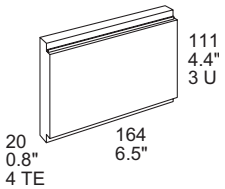
Features

- RoHS lead-free-solder product
- Input for all railway batteries (24 to 110 V)
- 2 outputs 12.6 and 5 V
- Class I equipment
- Very high efficiency
- Outputs with current limitation, short-circuit proof
- Excellent surge and transient protection
- Sense line for +5 V
- Extremly slim case (4 TE, 20 mm), fully enclosed
- Hipot test voltage 2.8 kVDC
- All PCBs coated with protective lacquer



Safety-approved to IEC/EN 60950-1 and UL/CSA 60950-1 2nd Ed.

Description

These extremely compact DC-DC converters incorporate all necessary input and output filters, signaling and protection features, which are required in this application.

MD098 is comprised of a 3 stage input filter, a standard DC-DC converter (110IMY70-12), a standard Point-of-Load regulator (YS12S16), output filters, and other circuits. MD099 and MD100 exhibit an aditional booster after the input filter to generate the voltage needed by the DC-DC converter.

All components are installed in a fully enclosed extremly slim metallic case (4 TE, 20 mm). Full input-to-output isolation, overtemperature protection, and input undervoltage lockout are provided.

The converter is particularly suitable for rugged environments in railway application and was designed in accordance with the European railway standards EN 50155 and EN 50121-3-2. All printed circuit boards are coated with a protective lacquer. The outputs are continuously open- and short-circuit proof.

Product Marking

Type designation, safety approval and recognition marks, CE mark, warnings, pin allocation, input voltage range, nominal output voltages and output currents, degree of protection, identification of LEDs, and data code including batch no., serial no., production site, version, and date of production.

Model selection

- MD098-000G intended for 72 V, 96 V, and 110 V batteries
- MD099-000G intended for 36 V, 48 V, and 54 V batteries
- MD100-000G intended for 24 V batteries

Table of Contents

Functional Description

The input voltage is fed via a fuse and a highly efficient input filter directly to a standard DC-DC converter 110IMY70-12.

In the systems MD099 and MD100 a storage capacitor C_{hu} is charged via a current source to 70 V. It guarantees maintaining the output voltages during the interruption time. A standard booster IBX15 generates a suitable intermediate voltage for the DC/DC converter. The interruption time is provided by the capacitor C_{hu}.

The isolated output of the DC/DC converter generates 12.6 V for output 2 and supplies a standard POL (step-down converter), which generates 5.1 V for output 1. Even though the POL exhibits an internal current limitation, an additional current sense disables the POL after a predefined time and reactivates it after a short pause. As a result, the mean current is limited to a lower value, such protecting thin wires connected to the 5.1 V output.

3 LEDs display the status of the input and both outputs.

The hole system is accommodated in a slim line Aluminum case equipped with an H15 connector. The pin configuration is compatibel to P-Series converters.

Detailed data sheets of the standard components (110IMY70, IBX15) are displayed on our web site.

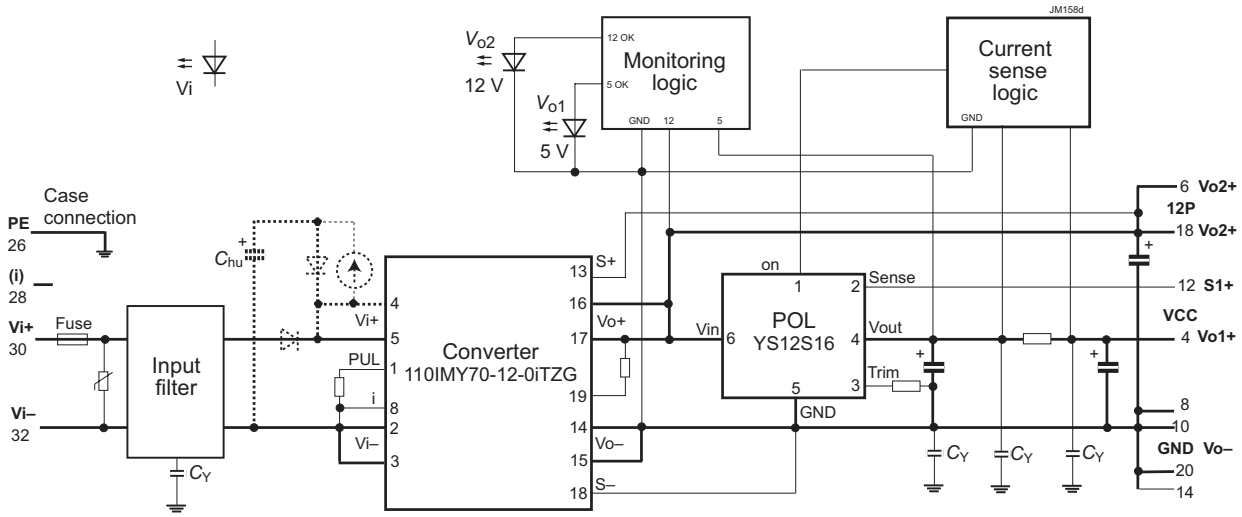


Fig. 1
Block diagram of MD098

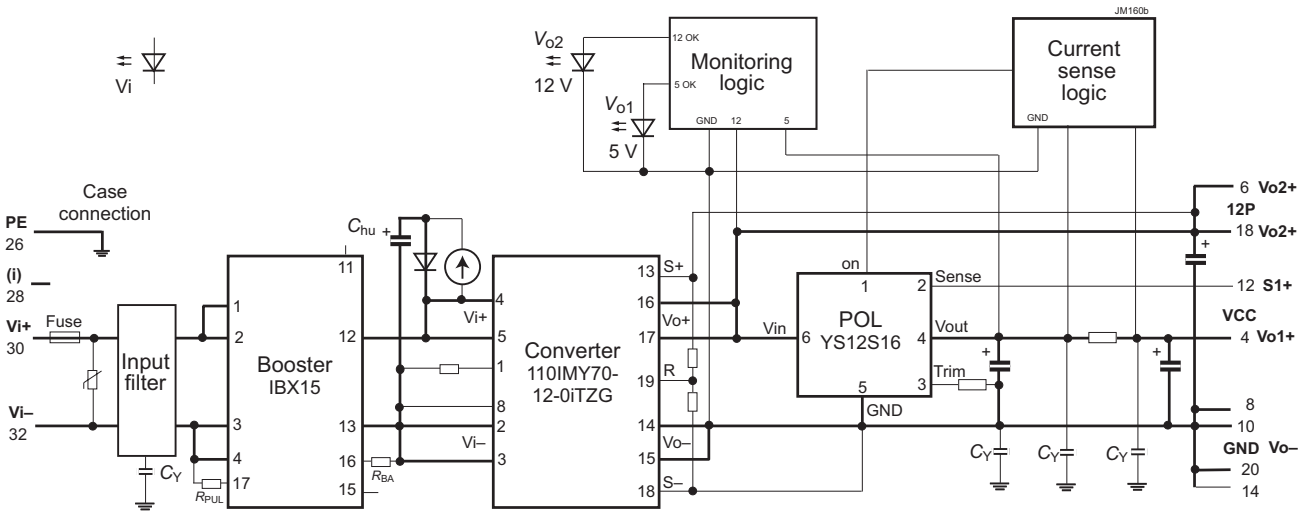


Fig. 2
Block diagram of MD099 and MD100

Electrical Input Data

General Conditions:
– T_A = 25 °C, unless specified
– Sense line connected directly at the connector

Table 2: Input data

Input			MD098-000G			MD099-000G			MD100-000G			Unit
Characteristics		Conditions	min	typ	max	min	typ	max	min	typ	max	
V_i	Operating input voltage for ≤ 2 s	I_o = 0 – $P_{o\,nom}$ $T_{C\,min}$ – $T_{C\,max}$	50.4 43.2		137.5 154	25.2 21.6		67.5 75.6	16.8 14.4		33.6 40.1	V
$V_{i\,nom}$	Nominal input voltage			(72) 110			36 (54)			24		
I_i	Typical input current	$V_{i\,nom}$, $P_{o\,nom}$		(1.2) 0.75			2.5 (1.7)			3.6		A
$P_{i\,0}$	No-load input power	$V_{i\,min}$ – $V_{i\,max}$	2.5		6	3		6	3		6	W
C_i	Input capacitance			32			66			330		µF
η	Efficiency	$V_{i\,nom}$, $P_{o\,nom}$	86	88		82	85		81	83.5		%
$t_{d\,on}$	Start-up time	0 → $V_{i\,min}$, $P_{o\,nom}$		0.5			0.5			0.5		s

Input Fuse and Protection

A VDR (Voltage Dependent Resistor), the input fuse, and a symmetrical input filter form an effective protection against input transients, which typically occur in most installations, but especially in battery-driven mobile applications.

The fuse is not user-accessible. Reverse polarity at the input will cause the fuse to blow.

Table 3: Fuse and undervoltage specification

Model	Battery	Fuse rating	Reference	$V_{i\,min}$ (on/off)
MD098	72, 96, 110 V	5 A, 250 V, fast	Littlefuse Pico 263	46 V 40.5 V
MD099	36, 48, 54 V	10 A, 125 V, fast	Littlefuse Pico 251	23 V 19 V
MD100	24 V	2x 7 A, 125 V	Littlefuse Pico 251	14.8 V 13 V

Interruption Time

Due to the integrated storage capacitor C_{hu}, the converters MD099 and MD100 provide an interruption time of 10 ms under nominal conditions.

MD098 is prepared for populating the components to provide the interruption time.

Electrical Output Data

General Conditions:
– T_A = 25 °C, unless T_C is specified.
– Sense line connected directly at the connector

Output data

Output				5.1 V			12.6 V			Unit
Characteristics			Conditions	min	typ	max	min	typ	max	
V_o	Output voltage		V_i = 110 V, $I_{o\,nom}$	5.05	5.1	5.15	12.53	12.6	12.67	V
V_{ow}	Worstcase output voltage		$V_{i\,min} - V_{i\,max}$ $T_{C\,min} - T_{C\,max}$	5.0		5.2	12.45		12.75	
$I_{o\,nom}$	Nominal output current				5			4		A
I_o	Continuous output current		$V_{i\,min} - V_{i\,max}$	10						
I_{oL} [1]	Peak output current [1]				22 [1]		8.5	8.8	9.2	
C_o	Output capacitance [2]			0		10	0		∞	mF
v_o	Output noise [3]	Switch. frequ.			10			30		mV_{pp}
		Totalincl.spikes			35			70		

[1] 5.1 V output: $I_{av\,max}$ = typ. 12 A, hiccup repetition rate typ. 6 Hz [2] for continuous start-up [3] measured with 20 MHz band width

Sense Lines

This feature enables compensation for voltage drop across the connector contacts and the load lines including OR-ing diodes in true redundant systems.

Environmental Conditions

Electromagnetic Immunity

Table 5: Immunity type tests

Phenomenon	Standard	Class Level	Coupling mode [1]	Value applied	Waveform	Source imped.	Test procedure	In oper.	Perf-[2] crit.
Electrostatic discharge to case	IEC/EN 61000-4-2	[3]	contact discharge	±6000 V_p	1/50 ns	330 Ω	10 positive and 10 negative discharges	yes	B
		3 [3]	air discharge	±8000 V_p					
Electromagnetic field	IEC/EN 61000-4-3	[4]	antenna	20 V/m	80% AM, 1 kHz	n.a.	80 – 1000 MHz	yes	A
		[5]	antenna	20 V/m	80% AM, 1 kHz	n.a.	800 – 1000 MHz	yes	A
				10 V/m			1400 – 2100 MHz		
				5 V/m			2100 – 2500 MHz		
Electrical fast transients/burst	IEC/EN 61000-4-4	3 [6]	direct coupl. +i/c, –i/c, +i/–i	±2000 V_p [6]	5/50 ns, 5 kHz over 15 ms	50 Ω	60 s pos. and neg. transients per coupling mode	yes	A
Surges	IEC/EN 61000-4-5	3 [7]	+i/c, –i/c	±2000 V_p	1.2/50 µs	42 Ω 0.5 µF	5 pos. and 5 neg. surges per coupling mode	yes	B
			+i/–i	±1000 V_p					
Conducted disturbances	IEC/EN 61000-4-6	3 [8]	i, o, signal wires	10 VAC (140 dBµV)	AM 80% 1 kHz	150 Ω	0.15 – 80 MHz	yes	A
Power frequency magnetic field	IEC / EN 61000-4-8	--	--	300 A/m			60 s in all 3 axis	yes	A

[1] i = input, o = output, c = case
[2] A = normal operation, no deviation from specification, B = temporary deviation from specs. possible
[3] Corresponds to EN 50121-3-2:2006, table 9.3
[4] Corresponds to EN 50121-3-2:2006, table 9.1
[5] Corresponds to EN 50121-3-2:2006, table 9.2 (compliance with digital mobile phones).
[6] Corresponds to EN 50121-3-2:2006, table 7.2
[7] Corresponds to EN 50121-3-2:2006, table 7.3
[8] Corresponds to EN 50121-3-2:2006, table 7.1

Electromagnetic Emissions

Compliance with EN 55011/22, class A, was tested for conducted and radiated disturbances.Test conditions: $V_{i\,nom}$, $P_{o\,nom}$.

Mechanical and Climatic Stress

Table 6: Mechanical and climatic stress

Test	method	Standard	Test conditions		Status
Db	Damp heat test, cyclic	EN 50155:2007, clause 12.2.5 IEC/EN 60068-2-30	Temperature: Cycles (respiration effect): Duration:	55 °C and 25 °C 2 2× 24 h	Converter not operating
Bd	Dry heat test, steady state	EN 50155:2007, clause 12.2.4 IEC/EN 60068-2-2	Temperature: Duration:	70 °C 6 h	Converter operating
Ad	Cooling test, steady state	EN 50155:2007, clause 12.2.3 IEC/EN 60068-2-1	Temperature, duration Performance test	–40 °C, 2 h +25 °C	Conv. not operating
--	Shock	EN 50155:2007 clause 12.2.11, EN 61373 sect. 10, class B, body mounted [1]	Acceleration amplitude: Bump duration: Number of bumps:	5.1 g_n 30 ms 18 (3 in each direction)	Converter operating
--	Simulated long life testing at increased random vibration levels	EN 50155:2007 clause 12.2.11, EN 61373 sect. 8 and 9, class B, body mounted [1]	Acceleration spectral density: Frequency band: Acceleration magnitude: Test duration:	0.02 g_n^2 / Hz 5 – 150 Hz 0.8 g_{nrms} 15 h (5 h in each axis)	Converter operating

[1] Body mounted = chassis of a railway coach

Temperatures

Table 7: Temperature specifications, valid for an air pressure of 800 – 1200 hPa (800 – 1200 mbar)

Temperature			Standard			
Characteristics		Conditions	min	typ	max	Unit
T_A	Ambient temperature	Converter operating	–40		71	°C
T_C	Case temperature		–40		95	
T_S	Storage temperature	Non operational	–55		100	
$R_{th\,C\text{-}A}$	Thermal resistance case to ambient in still air			1.6		K/W

Mechanical Data

The converters are designed for insertion into a 19" rack according to IEC 60297-3.

Dimensions in mm.

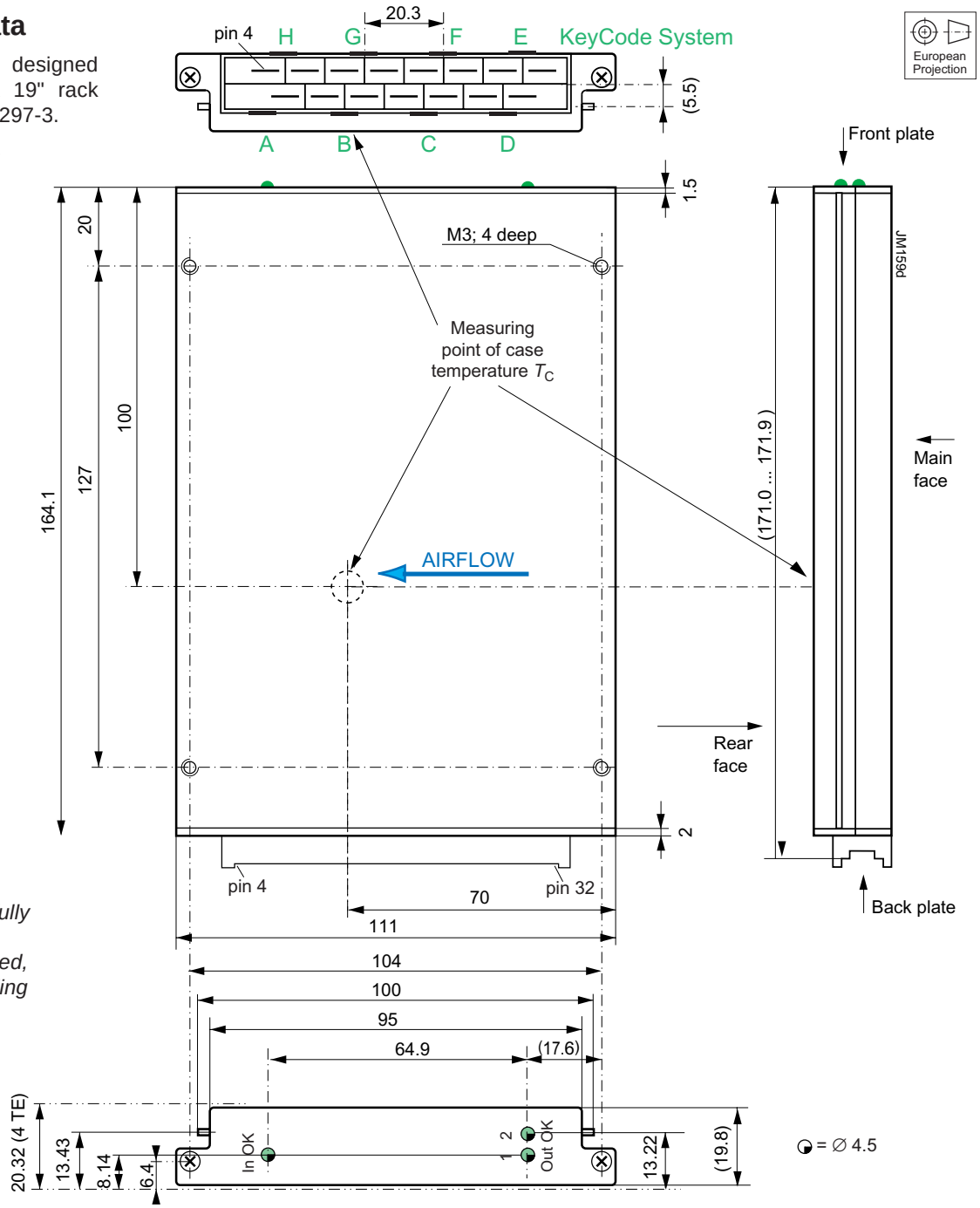


Fig. 3
Aluminum, fully enclosed, black anodized, and self cooling

Installation

Connector Pin Allocation

The connector pin allocation table defines the electrical potentials and the physical pin positions on the H15 connector. Pin no. 26, protective earth, is a leading pin to ensure that it makes contact with the female connector first.

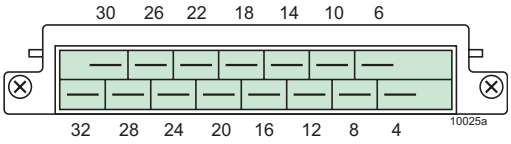


Fig. 4
View of male standard H15 connector. The key code positions are shown in fig. 3.

Table 8: Pin allocation of the H15 connector

Pin	Electrical determination	MD098/099/100	
4	5 V output (positive)	Vo1+	VCC
6	12 V output (positive)	Vo2+	12P
8	5 V output (negative)	Vo1–	GND
10	12 V output (negative)	Vo2–	GND
12	5 V sense line (positive) [1]	S1+	VCC (S)
14	Sense line (negative) [1]	S–	GND
16	n.c.	n.c.	--
18	12 V output (positive)	Vo2+	12P
20	12 V output (negative)	Vo2–	GND
22	n.c.	n.c.	--
24	n.c.	n.c.	--
26	Protective earth PE [1]	⏚	P E
28	not connected [2]	(i)	--
30	Input voltage (positive)	Vi+	Vi+
32	Input voltage (negative)	Vi–	Vi–

[1] Leading pin (pre-connecting).
[2] May be externally connected to pin 32.

Installation Instructions

These converters are components, intended exclusively for inclusion within other equipment by an industrial assembly process or by a professionally competent person.

Connection to the system shall be made via a female connector H15. Other installation methods may not meet the safety requirements. Pin 26 (PE) is a leading pin and is reliably connected to the case. For safety reasons it is essential to connect this pin to the protective earth.

Protection Degree and Cleaning Liquids

The DC-DC converters correspond to protection degree IP 40, provided that the female connector is fitted to the converter.

The converters are not hermetically sealed. In order to avoid possible damage, any penetration of liquids shall be avoided.

Railway Applications

This converter has been designed observing the railway standards EN 50155:2007 and EN 50121:2006. All boards are coated with a protective lacquer.

The converter complies to NF-F-16, Class I3/F2.

Safety and Isolation

The converters are class I equipment and have been designed for:

- Building-in
- Reinforced insulation input to output, basic insulation to the case, based on the input voltage of 150 V. The case is reliably connected to pin 26 (PE).
- Pollution degree 2
- Output is SELF at non-hazardous energy level.

The electric strength test is performed in the factory as a routine test according to EN 50514 and IEC/EN 60950-1.

Table 9: Electric strength test voltages

Characteristic	Input to (outputs+case)	Outputs to case	Unit
Factory test >1 s	2.8 [1]	0.7	kVDC
Equivalent AC voltage	2.0	0.5	kVAC
Insulation resistance at 500 VDC	>100	>100	MΩ

[1] According to IEC/EN 60950, subassemblies con-necting input to output are pre-tested with 4.2 kVDC or 3.0 kVAC.