intreXis®

Power Supplies with the X

Datasheet

intreXis Boardnet Converter Platform
IC303 and IC304, 500 W Single-Output
24 Vin – 110 Vin

- Xtra high efficiency: > 96 % @ 110 Vin, 500 W
- Xtra wide input voltage range: 24 – 110 VDC or optimized for 110 VDC
- Xtra high extra power for overload: 750 W for 100 ms
- Xtra high peak short circuit current: trips reliably circuit breakers: 13 A characteristic B, 8 A characteristic C
- Xtra high peak startup-current: can source up to twice the nominal output current during startup: satisfies high peak current absorption of demanding loads during startup.
  Startup-current: 40 A typ (IC303_X), 20 A typ (IC304_X)

This datasheet covers the details of the IC303_X and IC304_X power supplies with single output voltage and output power of 500 W. These DC/DC converters are designed according to EN 50155:2017 and IEC 60571:2012 for railway applications and are ideal for other demanding environments which require the highest performance and reliability.

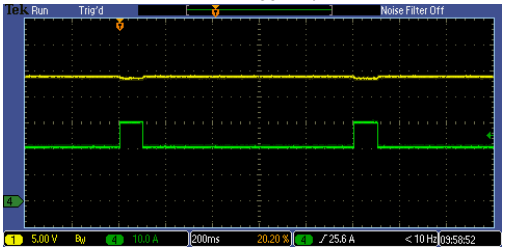
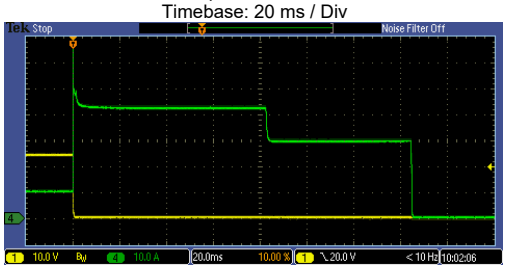
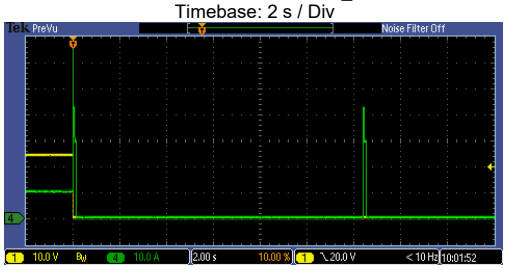
Output voltage: 24 V, 52 V. Other voltages on request.
Ordering codes: IC303_1, IC303_3, IC304_1, IC304_3. The differences between the variants are explained in this datasheet.

INPUT CHARACTERISTICS

Continuous Input Voltage Range	**IC303_1, IC304_1**		**IC303_3, IC304_3**	
	16.8 – 137.5 VDC		77.0 – 137.5 VDC	
Temporary Input Voltage Range according to EN50155:2017, 5.1.1.3	**IC303_1, IC304_1**		**IC303_3, IC304_3**	
	14.4–154.0 VDC for 1.0 sec		66.0–154.0 VDC for 1.0 sec	
Input Undervoltage Lockout	**IC303_1, IC304_1**		**IC303_3, IC304_3**	
	Vin_off = 13.5 VDC typ. Vin_on = 16.1 VDC typ.		Vin_off = 62.0 VDC typ. Vin_on = 73.0 VDC typ.	
Input Voltage Reverse Polarity Protection	Active reverse polarity protection: Iin_reverse< 500 µA @ Vin = -154 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 over the entire operating temperature range	An active inrush limitation circuit limits the input inrush current after turn-on of the input voltage. The charging current into EMI suppression capacitors is disregarded during the first microseconds after switch-on. Inrush Current Energy over the entire input voltage range: I_{inrush}^2t < 57 A^2s @ Vin = 16.8 – 137.5 VDC Inrush Current Peak = 50 A typ. @ 24 Vin Inrush Current Peak = 14 A typ. @ 110 Vin			
Input Capacitance	3300 µF			
Input Current typ. @ full Load	**24 Vin**	**36 Vin**	**72 Vin**	**110 Vin**
	22.5 A	14.8 A	7.32 A	4.73 A
Input Power typ. @ no Load over the input voltage range	**IC303_X**		**IC304_X**	
	2.5 – 3.0 W		1.7 – 2.2 W	
Internal Input Fuse	Fuse included, therefore no external fuse required. I^2t-fuse = 1689 A^2s			
External Circuit Breaker recommendation Important: Circuit Breaker must be rated for the maximum DC-input voltage	**24 Vin**	**36 Vin**	**72 Vin**	**110 Vin**
	40 A, type B	32 A, type B	16 A, type B	10 A, type B
Interruptions of Input Voltage Supply (Hold-up time)	Class S2 (10 ms) at 500 W load, Class S3 (20 ms) at 300 W load according to EN 50155:2017 The converter continues to operate as intended during and after the interruption, with no degradation of performance or loss of function (Performance criterion A).			
Startup time (Time input voltage ON to output voltage ON)	< 1 s for all input voltages			

OUTPUT CHARACTERISTICS

Output Voltage Nominal @ off load	**IC303_X**	**IC304_X**
	+24.4 VDC	+52.4 VDC
Max. Continuous Output Power @ Vin = 16.8–137.5 V,14.4–154 V for 1.0 sec (no derating over the entire temperature range)	500 W	
Max. Peak Output Power @ Vin = 16.8–137.5 V,14.4–154 V for 1.0 sec	750 W for 100 ms	
Minimum Load	No minimum load required.	
Setpoint Accuracy	< 1.0 %	
Load Regulation @ off-load to full load over the entire temperature range	**IC303_X**	**IC304_X**
	< 3.6 %	< 1.8 %
Line Regulation @ full load over the entire temperature range	< 0.1 %	
Output Ripple & Noise @ 20 MHz bandwidth, including spikes	< 50 mVpp @ 25 °C < 200 mVpp @ -50 – +85 °C	

Overload, Startup Current and Short-Circuit	The converter is continuous overload and short-circuit proof. **Output overloaded:** Short overloads up to 750 W for 100 ms: no limitation, output voltage remains stable: Measurement on IC303_1: 500 W for 900 ms, 750 W for 100 ms: CH1: output voltage 5 V / Div CH4: output current 10 A / Div Timebase: 200 ms / Div  **High peak startup current:** Sources up to twice the nominal output current during startup: satisfies high peak current absorption of demanding loads during startup. 40 A (IC303_X), 20A (IC304_X) for 80 ms, then 30 A (IC303_X), 15A (IC304_X) for 60 ms **Output short-circuited:** When the output is shorted, the converter delivers 40 A (IC303_X), 20A (IC304_X) for 80 ms, then 30 A (IC303_X), 15A (IC304_X) for 60 ms Measurement on IC303_1 CH1: output voltage 10 V / Div CH4: output current 10 A / Div Timebase: 20 ms / Div  Then it switches off and and tries periodically to switch on again, every 12 seconds for 140 ms: Measurement on IC303_1 Timebase: 2 s / Div  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 (hiccup). **Longer/Higher overloads:** >100 ms or >750 W: converter switches off and retries (hiccup)

Current Limit for overload >100 ms (varies due to component tolerances)	**IC303_X**	**IC304_X**
	21.8 A – 24.5 A	10.1 – 12.0 A
Short-Circuit current	**IC303_X**	**IC304_X**
	40 A for 80 ms followed by 30 A for 60 ms, every 12 sec < 10 Arms trips reliably following circuit breakers: characteristic B: up to 10 A characteristic C: up to 6 A with 2x IC303_X paralleled: characteristic B: up to 20 A characteristic C: up to 13 A	20 A for 80 ms followed by 15 A for 60 ms, every 12 sec < 5 Arms trips reliably following circuit breakers: characteristic B: up to 6 A characteristic C: up to 4 A with 2x IC304_X paralleled: characteristic B: up to 10 A characteristic C: up to 6 A
Overvoltage Protection (OVP) (output voltage is limited, if main regulation loop fails)	**IC303_X**	**IC304_X**
	< 30 VDC	< 60 VDC
	SELV-compliant according to EN 60950-1:2006+A2:2013, IEC 60950-1:2005+A1:2009+A2:2013 CSV	
Paralleling of Outputs	Paralleling up to 7 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.	
Maximum load-capacitance	**IC303_X**	**IC304_X**
	20000 µF	10000 µF

EFFICIENCY

IC303_X:

Conditions	24 Vin	36 Vin	72 Vin	110 Vin
Efficiency typ. @ 100 % Load	92.5 %	93.9 %	94.9 %	96.2 %
Efficiency typ. @ 66 % Load	92.9 %	93.6 %	94.7 %	96.2 %
Efficiency typ. @ 33 % Load	91.3 %	92.0 %	92.9 %	94.9 %

IC304_X:

Conditions	24 Vin	36 Vin	72 Vin	110 Vin
Efficiency typ. @ 100 % Load	92.6 %	93.9 %	95.0 %	96.5 %
Efficiency typ. @ 66 % Load	92.9 %	93.6 %	94.7 %	96.4 %
Efficiency typ. @ 33 % Load	90.8 %	91.4 %	92.6 %	94.5 %

SIGNALS AND INTERFACES

DC-OK-Signal (PWR Good)	**IC303_X**	**IC304_X**
	Isolated open-collector transistor (between connector X30/pin 1-2)	Open-collector transistor (between connector X30/pin 1-2)
DC-OK-Signal (PWR Good) transistor switch on threshold	**IC303_X**	**IC304_X**
	Vout> 23.0 VDC ±2 %	Vout< 46.8 VDC ±2 %
DC-OK-Signal (PWR Good) transistor switch off threshold	**IC303_X**	**IC304_X**
	Vout< 22.5 VDC ±2 %	Vout> 47.8 VDC ±2 %
DC-OK-Signal (PWR Good) max. transistor current, when on	8 mA max.	
DC-OK-Signal (PWR Good) max. transistor voltage-drop, when on	**IC303_X**	**IC304_X**
	< 2.0 VDC @ 8 mA	< 0.5 VDC @ 8 mA
DC-OK-Signal (PWR Good) max. transistor voltage, when off (max voltage which can be applied externally between connector X30/pin 1-2, see block diagram)	+60 VDC	
External ON/OFF Signal	Output voltage is ON if: - connection between ON (X40/pin2) and +Vin input (X40/pin1) (low impedance connection < 500 Ω) For this purpose a mating connector for X40 is supplied, with a wire bridge assembled. See also section 'Connector Types'. or - external voltage 14.4 – 154 VDC applied between ON (X40/pin2) and -Vin input (X10/pin2) Current into ON-Pin: 1.0 – 2.0 mA (see block diagram) Output voltage is OFF if: - no connection between ON (X40/pin2) and +Vin input (X40/pin1) (high impedance > 500 kΩ) or - external voltage < 8.0 VDC applied between ON (X40/pin2) and -Vin input (X10/pin2)	

LED	Green LED on output side indicates that output voltage is ok.

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 (carriervoltage) 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	

ENVIRONMENATAL CHARACTERISTICS

Operating Temperature	-50 °C – +85 °C Class OT4: -40 – +70 °C and class ST1,ST2: +15 °C according to EN50155:2017 extended down to -50 °C
Cooling	Natural convection
Storage Temperature Range	-50 °C – +100 °C
Altitude Class	5000 m above sea level max.
Pollution Degree	PD2 according to EN50124-1:2017
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.
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

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>IC30X_1:
5 596 000 h

IC30X_3:
7 305 000 h</td><td>IC30X_1:
4 065 000 h

IC30X_3:
5 169 000 h</td><td>IC30X_1:
800 000 h

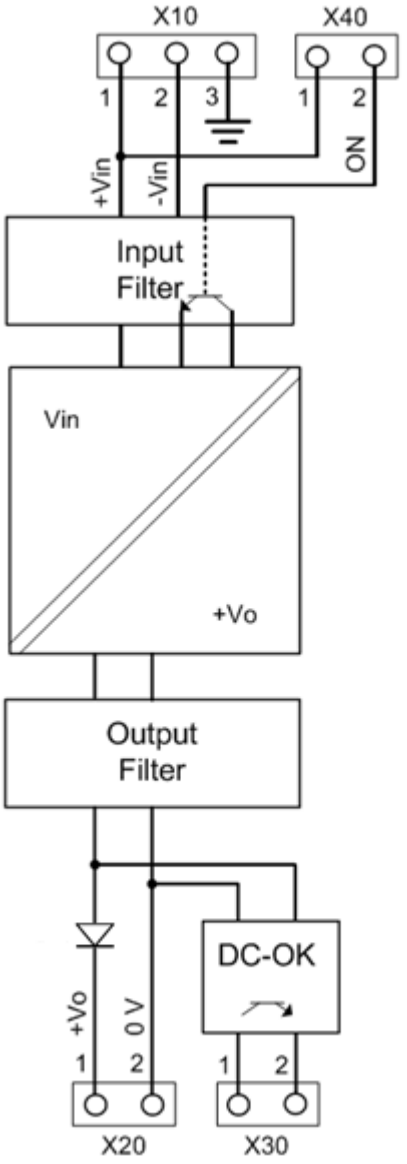
IC30X_3:
983 000 h</td><td>IC30X_1:
405 000 h

IC30X_3:
499 000 h</td></tr>
<tr><td>MTBF
Calculation method: SN 29500 (IEC 61709)</td><td colspan="4">IC30X_1: 925 000 h @ +50 °C
IC30X_3: 1 116 000 h @ +50 °C</td></tr>
<tr><td>Marking</td><td colspan="4">Label with following information:
- part number, input voltage range, output voltage, output power
- unique 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">Printings on chassis to identify connectors and pin-functions.</td></tr>
</table>

SAFETY AND INSULATION

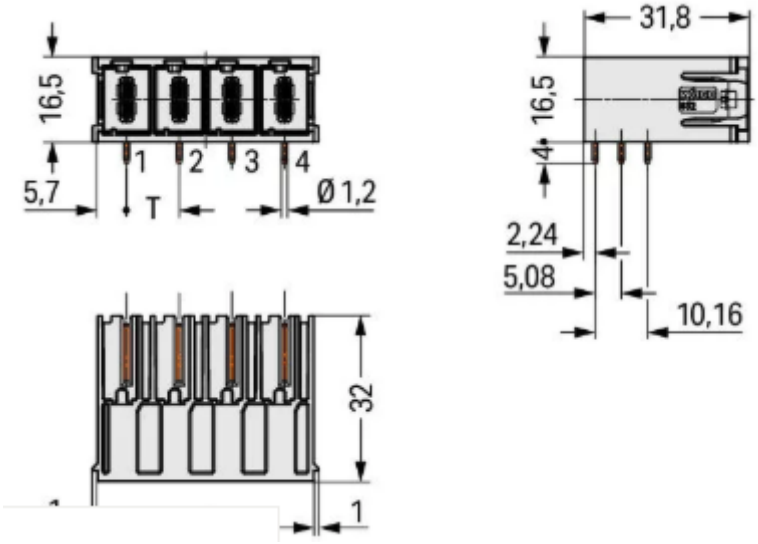
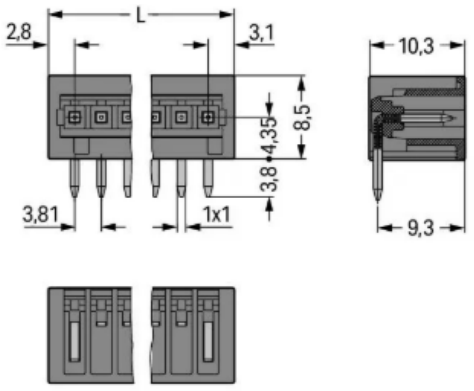
Safety Standards	EN 60950-1:2006+A2:2013, IEC 60950-1:2005+A1:2009+A2:2013 CSV, EN 62368-1:2014+A11:2017 IEC 62368-1:2018
Insulation Coordination	According to EN50124-1:2017
Input, Output, Chassis	The input is galvanically isolated to the output. Input, output and DC-OK (only for IC303_X) are galvanically isolated to the chassis.
Input to Output	Isolation Voltage: 3300 Vrms at 2000 m altitude, 60 s 2500 Vrms at 5000 m altitude, 60 s Clearance: 5.50 mm Creepage: 5.50 mm For the type test, the Y-capacitors must be removed according to EN 61287-1:2014. Please ask intreXis AG for advice. For the routine test according to EN50124-1:2017 of Input to Output and Input to Chassis, intreXis AG recommends the following procedure: connect Output to Chassis, apply a test-voltage of 2125 VDC or 1500 VAC with trigger threshold ≥10 mA), 10 s between Input and Chassis. For this test, the Y-capacitors must not be removed. Please ask intreXis AG for advice.
Input to Chassis	Isolation Voltage: 1500 Vrms, 60 s Clearance: 2.50 mm Creepage: 3.20 mm For the routine test, see above.
Output to Chassis Only IC303_X: DC-OK Signal to Chassis	Isolation Voltage: 1500 Vrms, 60 s Clearance: 1.93 mm Creepage: 1.93 mm
Only IC303_X: DC-OK Signal to Output	Isolation Voltage: 1000 Vrms, 60 s Clearance: 1.60 mm Creepage: 1.60 mm
Insulation Resistance	Input-Chassis: >550 MΩ Input-Output: >550 MΩ Output-Chassis: >550 MΩ Only IC303_X: DC-OK Signal-Chassis: >550 MΩ DC-OK Signal-Output: >550 MΩ Test-voltage: 500 VDC

BLOCKDIAGRAM



DC-OK Signal:
- IC303_X: isolated open-collector transistor
- IC304_X: open-collector transistor

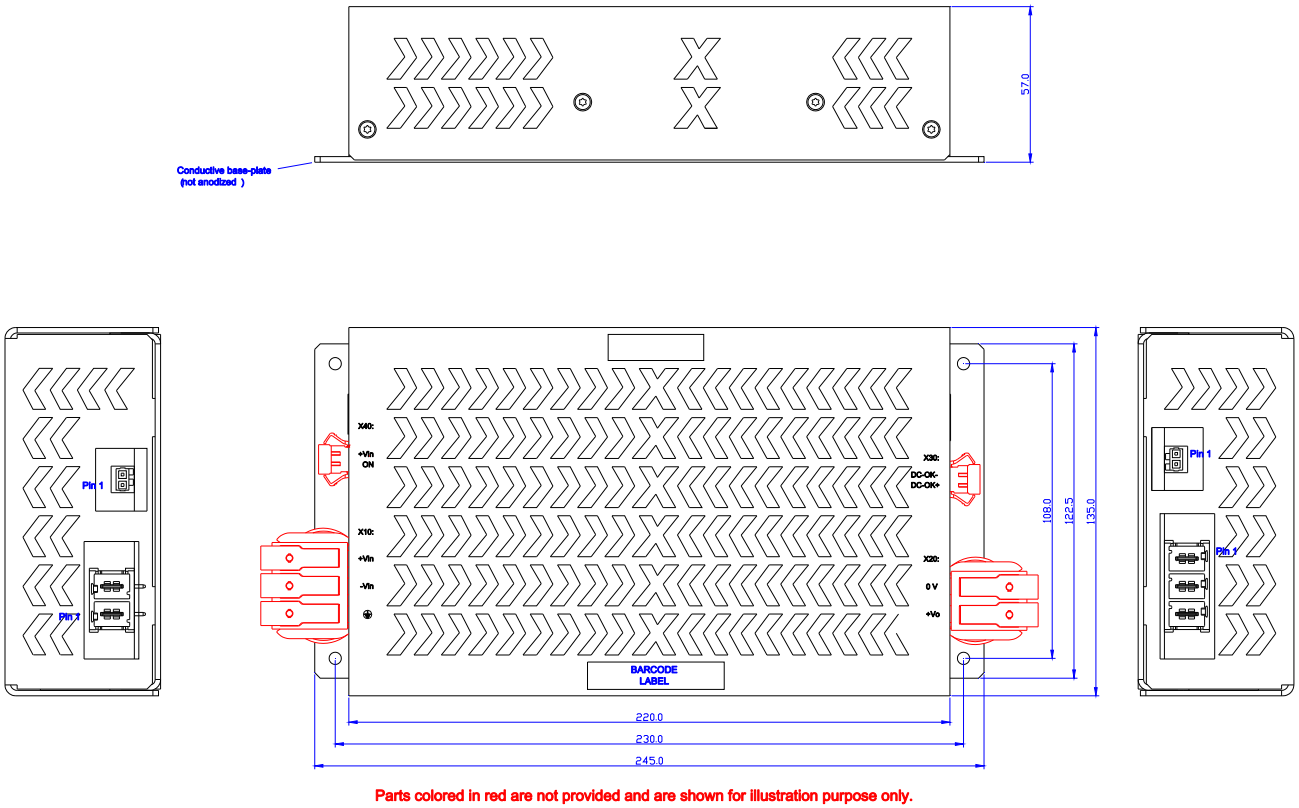
CONNECTOR TYPES

Input connector X10	Wago 832-3623 Pitch: 10.16 mm Number of pins:3, horizontal Mating part: Wago 832-1103/037-000 
Output connector X20	Wago 832-3622 Pitch: 10.16 mm Number of pins:2, horizontal Mating part: Wago 832-1102/037-000
Signal connector X30, X40	Wago 734-262 Number of pins: 2, horizontal Mating part: Wago 734-202/037-000 With each unit, one mating connector 734-202/037-000 for X40 is supplied, with a wire bridge already assembled. 

MECHANICAL CHARACTERISTICS

Chassis	Aluminium: EN AW 5052 - AL5052 - AlMg2.5 or EN AW 5754 - AL5754 - AlMg3 Baseplate: blank Cover: black anodized	
Overall dimensions	According to the drawing (millimeters, unless otherwise specified)	
Weight	**IC30X_1**	**IC30X_3**
	1370 g	1200 g
IP code	IP20	
Mounting	Mounting in any position is allowed	

Mechanical drawings:



Parts colored in red are not provided and are shown for illustration purpose only.

Output connector X20:
1. +Vo
2. 0 V

Signal Connector X30:
1. DC-OK+
2. DC-OK-

Input connector X10:
1. +Vin
2. -Vin
3. EARTH

Signal connector X40:
1. +Vin
2. ON

The unit must be secured using four M4 screws or bolts (not supplied) in the mounting holes.

TEST COMPLIANCE SUMMARY (CERTIFICATE OF CONFORMITY)

Performed 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: 24 VDC and 110 VDC Supply voltage range: 16.8 – 137.5 VDC (static)	Criterion A	Test report
Power supply test Supply overvoltages	EN 50155:2017 IEC60571:2012	Supply voltage: 14.4–154 VDC 1s	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 Only IC303_X: DC-OK Signal – Output 500 VDC DC-OK Signal – 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 Only IC303_X DC-OK – 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= -50 °C	Criterion A (exceeds the requirements, extended range down to -50 °C for extremely cold environments)	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-354-1018-04A
Vibration and shock test	EN 50155:2017 IEC60571:2012	EN 61373:2010, Category 1, class B		compliant

Additional tests:

Performed 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_IC303

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, 20.03.2019

Thomas Schiegg
intreXis AG

EU DECLARATION OF CONFORMITY (DoC)

CE

Product Models	IC303_1, IC303_3, IC304_1, IC304_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.		
IC303_1, IC303_3, IC304_1, IC304_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: 	

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. For 72 V and 110 V input applications, in addition to the main protective earthing terminal (X10/pin3), a separate protective earthing terminal must be permanently connected to the conductive chassis-baseplate.
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.
Operation of the Unit	Once the input power is applied, the output voltage is enabled, if the supplied mating connector for X40 (with the wire bridge assembled) is connected. If the mating connector X40 is not used, the output voltage can be enabled/disabled with the External ON/OFF signal on X40.