P R
B X

POWERBOX Railway Line
ENAR150D Series
150W Dual Output
DC/DC Power Supply
Manual V1.0

This document explains the features, benefits and use of the ENAR150D family.

Table of Contents

1. General Description

The ENAR 150 family dual output isolated DC/DC converter family uses the very latest design with planar transformer technology giving maximum performance. It is designed for ruggedized environment and use. With 150W of output power, efficiency up to 93% and the compact format with only 18.5mm in Euro cassette format it is a market leading product.

Input voltages available are 110VDC and 24VDC. Other voltages as 36, 48, 72 and 96 volt can be considered but MOQ may apply. Contact your Powerbox office for a quotation.

Two outputs are isolated and independent with 75 Watts on each. The outputs available are 2x24 or 2x12 VDC. The outputs may be paralleled or serial connected for more power or other voltages. Several converters may be connected in serial or parallel for higher voltages and/or more current.

The design and choice of components has been done to meet or exceed the demanding needs of railway and industrial applications, but also meets most demands from other applications.

The ENAR 150 family has a unique feature where the maximum power of the unit is controlled by the internal temperature, and at over temperature conditions the total output is decreased until shut off. The DC/DC converter is designed with built in protection for overload and/or short circuit on outputs, and reverse polarity protection on the input. The ENAR150 family is designed and approved to relevant railway standards of EN50155, 50121-3-2 (EMC), EN61373 (Shock and vibration) and EN45545 (Fire and smoke). It is also designed to meet relevant standards for industrial applications as EN60950 (Safety) and EN55022 level A (EMC) and approvals are in progress.

2. Model Description

The ENAR150D family is designed with 4 different input ranges. 110VDC and 24VDC input are available as standard products of the shelf. 72VDC and 48VDC input is available on request. Min order quantity apply. Input voltages are according to EN50155. The converter has two (2) isolated and independent outputs of 12 or 24VDC that can be used as two separate outputs, paralleled, symmetrical or serial connected.

2.1 Part Number Structure

ENAR	**150**	**D**	**110**	**/ 2x24**
Series Name	**Power**		**Input Voltage**	**Output Voltage and Quantity**
EN: Enclosed	150: 150W	D: DC/DC	24: 16.8-30VDC	2x12: Dual 12VDC
A: Automotive			48: 33.6-60VDC	2x24: Dual 24VDC
R: Railway			72: 50.4-90VDC	
			110: 77-137.5VDC	

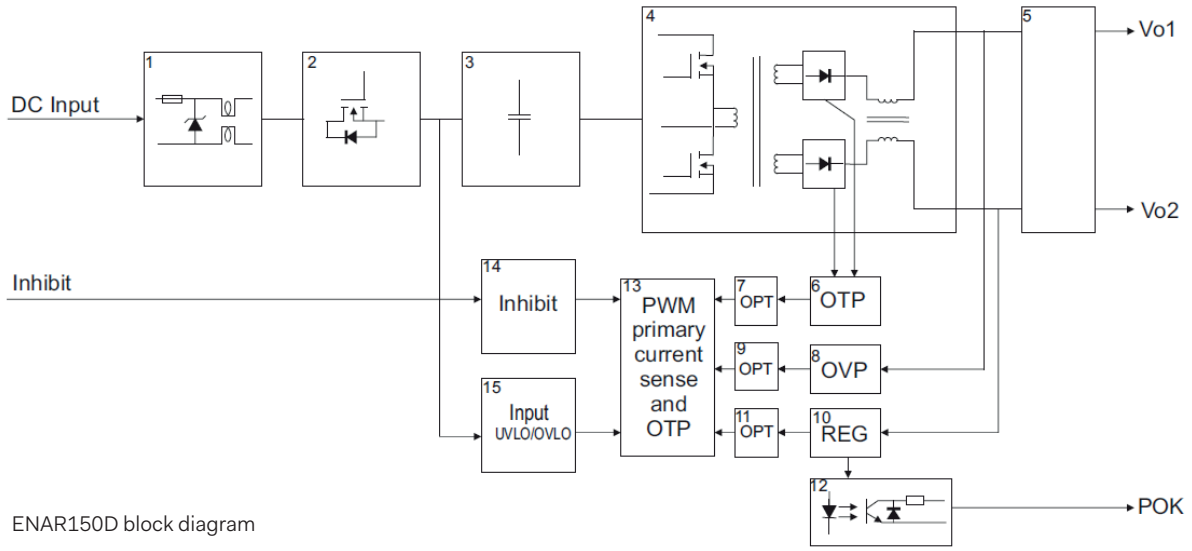
2.2 Model Selection and Configuration

Model Number	**Nominal Input Voltage**	**Output1**	**Output2**	**Configuration**	**Note**
ENAR150D110/2x24	110VDC	24V/3.12A	24V/3.12A	Independent configured	
ENAR150D110/2x24	110VDC	24V/6.25A		Paralleled outputs	
ENAR150D110/2x24	110VDC	24V/3.12A	-24V/3.12A	Symmetrical connected	
ENAR150D110/2x24	110VDC	48V/3.12A		Serial Connected	
ENAR150D110/2x12	110VDC	12V/6.25A	12V/6.25A	Independent configured	
ENAR150D110/2x12	110VDC	12V/12.5A		Paralleled outputs	
ENAR150D110/2x12	110VDC	12V/6.25A	-12V/6.25A	Symmetrical connected	
ENAR150D110/2x12	110VDC	24V/6.25A		Serial Connected	
ENAR150D24/2x24	24VDC	24V/3.12A	24V/3.12A	Independent configured	
ENAR150D24/2x24	24VDC	24V/6.25A		Paralleled outputs	
ENAR150D24/2x24	24VDC	24V/3.12A	-24V/3.12A	Symmetrical connected	
ENAR150D24/2x24	24VDC	48V/3.12A		Serial Connected	
ENAR150D24/2x12	24VDC	12V/6.25A	12V/6.25A	Independent configured	
ENAR150D24/2x12	24VDC	12V/12.5A		Paralleled outputs	
ENAR150D24/2x12	24VDC	12V/6.25A	-12V/6.25A	Symmetrical connected	
ENAR150D24/2x12	24VDC	24V/6.25A		Serial Connected	
ENAR150D72/2x24	72VDC	24V/3.12A	24V/3.12A	Independent configured	MOQ apply
ENAR150D72/2x24	72VDC	24V/6.25A		Paralleled outputs	MOQ apply
ENAR150D72/2x24	72VDC	24V/3.12A	-24V/3.12A	Symmetrical connected	MOQ apply
ENAR150D72/2x24	72VDC	48V/3.12A		Serial Connected	MOQ apply
ENAR150D72/2x12	72VDC	12V/6.25A	12V/6.25A	Independent configured	MOQ apply
ENAR150D72/2x12	72VDC	12V/12.5A		Paralleled outputs	MOQ apply
ENAR150D72/2x12	72VDC	12V/6.25A	-12V/6.25A	Symmetrical connected	MOQ apply
ENAR150D72/2x12	72VDC	24V/6.25A		Serial Connected	MOQ apply
ENAR150D48/2x24	48VDC	24V/3.12A	24V/3.12A	Independent configured	MOQ apply
ENAR150D48/2x24	48VDC	24V/6.25A		Paralleled outputs	MOQ apply
ENAR150D48/2x24	48VDC	24V/3.12A	-24V/3.12A	Symmetrical connected	MOQ apply
ENAR150D48/2x24	48VDC	48V/3.12A		Serial Connected	MOQ apply
ENAR150D48/2x12	48VDC	12V/6.25A	12V/6.25A	Independent configured	MOQ apply
ENAR150D48/2x12	48VDC	12V/12.5A		Paralleled outputs	MOQ apply
ENAR150D48/2x12	48VDC	12V/6.25A	-12V/6.25A	Symmetrical connected	MOQ apply
ENAR150D48/2x12	48VDC	24V/6.25A		Serial Connected	MOQ apply

3. Technical Function

ENAR150D Series is based on latest high efficiency switching topologies. The 24VDCin versions utilises push-pull switching topology and 110VDC in versions use half bridge switching, all complemented with secondary diode rectification(4). The switching frequency is typically 140 kHz.

The input stage(1) consist of a emergency fuse on negative input pole, Metal-Oxide Varisto (MOV) transient absorber and a two stage LC filtering circuit. The input stage is followed by lossless FET based reverse protection circuit(2) and stabilizing capacitors(3). The output after switching stage(4) is further conditioned with a ripple filter circuit. Primary side control circuit(13) monitors inhibit signal(14), Input under and over voltage(15), output over voltage(8) as well as internal temperature at three points, primary side switchers and secondary rectifying bridge(6). The primary control circuit(13) controls the Pulse Width Modulation for switchers as well as DCOK signal on front panel LED and DCOK signal bus.



ENAR150D block diagram

4. Electrical Input Data

General conditions are 25°C, 53% RH, sea level, inhibit(28) connected to –Vin(32) unless otherwise noted.

Model	**ENAR150D24xxxx**			**ENAR150D48xxxx**			**ENAR150D72xxxx**			**ENAR150D110xxxx**				
Data	**min**	**nom**	**max**	**min**	**nom**	**max**	**min**	**nom**	**max**	**min**	**nom**	**max**	**Unit**	**Comment**
Input voltage	16,8	24	30	33,6	48	60	50,4	72	90	77	110	137,5	VDC	EN50155
Max voltage			31,5			63			94,5			144	VDC	Continuous
UVLO	Lock out		12,6			25,2			37,8		55	58	70	VDC
	Turn on										58	59	68	VDC
OVLO	Lock out		33			66			99		157		163	VDC
	Turn on										150		156	VDC
Input current	5,4	6,7	9,6	2,7	3,4	4,8	1,8	2,2	3,2	1,2	1,5	2,1	A	Full load
Inrush peak current			60									100	A	20µH source imp.
Input capacitance		880									88		µF	
Stand by power		0,4	2								1,4	2	W	
Start up time		60	100								40	100	ms	
Fuse rating	12A / 72V		8A / 72V		5A / 125V		5A / 125V		A/V					
Source inductance			0,5									2	mH	without added capacitance

Electrical input data

4.1. Input Fuses

One internal catastrophic input fuse is mounted in -Vin branch.
Fuse shall protect the unit if an internal failure occurs.
Fuse type used: Littelfuse series 452, Slow-Blow type.

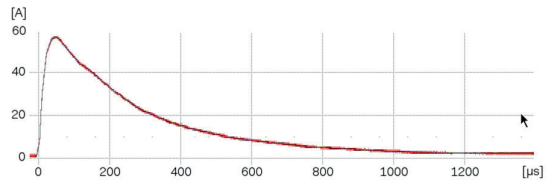
Fuse level:
5A/125V for 110V nominal input voltage type
5A/125V for 72V nominal input voltage type
8A/72V for 48V nominal input voltage type
12A/72V for 24V nominal input voltage type

4.2. Input Under/Over Voltage Lockout

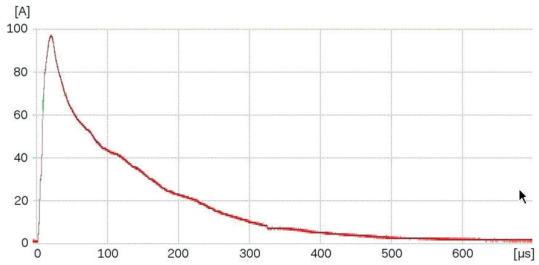
ENAR150D converters have input Under and Over Voltage Lockout (UVLO and OVLO) function with auto-recovery. The UVLO/OVLO is presented as block 15 on the block diagram and lock out/turn on values on electrical input data. In case the input voltage is out of specification the primary control circuit will turn the converter off. If the input voltage returns to specified voltage range including hysteresis the converter will automatically turn on.

4.3. Inrush Current

The ENAR150D Series converters have been designed with very low input capacitance hence low energy inrush current according to ETS 300 132-2. The actual inrush current curve is dependant of source impedance. Below are example curves at given source impedance.



ENAR150D24 inrush current
measured at 24VDC, 20µH, 0.1Ohm supply



ENAR150D110 inrush current
measured at 110VDC, 20µH, 0.5Ohm supply

4.4. Transient Protectrion

Inputs are protected with metal-oxide varistor (MOV) against transient voltages that may occur on battery powered systems as trains and other vehicles. The transient protection on all models complies with railway EN50155 transients. The 24VDC input versions comply also with ISO7637-2 transients for road vehicles and 48VDC input versions with IEC/EN12895 transients for industrial trucks.

4.5. Reverse Protection

All units are protected against reverse input. A vehicle battery in bad condition may switch polarity or input polarity may also be incorrectly connected in reverse on installation.

The reverse protection is based on a MOSFET circuit which appears as open circuit to the source in case the input is reversed. The reverse input protection does not blow internal nor possible external input fuses.
The 24VDC input versions are also compliant according to the ISO7637-2 for road vehicles.

4.6. Hot-Swap

ENAR150D Series units have virtually no internal hold-up, very low input capacitance and therefore very small inrush current. This allows hot-swapping in a live system however a small spark may be caused at the connector on insertion of the unit.

4.7 Source Inductance

Any converter may start oscillating with its source if the source inductance resonates with it. The 110VDC input version can accept source inductance up to 2mH and the 24VDC input versions can accept source impedance up to 0,5mH without any additional input capacitance. If 2mH source impedance is required for the 24VDC input version a 1500uF capacitor is recommended in parallel with the input lines however a typical impedance of the input cables is approximately 0,2mH so requirement of additional input capacitance is unlikely.

5. Electrical Output Data

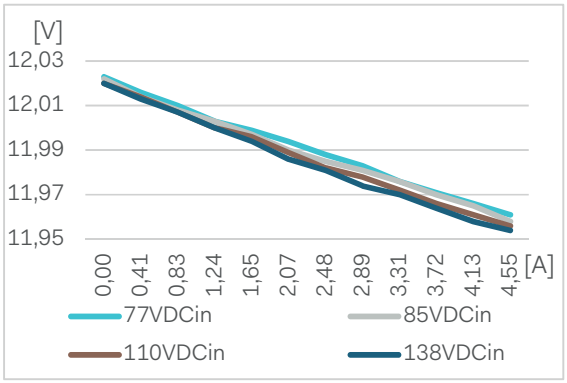
General conditions are 25°C, 53% RH, sea level, inhibit(28) connected to –Vin(32) unless otherwise noted.

Model		**ENAR150Dxxx/2x12**			**ENAR150Dxxx/2x24**				
Data		**min**	**nom**	**max**	**min**	**nom**	**max**	**Unit**	**Comment**
Independent	OP1	11,75	12	12,25	23,75	24,00	24,25	VDC	Total accuracy
	OP2	11,4	12	12,6	22,80	24,00	25,20	VDC	
Symmetrical	OP1	11,75	12	12,25	23,75	24,00	24,25	VDC	Total accuracy
	OP2	-11,4	-12	-12,6	-22,80	-24,00	-25,20	VDC	
Paralleled		11,75	12	12,25	23,75	24,00	24,25	VDC	Total accuracy
Series		23,5	24	24,5	47,50	48,00	48,50	VDC	Total accuracy
Start-up overshoot			280	360		200	720	mV	
Total power			150			150		W	
Current	OP1	1,25	6,25	7,19	0,63	3,13	3,59	A	
	OP2	0	6,25	7,19	0	3,13	3,59	A	
Load regulation	Overshoot		122			168		mV	Load step 20-90%
	Undershoot		81			200		mV	
Line regulation		11,88		12,12	23,76		24,24		
Efficiency			90,5	92		92	93	%	
Temp. coefficient		0,3		0,4	0,3		0,4		
Ripple			70	120		40	120	mV	Amax,Vnom
Over current limit		6,2	6,5	10	3	3,8	6	A	
Over voltage limit		14,4	15	15,6	28,8	30	31,2	VDC	
Isolation	Out-In		2100			2100		VAC	
	Out-Case		1000			1000		VAC	
	Out-Out		500			500		VDC	
	Out-DCOK		2000			2000		VDC	

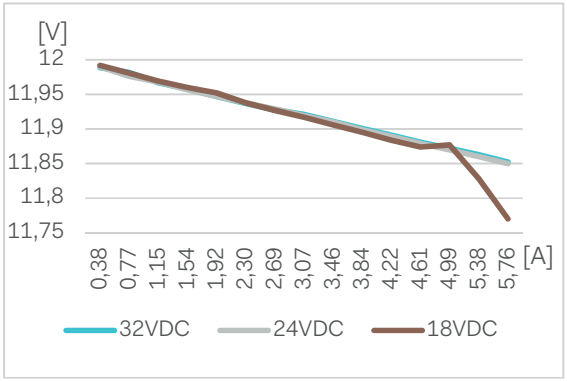
5.1. Output Voltage Regulation

Converter output voltage varies slightly as a function of several conditions such as load and input voltage. A load step will cause a short peak or dip in the output voltage known as overshoot or undershoot. Measured typical overshoot and undershoot values are given on above table for 20% to 90% and 90% to 20% load step at nominal input voltage.

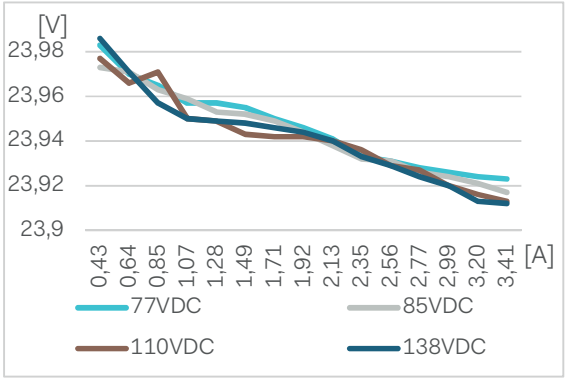
Typical load and line regulation for ENAR150 in within +/-1% of output voltage. Below charts are example measurements of output voltages at different load currents and input voltages.



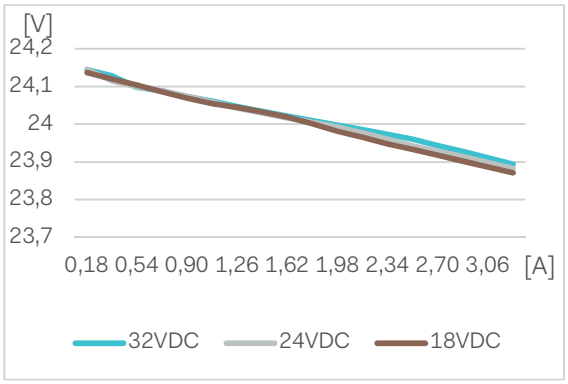
Regulation on ENAR150D110/2x12



Regulation on ENAR150D24/2x12



Regulation on ENAR150D110/2x24



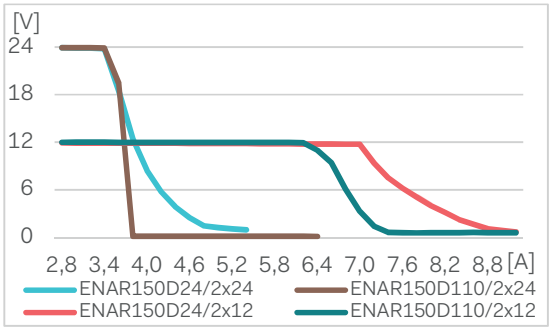
Regulation on ENAR150D24/2x24

5.2. Output Overvoltage Protection

The ENAR150D Series converters has built in output overvoltage protection (OVP) with auto-recovery. The OVP is set to trigger at 125% +/-5% of nominal voltage measured at output 1. In case OVP is triggered the converter will turn off and turn on again if voltage is within specification. The OVP will not protect the converter against externally applied over voltages. Externally applied voltage of >133% to the output may damage output capacitors.

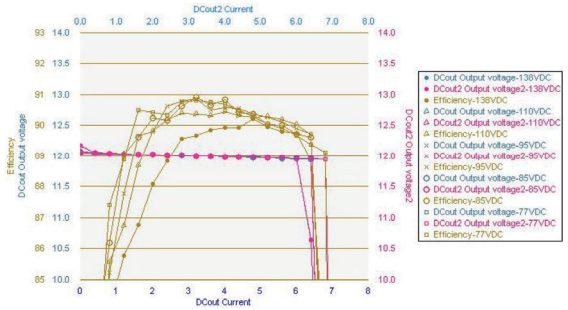
5.3. Over Current Protection

Over current protection (OCP) on ENAR150 units is based on current measurement on the primary side as well as the internal temperature measurement on three points of the unit. Over current on either output will affect both outputs. The OCP is fast acting limiting almost any peak load. The ENAR converters have near cv/cc characteristic and limits at approx. 115% of max power with auto-recovering. 110V input versions have deeper voltage drop after OCP trip point as can be seen on adjacent OCP chart.

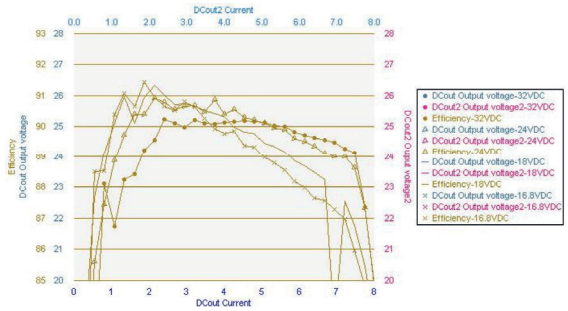


5.4. Efficiency

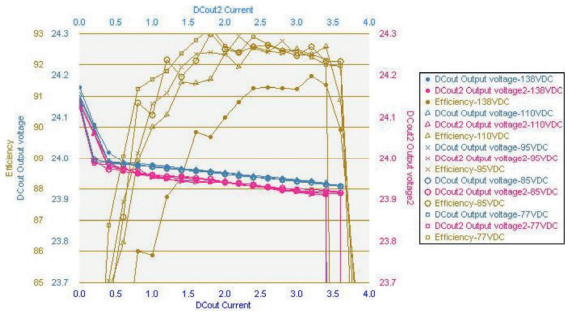
Efficiency is important parameter for thermal design of a system. Efficiency indicates how much of the input power turns to heat in converter. Efficiency is a function of input voltage and load current. Below charts are example efficiency measurements or ENAR150 converters in different input voltage and load current conditions.



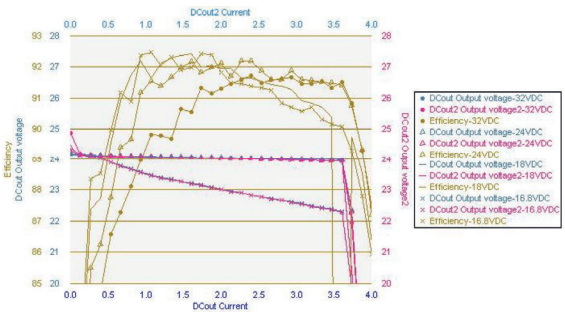
Efficiency on ENAR150D110/2x12



Efficiency on ENAR150D24/2x12



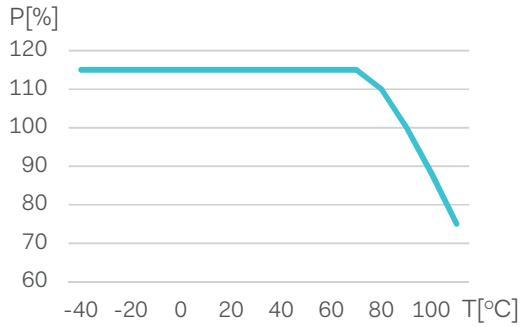
Efficiency on ENAR150D110/2x24



Efficiency on ENAR150D24/2x24

5.5. Derating

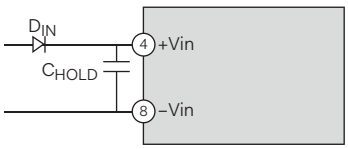
The ENAR150D Series converters are able to supply 115% over power up to 70°C base plate temperature after which the intelligent over temperature circuit starts to derate the output power. The converters are able to supply full load up to 90°C base plate temperature and is still capable to supply 75% load at 110°C base plate temperature. Please refer to chapter 7.1 Thermal considerations for proper cooling of the converter. The ENAR150D Series converters does not have input voltage related output power derating if input voltage is within specified limits.

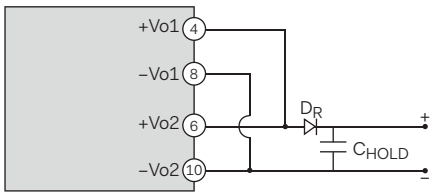


Temperature derating (base plate temperature)

5.6. Hold up Time

The ENAR family is designed with shot hold up time. The design with low hold up capacitance on the input will make ENAR converters easy to replace by hot plugging as only limited surges will appear when connected. In case hold up is required it can be created with external capacitors parallel connected with output or by parallel connecting capacitors at input with a series diode. The series diode will block the current from flowing to source, but there will be power loss over the diode however the converter will keep the output regulated as long as capacitor charge is within converter input range. Using output hold up the voltage begins to drop after converter is off by losing the source or inhibiting the converter. In case the converter has failed with shorted output the hold up capacitor will be depleted unless it is connected after redundancy diode. Hot-plugging the converter to an output hold up circuit will cause inrush current that will trip converter OCP to ramp up the voltage slowly.





Below is a formula how to calculate the value of the needed input capacitor for a given hold up time.

$$C_{hold} = \frac{2 \; x \; P_{out} \; x \; T_{hu}}{(U^2nom - U^2min)x \; \eta/100} \; x10^6$$

Chold= Capacitance at the input to get the wanted hold up time in µF
Pout=Output Power
Thu=Hold up time in sec
Unom=The nominal input voltage in Volt
Umin=The minimum input voltage allowed for the converter in Volt
η = Efficiency of the converter in percent

Example:
To get 10 mS hold up time using the formula above and the values below you need to add 450µF in parallel with the input. Pout=150W, Unom=110 VDC, Umin= 77VDC, n=90%

5.7. Load Types

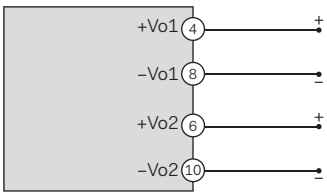
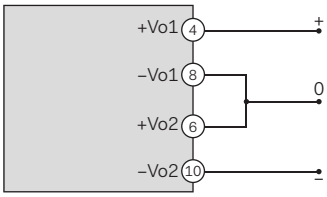
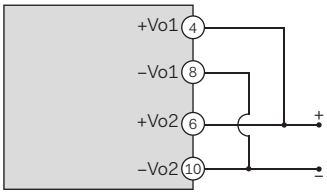
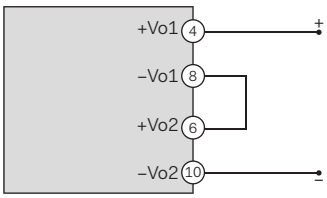
The ENAR150D Series converters can accept maximum of 15mF capacitive load with output within specification. Higher capacitive loads will trip OCP and cause slower start up, but does not damage the converter. The secondary rectifying diodes will protect converter for reverse current of inductive or regenerative loads, but in case externally applied voltage may increase over 125% of converter nominal voltage, external block and freewheeling diodes are recommended at converter output.

6. Parallel and Series Connection

Several ENAR150D Series converters and their outputs can be parallel and series connected very flexibly to meet wide range of application requirements.

6.1. Dual Output Connections

If output 2 is not used it is recommended to connect it in parallel with output 1 to share the current between outputs and keeping the converter thermally better in balance as well as gaining higher output power.

Configuration	Definition	Note	Wiring
Independent	Output 1 and output 2 connected to separate load. Galvanic isolation between output 1 and output 2.	Load range 0 to 100%. Max 75W load per output.*	
Symmetrical	Outputs connected together. Vo1- pin connected to Vo2+ pin One load connected to Vo1+ and Vo1-/Vo2+ One load connected to Vo1-/Vo2+ and Vo2-	Load range 0 to 100%. Max 75W load per output.*	
Parallel	Outputs connected together. Vo1+ pin connected to Vo2+ pin Vo1- pin connected to Vo2- pin	Load range 0 to 100%. Max 150W output load.	
Series	Outputs connected together. Vo1- pin connected to Vo2+ pin One load connected to Vo1+ and Vo2-	Load range 0 to 100%. Max 150W output load.	

*Load range for output 1 is 0 to 100%.load range for output 2 is 0 to 100% if load at output 1 is above 20% (15W). If load at output 1 is below 20%, load for output 2 needs to be equal or less than load for output 1.

6.2. Parallel Connection of Multiple Units

Two or more ENAR150D Series converters can be connected in parallel to increase the total output current and thus the power. Note: Only same type and model of converters can be safely connected in parallel. Converters will passively share the load current with 70% accuracy. The passive current sharing is based on converter internal temperature measurement. The converter with highest initial output voltage will conduct higher current. Higher current flow will heat up the unit triggering the intelligent thermal protection to reduce the output power sharing the current to other parallel connected converters. In parallel operation less than 90% continuous loading of combined power is recommended.

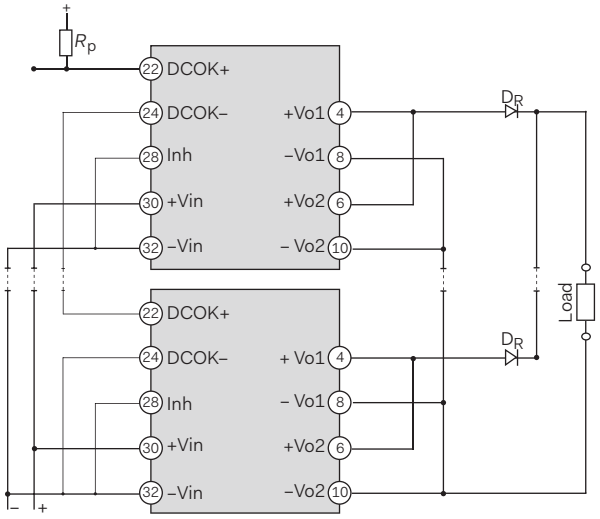
Virtually any number of ENAR150D Series converters can be connected in parallel, but some considerations needs to be taken in to account. As the converters will share the load passively based on the internal temperature the paralleled converters need to be cooled equally. Output cables should also be same length and connected in same star point to maintain equal current share.

Parallel connecting the units to increase total power does not require blocking diodes DR in series with outputs, but please notice that a failure of one converter in parallel array will likely bring the whole system down. Further consideration for the output diodes in chapter 6.4 Redundant configuration.

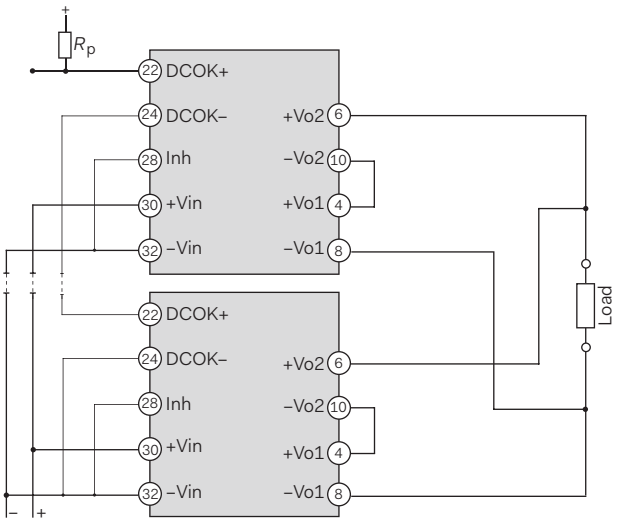
In parallel operation the DCOK signal can be chained according to adjacent example connection diagrams to achieve a common failure signal. If any of the paralleled converters fail, the DCOK signal will trigger. As DCOK signal is isolated this can be done with paralleled or separate sources. The DCOK signal can also be connected separately for each converter with individual pull up resistors Rp.

Inhibit signals Inh are preferred to be connected directly to negative input –Vin in parallel operation as shown on adjacent connection diagrams to prevent converters start up asynchronously. Alternatively, Inh signals can be connected to a common switching device. Inh signal is internally referenced to –Vin so common switch should be used only in case inputs are parallel connected.

Parallel connection of several converters will result in slightly higher load regulation, but combined performance is still within specified tolerances for one single converter.



Parallel connection with parallel connected outputs.



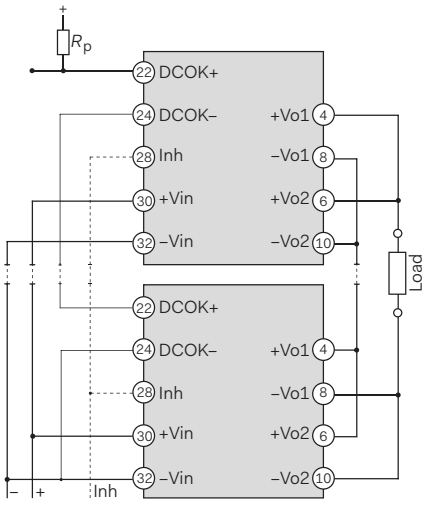
Parallel connection with series connected outputs.

6.3. Serial Connection of Multiple Units

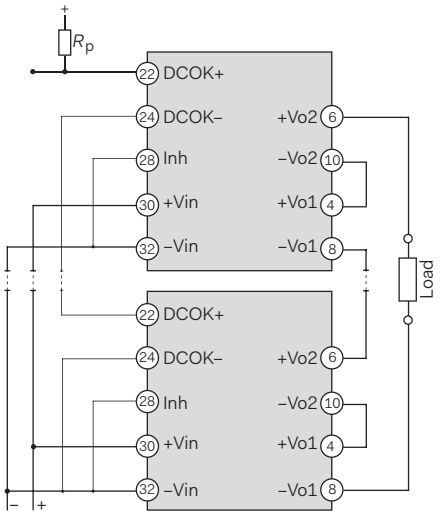
To achieve higher output voltages or symmetrical output, two or more converters can be connected in series. Note: The lowest current rating unit in series operation must not exceeded. Virtually any number of outputs can be connected in series below 500VDC output-output isolation voltage, but it is recommended to keep the total output voltage below SELV limit of 60V including 125% OVP. Powerbox does not hold responsibility if output voltage limit of 60V is exceeded.

ENAR150D Series converters does not require external protective diodes in series operations. The converters' secondary rectifying bridge acts as internal series block diode for back driven loads as well as parallel freewheeling diode to prevent negative output on start-up and converter failure events.

Example of configuration of two or more ENAR150D converters to achieve higher output voltage. If voltages of serial connected outputs exceed 48VDC special precautions need to be taken on the secondary side



Series connection with parallel connected outputs.



Series connection with series connected outputs.

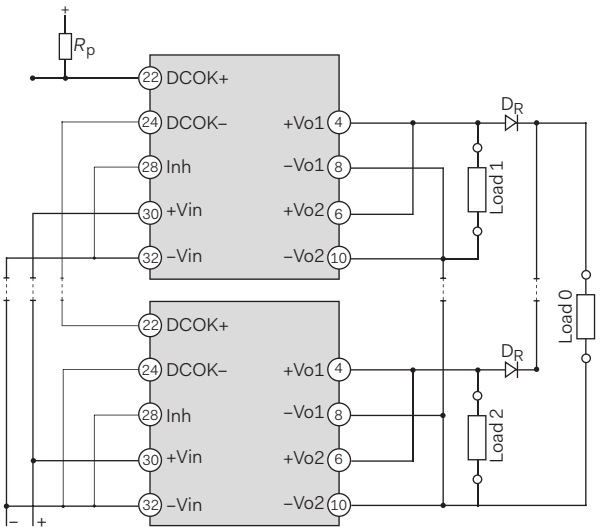
6.4. Redundant Configuration

Two or more ENAR150D Series converters can be connected in redundant configuration. In redundant configuration the power of parallel connected converter array exceeds the required load power by at least one converter. In case failure of one converter the rest of the converters will supply the load without interruptions.

In redundant configuration each converter need to be separated from the parallel load with ORing diode DR to prevent current flowing through failed converter, over loading the parallel array. The ORing diode DR is to be added on non-grounded output pole.

Non-critical loads can be left out side of the redundancy secured loop by connecting them before the ORing diode DR as in the example drawing the Load1 and Load2. Failure of the converter will disable the directly connected load.

The ORing diodes DR should be of low voltage drop type and withstand more than 115% of nominal current output of single converter. A good design rule is to choose an ORing diode DR that can withstand double the maximum rated current to withstand fast current peaks that exceeds the nominal maximum voltage.



Redundant operation

6.5. Input Parallel and Series Configuration

When two or more ENAR150D Series converters are used in same system, regardless of the output configuration, the inputs can be connected to separate sources, in parallel or to a symmetrical three wire source with common centre point.

In case of separate sources, it is mandatory to keep the potential difference of the sources below converters' input to ground isolation 1500V.

In symmetrical input configuration the inhibit signals need to be connected locally to negative input –Vin.
Regardless of the input configuration the DCOK signal can be connected freely within -2kV potential difference to chassis.

Series connecting several converter inputs without centre point is not possible.

7. Environmental

7.1. Thermal Considerations

The ENAR150D Series converters are designed to work in -40 to +70°C convection cooled ambient temperature complying to EN50155 class TX. Without additional cooling the converter can supply max 140W continuous power above +55°C.

Most of the heat is transferred to the baseplate of the unit. Therefore, it is essential to keep air moving over that surface, or mounting is against a cooling surface like an enclosure box wall or extra heatsink mounted on the baseplate surface. If the converter is rack mounted, ensure that it is mounted vertically and that air is allowed to move across the base plate area. In case several converters are stacked together, make sure converters have adequate distance in between. The distance can be shortened with additional heat sink.

If conduction cooling method to heatsink, enclosure or other thermally conductive surface is used, a thermal pad or other thermal conductor is recommended between layers to improve thermal conductivity.

ENAR150D Series converters are designed with an intelligent, auto-recovery Over Temperature Protection function. Internal temperature is measured at three points: at primary switching devices and at both secondary rectifiers. The converter will limit the output power if it senses temperature rise due to over load or if it's exposed to externally applied heat. For the output power derating curve by base plate temperature please refer to chapter 5.5 Derating.

As general rule of thumb, every 10°C degrease in ambient temperature will double the converter life time and vice versa. A recommended transportation and storage temperature is -55 to +85°C.

7.2. Humidity

All ENAR150D Series printed circuit boards are conformal coated in accordance to EN 50155 to protect the converter for moisture and atmospheric contaminants. The converters are operational up to 95% relative humidity.

7.3. Shock and Vibration

ENAR150D Series converters are approved according to IEC61373 category 1, class B shock and vibration. They are tested in all directions and the testing has been carried out at the following levels of severity.

X/Y/Z-directions	**Random**	**Shock**	**Shock**
	5-20 Hz: 4.05 (m/s^2)2/Hz	100 m/s2	200 m/s2
	20-150 Hz: -6 dB/oct	30 ms	11 ms
	5h: 11.4 m/s2 rms	Half sine	Saw tooth
		±3 shocks	±3 shocks

Operational test

Transversal/ Longitudinal/ Vertical	**Random**
	5-20 Hz: 4.05 (m/s^2)2/Hz
	20-150 Hz: -6 dB/oct
	5h: 11.4 m/s2 rms

Long-life test

7.4. Material Compliance

The ENAR150D Series converters are compliant to RoHS II and REACH directives.

7.5. Fire Protection

All material used on ENAR150D Series converters comply with UL94V-0 flammability and the converters comply with DIN5510-2 class S1 fire behaviour. The converters are also 3rd party approved according to EN45545 fire and fumes.

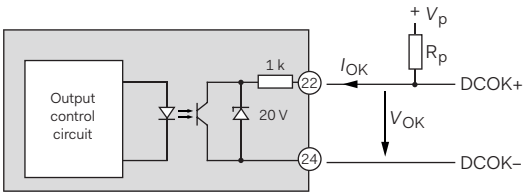
7.6. MTBF and Technical Lifetime

The ENAR150D Series converters have minimum calculated MTBF of 500 000 hours at +45°C, ground benign calculated by Phillips modified MIL-HDBK-217F method. The calculated minimum technical lifetime is 10 years at ambient temperature of +45°C, 80% load level and continuous operation.

8. Control Signals

8.1. Output DCOK

The ENAR150D Series converters have built-in output DCOK function available at DCOK+ pin 22 and DCOK- pin24 as well as visualized with a green LED on the front panel. The DCOK pins will conduct current when output 1 voltage is within nominal range. DCOK signal is opto-isolated with 2kVDC from any other electronics, input, output and case and can be referenced freely to input or output.



Redundant operation

The absolutely maximum voltage VOK over the DCOK pins is 20V and it is highly recommended to keep the current IOK below 1mA as higher currents or voltage may damage the unit. The DCOK signal is not powerful enough to drive a relay coil directly without external buffering, but it is suitable for open collector type application.

8.2. Inhibit Signal

The ENAR150D Series converters have an inhibit function to turn the converter output on and off. Inhibit input is on connector pin number 28 and it is referenced to negative input –Vin pin 32. The inhibit function is MOS type negative logic and accepts maximum rating of +/-30V externally applied voltage. To enable the unit output the inhibit should be connected to the negative input through less than 10 ohm switching device.

9. EMC

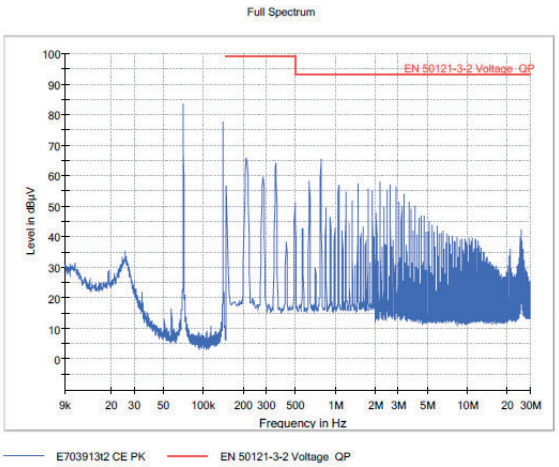
The ENAR150D Series converters meet or exceed the railway standards EN50155, EN50121-3-2 requirements and has been approved by a third party test house. A summary of the test report can be found below.

9.1. Summary of EMC Tests

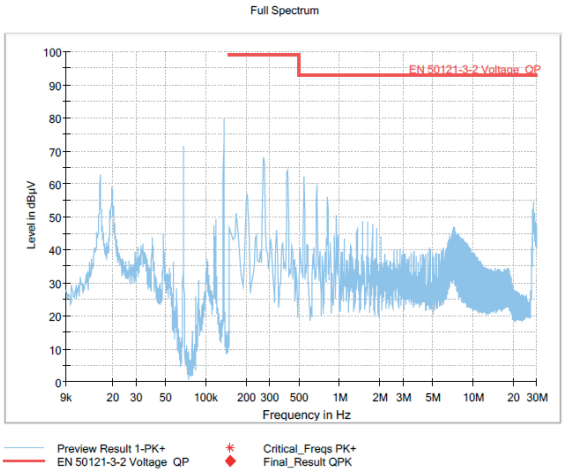
Test	Test method	Result
Immunity to electrostatic discharges	EN/(IEC) 61000-4-2:2009	Passed
Immunity to radio frequency electromagnetic fields	EN/(IEC) 61000-4-3:2006+A1+A2	Passed
Immunity to fast transients	EN/(IEC) 61000-4-4:2012	Passed
Immunity to surge transients	EN/(IEC) 61000-4-5:2006	Passed
Immunity to conducted radio frequency disturbances	EN/(IEC) 61000-4-6:2009	Passed
Measurement of radio frequency voltage on mains	CISPR 16-2-1:2008+A1	Passed
Measurement of radio frequency electromagnetic field	CISPR 16-2-3:2010+A1	Passed

9.2.Conducted Emission

The ENAR150D Series converters are third party tested according to EN50121-3-2 and EN55011 in bandwidth of 9kHz to 30MHz.



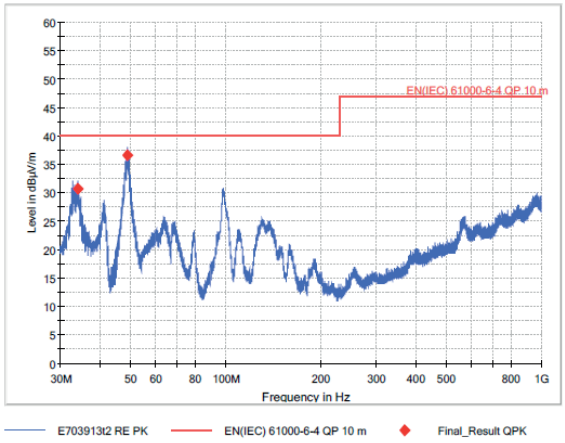
Conducted emission on ENAR150D110/2x12



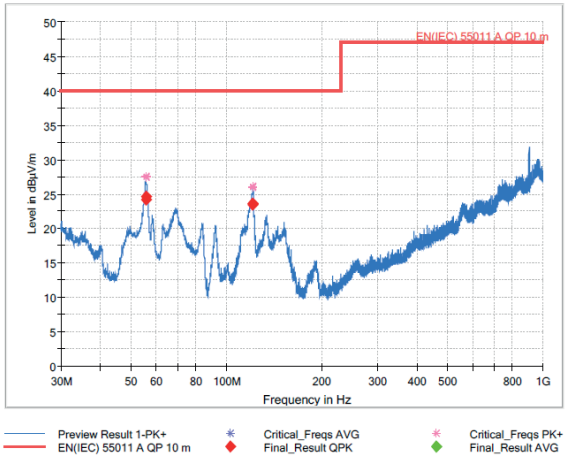
Conducted emission on ENAR150D24/2x24

9.3. Radiated Emission

The ENAR150D Series converters are third party tested according to EN50121-3-2 and EN55011 radiated emissions in full range bandwidth of 30MHz to 1000MHz.



Radiated emission on ENAR150D110/2x12

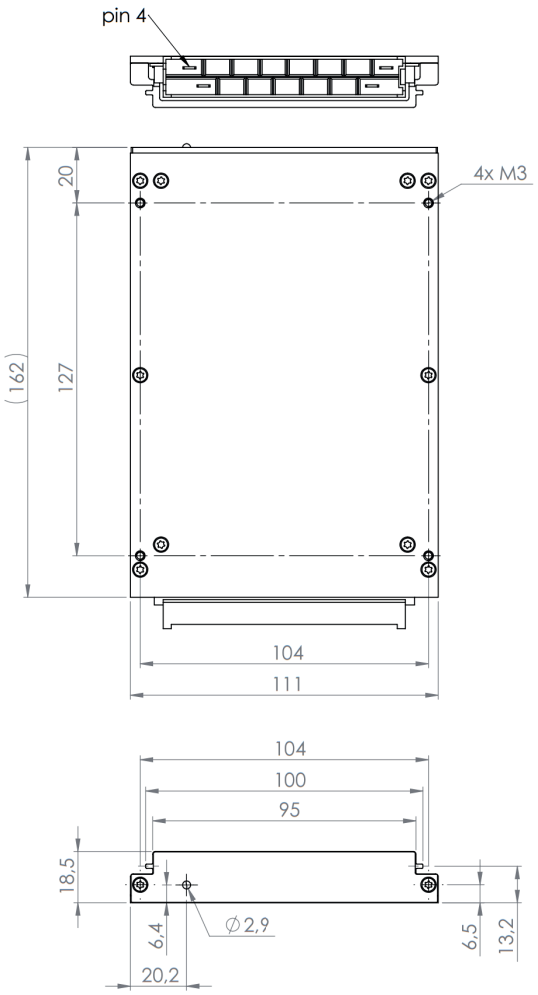


Radiated emission on ENAR150D24/2x24

10. Mechanical

10.1. Dimensions

The ENAR150D family is designed to be used in rack systems according to IEC 60297-3. The unit fits in 3U rack height and 4TE width. All measurements are metric in (mm).



10.2. Mechanical Protection

The ENAR150D Series converters are designed with protection class of IP30. All PCB's have Humiseal 1B73 EPA, or equal protective coating according to EN50155:2007.

10.3. Enclosure

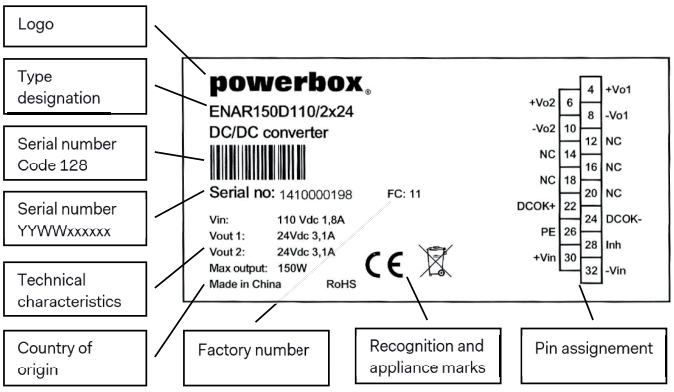
The ENAR150D Series enclosure is aluminium and is in natural aluminium colour. Surface has been treated with ChromitAl TCP.

10.4. Weight

The unit weight is 450gr +/-10gr excluding accessories.

10.5. Label

The unit label is 155x80 mm white polyester label with black print. Fonts are Arial or Helvetica light type with 2,5-3,5 mm height. Below picture shows label content and positioning.

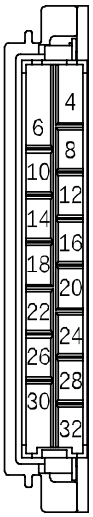


11. Connector

ENAR150D Series converters are equipped with H15 type connector according to DIN41612/IEC60603-2 and is mounted according to be used in 19" rack systems according to IEC60297-3.
The protective earth PE pin 261 is a leading pin. It is slightly longer than others to make the contact first when inserted and last when ejected.
In case inhibit function on pin 282 is not used, please connect it to –Vin pin 32 to enable the converter.

Pin No	Signal
4	+Vo1
6	+Vo2
8	-Vo1
10	-Vo2
12	NC
14	NC
16	NC
18	NC
20	NC
22	DC OK +
24	DC OK -
26	PE 1
28	Inhibit2
30	+Vin
32	-Vin

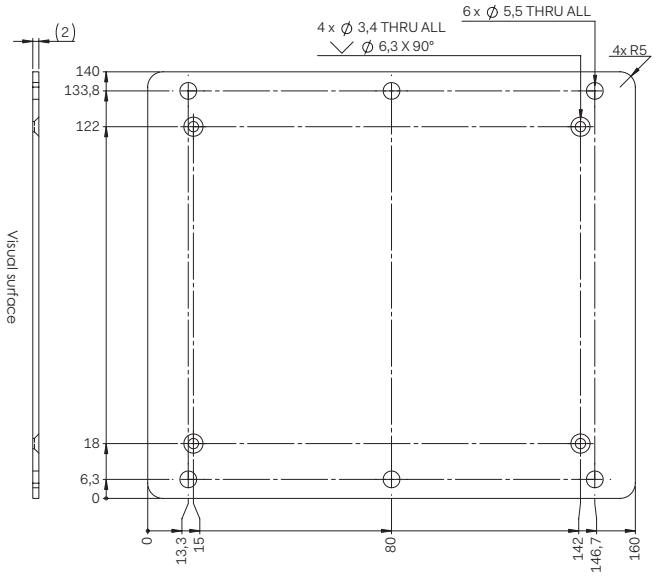
Pin assignment



12. Accessories

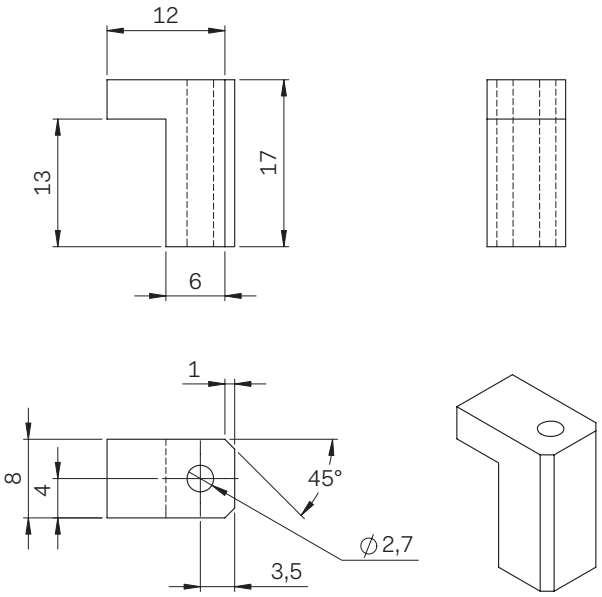
12.1 ACCM1101A Wall Mounting Kit

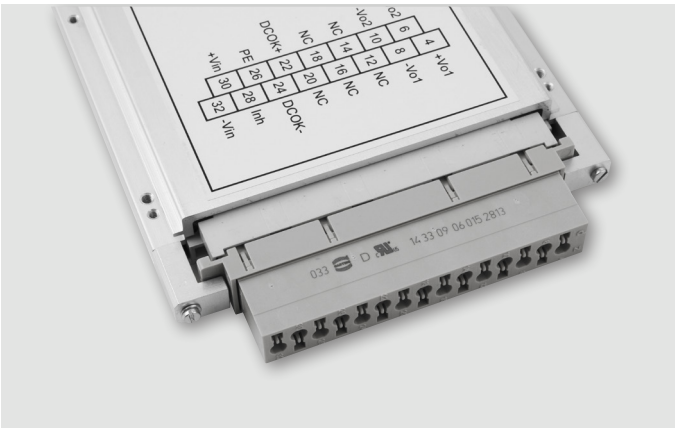
The mounting plate is used to mount the ENAR150D DC/DC converter on a metal surface. It is mounted on the flat side of the converter using the mounting holes. The converter can then be mounted horizontal or vertical. As most of the heat from inside the converted is transferred to the bottom surface, be sure to provide proper thermal connection either through the surface the unit mounted against or be sure that surrounding air can move.To lock the connector use the connector locking block provided in the accessory kit ACCM1102A.



12.2 ACCM1102A Connector Lockingblock Kit

The connector locking block kit contains 2 locking blocks and 2 M2,5 screws. Attach the locking block as shown in the picture to lock the connector in the appropriate position.



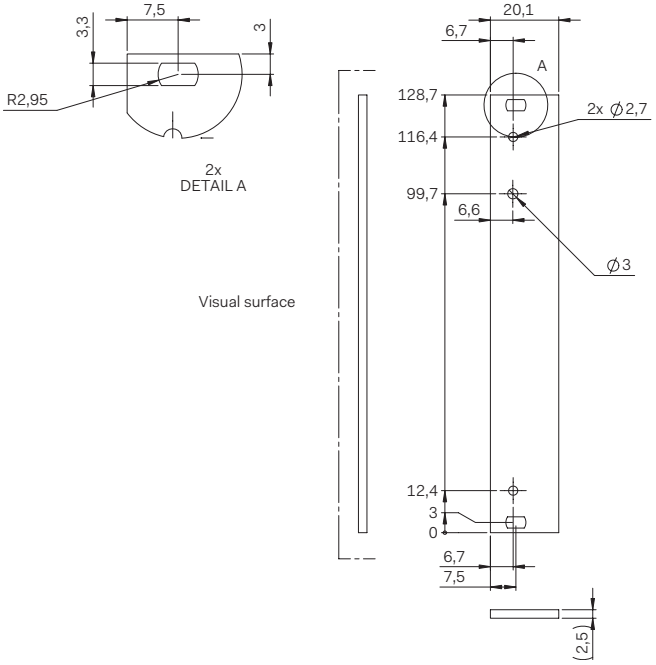


12.3 ACCM1103A Front Panel Kit

The front panes is designed to fit in the Eurocard system according to IEC60297-3.

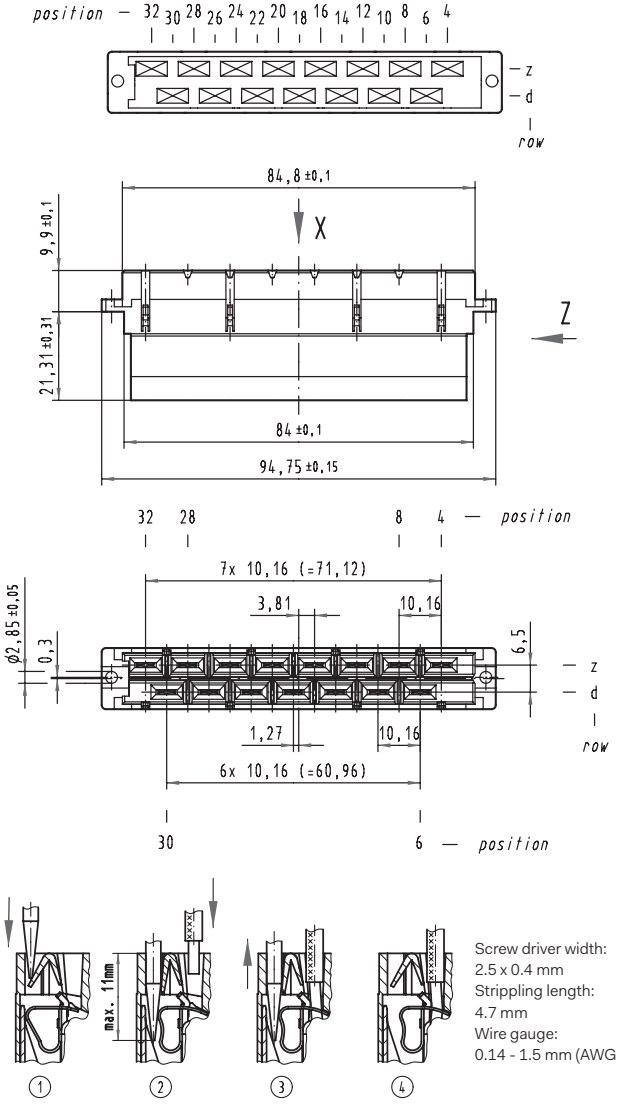
The panel has the dimensions 20 mm (w) x 129mm (h). The frontpanel shall be mounted on top of the existing coverplate using the same screws. Be sure that the frontpanel is mounted with the logo readable and the green light is visible. The kit also contains a front paned handle that should be mounted with the lower screw for the front panel.

The converter can be secured in a rack, using the provided sleeves and screws.



12.4 ACCX2001A Connector

The connector is of type Harting type DS 09 06 210 07 01 or equivalent. The cable connection is done by inserting the appropriate cable in the mounting hole. After inserted the cable will be self-locked in the position.



Screw driver width:
2.5 x 0.4 mm
Strippling length:
4.7 mm
Wire gauge:
0.14 - 1.5 mm (AWG 26 - 16)