intreXis®
Power Supplies with the X

vitec POWER GmbH

Datasheet

intreXis Boardnet Converter Platform
IC50X, 250 W Single-Output
600 Vin – 750 Vin

- Xtra wide input voltage range: continuous operation from 400 – 1100 exceeding requirements of EN 50163: 2006
- Xtra high Surge-Robustness: active surge-limiter withstands 3 kV for 20 ms and 4.5 kV falling to 2.25 kV for 1 ms exceeding requirements of EN 50124-2:2017
- Xtra high extra power for overload: 400 W for 500 ms
- Xtra high efficiency: > 89 % over the entire input-voltage range
- Xtra compact design: the weight of the unit is only 1.2 kg

This datasheet covers the details of the IC50X power supplies with single output voltage and output power of 250 W, which can be powered directly by the electric rail traction systems (600 VDC and 750 VDC). These DC/DC converters are designed according to EN50155:2017 for railway applications and are ideal for other demanding environments which require the highest performance and reliability.

Output voltages: 24 V, 48 V, 72 V, 110 V. Other voltages on request.
Ordering codes: IC501_3, IC503, IC504, IC506_3.
The differences between the variants are explained in this datasheet.

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INPUT CHARACTERISTICS

Continuous Input Voltage Range	400 – 1100 VDC			
Temporary Input Voltage Range dynamic according to EN 50163:2006	1270 VDC for 20 ms			
Input Overvoltage Protection: Medium-term Overvoltages	3.0 kV for 20 ms, 4.5 kV falling to 2.25 kV for 1 ms Performance criterion A according to EN 50121-1:2017. *EN 50124-2:2017 requires only 2.8 kV for 2 ms.* *EN 50124-2:2017 defines that the equipment shall withstand a voltage pulse of trapezoidal shape, lasting 2 milliseconds with an amplitude equal to 70 % of the reference voltage Up. It is applied to the equipment without considering the presence of its metal-oxide arrester. Up=4 kV for a 750 V network according to EN 50163:2006.*			
Input Overvoltage Protection: Short-term Overvoltages	According to EN 50124-2:2017 Performance criterion A according to EN 50121-1:2017. *EN 50124-2:2017 defines that the equipment shall withstand the 4/10 current pulse defined in EN 60099-4:2014. Its amplitude value is 100 kA. It is applied to the equipment including the arrester, where the metal-oxide arrester is replaced by a theoretical one the characteristic of which, in log(current in kA) versus log(voltage in kV), is a straight line which includes the two points: (log(10), log(Up)) and (log(100), log(1,5 Up)).*			
Input Voltage Reverse Polarity Protection	Reverse polarity protection: Iin_reverse < 200 µA @ Vin = -1100 VDC (with reverse polarity of Vin, the converter remains off without being damaged. Only a small reverse current Iin_reverse flows. With correct polarity of Vin, the converter works correctly)			
Inrush Current @ T = +25 °C	85 Apeak @ 750 Vin Inrush-Current-Integral: I_{inrush}^2t < 1.8 A^2s @ Vin = 400 – 1100 VDC			
Input Capacitance	11 µF			
Input Current typ. @ full Load	**400 Vin**	**750 Vin**	**1100 Vin**	
	0.70 A	0.37 A	0.26 A	
Input Power typ. @ no Load over the input voltage range	**IC501_3**	**IC503**	**IC504**	**IC506_3**
	0.63 – 2.8 W	0.96 – 3.1 W	1.7 – 3.9 W	1.9 – 4.3 W
Internal Input Fuse	Fuse included, therefore no external fuse required. I^2t-fuse = 42.6 A^2s			
Interruptions of Input Voltage Supply (Hold-up time)	Class S2 (10 ms) according to EN50155:2017 The converter continues to operate as intended during and after the interruption, with no degradation of performance or loss of function (Performance criterion A).			

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Startup time typ. @ 750 VDC input voltage (Time input voltage ON to output voltage ON)	**IC501_3**	**IC503**	**IC504**	**IC506_3**
	2.9 s	4.7 s	2.9 s	2.9 s

OUTPUT CHARACTERISTICS

Output Voltage Nominal	**IC501_3**	**IC503**	**IC504**	**IC506_3**
	+24.0 VDC	+48.0 VDC	+72.0 VDC	+108.9 VDC
Max. Continuous Output Power @ Vin = 400 – 1100 V, 1270 V for 20 ms (no derating over the entire temperature range)	250 W			
Max. Peak Output Power @ Vin = 400 – 1100 V	Power Boost feature allows to drive contactors up to 400 W for 0.5 s			
Minimum Load	No minimum load required			
Setpoint Accuracy	< 1.0 %			
Load Regulation @ off-load to full load over the entire temperature range	**IC501_3**	**IC503**	**IC504**	**IC506_3**
	< 0.3 %	< 0.4 %	< 0.4 %	< 0.4 %
Line Regulation @ full load over the entire temperature range	< 0.1 %			
Output Ripple & Noise @ 20 MHz bandwidth, including spikes	**IC501_3**	**IC503**	**IC504**	**IC506_3**
	< 80 mV @ +25 °C < 250 mV @ -40 – +85 °C		< 50 mV @ +25 °C < 800 mV @ -40 – +85 °C	
Overload and Short-Circuit	The converter is continuous overload and short-circuit proof. **Output overloaded:** The output voltage is reduced and the output current limited (constant current). **Output short-circuited:** The converter goes into Hiccup-Mode: The converter switches off and tries periodically to switch on again. If the short-circuit is still present, the converter switches off again and tries again periodically. If the short-circuit is removed, the converter switches on at the next switch-on attempt.			
Current Limit (varies due to component tolerances)	**IC501_3**	**IC503**	**IC504**	**IC506_3**
	10.9 – 12.8 A	5.4 – 6.4 A	3.6 – 4.3 A	2.4 – 2.8 A
Short-Circuit current	**IC501_3**	**IC503**	**IC504**	**IC506_3**
	12.8 Arms	6.4 Arms	4.3 Arms	2.8 Arms

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Overvoltage Protection (OVP) (output voltage is limited, if main regulation loop fails)	**IC501_3**	**IC503**	**IC504**	**IC506_3**
	< 35 VDC	< 65 VDC	< 100 VDC	< 150 VDC
Paralleling of Outputs	Paralleling up to 3 units. Falling output-voltage-characteristic ensures current-sharing. Lead lines to load with equal length and cross section ensure accurate current-sharing between units. If one or more units fail, the other units continue delivering power without limitations.			
Internal Decoupling Diode	Decoupling diode on the output for redundancy is included. Allows paralleling with battery.			
Maximum load-capacitance	**IC501_3**	**IC503**	**IC504**	**IC506_3**
	2000 µF	1000 µF	450 µF	300 µF

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EFFICIENCY

IC501_3:

Conditions	400 Vin	750 Vin	1000 Vin
Efficiency typ. @ 100 % Load	88.8 %	89.9 %	89.1 %
Efficiency typ. @ 66 % Load	89.7 %	89.8 %	88.6 %
Efficiency typ. @ 33 % Load	90.6 %	89.0 %	88.1 %

IC503:

Conditions	400 Vin	750 Vin	1000 Vin
Efficiency typ. @ 100 % Load	90.5 %	91.5 %	91.1 %
Efficiency typ. @ 66 % Load	91.2 %	91.8 %	91.7 %
Efficiency typ. @ 33 % Load	91.3 %	89.6 %	88.1 %

IC504:

Conditions	400 Vin	750 Vin	1000 Vin
Efficiency typ. @ 100 % Load	90.4 %	91.5 %	91.2 %
Efficiency typ. @ 66 % Load	91.1 %	92.0 %	91.5 %
Efficiency typ. @ 33 % Load	90.4 %	89.5 %	89.0 %

IC506_3:

Conditions	400 Vin	750 Vin	1000 Vin
Efficiency typ. @ 100 % Load	90.4 %	91.6 %	91.3 %
Efficiency typ. @ 66 % Load	91.0 %	92.2 %	90.0 %
Efficiency typ. @ 33 % Load	90.4 %	88.6 %	89.2 %

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SIGNALS AND INTERFACES

<table>
<tr><td>DC-OK Signal</td><td colspan="4">Isolated Open-collector transistor
(between connector J2/pin5-6, see block diagram)</td></tr>
<tr><td rowspan="4">DC-OK
transistor switch on threshold</td><td>IC501_3</td><td colspan="3">IC503</td></tr>
<tr><td>Vout > +22.8 VDC ±2 %</td><td colspan="3">Vout > +45.7 VDC ±2 %</td></tr>
<tr><td>IC504</td><td colspan="3">IC506_3</td></tr>
<tr><td>Vout > +67.4 VDC ±2 %</td><td colspan="3">Vout > +105.0 VDC ±2 %</td></tr>
<tr><td rowspan="4">DC-OK
transistor switch off threshold</td><td>IC501_3</td><td colspan="3">IC503</td></tr>
<tr><td>Vout < +22.3 VDC ±2 %</td><td colspan="3">Vout < +44.8 VDC ±2 %</td></tr>
<tr><td>IC504</td><td colspan="3">IC506_3</td></tr>
<tr><td>Vout < +66.2 VDC ±2 %</td><td colspan="3">Vout < +103.0 VDC ±2 %</td></tr>
<tr><td>DC-OK
max. transistor current, when on</td><td colspan="4">50 mA max.</td></tr>
<tr><td>DC-OK
max. transistor voltage-drop, when on</td><td colspan="4">< 2.5 VDC @ 50 mA
(between connector J2/pin5-6, see block diagram)</td></tr>
<tr><td rowspan="2">DC-OK
max. transistor voltage, when off
(max voltage which can be applied externally between connector J2/pin5-6, see block diagram)</td><td>IC501_3</td><td>IC503</td><td>IC504</td><td>IC506_3</td></tr>
<tr><td>+34 VDC</td><td>+67 VDC</td><td>+154 VDC</td><td>+154 VDC</td></tr>
<tr><td rowspan="5">External ON/OFF Signal
(Isolated optocoupler input)</td><td colspan="4">Output voltage is ON if:
- no connection between +ON/OFF and -ON/OFF (J2/pin3-4) (high impedance > 500 kΩ)
or
- external voltage applied between +ON/OFF and -ON/OFF (J2/pin3-4) is < External ON threshold:</td></tr>
<tr><td>IC501_3</td><td>IC503</td><td>IC504</td><td>IC506_3</td></tr>
<tr><td>< 10.8 VDC</td><td>< 24.6 VDC</td><td>< 36.9 VDC</td><td>< 66.5 VDC</td></tr>
<tr><td colspan="4">Output voltage is OFF if:
- external voltage applied between +ON/OFF and -ON/OFF (J2/pin3-4) is > External OFF threshold:</td></tr>
<tr><td>IC501_3</td><td>IC503</td><td>IC504</td><td>IC506_3</td></tr>
<tr><td>External ON/OFF max. voltage which can be applied externally
(between connector J2/pin3-4, see block diagram)</td><td>IC501_3</td><td>IC503</td><td>IC504</td><td>IC506_3</td></tr>
<tr><td>+34 VDC</td><td>+67 VDC</td><td>+154 VDC</td><td>+154 VDC</td></tr>
<tr><td rowspan="2">Current into +ON/OFF-Pin (J2/pin3) is internally limited to:</td><td>IC501_3</td><td>IC503</td><td>IC504</td><td>IC506_3</td></tr>
<tr><td>15 mA max.</td><td>9 mA max.</td><td>8 mA max.</td><td>6 mA max.</td></tr>
</table>

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ELECTROMAGNETIC COMPATIBILITY (EMC)

Test	Standard	Test severity levels	Performance Criteria
Surges	EN 50155:2017 EN 50121-3-2:2016/ A1:2019 IEC60571:2012 IEC 62236-3-2:2018	1.2/50 µs 42 Ω, 0.5 µF DC power supply port ±2 kV line to ground ±1 kV line to line	Criterion B required, but compliant with more strict criterion A
Electrostatic discharge	EN 50155:2017 EN 50121-3-2:2016/ A1:2019 IEC60571:2012 IEC 62236-3-2:2018	±6 kV contact discharge ±8 kV air discharge	Criterion B required, but compliant with more strict criterion A
Fast transients	EN 50155:2017 EN 50121-3-2:2016/ A1:2019 IEC60571:2012 IEC 62236-3-2:2018	±2 kV 5/50 ns tr/th 5 kHz repetition frequency	Criterion A
Radio-frequency common mode	EN 50155:2017 EN 50121-3-2:2016/ A1:2019 IEC60571:2012 IEC 62236-3-2:2018	150 kHz – 80 MHz 10 Vrms (carrier voltage) 80 % AM, 1 kHz Source impedance 150 Ω	Criterion A
Radio-frequency electromagnetic field	EN 50155:2017 EN 50121-3-2:2016/ A1:2019 IEC60571:2012 IEC 62236-3-2:2018	80 MHz – 1000 MHz 20 Vrms/m 80 % AM, 1 kHz unmodulated carrier; 1400 MHz – 2000 MHz 10 Vrms/m 80 % AM, 1 kHz unmodulated carrier; 2000 MHz – 2700 MHz 5 Vrms/m 80 % AM, 1 kHz unmodulated carrier; 5100 MHz – 6000 MHz 3 Vrms/m 80 % AM, 1 kHz unmodulated carrier	Criterion A
Conducted emissions	EN 50155:2017 EN 50121-3-2:2016/ A1:2019 IEC60571:2012 IEC 62236-3-2:2018	150 kHz – 500 kHz: 99 dBµV quasi-peak 500 kHz – 30 MHz: 93 dBµV quasi-peak	
Radiated emissions	EN 50155:2017 EN 50121-3-2:2016/ A1:2019 IEC60571:2012 IEC 62236-3-2:2018	30 MHz – 230 MHz: 40 dBµV/m quasi-peak at 10 m 230 MHz – 1000 MHz: 47 dBµV/m quasi-peak at 10 m	

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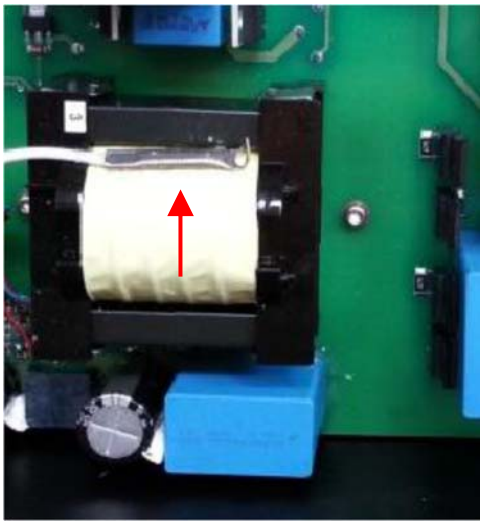
ENVIRONMENATAL CHARACTERISTICS

Operating Temperature	-40 °C – +85 °C Class OT4: -40 – +70 °C and class ST1,ST2: +15 °C according to EN50155:2017
Cooling	Natural convection
Storage Temperature Range	-50 °C – +100 °C
Temperature measurement reference point T_m	T_m must be ≤125 °C @ Tambient = 70 °C under all load-conditions in order to guarantee safe operation (measurement point = transformer copper, see red arrow on image below for exact position) 
Pollution Degree	PD2 according to EN 50124-1:2017
Shock and Vibration	According to EN 61373:2010, category 1, class B
Rapid Temperature Variation	Class H2 according to EN 50155:2017: -25 °C to +15 °C / 95 %RH, ±3 °C/s +10 °C to 40 °C / 60 %RH, ±3 °C/s
Protective Coating	Class PC2 according to EN 50155:2017 The board is protected on both sides with a protective transparent fluorescent-pigment coating to prevent deterioration or damage due to moisture and atmospheric contaminants. The coating is compliant with class 2, according to IPC-A-610G: 2017.

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Prohibited Substances	No substances defined as Prohibited according to the RoHS, REACH, UNIFE (RISL), or Prohibited for the Project, are present. No substances defined as Declarable according to RoHS, REACH, UNIFE (RISL), or Declarable for the Project, are present.
Fire behaviour	EN 45545-2:2013+A1:2015 compliant with all Hazard Levels HL1-HL3

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GENERAL CHARACTERISTICS

<table>
<tr><td>General Standard</td><td colspan="4">EN 50155:2017
Railway applications - Rolling stock - Electronic equipment
IEC 60571:2012
Railway applications - Electronic equipment used on rolling stock</td></tr>
<tr><td>Useful Life Class</td><td colspan="4">Class L4 (20 years) according to EN50155:2017</td></tr>
<tr><td rowspan="2">MTBF
Calculation method: MIL-HDBK-217-F2
Using demonstrated Failure Rates of components</td><td>Ground Benign (GB), +25 °C</td><td>Ground Benign (GB), +40 °C</td><td>Ground Fixed (GF), +40°C</td><td>Ground Mobile (GM), +40 °C</td></tr>
<tr><td>6 847 000 h</td><td>4 736 000 h</td><td>870 000 h</td><td>472 000 h</td></tr>
<tr><td>Marking</td><td colspan="4">Label with following information:
- part number, input voltage, output voltage, output power
- serial number for identification and traceability
(printed in text format and as barcode)
- revision index</td></tr>
<tr><td>Connector identification</td><td colspan="4">On input connectors: printings on the PCB to identify polarity</td></tr>
</table>

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SAFETY AND INSULATION

Safety Standards	EN 60950-1:2006+A2:2013, IEC 60950-1:2005+A1:2009+A2:2013 CSV, EN 62368-1:2014+A11:2017 IEC 62368-1:2018
Insulation Coordination	Compliant to EN 50124-1:2017: OV3,PD2,U_{Nm}=1.2 kV, U_{Ni}=8.0 kV Compliant to EN 60077-1:2017: U_{Nm}=0.9 kV (no Y-capacitors are used between input-earth and output-earth)
Input, Output, Chassis	The input is galvanically isolated to the output. Input, output and signals are galvanically isolated to the chassis.
Partial discharge	Inception voltage: 1.77 kV; Extinction voltage: 1.49 kV @ 20 pC threshold
Input to Output	Isolation Voltage: 7000 Vrms, 60 s Clearance: 15.0 mm Creepage: 24.0 mm
Input to Chassis	Isolation Voltage: 4300 Vrms, 60 s Clearance: 8.0 mm Creepage: 12.0 mm
Output to Chassis	Isolation Voltage: 1400 Vrms, 60 s Clearance: 1.5 mm Creepage: 1.5 mm
DC-OK Signal to Output DC-OK Signal to Chassis	Isolation Voltage: 1400 Vrms, 60 s Clearance: 1.5 mm Creepage: 1.5 mm
ON/OFF Signal to Output ON/OFF Signal to Chassis	Isolation Voltage: 1400 Vrms, 60 s Clearance: 1.5 mm Creepage: 1.5 mm
Insulation Resistance	Input-Chassis: > 550 MΩ Input-Output: > 550 MΩ Output-Chassis: > 550 MΩ Test-voltage: 500 VDC

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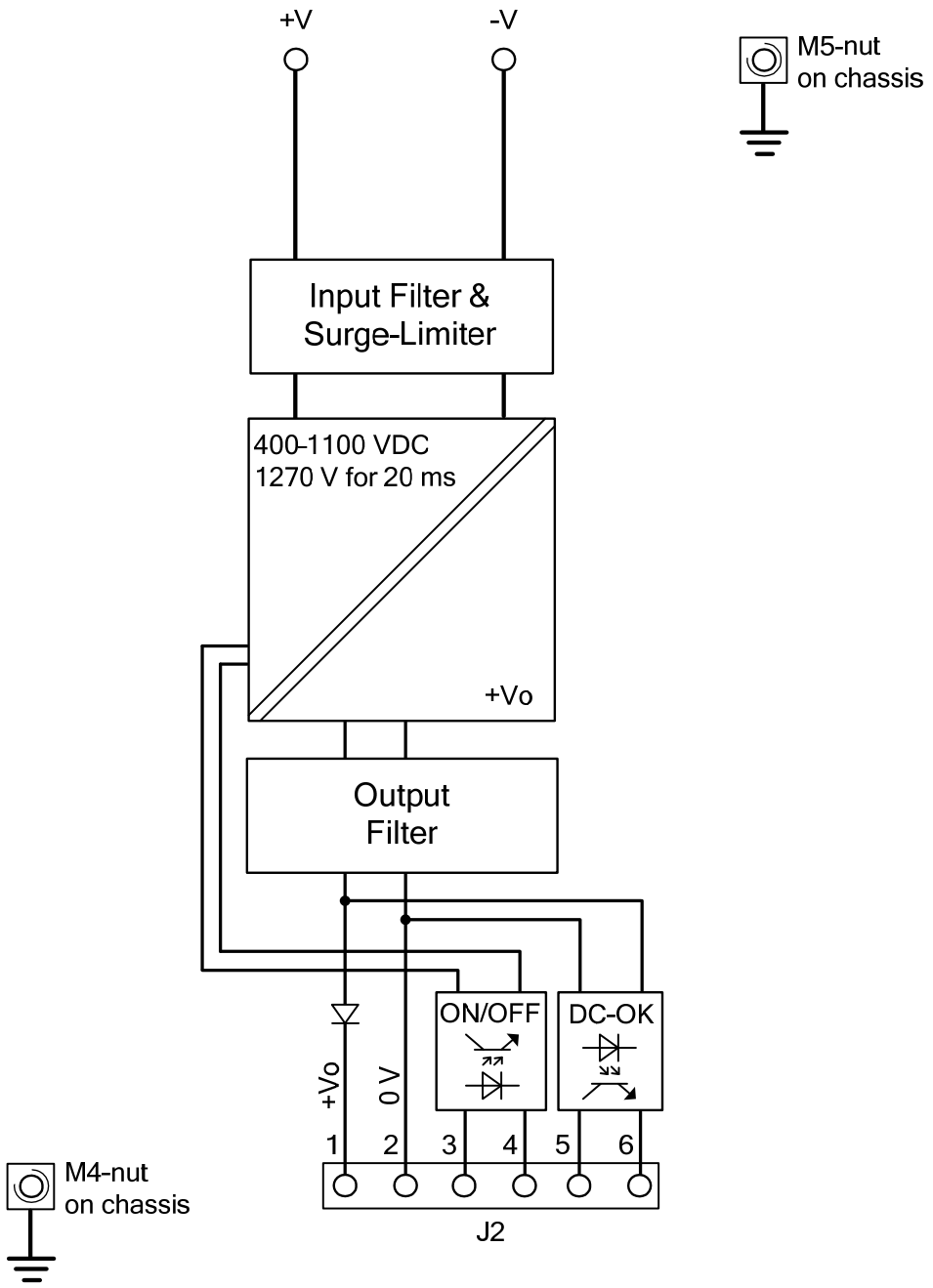
BLOCK DIAGRAM



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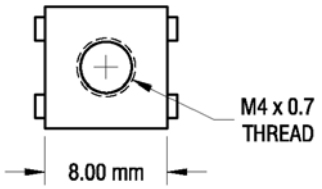
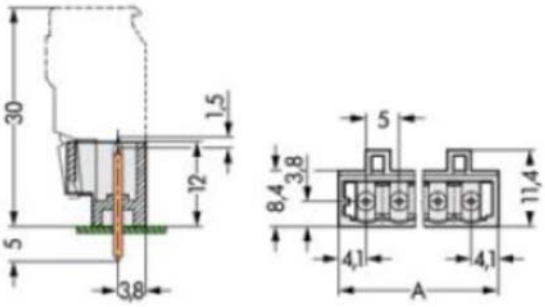
CONNECTOR TYPES

Input connectors +V, -V	Keystone, M4-thread 7795  Mating part: M4 ring-terminals, washers and screws.
Output connector J2	Wago 721-166/001-000 Pitch: 5.0 mm, Number of pins: 6, vertical  Mating part: Wago 721-106/037-000

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MECHANICAL CHARACTERISTICS

Chassis	Aluminium: EN AW 5052 - AL5052 - AlMg2.5 or EN AW 5754 - AL5754 - AlMg3 black anodized Two circles (20 mm diameter) free of anodization are implemented around nuts for chassis-earthing.
Overall dimensions	According to the drawing (millimeters, unless otherwise specified)
Weight	1200 g
IP code	IP00
Mounting	Mounting in any position is allowed

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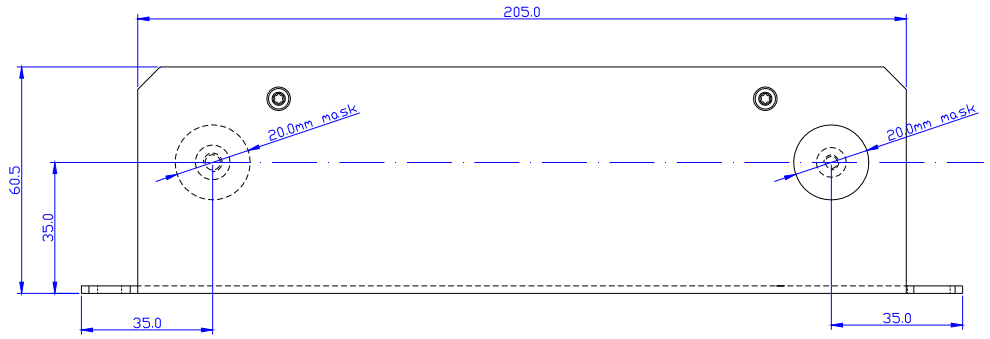
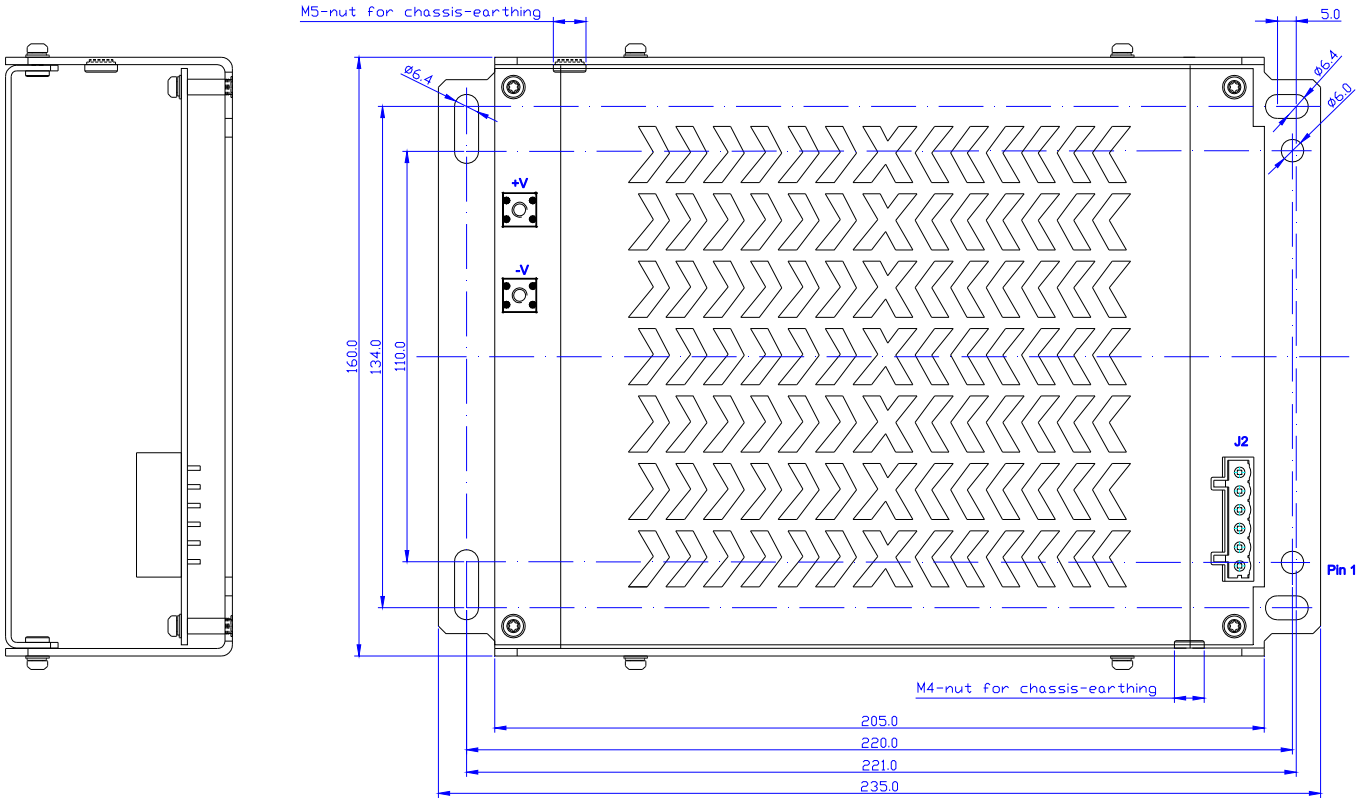
Mechanical drawings:





Input connectors
+V, marked on the PCB
-V, marked on the PCB

Output connector J2: X10:
1. +Vo
2. 0 V
3. +ON/OFF
4. -ON/OFF
5. +DC-OK
6. -DC-OK

The unit must be secured using four M6 screws or bolts (not supplied) in the mounting holes.

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TEST COMPLIANCE SUMMARY (CERTIFICATE OF CONFORMITY)

Perfomed Test	Standard	Test conditions	Performance level	Reference document
Visual inspection	EN 50155:2017 IEC60571:2012	Aspect, dimensions, weight, markings	According to design specification	Test report
Performance test	EN 50155:2017 IEC60571:2012	Ambient temperature. Nominal supply voltage: 600 VDC and 750 VDC Supply voltage range: 400 – 1100 VDC (static)	Criterion A	Test report
Power supply test Supply overvoltages	EN 50155:2017 IEC60571:2012	Supply voltage: 400 – 1270 VDC for 20 ms	Criterion A Criterion B required, but tested with more strict criterion A	Test report
Insulation test	EN 50155:2017 IEC60571:2012	Input – Chassis 500 VDC Input – Output 500 VDC Output – Chassis 500 VDC Signals – Output 500 VDC Signals – Chassis 500 DC Repeated after Voltage withstand test Voltage withstand test: Input – Chassis 1500 Vrms 60 s Input – Output 3300 Vrms 60 s Output – Chassis 1000 Vrms 60 s Signals – Chassis 1000 Vrms 60 s	Resistance > 20 MΩ (measured >550 MΩ, exceeding the requirement) No disruptive discharge	Test report
Low temperature start-up test Cold start test	EN 50155:2017 IEC60571:2012	T = -40 °C	Criterion A	Test report
Dry heat test	EN 50155:2017 IEC60571:2012	T = +70 °C (cycle A) T = +85 °C (cycles B and C)	Criterion A	Test report
Cyclic damp heat test	EN 50155:2017 IEC60571:2012	T = +55 °C and +25 °C (2 cycles)	Criterion A	Test report
EMC test	EN 50155:2017 EN 50121-3-2:2016/ A1:2019 IEC60571:2012 IEC 62236-3-2:2018	See section 'Electromagnetic Compatibility (EMC)'		R-EM-354-0613-02A
Vibration and shock test	EN 50155:2017 IEC60571:2012	EN 61373:2010, Category 1, class B		compliant

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Additional tests:

Perfomed Test	Standard	Test conditions	Performance level	Reference document
Fire behaviour	EN 45545-2:2013+ A1:2015	PCB: R25 (EN 60695-2-11, T16: No ignition at T=850 °C)	PASSED (HL1-HL2-HL3)	Fire_Certificate_IC50X

Furthermore, the product is compliant with the requirements of:

- EC 1907/2006 (December, 18th 2006) REACH regulation: Registration, Evaluation, Authorisation and Restriction of Chemicals.

- UNIFE Railway Industry Substance List

Neuhausen am Rheinfall, 29.03.2020

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intreXis AG

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EU DECLARATION OF CONFORMITY (DoC)

CE

Product Models	IC501_3, IC503, IC504, IC506_3	
Name and address of the manufacturer	intreXis AG Tobelraastrasse 4 CH-8212 Neuhausen am Rheinfall Switzerland	
This declaration of conformity is issued under the sole responsibility of the manufacturer.		
IC501_3, IC503, IC504, IC506_3 		
The object of the declaration described above is in conformity with the relevant Union harmonisation legislation:	Low Voltage Directive: RoHS Directive: EMC Directive:	2014/35/EU 2011/65/EU 2014/30/EU
References to the relevant harmonised standards used or references to the other technical specifications in relation to which conformity is declared:	Low Voltage Directive: RoHS Directive: EMC Directive: Railway Applications:	EN 60950-1:2006+A2:2013 EN 62368-1:2014+A11:2017 EN 63000:2018 EN 50121-3-2:2016/ A1:2019 EN 50155:2017
Signed for and on behalf of:	intreXis AG Tobelraastrasse 4 CH-8212 Neuhausen am Rheinfall Switzerland	
Place, Date of issue	Neuhausen am Rheinfall, 29.03.2020	
Name, Function, Signature	Thomas Schiegg, Managing Director: 	

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INSTALLATION AND OPERATION

Safety	Warning / Caution ! The power supplies should be installed and put into operation only by qualified personnel. Before installing or removing the unit, disconnect the power from the system. A protective earthing terminal must be permanently connected to the M4-nut or M5-nut provided on the chassis.
Servicing	In case of failures, malfunctions or defects, the converter must be returned to intreXis for analysis and repair. In particular, the converter should be sent to intreXis for analysis if any damage has occurred to the unit (e.g. the unit dropped). Any attempts to open and repair the unit could void the warranty and could expose the operator to hazardous voltages.
Spare Parts	List and drawings of spare parts are not provided, since the failed units have to be returned to intreXis for analysis and repair.
Disposal	Disused units must be collected separately and disposed at a suitable recycling facility.
Connecting the Cables	Ensure that proper wires are used according to the input current specifications. Prepare the cables according to the specifications of the particular connector used. The input cables must be connected to the screw terminals (+V, -V marked on the PCB) with suitable hardware (2x M4 ring-terminals, washers and screws, not provided).
Operation of the Unit	Once the input power is applied, the output voltage is enabled, unless the External ON/OFF signal is disabling the converter (OFF-state).

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