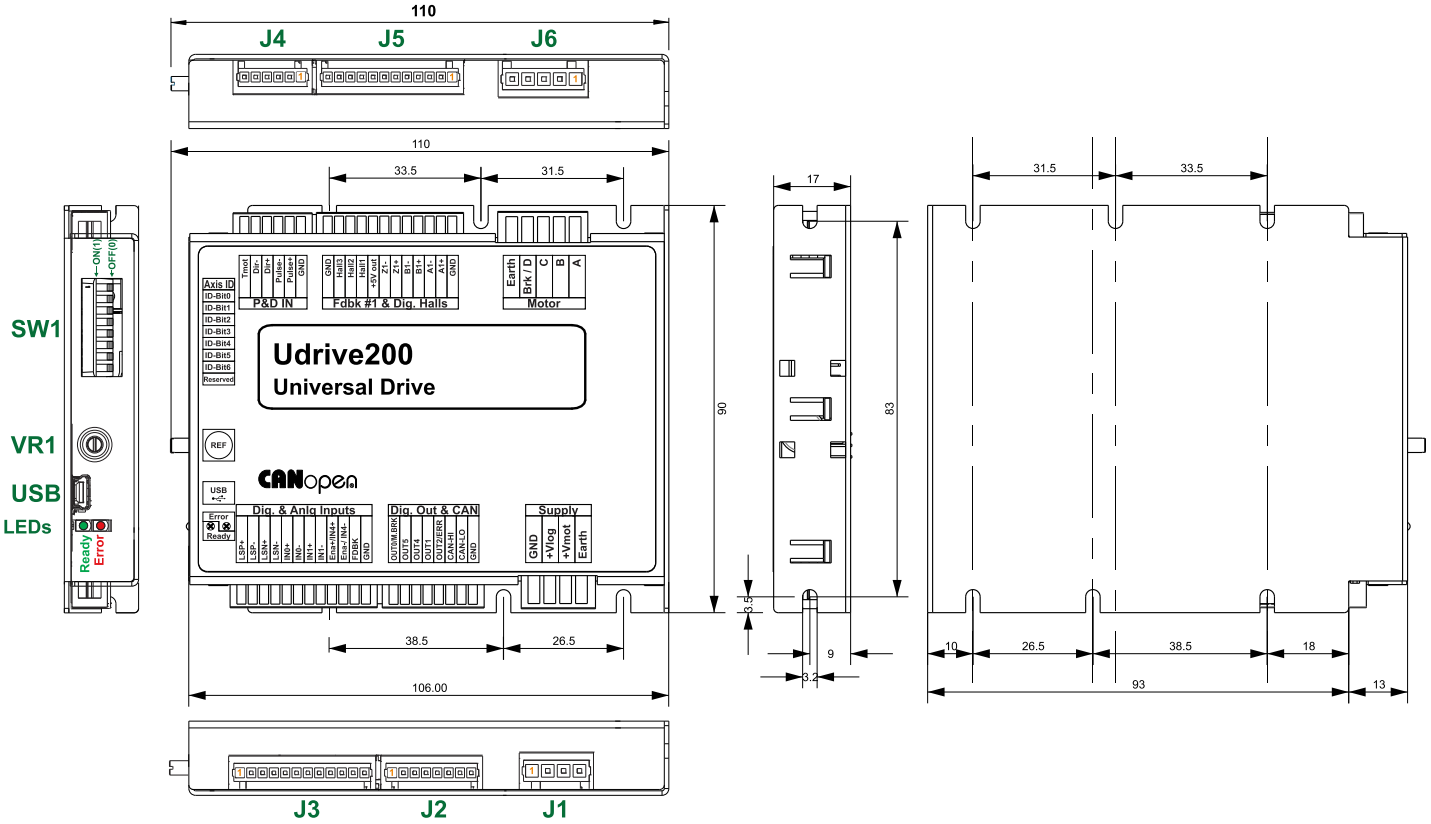


All dimensions are in mm; Drawing not to scale.

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

- **Features**
- Motion controller and drive in a single compact unit
- Universal solution for control of rotary and linear brushless, brushed and 2 or 3-phase step motors
- CANopen communication protocol (CiA 301v4.2, CiA 305v2.213 and 402v3.0)
- Various modes of operating supported: Position or Speed Profile, interpolated Cyclic Synchronous Position (CSP) mode, external reference mode (Position, Speed, Torque), 35 homing modes
- Motor supply: 11-50V. Logic supply: 9-36V
- Output current: 4A cont. (BLDC mode); $10A_{PEAK}$, up to 100KHz PWM
- 5 opto-isolated digital inputs, 12-36V, PNP/NPN compatible: 2 for limit switches, 3 general-purpose
- 5 digital outputs, 5-36V, 0.5A, NPN open-collector: Error, 1 Motor brake [2A], 3 general-purpose [0.5A]
- Mini USB[1] & CAN-bus 2.0B interfaces
- 127 h/w addresses selectable by h/w DIP switch
- NTC/PTC analogue Motor Temperature sensor input
- Protections: short-circuit between motor phases and from motor phases to GND, over/under-voltage, over-current, I^2t, control error, over temperature, communication error
- Feedback Devices :
  - 1st feedback devices supported:
    - Incremental encoder interface (differential)
    - Digital Hall sensor interface (single-ended and open collector)
  - 2nd feedback devices supported:
    - pulse & direction interface (differential) for external (master) digital reference
- 1 analogue input: 12-bit, 0-5V: Feedback
- 1 rotating potentiometer used as Reference
- 16k x16 SRAM memory for data acquisition
- 16k x16 E^2ROM to store setup and other user data
- Operating ambient temperature: 0-40°C (over 40°C with derating)

Mating Connectors				
Producer	**Part No.**	**Connector**	**Description**	**Image**
WAGO	734-104	J1	Pluggable terminal block 4-pole Pin spacing 3.5 mm	AWG 14-28
WAGO	733-108	J2	Pluggable terminal block 8-pole Pin spacing 2.5 mm	AWG 20-28
WAGO	733-112	J3 & J5	Pluggable terminal block 12-pole Pin spacing 2.5 mm	AWG 20-28
WAGO	733-106	J4	Pluggable terminal block 6-pole Pin spacing 2.5 mm	AWG 20-28
WAGO	734-105	J6	Pluggable terminal block 5-pole Pin spacing 3.5 mm	AWG 14-28

[1]Mini USB cable not provided

Connectors Description

	Pin	Name	Type	Description
J1	1	GND	-	Negative return (ground) of the power supply
	2	$+V_{LOG}$	I	Positive terminal of the logic supply input: 12 to $36V_{DC}$
	3	$+V_{MOT}$	I	Positive terminal of the motor supply: 12 to $50V_{DC.}$
	4	Earth	-	Earth connection

	Pin	Name	Type	Description
J2	1	OUT0/M.BRK	O	5-36V 2A, digital output used for an electro-mechanical brake, NPN open-collector/TTL pull-up
	2	OUT5	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
	3	OUT4	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
	4	OUT1	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
	5	OUT2/Error	O	12-36V 0.5A, drive Error output, active low, NPN open-collector/TTL pull-up. Also drives the red Error LED.
	6	CAN Hi	I/O	CAN-Bus positive line(dominant high)
	7	CAN Lo	I/O	CAN-Bus negative line (dominant low)
	8	GND	-	Return ground for I/O and CAN pins

	Pin	Name	Type	Description
J3	1	IN2+/LSP+	I	12-36V digital PNP/NPN opto-isolated input. Positive limit switch function, positive input
	2	IN2-/LSP-	I	12-36V digital PNP/NPN opto-isolated input. Positive limit switch function, negative input
	3	IN3+/LSN+	I	12-36V digital PNP/NPN opto-isolated input. Negative limit switch function, positive input
	4	IN3-/LSN-	I	12-36V digital PNP/NPN opto-isolated input. Negative limit switch function, negative input
	5	IN0+	I	12-36V general-purpose digital PNP/NPN opto-isolated positive input.
	6	IN0-	I	12-36V general-purpose digital PNP/NPN opto-isolated negative input.
	7	IN1+	I	12-36V general-purpose digital PNP/NPN opto-isolated positive input.
	8	IN1-	I	12-36V general-purpose digital PNP/NPN opto-isolated negative input.
	9	Ena+/IN4+	I	12-36V digital PNP/NPN opto-isolated input. Drive enable function, positive input
	10	Ena-/ IN4-	I	12-36V digital PNP/NPN opto-isolated input. Drive enable function, negative input
	11	FDBK	I	Analogue input, 12-bit, 0-5V. Used to read an analogue position or speed feedback (as tacho), or used as general purpose analogue input.
	12	GND	-	Negative return (ground) of the motor supply

	Pin	Name	Type	Description
J4	1	GND	-	Return ground
	2	Pulse+	I	Pulse+ differential input; has 120Ω resistor between pins 2 and 3
	3	Pulse-	I	Pulse- differential input; has 120Ω resistor between pins 2 and 3
	4	Dir+	I	Direction+ differential input; has 120Ω resistor between pins 4 and 5
	5	Dir-	I	Direction- differential input; has 120Ω resistor between pins 4 and 5
	6	Temp Mot	I	NTC/PTC input. Used to read an analog temperature value

	Pin	Name	Type	Description
J5	1	GND	-	Return ground for sensors supply
	2	A1+	I	Incr. encoder1 A+ diff. input; has 120Ω resistor between pins 2 and 3
	3	A1-	I	Incr. encoder1 A- diff. input; has 120Ω resistor between pins 2 and 3
	4	B1+	I	Incr. encoder1 B+ diff. input; has 120Ω resistor between pins 4 and 5
	5	B1-	I	Incr. encoder1 B- diff. input; has 120Ω resistor between pins 4 and 5
	6	Z1+	I	Incr. encoder1 Z+ diff. input; has 120Ω resistor between pins 6 and 7
	7	Z1-	I	Incr. encoder1 Z- diff. input; has 120Ω resistor between pins 6 and 7
	8	$+5V_{OUT}$	O	5V output supply for I/O usage
	9	Hall 1	I	Digital input Hall 1 sensor
	10	Hall 2	I	Digital input Hall 2 sensor
	11	Hall 3	I	Digital input Hall 3 sensor
	12	GND	-	Return ground for sensors supply

	Pin	Name	Type	Description
J6	1	A/A+	O	**Phase A** for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors
	2	B/A-	O	**Phase B** for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors
	3	C/B+	O	**Phase C** for 3-ph motors, B+ for 2-ph steppers
	4	CR/B-	O	**Chopping resistor / Phase B-** for 2-ph step motors
	5	Earth	-	Earth connection

	Pin	Name	Type	Description
SW1	1	ID-Bit0	-	Hardware AxisID selection switches They represent the first 7 LSB bits of an 8 bit binary Axis ID number. Switch = ON(down) -> ID bit = 1 Switch = OFF(up) -> ID bit = 0
	2	ID-Bit1	-	
	3	ID-Bit2	-	
	4	ID-Bit3	-	
	5	ID-Bit4	-	
	6	ID-Bit5	-	
	7	ID-Bit6	-	
	8	Reserved	-	Reserved

Electrical characteristics

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

- VLOG = 24 VDC; VMOT = 48VDC
- Supplies start-up / shutdown sequence: -any-
- Load current (sinusoidal amplitude / continuous BLDC, DC, stepper) = 4A

Operating Conditions		Min.	Typ.	Max.	Units
Ambient temperature		0		40[1, 3]	ºC
Ambient humidity	Non-condensing	0		90	%Rh
Altitude / pressure[2]	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		105	ºC
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[3], closed box			

[1] Operating temperature at higher temperatures is possible with reduced current and power ratings
[2] Udrive 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.
[3] In case of forced cooling (conduction or ventilation) the maximum ambient temperature can be increased substantially.

Environmental Characteristics		**Min.**	**Typ.**	**Max.**	**Units**
Size (Length x Width x Height)	Without mating connectors		110 x 90 x 17		mm
			~4.33 x 3.54 x 0.67		inch
	With recommended mating connectors.		110 x 110 x 19.1		mm
			~4.33 x 4.33 x 0.75		inch
Weight	Without mating connectors		130		g
Efficiency			98		%
Cleaning agents	Dry cleaning is recommended	Only Water- or Alcohol- based			
Protection degree	According to IEC60529, UL508		IP20		-

Logic Supply Input (+V_{LOG})		**Min.**	**Typ.**	**Max.**	**Units**
Supply voltage	Nominal values	9		36	V_{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	8		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		120		mA
	+V_{LOG} = 24V		70		
	+V_{LOG} = 40V		50		

Motor Supply Input (+V_{MOT})		**Min.**	**Typ.**	**Max.**	**Units**
Supply voltage	Nominal values	11	48	52	V_{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	9		55	V_{DC}
	Absolute maximum values, surge (duration ≤ 10ms) †	-1		63	V
Supply current	Idle		1	5	mA
	Operating	-10	±4	+10	A
	Absolute maximum value, short-circuit condition (duration ≤ 10ms) †			18	A

Motor Outputs (A/A+, B/A-, C/B+, BR/B-)			**Min.**	**Typ.**	**Max.**	**Units**
Nominal output current, continuous[1]	for DC brushed, steppers and BLDC motors with Hall-based trapezoidal control				4	A
	for PMSM motors with FOC sinusoidal control (sinusoidal amplitude value)				4	
	for PMSM motors with FOC sinusoidal control (sinusoidal effective value)				2.83	
Motor output current, peak	maximum 2.5s		-10.2		+10.2	A
Short-circuit protection threshold			±22	±26	±30	A
Short-circuit protection delay			5	10		µs
On-state voltage drop	Nominal output current; including typical mating connector contact resistance			±0.3	±0.5	V
Off-state leakage current				±0.5	±1	mA
Motor inductance (phase-to-phase)	Recommended value, for current ripple max. ±5% of full range; +V_{MOT} = 36 V	F_{PWM}				µH
		20 kHz	330			
		40 kHz	150			
		60 kHz	120			
		80 kHz	80			
		100 kHz	60			
	Minimum value, limited by short-circuit protection; +V_{MOT} = 36 V	20 kHz	120			µH
		60 kHz	40			
		40 kHz	30			
		80 kHz	15			
		100 kHz	8			
Motor electrical time-constant (L/R)	Recommended value for ±5% current measure-ment 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 Inputs – opto-isolated- (IN0, IN1, IN2/LSP, IN3/LSN, IN4)[2]			**Min.**	**Typ.**	**Max.**	**Units**
Mode compliance	PNP		Connect negative pin to GND and positive pin to signal			
	NPN		Connect positive pin to supply and connect negative pin to signal			
Default state	Input floating (wiring disconnected)		Logic LOW			
Input voltage	Logic LOW		0		36	V
	Logic HIGH		5		36	
	Absolute maximum		-7		50	
Input current	Logic LOW		0		50	mA
	Logic HIGH		8	10	12	
	Absolute maximum		-20		20	
Input frequency				2		kHz
Minimum pulse				500		µs
ESD protection	Human body model		±15			kV

Digital Outputs (OUT0, OUT1, OUT2/Error, OUT4, OUT5)			**Min.**	**Typ.**	**Max.**	**Units**
Mode compliance	All outputs (OUT0, 1, 4, 5 OUT2/Error)		NPN 24V			
Default state	Not supplied (+V_{LOG} floating or to GND)		High-Z (floating)			
	Immediately after power-up	OUT0, OUT1	Logic "HIGH"			
		OUT2/Error	Logic "LOW"			
	Normal operation	OUT0, OUT1, OUT2/Error	Logic "HIGH"			
Output voltage	Logic "LOW"; output current = 0.5A			0.3	0.65	V
	Logic "HIGH"; output current = 0, no load		3.6			
			V_{LOG}		5	
	Logic "HIGH", external load to +V_{LOG}		-0.5		V_{LOG}+0.5	
	Absolute maximum, continuous		-1		V_{LOG}+1	
	Absolute maximum, surge (duration ≤ 1s) †		-1		V_{LOG}+1	
Output current	Logic "LOW", sink current, continuous	OUT2/Error, OUT1,4,5			0.5	A
		OUT0			2	A
	Logic "HIGH", source current; external load to GND; V_{OUT} >= 2.0V	OUT2/Error, OUT1,4,5			3	mA
	Logic "HIGH", leakage current; external load to +V_{LOG}; V_{OUT} = V_{LOG} max = 40V			0.1		mA
Minimum pulse width			2			
ESD protection	Human body model		±15			kV

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

[1] @20Khz F_{PWM}

[2] The digital inputs are software selectable as PNP or NPN

Feedback 1 &2 inputs (A1+, A1-, B1+, B1-, Z1+, Z1-, P+, P-, D+, D-)[1]		**Min.**	**Typ.**	**Max.**	**Units**
Differential mode compliance	For full RS422 compliance, see [2]	TIA/EIA-422-A			
Input voltage	Hysteresis	±0.06	±0.1	±0.2	V
	Differential mode	-14		+14	
	Common-mode range (A+ to GND, etc.)	-11		+14	
Input impedance, differential			120		Ω
Input frequency	Differential mode	0		10	MHz
Minimum pulse width	Differential mode	50			ns

Analog 0…5V Inputs (REF, FDBK)		**Min.**	**Typ.**	**Max.**	**Units**
Input voltage	Operational range	0		5	V
	Absolute maximum values, continuous	-16		+23	
	Absolute maximum, surge (duration ≤ 1s) †			±36	
Input impedance	To GND		15		kΩ
Resolution		12			bits
Integral linearity				±2	bits
Offset error			±2	±10	bits
Gain error			±1%	±3%	% FS[2]
Bandwidth (-3Db)	Software selectable	0		1	kHz
ESD protection	Human body model	±2			kV

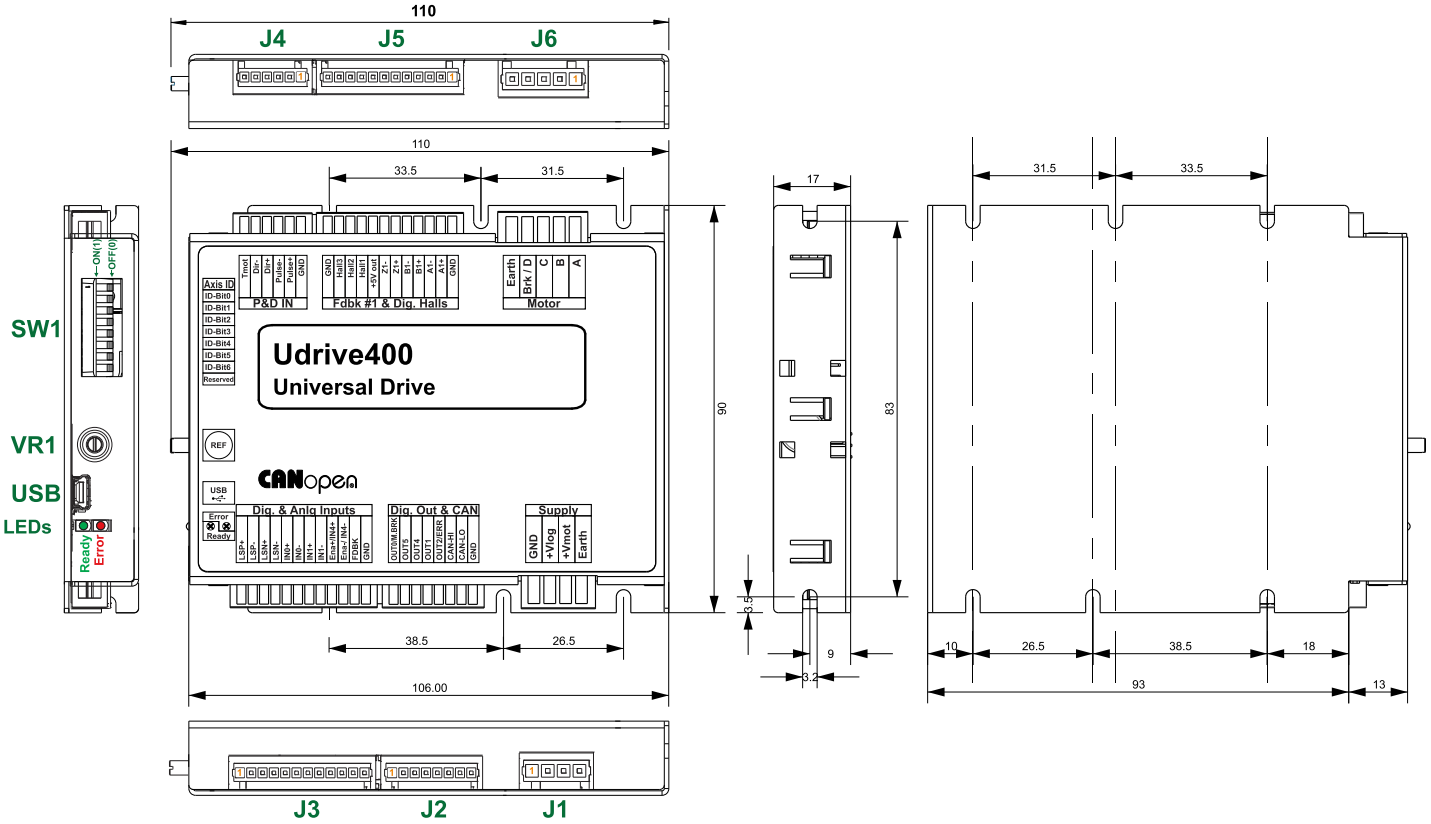
CAN-Bus		**Min.**	**Typ.**	**Max.**	**Units**
Compliance		ISO11898, CiA-301v4.2 & 402v3.0			
Bit rate	Software selectable	125		1000	Kbps
Bus length	1Mbps			25	m
	500Kbps			100	
	≤ 250Kbps			250	
Resistor	Between CAN-Hi, CAN-Lo	none on-board			
Node addressing	by hardware through SW1	1 ÷ 127 ; 255 (all bits 0)			
	by software using EasySetup	1- 255 (numbers above 127 will be considered as LSS non-configured)			
ESD protection	Human body model	±15			kV

Supply Output (+5V)		**Min.**	**Typ.**	**Max.**	**Units**
Output voltage	Current sourced = 250mA	4.8	5	5.2	V
Output current				500	mA
Short-circuit		Protected			
Over-voltage		Protected			
ESD protection	Human body model	±15			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.

[1] All differential input pins have internal 120Ω termination resistors connected across

[2] “FS” stands for “Full Scale”



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	✓	✓			
Digital halls only	✓				
Tacho			✓		
Open-loop (no sensor)				✓	✓
Open-loop (with step loss detection using incr. enc.)				✓	✓
Open-loop (with enc. on load)				✓	✓

- **Features**
- Motion controller and drive in a single compact unit
- Universal solution for control of rotary and linear brushless, brushed and 2 or 3-phase step motors
- CANopen communication protocol (CiA 301v4.2, CiA 305v2.213 and 402v3.0)
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- Motor supply: 11-50V. Logic supply: 9-36V
- Output current: 8A cont. (BLDC mode); 21A_{PEAK} , up to 100KHz PWM
- 5 opto-isolated digital inputs, 12-36V, PNP/NPN compatible: 2 for limit switches, 3 general-purpose
- 5 digital outputs, 5-36V, 0.5A, NPN open-collector: Error, 1 Motor brake [2A], 3 general-purpose [0.5A]
- Mini USB[1] & CAN-bus 2.0B interfaces
- 127 h/w addresses selectable by h/w DIP switch
- NTC/PTC analogue Motor Temperature sensor input
- Protections: short-circuit between motor phases and from motor phases to GND, over/under-voltage, over-current, I^2t, control error, over temperature, communication error
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  - 1st feedback devices supported:
    - Incremental encoder interface (differential)
    - Digital Hall sensor interface (single-ended and open collector)
  - 2nd feedback devices supported:
    - pulse & direction interface (differential) for external (master) digital reference
- 1 analogue input: 12-bit, 0-5V: Feedback
- 1 rotating potentiometer used as Reference
- 16k x16 SRAM memory for data acquisition
- 16k x16 E^2ROM to store setup and other user data
- Operating ambient temperature: 0-40°C (over 40°C with derating)

Mating Connectors				
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WAGO	733-112	J3 & J5	Pluggable terminal block 12-pole Pin spacing 2.5 mm	AWG 20-28
WAGO	733-106	J4	Pluggable terminal block 6-pole Pin spacing 2.5 mm	AWG 20-28
WAGO	734-105	J6	Pluggable terminal block 5-pole Pin spacing 3.5 mm	AWG 14-28

[1]Mini USB cable not provided

Connectors Description

J1

Pin	Name	Type	Description
1	GND	-	Negative return (ground) of the power supply
2	$+V_{LOG}$	I	Positive terminal of the logic supply input: 11 to $36V_{DC}$
3	$+V_{MOT}$	I	Positive terminal of the motor supply: 11 to $50V_{DC.}$
4	Earth	-	Earth connection

J2

Pin	Name	Type	Description
1	OUT0/M.BRK	O	5-36V 2A, digital output used for an electro-mechanical brake, NPN open-collector/TTL pull-up
2	OUT5	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
3	OUT4	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
4	OUT1	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
5	OUT2/Error	O	12-36V 0.5A, drive Error output, active low, NPN open-collector/TTL pull-up. Also drives the red Error LED.
6	CAN Hi	I/O	CAN-Bus positive line(dominant high)
7	CAN Lo	I/O	CAN-Bus negative line (dominant low)
8	GND	-	Return ground for I/O and CAN pins

J3

Pin	Name	Type	Description
1	IN2+/LSP+	I	12-36V digital PNP/NPN opto-isolated input. Positive limit switch function, positive input
2	IN2-/LSP-	I	12-36V digital PNP/NPN opto-isolated input. Positive limit switch function, negative input
3	IN3+/LSN+	I	12-36V digital PNP/NPN opto-isolated input. Negative limit switch function, positive input
4	IN3-/LSN-	I	12-36V digital PNP/NPN opto-isolated input. Negative limit switch function, negative input
5	IN0+	I	12-36V general-purpose digital PNP/NPN opto-isolated positive input.
6	IN0-	I	12-36V general-purpose digital PNP/NPN opto-isolated negative input.
7	IN1+	I	12-36V general-purpose digital PNP/NPN opto-isolated positive input.
8	IN1-	I	12-36V general-purpose digital PNP/NPN opto-isolated negative input.
9	Ena+/IN4+	I	12-36V digital PNP/NPN opto-isolated input. Drive enable function, positive input
10	Ena-/ IN4-	I	12-36V digital PNP/NPN opto-isolated input. Drive enable function, negative input
11	FDBK	I	Analogue input, 12-bit, 0-5V. Used to read an analogue position or speed feedback (as tacho), or used as general purpose analogue input.
12	GND	-	Negative return (ground) of the motor supply

J4

Pin	Name	Type	Description
1	GND	-	Return ground
2	Pulse+	I	Pulse+ differential input; has 120Ω resistor between pins 2 and 3
3	Pulse-	I	Pulse- differential input; has 120Ω resistor between pins 2 and 3
4	Dir+	I	Direction+ differential input; has 120Ω resistor between pins 4 and 5
5	Dir-	I	Direction- differential input; has 120Ω resistor between pins 4 and 5
6	Temp Mot	I	NTC/PTC input. Used to read an analog temperature value

J5

Pin	Name	Type	Description
1	GND	-	Return ground for sensors supply
2	A1+	I	Incr. encoder1 A+ diff. input; has 120Ω resistor between pins 2 and 3
3	A1-	I	Incr. encoder1 A- diff. input; has 120Ω resistor between pins 2 and 3
4	B1+	I	Incr. encoder1 B+ diff. input; has 120Ω resistor between pins 4 and 5
5	B1-	I	Incr. encoder1 B- diff. input; has 120Ω resistor between pins 4 and 5
6	Z1+	I	Incr. encoder1 Z+ diff. input; has 120Ω resistor between pins 6 and 7
7	Z1-	I	Incr. encoder1 Z- diff. input; has 120Ω resistor between pins 6 and 7
8	$+5V_{OUT}$	O	5V output supply for I/O usage
9	Hall 1	I	Digital input Hall 1 sensor
10	Hall 2	I	Digital input Hall 2 sensor
11	Hall 3	I	Digital input Hall 3 sensor
12	GND	-	Return ground for sensors supply

J6

Pin	Name	Type	Description
1	A/A+	O	**Phase A** for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors
2	B/A-	O	**Phase B** for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors
3	C/B+	O	**Phase C** for 3-ph motors, B+ for 2-ph steppers
4	CR/B-	O	**Chopping resistor / Phase B-** for 2-ph step motors
5	Earth	-	Earth connection

SW1

Pin	Name	Type	Description
1	ID-Bit0	-	Hardware AxisID selection switches They represent the first 7 LSB bits of an 8 bit binary Axis ID number. Switch = ON(down) -> ID bit = 1 Switch = OFF(up) -> ID bit = 0
2	ID-Bit1	-	
3	ID-Bit2	-	
4	ID-Bit3	-	
5	ID-Bit4	-	
6	ID-Bit5	-	
7	ID-Bit6	-	
8	Reserved	-	Reserved

Electrical characteristics

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

- VLOG = 24 VDC; VMOT = 48VDC
- Supplies start-up / shutdown sequence: -any-
- Load current (sinusoidal amplitude / continuous BLDC, DC, stepper) = 4A

Operating Conditions		Min.	Typ.	Max.	Units
Ambient temperature		0		40[1, 3]	ºC
Ambient humidity	Non-condensing	0		90	%Rh
Altitude / pressure[2]	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		105	ºC
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[3], closed box			

[1] Operating temperature at higher temperatures is possible with reduced current and power ratings
[2] Udrive 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.
[3] In case of forced cooling (conduction or ventilation) the maximum ambient temperature can be increased substantially.

Environmental Characteristics		**Min.**	**Typ.**	**Max.**	**Units**
Size (Length x Width x Height)	Without mating connectors		110 x 90 x 17		mm
			~4.33 x 3.54 x 0.67		inch
	With recommended mating connectors.		110 x 110 x 19.1		mm
			~4.33 x 4.33 x 0.75		inch
Weight	Without mating connectors		130		g
Efficiency			98		%
Cleaning agents	Dry cleaning is recommended		Only Water- or Alcohol- based		
Protection degree	According to IEC60529, UL508		IP20		-

Logic Supply Input (+V_{LOG})		**Min.**	**Typ.**	**Max.**	**Units**
Supply voltage	Nominal values	9		36	V_{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	8		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		120		mA
	+V_{LOG} = 24V		70		
	+V_{LOG} = 40V		50		

Motor Supply Input (+V_{MOT})		**Min.**	**Typ.**	**Max.**	**Units**
Supply voltage	Nominal values	11	48	52	V_{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	9		55	V_{DC}
	Absolute maximum values, surge (duration ≤ 10ms) †	-1		63	V
Supply current	Idle		1	5	mA
	Operating	-22	±8	+22	A
	Absolute maximum value, short-circuit condition (duration ≤ 10ms) †			37	A

Motor Outputs (A/A+, B/A-, C/B+, BR/B-)			**Min.**	**Typ.**	**Max.**	**Units**
Nominal output current, continuous[1]	for DC brushed, steppers and BLDC motors with Hall-based trapezoidal control				8	A
	for PMSM motors with FOC sinusoidal control (sinusoidal amplitude value)				8	
	for PMSM motors with FOC sinusoidal control (sinusoidal effective value)				5.67	
Motor output current, peak	maximum 2.5s		-21.4		+21.4	A
Short-circuit protection threshold			±22	±26	±30	A
Short-circuit protection delay			5	10		µs
On-state voltage drop	Nominal output current; including typical mating connector contact resistance			±0.3	±0.5	V
Off-state leakage current				±0.5	±1	mA
Motor inductance (phase-to-phase)	Recommended value, for current ripple max. ±5% of full range; +V_{MOT} = 36 V	F_{PWM}				µH
		20 kHz	330			
		40 kHz	150			
		60 kHz	120			
		80 kHz	80			
		100 kHz	60			
	Minimum value, limited by short-circuit protection; +V_{MOT} = 36 V	20 kHz	120			µH
		60 kHz	40			
		40 kHz	30			
		80 kHz	15			
		100 kHz	8			
Motor electrical time-constant (L/R)	Recommended value for ±5% current measure-ment 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 Inputs – opto-isolated- (IN0, IN1, IN2/LSP, IN3/LSN, IN4)[2]			**Min.**	**Typ.**	**Max.**	**Units**
Mode compliance	PNP		Connect negative pin to GND and positive pin to signal			
	NPN		Connect positive pin to supply and connect negative pin to signal			
Default state	Input floating (wiring disconnected)		Logic LOW			
Input voltage	Logic LOW		0		36	V
	Logic HIGH		5		36	
	Absolute maximum		-7		50	
Input current	Logic LOW		0		50	mA
	Logic HIGH		8	10	12	
	Absolute maximum		-20		20	
Input frequency				2		kHz
Minimum pulse				500		µs
ESD protection	Human body model		±15			kV

Digital Outputs (OUT0, OUT1, OUT2/Error, OUT4, OUT5)			**Min.**	**Typ.**	**Max.**	**Units**
Mode compliance	All outputs (OUT0, 1, 4, 5 OUT2/Error)		NPN 24V			
Default state	Not supplied (+V_{LOG} floating or to GND)		High-Z (floating)			
	Immediately after power-up	OUT0, OUT1	Logic "HIGH"			
		OUT2/Error	Logic "LOW"			
	Normal operation	OUT0, OUT1, OUT2/Error	Logic "HIGH"			
Output voltage	Logic "LOW"; output current = 0.5A			0.3	0.65	V
	Logic "HIGH"; output current = 0, no load		3.6			
			V_{LOG}		5	
	Logic "HIGH", external load to +V_{LOG}		-0.5		V_{LOG}+0.5	
	Absolute maximum, continuous		-1		V_{LOG}+1	
	Absolute maximum, surge (duration ≤ 1s) †		-1		V_{LOG}+1	
Output current	Logic "LOW", sink current, continuous	OUT2/Error, OUT1,4,5			0.5	A
		OUT0			2	A
	Logic "HIGH", source current; external load to GND; V_{OUT} >= 2.0V	OUT2/Error, OUT1,4,5			3	mA
	Logic "HIGH", leakage current; external load to +V_{LOG}; V_{OUT} = V_{LOG} max = 40V			0.1		mA
Minimum pulse width			2			
ESD protection	Human body model		±15			kV

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

[1] @20Khz F_{PWM}

[2] The digital inputs are software selectable as PNP or NPN

Feedback 1 &2 inputs (A1+, A1-, B1+, B1-, Z1+, Z1-, P+, P-, D+, D-)[1]		**Min.**	**Typ.**	**Max.**	**Units**
Differential mode compliance	For full RS422 compliance, see [2]	TIA/EIA-422-A			
Input voltage	Hysteresis	±0.06	±0.1	±0.2	V
	Differential mode	-14		+14	
	Common-mode range (A+ to GND, etc.)	-11		+14	
Input impedance, differential			120		Ω
Input frequency	Differential mode	0		10	MHz
Minimum pulse width	Differential mode	50			ns

Analog 0…5V Inputs (REF, FDBK)		**Min.**	**Typ.**	**Max.**	**Units**
Input voltage	Operational range	0		5	V
	Absolute maximum values, continuous	-16		+23	
	Absolute maximum, surge (duration ≤ 1s) †			±36	
Input impedance	To GND		15		kΩ
Resolution		12			bits
Integral linearity				±2	bits
Offset error			±2	±10	bits
Gain error			±1%	±3%	% FS[2]
Bandwidth (-3Db)	Software selectable	0		1	kHz
ESD protection	Human body model	±2			kV

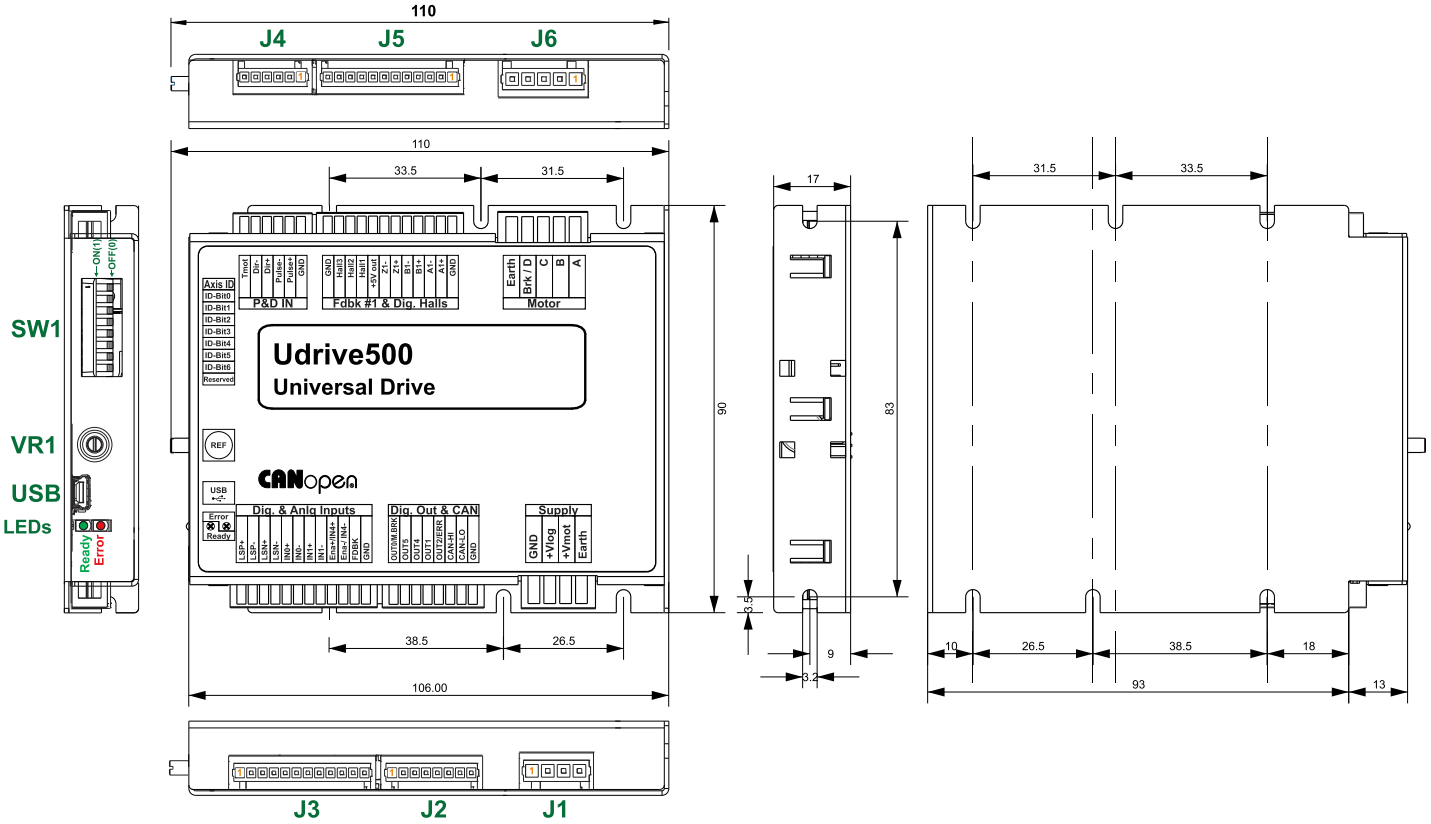
CAN-Bus		**Min.**	**Typ.**	**Max.**	**Units**
Compliance		ISO11898, CiA-301v4.2 & 402v3.0			
Bit rate	Software selectable	125		1000	Kbps
Bus length	1Mbps			25	m
	500Kbps			100	
	≤ 250Kbps			250	
Resistor	Between CAN-Hi, CAN-Lo	none on-board			
Node addressing	by hardware through SW1	1 ÷ 127 ; 255 (all bits 0)			
	by software using EasySetup	1- 255 (numbers above 127 will be considered as LSS non-configured)			
ESD protection	Human body model	±15			kV

Supply Output (+5V)		**Min.**	**Typ.**	**Max.**	**Units**
Output voltage	Current sourced = 250mA	4.8	5	5.2	V
Output current				500	mA
Short-circuit		Protected			
Over-voltage		Protected			
ESD protection	Human body model	±15			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.

[1] All differential input pins have internal 120Ω termination resistors connected across

[2] “FS” stands for “Full Scale”



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	✓	✓			
Digital halls only	✓				
Tacho			✓		
Open-loop (no sensor)				✓	✓
Open-loop (with step loss detection using incr. enc.)				✓	✓
Open-loop (with enc. on load)				✓	✓

- **Features**
- Motion controller and drive in a single compact unit
- Universal solution for control of rotary and linear brushless, brushed and 2 or 3-phase step motors
- CANopen communication protocol (CiA 301v4.2, CiA 305v2.213 and 402v3.0)
- Various modes of operating supported: Position or Speed Profile, interpolated Cyclic Synchronous Position (CSP) mode, external reference mode (Position, Speed, Torque), 35 homing modes
- Motor supply: 11-90V. Logic supply: 9-36V
- Output current: 6A cont. (BLDC mode); 21A_{PEAK} , up to 100KHz PWM
- 5 opto-isolated digital inputs, 12-36V, PNP/NPN compatible: 2 for limit switches, 3 general-purpose
- 5 digital outputs, 5-36V, 0.5A, NPN open-collector: Error, 1 Motor brake [2A], 3 general-purpose [0.5A]
- Mini USB[1] & CAN-bus 2.0B interfaces
- 127 h/w addresses selectable by h/w DIP switch
- NTC/PTC analogue Motor Temperature sensor input
- Protections: short-circuit between motor phases and from motor phases to GND, over/under-voltage, over-current, I^2t, control error, over temperature, communication error
- Feedback Devices :
  - 1st feedback devices supported:
    - Incremental encoder interface (differential)
    - Digital Hall sensor interface (single-ended and open collector)
  - 2nd feedback devices supported:
    - pulse & direction interface (differential) for external (master) digital reference
- 1 analogue input: 12-bit, 0-5V: Feedback
- 1 rotating potentiometer used as Reference
- 16k x16 SRAM memory for data acquisition
- 16k x16 E^2ROM to store setup and other user data
- Operating ambient temperature: 0-40°C (over 40°C with derating)

Mating Connectors				
Producer	**Part No.**	**Connector**	**Description**	**Image**
WAGO	734-104	J1	Pluggable terminal block 4-pole Pin spacing 3.5 mm	AWG 14-28
WAGO	733-108	J2	Pluggable terminal block 8-pole Pin spacing 2.5 mm	AWG 20-28
WAGO	733-112	J3 & J5	Pluggable terminal block 12-pole Pin spacing 2.5 mm	AWG 20-28
WAGO	733-106	J4	Pluggable terminal block 6-pole Pin spacing 2.5 mm	AWG 20-28
WAGO	734-105	J6	Pluggable terminal block 5-pole Pin spacing 3.5 mm	AWG 14-28

[1]Mini USB cable not provided

Connectors Description

J1

Pin	Name	Type	Description
1	GND	-	Negative return (ground) of the power supply
2	$+V_{LOG}$	I	Positive terminal of the logic supply input: 11 to $36V_{DC}$
3	$+V_{MOT}$	I	Positive terminal of the motor supply: 11 to $90V_{DC.}$
4	Earth	-	Earth connection

J2

Pin	Name	Type	Description
1	OUT0/M.BRK	O	5-36V 2A, digital output used for an electro-mechanical brake, NPN open-collector/TTL pull-up
2	OUT5	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
3	OUT4	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
4	OUT1	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
5	OUT2/Error	O	12-36V 0.5A, drive Error output, active low, NPN open-collector/TTL pull-up. Also drives the red Error LED.
6	CAN Hi	I/O	CAN-Bus positive line(dominant high)
7	CAN Lo	I/O	CAN-Bus negative line (dominant low)
8	GND	-	Return ground for I/O and CAN pins

J3

Pin	Name	Type	Description
1	IN2+/LSP+	I	12-36V digital PNP/NPN opto-isolated input. Positive limit switch function, positive input
2	IN2-/LSP-	I	12-36V digital PNP/NPN opto-isolated input. Positive limit switch function, negative input
3	IN3+/LSN+	I	12-36V digital PNP/NPN opto-isolated input. Negative limit switch function, positive input
4	IN3-/LSN-	I	12-36V digital PNP/NPN opto-isolated input. Negative limit switch function, negative input
5	IN0+	I	12-36V general-purpose digital PNP/NPN opto-isolated positive input.
6	IN0-	I	12-36V general-purpose digital PNP/NPN opto-isolated negative input.
7	IN1+	I	12-36V general-purpose digital PNP/NPN opto-isolated positive input.
8	IN1-	I	12-36V general-purpose digital PNP/NPN opto-isolated negative input.
9	Ena+/IN4+	I	12-36V digital PNP/NPN opto-isolated input. Drive enable function, positive input
10	Ena-/ IN4-	I	12-36V digital PNP/NPN opto-isolated input. Drive enable function, negative input
11	FDBK	I	Analogue input, 12-bit, 0-5V. Used to read an analogue position or speed feedback (as tacho), or used as general purpose analogue input.
12	GND	-	Negative return (ground) of the motor supply

J4

Pin	Name	Type	Description
1	GND	-	Return ground
2	Pulse+	I	Pulse+ differential input; has 120Ω resistor between pins 2 and 3
3	Pulse-	I	Pulse- differential input; has 120Ω resistor between pins 2 and 3
4	Dir+	I	Direction+ differential input; has 120Ω resistor between pins 4 and 5
5	Dir-	I	Direction- differential input; has 120Ω resistor between pins 4 and 5
6	Temp Mot	I	NTC/PTC input. Used to read an analog temperature value

J5

Pin	Name	Type	Description
1	GND	-	Return ground for sensors supply
2	A1+	I	Incr. encoder1 A+ diff. input; has 120Ω resistor between pins 2 and 3
3	A1-	I	Incr. encoder1 A- diff. input; has 120Ω resistor between pins 2 and 3
4	B1+	I	Incr. encoder1 B+ diff. input; has 120Ω resistor between pins 4 and 5
5	B1-	I	Incr. encoder1 B- diff. input; has 120Ω resistor between pins 4 and 5
6	Z1+	I	Incr. encoder1 Z+ diff. input; has 120Ω resistor between pins 6 and 7
7	Z1-	I	Incr. encoder1 Z- diff. input; has 120Ω resistor between pins 6 and 7
8	$+5V_{OUT}$	O	5V output supply for I/O usage
9	Hall 1	I	Digital input Hall 1 sensor
10	Hall 2	I	Digital input Hall 2 sensor
11	Hall 3	I	Digital input Hall 3 sensor
12	GND	-	Return ground for sensors supply

J6

Pin	Name	Type	Description
1	A/A+	O	**Phase A** for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors
2	B/A-	O	**Phase B** for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors
3	C/B+	O	**Phase C** for 3-ph motors, B+ for 2-ph steppers
4	CR/B-	O	**Chopping resistor / Phase B-** for 2-ph step motors
5	Earth	-	Earth connection

SW1

Pin	Name	Type	Description
1	ID-Bit0	-	Hardware AxisID selection switches They represent the first 7 LSB bits of an 8 bit binary Axis ID number. Switch = ON(down) -> ID bit = 1 Switch = OFF(up) -> ID bit = 0
2	ID-Bit1	-	
3	ID-Bit2	-	
4	ID-Bit3	-	
5	ID-Bit4	-	
6	ID-Bit5	-	
7	ID-Bit6	-	
8	Reserved	-	Reserved

Electrical characteristics

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

- VLOG = 24 VDC; VMOT = 48VDC
- Supplies start-up / shutdown sequence: -any-
- Load current (sinusoidal amplitude / continuous BLDC, DC, stepper) = 4A

Operating Conditions		Min.	Typ.	Max.	Units
Ambient temperature		0		40[1, 3]	ºC
Ambient humidity	Non-condensing	0		90	%Rh
Altitude / pressure[2]	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		105	ºC
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[3], closed box			

[1] Operating temperature at higher temperatures is possible with reduced current and power ratings
[2] Udrive 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.
[3] In case of forced cooling (conduction or ventilation) the maximum ambient temperature can be increased substantially.

Environmental Characteristics		**Min.**	**Typ.**	**Max.**	**Units**
Size (Length x Width x Height)	Without mating connectors		110 x 90 x 17		mm
			~4.33 x 3.54 x 0.67		inch
	With recommended mating connectors.		110 x 110 x 19.1		mm
			~4.33 x 4.33 x 0.75		inch
Weight	Without mating connectors		130		g
Efficiency			98		%
Cleaning agents	Dry cleaning is recommended	Only Water- or Alcohol- based			
Protection degree	According to IEC60529, UL508		IP20		-

Logic Supply Input (+V_{LOG})		**Min.**	**Typ.**	**Max.**	**Units**
Supply voltage	Nominal values	9		36	V_{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	8		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		120		mA
	+V_{LOG} = 24V		70		
	+V_{LOG} = 40V		50		

Motor Supply Input (+V_{MOT})		**Min.**	**Typ.**	**Max.**	**Units**
Supply voltage	Nominal values	11	90	92	V_{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	9		95	V_{DC}
	Absolute maximum values, surge (duration ≤ 10ms) †	-1		102	V
Supply current	Idle		1	5	mA
	Operating	-22	±10	+22	A
	Absolute maximum value, short-circuit condition (duration ≤ 10ms) †			37	A

Motor Outputs (A/A+, B/A-, C/B+, BR/B-)			**Min.**	**Typ.**	**Max.**	**Units**
Nominal output current, continuous[1]	for DC brushed, steppers and BLDC motors with Hall-based trapezoidal control				6	A
	for PMSM motors with FOC sinusoidal control (sinusoidal amplitude value)				6	
	for PMSM motors with FOC sinusoidal control (sinusoidal effective value)				4.26	
Motor output current, peak	maximum 2.5s		-21.4		+21.4	A
Short-circuit protection threshold			±22	±26	±30	A
Short-circuit protection delay			5	10		µs
On-state voltage drop	Nominal output current; including typical mating connector contact resistance			±0.3	±0.5	V
Off-state leakage current				±0.5	±1	mA
Motor inductance (phase-to-phase)	Recommended value, for current ripple max. ±5% of full range; +V_{MOT} = 36 V	F_{PWM}				µH
		20 kHz	330			
		40 kHz	150			
		60 kHz	120			
		80 kHz	80			
		100 kHz	60			
	Minimum value, limited by short-circuit protection; +V_{MOT} = 36 V	20 kHz	120			µH
		60 kHz	40			
		40 kHz	30			
		80 kHz	15			
		100 kHz	8			
Motor electrical time-constant (L/R)	Recommended value for ±5% current measure-ment 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 Inputs – opto-isolated- (IN0, IN1, IN2/LSP, IN3/LSN, IN4)[2]		**Min.**	**Typ.**	**Max.**	**Units**
Mode compliance	PNP	Connect negative pin to GND and positive pin to signal			
	NPN	Connect positive pin to supply and connect negative pin to signal			
Default state	Input floating (wiring disconnected)	Logic LOW			
Input voltage	Logic LOW	0		36	V
	Logic HIGH	5		36	
	Absolute maximum	-7		50	
Input current	Logic LOW	0		50	mA
	Logic HIGH	8	10	12	
	Absolute maximum	-20		20	
Input frequency			2		kHz
Minimum pulse			500		µs
ESD protection	Human body model	±15			kV

Digital Outputs (OUT0, OUT1, OUT2/Error, OUT4, OUT5)			**Min.**	**Typ.**	**Max.**	**Units**
Mode compliance	All outputs (OUT0, 1, 4, 5 OUT2/Error)		NPN 24V			
Default state	Not supplied (+V_{LOG} floating or to GND)		High-Z (floating)			
	Immediately after power-up	OUT0, OUT1	Logic "HIGH"			
		OUT2/Error	Logic "LOW"			
	Normal operation	OUT0, OUT1, OUT2/Error	Logic "HIGH"			
Output voltage	Logic "LOW"; output current = 0.5A			0.3	0.65	V
	Logic "HIGH"; output current = 0, no load		3.6			
			V_{LOG}		5	
	Logic "HIGH", external load to +V_{LOG}		-0.5		V_{LOG}+0.5	
	Absolute maximum, continuous		-1		V_{LOG}+1	
	Absolute maximum, surge (duration ≤ 1s) †		-1		V_{LOG}+1	
Output current	Logic "LOW", sink current, continuous	OUT2/Error, OUT1,4,5			0.5	A
		OUT0			2	A
	Logic "HIGH", source current; external load to GND; V_{OUT} >= 2.0V	OUT2/Error, OUT1,4,5			3	mA
	Logic "HIGH", leakage current; external load to +V_{LOG}; V_{OUT} = V_{LOG} max = 40V			0.1		mA
Minimum pulse width			2			
ESD protection	Human body model		±15			kV

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

[1] @20Khz F_{PWM}

[2] The digital inputs are software selectable as PNP or NPN

Feedback 1 &2 inputs (A1+, A1-, B1+, B1-, Z1+, Z1-, P+, P-, D+, D-)[1]		**Min.**	**Typ.**	**Max.**	**Units**
Differential mode compliance	For full RS422 compliance, see [2]	TIA/EIA-422-A			
Input voltage	Hysteresis	±0.06	±0.1	±0.2	V
	Differential mode	-14		+14	
	Common-mode range (A+ to GND, etc.)	-11		+14	
Input impedance, differential			120		Ω
Input frequency	Differential mode	0		10	MHz
Minimum pulse width	Differential mode	50			ns

Analog 0…5V Inputs (REF, FDBK)		**Min.**	**Typ.**	**Max.**	**Units**
Input voltage	Operational range	0		5	V
	Absolute maximum values, continuous	-16		+23	
	Absolute maximum, surge (duration ≤ 1s) †			±36	
Input impedance	To GND		15		kΩ
Resolution		12			bits
Integral linearity				±2	bits
Offset error			±2	±10	bits
Gain error			±1%	±3%	% FS[2]
Bandwidth (-3Db)	Software selectable	0		1	kHz
ESD protection	Human body model	±2			kV

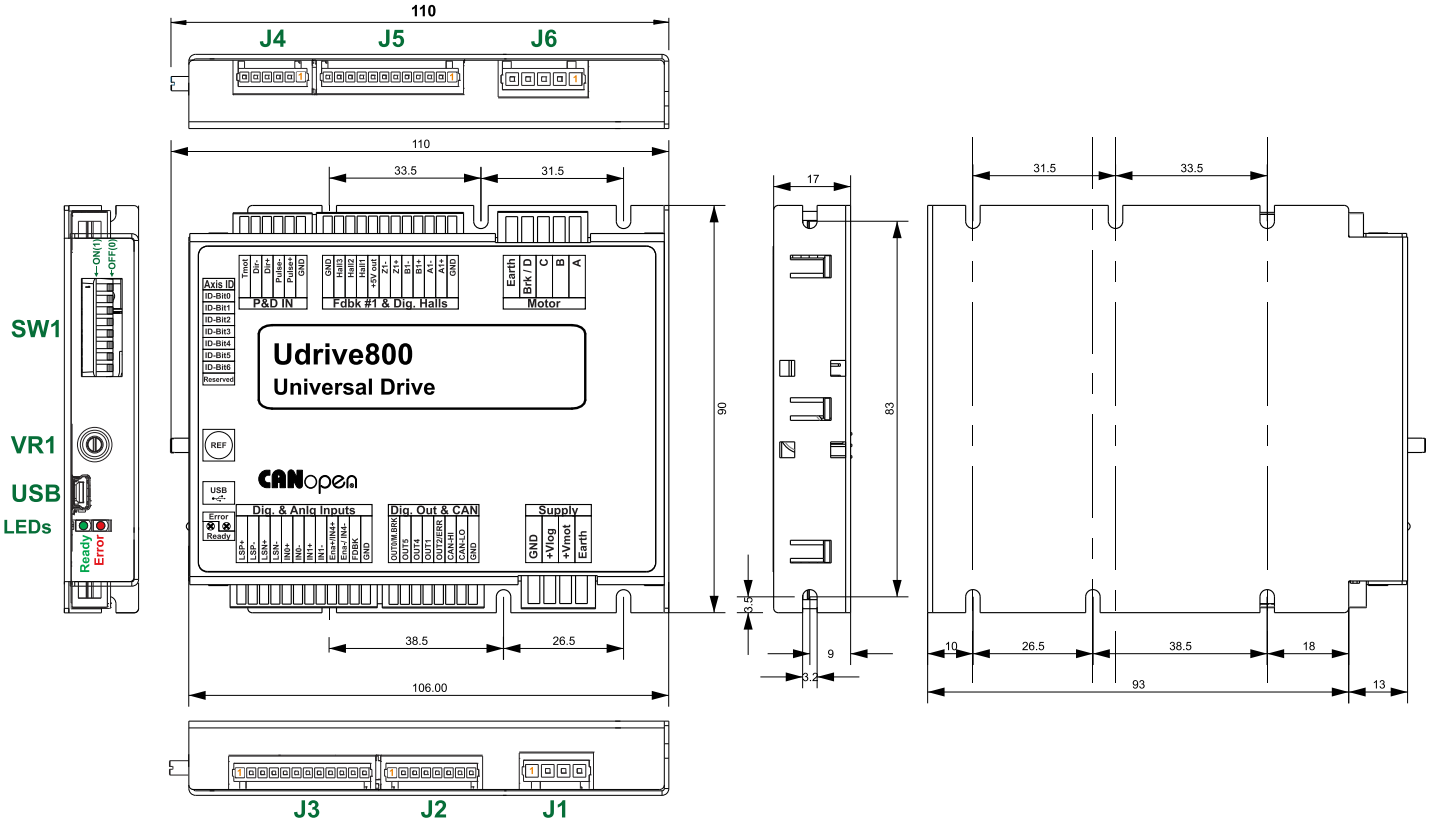
CAN-Bus		**Min.**	**Typ.**	**Max.**	**Units**
Compliance		ISO11898, CiA-301v4.2 & 402v3.0			
Bit rate	Software selectable	125		1000	Kbps
Bus length	1Mbps			25	m
	500Kbps			100	
	≤ 250Kbps			250	
Resistor	Between CAN-Hi, CAN-Lo	none on-board			
Node addressing	by hardware through SW1	1 ÷ 127 ; 255 (all bits 0)			
	by software using EasySetup	1- 255 (numbers above 127 will be considered as LSS non-configured)			
ESD protection	Human body model	±15			kV

Supply Output (+5V)		**Min.**	**Typ.**	**Max.**	**Units**
Output voltage	Current sourced = 250mA	4.8	5	5.2	V
Output current				500	mA
Short-circuit		Protected			
Over-voltage		Protected			
ESD protection	Human body model	±15			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.

[1] All differential input pins have internal 120Ω termination resistors connected across

[2] “FS” stands for “Full Scale”



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	✓	✓			
Digital halls only	✓				
Tacho			✓		
Open-loop (no sensor)				✓	✓
Open-loop (with step loss detection using incr. enc.)				✓	✓
Open-loop (with enc. on load)				✓	✓

- **Features**
- Motion controller and drive in a single compact unit
- Universal solution for control of rotary and linear brushless, brushed and 2 or 3-phase step motors
- CANopen communication protocol (CiA 301v4.2, CiA 305v2.213 and 402v3.0)
- Various modes of operating supported: Position or Speed Profile, interpolated Cyclic Synchronous Position (CSP) mode, external reference mode (Position, Speed, Torque), 35 homing modes
- Motor supply: 11-90V. Logic supply: 9-36V
- Output current: 10A cont. (BLDC mode); $21A_{PEAK}$, up to 100KHz PWM
- 5 opto-isolated digital inputs, 12-36V, PNP/NPN compatible: 2 for limit switches, 3 general-purpose
- 5 digital outputs, 5-36V, 0.5A, NPN open-collector: Error, 1 Motor brake [2A], 3 general-purpose [0.5A]
- Mini USB[1] & CAN-bus 2.0B interfaces
- 127 h/w addresses selectable by h/w DIP switch
- NTC/PTC analogue Motor Temperature sensor input
- Protections: short-circuit between motor phases and from motor phases to GND, over/under-voltage, over-current, I^2t, control error, over temperature, communication error
- Feedback Devices :
  - 1st feedback devices supported:
    - Incremental encoder interface (differential)
    - Digital Hall sensor interface (single-ended and open collector)
  - 2nd feedback devices supported:
    - pulse & direction interface (differential) for external (master) digital reference
- 1 analogue input: 12-bit, 0-5V: Feedback
- 1 rotating potentiometer used as Reference
- 16k x16 SRAM memory for data acquisition
- 16k x16 E^2ROM to store setup and other user data
- Operating ambient temperature: 0-40°C (over 40°C with derating)

Mating Connectors				
Producer	**Part No.**	**Connector**	**Description**	**Image**
WAGO	734-104	J1	Pluggable terminal block 4-pole Pin spacing 3.5 mm	AWG 14-28
WAGO	733-108	J2	Pluggable terminal block 8-pole Pin spacing 2.5 mm	AWG 20-28
WAGO	733-112	J3 & J5	Pluggable terminal block 12-pole Pin spacing 2.5 mm	AWG 20-28
WAGO	733-106	J4	Pluggable terminal block 6-pole Pin spacing 2.5 mm	AWG 20-28
WAGO	734-105	J6	Pluggable terminal block 5-pole Pin spacing 3.5 mm	AWG 14-28

[1]Mini USB cable not provided

Connectors Description

	Pin	Name	Type	Description
J1	1	GND	-	Negative return (ground) of the power supply
	2	$+V_{LOG}$	I	Positive terminal of the logic supply input: 11 to $36V_{DC}$
	3	$+V_{MOT}$	I	Positive terminal of the motor supply: 11 to $90V_{DC.}$
	4	Earth	-	Earth connection

	Pin	Name	Type	Description
J2	1	OUT0/M.BRK	O	5-36V 2A, digital output used for an electro-mechanical brake, NPN open-collector/TTL pull-up
	2	OUT5	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
	3	OUT4	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
	4	OUT1	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
	5	OUT2/Error	O	12-36V 0.5A, drive Error output, active low, NPN open-collector/TTL pull-up. Also drives the red Error LED.
	6	CAN Hi	I/O	CAN-Bus positive line(dominant high)
	7	CAN Lo	I/O	CAN-Bus negative line (dominant low)
	8	GND	-	Return ground for I/O and CAN pins

	Pin	Name	Type	Description
J3	1	IN2+/LSP+	I	12-36V digital PNP/NPN opto-isolated input. Positive limit switch function, positive input
	2	IN2-/LSP-	I	12-36V digital PNP/NPN opto-isolated input. Positive limit switch function, negative input
	3	IN3+/LSN+	I	12-36V digital PNP/NPN opto-isolated input. Negative limit switch function, positive input
	4	IN3-/LSN-	I	12-36V digital PNP/NPN opto-isolated input. Negative limit switch function, negative input
	5	IN0+	I	12-36V general-purpose digital PNP/NPN opto-isolated positive input.
	6	IN0-	I	12-36V general-purpose digital PNP/NPN opto-isolated negative input.
	7	IN1+	I	12-36V general-purpose digital PNP/NPN opto-isolated positive input.
	8	IN1-	I	12-36V general-purpose digital PNP/NPN opto-isolated negative input.
	9	Ena+/IN4+	I	12-36V digital PNP/NPN opto-isolated input. Drive enable function, positive input
	10	Ena-/ IN4-	I	12-36V digital PNP/NPN opto-isolated input. Drive enable function, negative input
	11	FDBK	I	Analogue input, 12-bit, 0-5V. Used to read an analogue position or speed feedback (as tacho), or used as general purpose analogue input.
	12	GND	-	Negative return (ground) of the motor supply

	Pin	Name	Type	Description
J4	1	GND	-	Return ground
	2	Pulse+	I	Pulse+ differential input; has 120Ω resistor between pins 2 and 3
	3	Pulse-	I	Pulse- differential input; has 120Ω resistor between pins 2 and 3
	4	Dir+	I	Direction+ differential input; has 120Ω resistor between pins 4 and 5
	5	Dir-	I	Direction- differential input; has 120Ω resistor between pins 4 and 5
	6	Temp Mot	I	NTC/PTC input. Used to read an analog temperature value

	Pin	Name	Type	Description
J5	1	GND	-	Return ground for sensors supply
	2	A1+	I	Incr. encoder1 A+ diff. input; has 120Ω resistor between pins 2 and 3
	3	A1-	I	Incr. encoder1 A- diff. input; has 120Ω resistor between pins 2 and 3
	4	B1+	I	Incr. encoder1 B+ diff. input; has 120Ω resistor between pins 4 and 5
	5	B1-	I	Incr. encoder1 B- diff. input; has 120Ω resistor between pins 4 and 5
	6	Z1+	I	Incr. encoder1 Z+ diff. input; has 120Ω resistor between pins 6 and 7
	7	Z1-	I	Incr. encoder1 Z- diff. input; has 120Ω resistor between pins 6 and 7
	8	$+5V_{OUT}$	O	5V output supply for I/O usage
	9	Hall 1	I	Digital input Hall 1 sensor
	10	Hall 2	I	Digital input Hall 2 sensor
	11	Hall 3	I	Digital input Hall 3 sensor
	12	GND	-	Return ground for sensors supply

	Pin	Name	Type	Description
J6	1	A/A+	O	**Phase A** for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors
	2	B/A-	O	**Phase B** for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors
	3	C/B+	O	**Phase C** for 3-ph motors, B+ for 2-ph steppers
	4	CR/B-	O	**Chopping resistor / Phase B-** for 2-ph step motors
	5	Earth	-	Earth connection

	Pin	Name	Type	Description
SW1	1	ID-Bit0	-	Hardware AxisID selection switches They represent the first 7 LSB bits of an 8 bit binary Axis ID number. Switch = ON(down) -> ID bit = 1 Switch = OFF(up) -> ID bit = 0
	2	ID-Bit1	-	
	3	ID-Bit2	-	
	4	ID-Bit3	-	
	5	ID-Bit4	-	
	6	ID-Bit5	-	
	7	ID-Bit6	-	
	8	Reserved	-	Reserved

Electrical characteristics

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

- VLOG = 24 VDC; VMOT = 48VDC
- Supplies start-up / shutdown sequence: -any-
- Load current (sinusoidal amplitude / continuous BLDC, DC, stepper) = 4A

Operating Conditions		Min.	Typ.	Max.	Units
Ambient temperature		0		40[1, 3]	ºC
Ambient humidity	Non-condensing	0		90	%Rh
Altitude / pressure[2]	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		105	ºC
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[3], closed box			

[1] Operating temperature at higher temperatures is possible with reduced current and power ratings
[2] Udrive 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.
[3] In case of forced cooling (conduction or ventilation) the maximum ambient temperature can be increased substantially.

Environmental Characteristics		**Min.**	**Typ.**	**Max.**	**Units**
Size (Length x Width x Height)	Without mating connectors		110 x 90 x 17		mm
			~4.33 x 3.54 x 0.67		inch
	With recommended mating connectors.		110 x 110 x 19.1		mm
			~4.33 x 4.33 x 0.75		inch
Weight	Without mating connectors		130		g
Efficiency			98		%
Cleaning agents	Dry cleaning is recommended	Only Water- or Alcohol- based			
Protection degree	According to IEC60529, UL508	IP20			-

Logic Supply Input (+V_{LOG})		**Min.**	**Typ.**	**Max.**	**Units**
Supply voltage	Nominal values	9		36	V_{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	8		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		120		mA
	+V_{LOG} = 24V		70		
	+V_{LOG} = 40V		50		

Motor Supply Input (+V_{MOT})		**Min.**	**Typ.**	**Max.**	**Units**
Supply voltage	Nominal values	11	90	92	V_{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	9		95	V_{DC}
	Absolute maximum values, surge (duration ≤ 10ms) †	-1		102	V
Supply current	Idle		1	5	mA
	Operating	-22	±10	+22	A
	Absolute maximum value, short-circuit condition (duration ≤ 10ms) †			37	A

Motor Outputs (A/A+, B/A-, C/B+, BR/B-)			**Min.**	**Typ.**	**Max.**	**Units**
Nominal output current, continuous[1]	for DC brushed, steppers and BLDC motors with Hall-based trapezoidal control				10	A
	for PMSM motors with FOC sinusoidal control (sinusoidal amplitude value)				10	
	for PMSM motors with FOC sinusoidal control (sinusoidal effective value)				7.09	
Motor output current, peak	maximum 2.5s		-21.4		+21.4	A
Short-circuit protection threshold			±22	±26	±30	A
Short-circuit protection delay			5	10		µs
On-state voltage drop	Nominal output current; including typical mating connector contact resistance			±0.3	±0.5	V
Off-state leakage current				±0.5	±1	mA
Motor inductance (phase-to-phase)	Recommended value, for current ripple max. ±5% of full range; +V_{MOT} = 36 V	F_{PWM}				µH
		20 kHz	330			
		40 kHz	150			
		60 kHz	120			
		80 kHz	80			
		100 kHz	60			
	Minimum value, limited by short-circuit protection; +V_{MOT} = 36 V	20 kHz	120			µH
		60 kHz	40			
		40 kHz	30			
		80 kHz	15			
		100 kHz	8			
Motor electrical time-constant (L/R)	Recommended value for ±5% current measure-ment 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 Inputs – opto-isolated- (IN0, IN1, IN2/LSP, IN3/LSN, IN4)[2]			**Min.**	**Typ.**	**Max.**	**Units**
Mode compliance	PNP		Connect negative pin to GND and positive pin to signal			
	NPN		Connect positive pin to supply and connect negative pin to signal			
Default state	Input floating (wiring disconnected)		Logic LOW			
Input voltage	Logic LOW		0		36	V
	Logic HIGH		5		36	
	Absolute maximum		-7		50	
Input current	Logic LOW		0		50	mA
	Logic HIGH		8	10	12	
	Absolute maximum		-20		20	
Input frequency				2		kHz
Minimum pulse				500		µs
ESD protection	Human body model		±15			kV

Digital Outputs (OUT0, OUT1, OUT2/Error, OUT4, OUT5)			**Min.**	**Typ.**	**Max.**	**Units**
Mode compliance	All outputs (OUT0, 1, 4, 5 OUT2/Error)		NPN 24V			
Default state	Not supplied (+V_{LOG} floating or to GND)		High-Z (floating)			
	Immediately after power-up	OUT0, OUT1	Logic "HIGH"			
		OUT2/Error	Logic "LOW"			
	Normal operation	OUT0, OUT1, OUT2/Error	Logic "HIGH"			
Output voltage	Logic "LOW"; output current = 0.5A			0.3	0.65	V
	Logic "HIGH"; output current = 0, no load		3.6			
			V_{LOG}		5	
	Logic "HIGH", external load to +V_{LOG}		-0.5		V_{LOG}+0.5	
	Absolute maximum, continuous		-1		V_{LOG}+1	
	Absolute maximum, surge (duration ≤ 1s) †		-1		V_{LOG}+1	
Output current	Logic "LOW", sink current, continuous	OUT2/Error, OUT1,4,5			0.5	A
		OUT0			2	A
	Logic "HIGH", source current; external load to GND; V_{OUT} >= 2.0V	OUT2/Error, OUT1,4,5			3	mA
	Logic "HIGH", leakage current; external load to +V_{LOG}; V_{OUT} = V_{LOG} max = 40V			0.1		mA
Minimum pulse width			2			
ESD protection	Human body model		±15			kV

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

[1] @20Khz F_{PWM}

[2] The digital inputs are software selectable as PNP or NPN

Feedback 1 &2 inputs (A1+, A1-, B1+, B1-, Z1+, Z1-, P+, P-, D+, D-)[1]		**Min.**	**Typ.**	**Max.**	**Units**
Differential mode compliance	For full RS422 compliance, see [2]	TIA/EIA-422-A			
Input voltage	Hysteresis	±0.06	±0.1	±0.2	V
	Differential mode	-14		+14	
	Common-mode range (A+ to GND, etc.)	-11		+14	
Input impedance, differential			120		Ω
Input frequency	Differential mode	0		10	MHz
Minimum pulse width	Differential mode	50			ns

Analog 0…5V Inputs (REF, FDBK)		**Min.**	**Typ.**	**Max.**	**Units**
Input voltage	Operational range	0		5	V
	Absolute maximum values, continuous	-16		+23	
	Absolute maximum, surge (duration ≤ 1s) †			±36	
Input impedance	To GND		15		kΩ
Resolution		12			bits
Integral linearity				±2	bits
Offset error			±2	±10	bits
Gain error			±1%	±3%	% FS[2]
Bandwidth (-3Db)	Software selectable	0		1	kHz
ESD protection	Human body model	±2			kV

CAN-Bus		**Min.**	**Typ.**	**Max.**	**Units**
Compliance		ISO11898, CiA-301v4.2 & 402v3.0			
Bit rate	Software selectable	125		1000	Kbps
Bus length	1Mbps			25	m
	500Kbps			100	
	≤ 250Kbps			250	
Resistor	Between CAN-Hi, CAN-Lo	none on-board			
Node addressing	by hardware through SW1	1 ÷ 127 ; 255 (all bits 0)			
	by software using EasySetup	1- 255 (numbers above 127 will be considered as LSS non-configured)			
ESD protection	Human body model	±15			kV

Supply Output (+5V)		**Min.**	**Typ.**	**Max.**	**Units**
Output voltage	Current sourced = 500mA	4.8	5	5.2	V
Output current				500	mA
Short-circuit		Protected			
Over-voltage		Protected			
ESD protection	Human body model	±15			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.

[1] All differential input pins have internal 120Ω termination resistors connected across

[2] “FS” stands for “Full Scale”