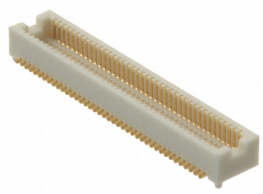
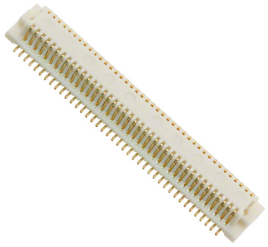
33	\STO1	Safe Torque Off input 1 (non-isolated). Both \STO1 and \STO2 must be high-level (3.3 V and 5 V level compatible) to allow operation of the motor. Holding different logic states (STO1 ≠ STO2) for more than 1s will cause a latching fault.	Input	**34**	\STO2	Safe Torque Off input 2 (non-isolated). Both \STO1 and \STO2 must be high-level (3.3 V and 5 V level compatible) to allow operation of the motor. Holding different logic states (STO1 ≠ STO2) for more than 1s will cause a latching fault.	Input
35	DNC	Reserved. Do not connect (leave floating).	-	**36**	DNC	Reserved. Do not connect (leave floating).	-
37	FAULT_SIGNAL	Fault state signalling output. Can directly drive a (typically) red LED anode at 3.3 V up to 3 mA.	Output	**38**	\HW_RESET	Everest CORE reset input. Keeps the motion controller disabled with low power consumption. 2 kΩ pull-up to 3.3 V is internally included.	Input
39	GND_D	Digital signal Ground.	Power	**40**	DNC	Reserved. Do not connect (leave floating).	-
41	\EXT_FAULT	External fault input. Could be configured to force the Everest CORE state-machine to the Fault state (motor will be stopped) when the pin is driven to 0 V. Includes an internal weak pull-up, although external pull-up to 3.3 V is advised.	Input	**42**	PWM_BRAKE	PWM output for driving a mechanical brake. Configurable up to 20 kHz. High level indicates the motor is free to move.	Output
43	GPO4	Digital Output 4.	Output	**44**	DNC	Reserved. Do not connect (leave floating).	-
45	DNC	Reserved. Do not connect (leave floating).	-	**46**	DNC		
47	GPI1	Digital Input 1.	Input	**48**	DNC		
49	GPI2	Digital Input 2.		**50**	ABSENC2_CLK	Clock output for Absolute Encoder 2.	Output
51	ABSENC2_DATA	Data input for Absolute Encoder 2 (supports SSI only)		**52**	DNC	Reserved. Do not connect (leave floating).	-
53	GPI3	Digital Input 3.		**54**	DNC		
55	GPO1	Digital Output 1.	Output	**56**	GPO2	Digital Output 2.	Output
57	GPO3	Digital Output 3.		**58**	GPI4	Digital Input 4.	Input
59	GND_D	Digital signal Ground.	Power	**60**	GND_D	Digital signal Ground.	Power
61	DNC	Reserved. Do not connect (leave floating).	-	**62**	DNC	Reserved. Do not connect (leave floating).	-
63	DNC			**64**	DNC		

65	DNC			**66**	DNC		
67	GND_D	Digital signal Ground.	Power	**68**	GND_D	Digital signal Ground.	Power
69	NC	Internally not connected. Recommended to leave them unconnected.	-	**70**	NC	Internally not connected. Recommended to leave them unconnected.	-
71	NC			**72**	NC		
73	NC			**74**	NC		
75	1.65V_REF	1.65 V voltage reference output with sink/source capability up to ±10 mA. An excessive current demand or noise coupled to this pin can cause a loss of performance or even malfunction of Everest CORE: route by following the best layout practices.	Power output	**76**	NC		
77	3.3V_REF	3.3 V voltage reference output with sink/source capability up to ±10 mA. An excessive current demand or noise coupled to this pin can cause a loss of performance or even malfunction of Everest CORE: route by following the best layout practices.		**78**	DNC	Reserved. Do not connect (leave floating).	
79	GND_A	Analog Ground. Do not connect to GND_D directly, use a ferrite bead or 1 Ω resistor in between.	Power	**80**	GND_A	Analog Ground. Do not connect to GND_D directly, use a ferrite bead or 1 Ω resistor in between.	Power

Notes and naming conventions:

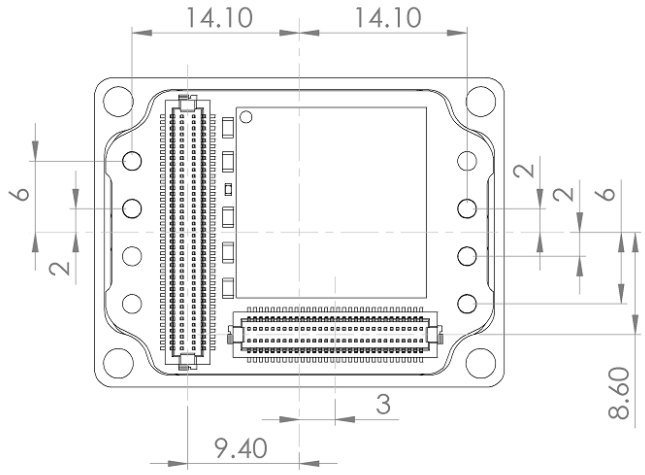
- All pins are tolerant to 3.3 V unless otherwise noted.
- "_P" and "_N" indicates positive and negative of differential signals
- "\" Indicates inverted (active low) signal
- "NC" means Not Connected. Pins marked with NC can be tied to GND or 3.3 V, but best practice is to leave them unconnected.
- "DNC" means Do Not Connect. Pins marked with DNC must not be tied to any driving voltage, including GND or 3.3 V.

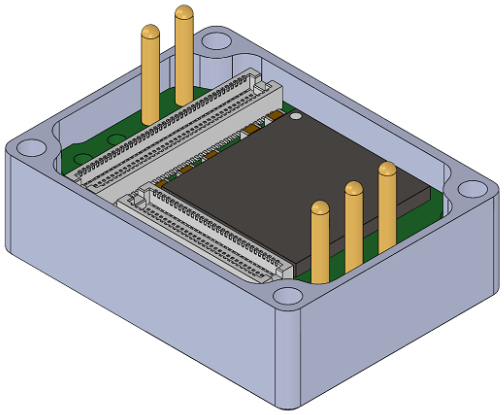
Motion Control Bus
Everest CORE can be controlled as a slave by means of its proprietary **Motion Control Bus** (MCB). Check how in the **Summit Series Reference Manual**.

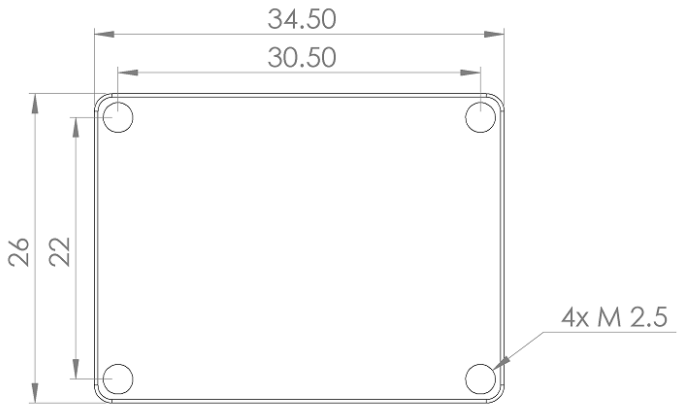
Manufacturer	Everest CORE connector	Required mating connector	Description
Hirose Electric			80-pin mezzanine stacking board connector. 0.5 mm pitch. Center strip, gold-plated surface mount contacts. 3 mm stacking height.
	DF12(3.0)-80DP-0.5V(86)	DF12(3.0)-80DS-0.5V(86)	

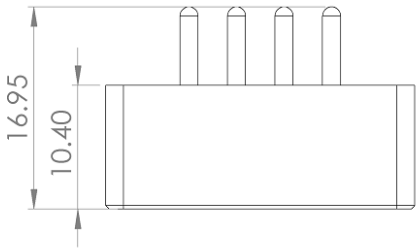
6. Dimensions

All dimensions are in **mm**. All tolerances **≤ ±0.2 mm**









3D Model
For further detail, download the STEP model.

7. 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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