power-one™ Changing the Shape of Power

[1] For 110IMY15 models

Features

Wide input voltage ranges up to 150 VDC
1 or 2 outputs up to 48 VDC
1200 to 3000 VAC I/O electric strength test

- Extremely wide input voltage ranges
- Electrical isolation, also between outputs
- Emissions below EN 55022, level B
- Immunity to IEC/EN 61000-4-2,-3,-4,-5, and -6
- High efficiency (typ. 87%)
- Input undervoltage lockout
- Shut down input, adjustable output voltages
- Flex power: Flexible load distribution on outputs
- Outputs no-load, overload and short-circuit proof
- Operating ambient temperature –40 to 85 °C
- Thermal protection
- 2" x 1.6" case with 10.5 mm profile
- Supplementary insulation: 20/40IMX15 models
- Double or reinforced insulation: 110IMY15 models

Description

The IMX15 and IMY15 Series of board mountable 15-Watt DC-DC converters has been designed according to the latest industry requirements and standards. The converters are particularly suitable for use in mobile or stationary applications in transport, railways, industry, or telecommunication where variable input voltages or high transient voltages are prevalent.

Covering a total input voltage range from 8.4 up to 150 V with 3 different models, the units are available with single, dual and electrically-isolated double outputs from 3.3 up to 48 V externally adjustable, with flexible load distribution on dual and double output units. A shut down input allows remote converter on-off. Features include consistently high efficiency over the entire input voltage range, high reliability and excellent dynamic response to load and line changes.

The converters are designed and built according to the international safety standards IEC/EN/UL 60950 and approved by TÜV, UL and cUL. The models 20IMX15 and 40IMX15 provide supplementary insulation. Connected to a secondary circuit the 40IMX15 models provide SELV outputs, even if the bus voltage at the converter input exceeds the SELV-limit of 60 VDC. The 110IMY15 models provide double insulation and are CE marked. They may be connected for example to a rectified 110 VAC source without any further isolation barrier.

The circuit comprises of integrated planar magnetics and all components are automatically assembled and solidly soldered onto a single PCB without any wire connection. Magnetic feedback ensures maximum reliability and repeatability in the control loop over all operating conditions. Careful considerations of possible thermal stresses ensure the absence of hot spots providing long life in environments where temperature cycles are a reality. The thermal design allows operation at full load up to an ambient temperature of 85 °C in free air without using any potting material. For extremely high vibration environments the case has holes for screw mounting.

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Model Selection

Table 1: Model Selection

Output 1		Output 2		Output power	Input voltage	Efficiency	Model	Options[2]
$V_{o\,nom}$ [VDC]	$I_{o\,nom}$[1] [A]	$V_{o\,nom}$ [V DC]	$I_{o\,nom}$[1] [A]	$P_{o\,nom}$ [W]	$V_{i\,min}$ to $V_{i\,max}$ [VDC]	η[6] [%]		
3.3	4.5	-	-	14.9	8.4 to 36[5]	84	20IMX15-03-8RG	-9, i, Z
3.3	4.5	-	-	14.9	16.8 to 75[3]	85	40IMX15-03-8RG	-9, i, Z
3.3	4.5	-	-	14.9	50 to 150[4]	84	110IMY15-03-8RG	i, Z
5.1	3.5	-	-	17.5	8.4 to 36[5]	86	20IMX15-05-8RG	i, Z
5.1	3.5	-	-	17.5	16.8 to 75[3]	87	40IMX15-05-8RG	i, Z
5.1	3.5	-	-	17.5	50 to 150[4]	86	110IMY15-05-8RG	i, Z
5.1	2.3	-	-	11.7	8.4 to 36[5]	85	20IMX15-05-8R	-9, i, Z
5.1	2.5	-	-	12.8	16.8 to 75[3]	83	40IMX15-05-8R	-9, i, Z
5.1	2.5	-	-	12.8	50 to 150[4]	83	110IMY15-05-8R	i, Z
5.1	1.35	3.3	1.35	11.3	8.4 to 36[5]	84	20IMX15-0503-8R	-9, i, Z
5.1	1.5	3.3	1.5	12.6	16.8 to 75[3]	84	40IMX15-0503-8R	-9, i, Z
5.1	1.5	3.3	1.5	12.6	50 to 150[4]	82	110IMY15-0503-8R	i, Z
5	1.3	5	1.3	13.0	8.4 to 36[5]	86	20IMX15-05-05-8	-9, i, R, Z
5	1.4	5	1.4	14.0	16.8 to 75[3]	86	40IMX15-05-05-8	-9, i, R, Z
5	1.4	5	1.4	14.0	50 to 150[4]	86	110IMY15-05-05-8	i, Z
12	0.65	12	0.65	15.6	8.4 to 36[5]	88	20IMX15-12-12-8	-9, i, Z
12	0.7	12	0.7	16.8	16.8 to 75[3]	88	40IMX15-12-12-8	-9, i, R, Z
12	0.7	12	0.7	16.8	50 to 150[4]	87	110IMY15-12-12-8	i, Z
15	0.5	15	0.5	15.0	8.4 to 36[5]	88	20IMX15-15-15-8	-9, i, R, Z
15	0.56	15	0.56	16.8	16.8 to 75[3]	88	40IMX15-15-15-8	-9, i, R, Z
15	0.56	15	0.56	16.8	50 to 150[4]	87	110IMY15-15-15-8	i, R, Z
24	0.32	24	0.32	15.4	8.4 to 36[5]	86	20IMX15-24-24-8	-9, i, R, Z
24	0.35	24	0.35	16.8	16.8 to 75[3]	86	40IMX15-24-24-8	-9, i, R, Z
24	0.35	24	0.35	16.8	50 to 150[4]	86	110IMY15-24-24-8	i, Z

[1] Flexible load distribution on dual and double outputs possible up to 75% of the total output power $P_{o\,nom}$ on one of the 2 outputs. IMX/IMY 15-0503 models have reduced load distribution flexibility; 1.8 A max. on one of the 2 outputs. The other output should not exceed the difference to the total output power $P_{o\,nom}$.

[2] See: *Description of Options.* For availability ask Power-One. Option -9 is not recommended for new designs.

[3] Short-time operation down to V_i = 14.4 V possible. P_o reduced to approx. 85% of $P_{o\,nom}$.

[4] Short-time operation down to V_i = 43.2 V possible. P_o reduced to approx. 85% of $P_{o\,nom}$.

[5] Initial start-up at 9 V, main output voltage regulation down to 8.4 V.

[6] Typ. efficiency at $V_{i\,nom}$, $I_{o\,nom}$.

Part Number Description

20 IMX 15 - 05 - 05 -8 R G i Z

Input voltage range V_i
- 8.4 to 36 VDC 20
- 16.8 to 75 VDC 40
- 50 to 150 VDC 110

Series IMX15, IMY15

Output voltage type output 1 .... 03, 05, 12, 15, 24

Dash designates double output unit with two independent electrically isolated outputs .... - [1]

Output voltage type output 2 .... 03, 05, 12, 15, 24

Operating ambient temperature range T_A
- –40 [5] to 85 °C (standard) .... -8
- –40 [5] to 71 °C NFND .... -9

Options and features:
- R input and magnetic feedback ....R [2, 3]
- Synchronous rectification .... G
- Inhibit .... i [2, 4]
- Open frame .... Z

[1] Not applicable to -0503 models.
[2] For lead times contact Power-One. Some types require a minimum order quantity.
[3] Standard features for single output and -0503- models.
[4] Option i excludes shut down.
[5] Only –25 °C for -RG models.

Examples: 20 IMX15-05-05-8: DC-DC converter, input voltage 9 to 36 V, 2 electrically isolated outputs each providing 5 V, 1.3 A.

110 IMY15-0503-8R: DC-DC converter, input voltage 50 to 150 V, 2 outputs with common return providing +5.1 V, 1.5 A and +3.3 V, 1.5 A. Unit fitted with magnetic feedback for tight output voltage regulation.

Product Marking

Basic type designation, output voltages and currents, applicable safety approval and recognition marks, Power-One patent nos. and company logo. Date code and serial no.

Functional Description

The IMX/IMY 15 series of DC-DC converters are magnetic feedback-controlled flyback converters using current mode PWM (Pulse Width Modulation). The -05- and -0503-output voltage models as well as all double output models fitted with option R feature an active magnetic feedback loop via a pulse transformer, which results in very tight regulation of the output voltage (see fig.: *Block diagram, single output types, -0503- types and double output types*). The output voltages of these versions can be adjusted via the R input. The R input is referenced to the secondary side and allows for programming of the output voltages in the range of approximately 80 to 105% of $V_{o\ nom}$ using either an external resistor or an external voltage source.

The voltage regulation on the dual and double output models without option R is achieved with a passive transformer feedback from the main transformer (see fig.: *Block diagram, double output types*). The output voltages can be adjusted via the Trim input. The Trim input is referenced to the primary side of the converter and allows for programming of the output voltages in the range 100 to 105% of $V_{o\ nom}$ via an external resistor or within 75 to 105% using an external voltage source. The load regulation output characteristic allows for paralleling of one or several double output units with equal output voltages.

Current limitation is provided by the primary circuit, thus limiting the total output power of double output types. The shut down input allows remote converter on/off.

Overtemperature protection will disable the unit under excessive overload conditions with automatic restart approximately every 50 to 60 ms.

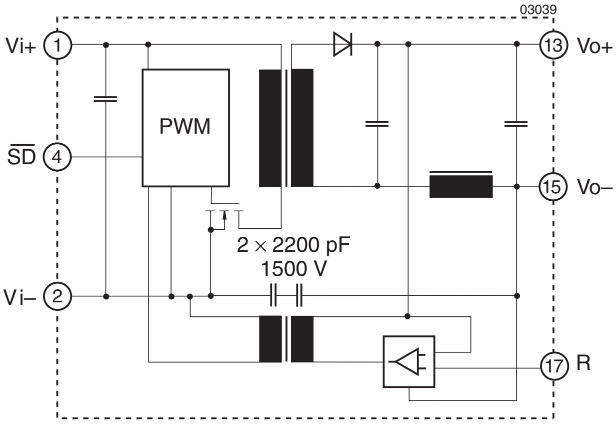

Fig. 1
Block diagram, single output models

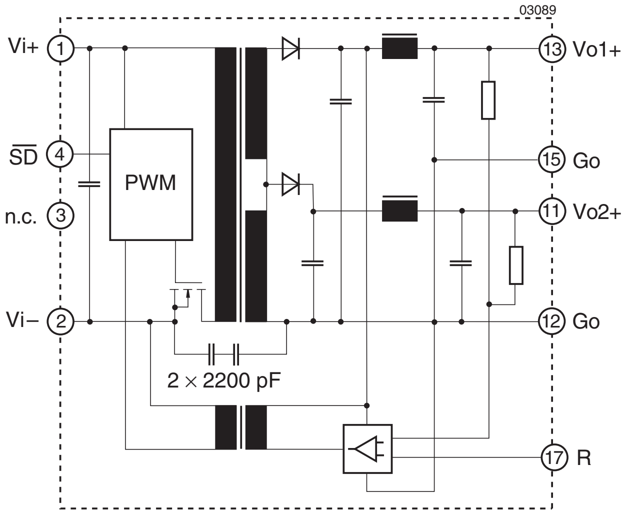

Fig. 2
Block diagram, -0503-models.

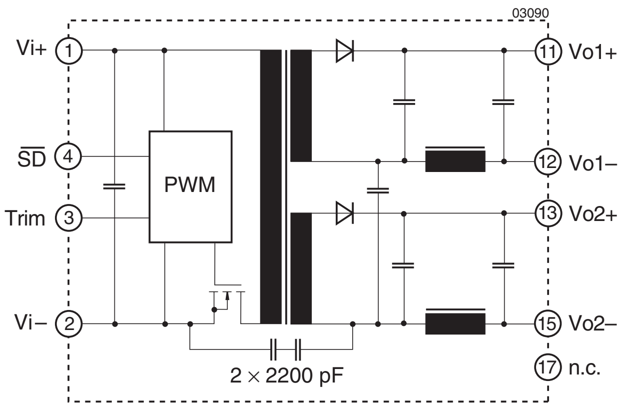

Fig. 3
Block diagram, double output models.

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Electrical Input Data

General conditions:
- T_A = 25°C, unless T_C is specified.
- Shut down pin left open-circuit.
- Trim or R input left open-circuit.

Table 2: Input Data

Input				20IMX			40IMX			110IMY			
Characteristics			Conditions	min	typ	max	min	typ	max	min	typ	max	Unit
V_i	Input voltage range [1]		$T_{A\,min}$ to $T_{A\,max}$ I_o = 0 to $I_{o\,nom}$	9 [5, 9]		36	16.8 [5, 6]		75	50 [5, 7]		150	VDC
$V_{i\,nom}$	Nominal input voltage				20			40			110		
$V_{i\,sur}$	Repetitive surge voltage		Abs. max input (3 s)			40			100			168	
$t_{start\,up}$	Converter start-up time [2]	Switch on	Worst case condition at $V_{i\,min}$ and full load		0.25	0.5		0.25	0.5		0.25	0.5	s
		$\overline{SD}$ high				0.1			0.1			0.1	
t_{rise}	Rise time [2]		$V_{i\,nom}$ resistive load		5			5			5		ms
			$I_{o\,nom}$ capac. load		10	20		10	20		10	20	
$I_{i\,o}$	No load input current		I_o = 0, $V_{i\,min}$ to $V_{i\,max}$			40			20			10	mA
I_{irr}	Reflected ripple current		I_o = 0 to $I_{o\,nom}$			30			30			20	mA_{pp}
$I_{inr\,p}$	Inrush peak current [3]		$V_i = V_{i\,nom}$			8			9			10	A
C_i	Input capacitance		for surge calculation		1.5			0.75			0.35		µF
$U_{\overline{SD}}$	Shut down voltage		Converter shut down		–10 to 0.7			–10 to 0.7			–10 to 0.7		VDC
			Converter operating		open or 2 to 20			open or 2 to 20			open or 2 to 20		
$R_{\overline{SD}}$	Shutdown input resistance		For current calculations		approx. 10			approx. 10			approx. 10		kΩ
$I_{\overline{SD}}$	Input current if unit shut down		$V_{i\,min}$ to $V_{i\,max}$			6			3			1	mA
f_s	Switching frequency		$V_{i\,min}$ to $V_{i\,max}$, I_o = 0 to $I_{o\,nom}$		approx. 300			approx. 300			approx. 300		kHz
$V_{i\,RFI}$	Input RFI level conducted		EN 55022 [4]		B [8]			B			B		

[1] If V_o is set above $V_{o\,nom}$ by use of the R or Trim input, $V_{i\,min}$ will be proportionately increased.
[2] Measured with resistive and max. admissible capacitive load.
[3] Source impedance according to ETS 300132-2, version 4.3.
[4] Measured with a lead length of 0.1 m, leads twisted. Double output units with both outputs in parallel.
[5] Input undervoltage lockout at typ. 80% of $V_{i\,min}$.
[6] Short time operation down to $V_{i\,min}$ >14.4 V possible. P_o reduced to approx. 85% of $P_{o\,nom}$.
[7] Short time operation down to $V_{i\,min}$ >43.2 V possible. P_o reduced to approx. 85% of $P_{o\,nom}$.
[8] 20IMX15 types require a 4.7 µF/50 V capacitor across the input.
[9] Initial start-up at V_i = 9 V, main output voltage regulation down to 8.4 V.

Inrush Current

The inrush current has been kept as low as possible by choosing a very small input capacitance. A series resistor may be installed in the input line to further reduce this current.

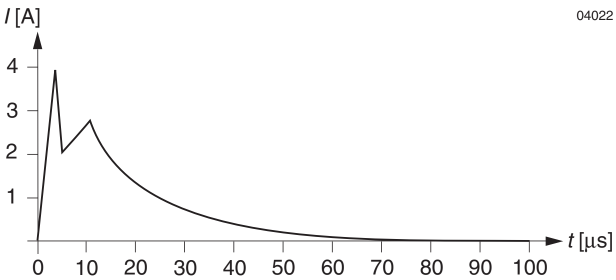

Fig. 4
Typical inrush current at $V_{i\,nom}$, $P_{o\,nom}$ versus time (40IMX15). Source impedance according to ETS 300132-2 at $V_{i\,nom}$.

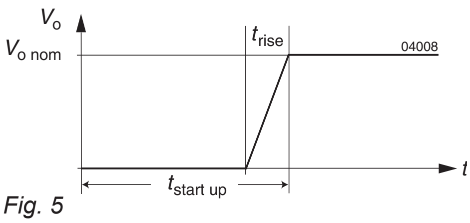

Fig. 5
Converter start-up and rise time

Input Undervoltage Lockout

A special feature of these units is the accurate undervoltage lockout protection which protects the units (and system) from large currents caused by operation at low voltages. This ensures easier start-up in distributed power systems.

Table 3: Turn-on and turn-off voltage

Type	Turn On	Turn Off	Unit
20IMX	7.5 to 8	7 to 7.5	V
40IMX	12.5 to 13.5	12 to 13	
110IMY	40 to 42.5	38 to 40.5	

Fuse and Reverse Polarity Protection

The built-in suppressor diode also provides for reverse polarity protection at the input by conducting current in the reverse direction. An external fuse is required to limit this current.

Table 4: Recommended external fuses

Model	Fuse type
20IMX15	F4.0A
40IMX15	F2.0A
110IMY15	F1.0A

Input Transient Voltage Protection

A built-in suppressor diode provides effective protection against input transients which may be caused for example by short-circuits across the input lines where the network inductance may cause high energy pulses.

Table 5: Built-in transient voltage suppressor

Type	Breakdown voltage $V_{Br\,nom}$ [V]	Peak power at 1 ms P_p [W]	Peak pulse current I_{pp} [A]
20IMX15	40	1500	22
40IMX15	100	1500	9.7
110IMY15	168	600	0.5

For very high energy transients as for example to achieve IEC/EN 61000-4-5 compliance (as per table: *Electromagnetic Immunity*) an external inductor and capacitor are required. The components should have similar characteristics as listed in table: *Components for external circuitry for IEC/EN 61000-4-5, level 2 compliance*.

Note: The suppressor diode D is only necessary for 20IMX15 models.

Table 6: Components for external circuitry for IEC/EN 61000-4-5, level 2 or ETR 283 (19Pfl1) compliance.

Type	Inductor (L)	Capacitor (C)	Diode (D)
20IMX	68 μH, 2.7 A	330 μF, 63 V	1.5 k E47A
40IMX	220 μH, 1.3 A	2 x 100 μF, 100 V	-
110IMY	330 μH, 0.43 A	2 x 100 μF, 200 V	-

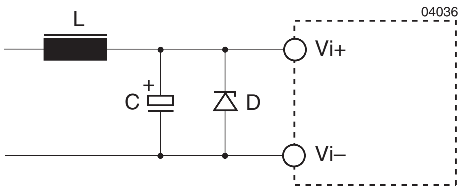

Fig. 6
Example for external circuitry to comply with IEC/EN 61000-4-5; the suppressor diode D is only necessary for 20IMX15 types.

Electrical Output Data

General conditions:
– T_A = 25°C, unless T_C is specified
– Shutdown pin or R pin left open-circuit (not connected)

Table 7a: Output data for single output models -03-8RG[1] and 05-8RG[1]

Output				3.3 V			5.1 V			
	Characteristics		Conditions	min	typ	max	min	typ	max	Unit
V_{o1} V_{o2}	Output voltage		$V_{i\,nom}$ $I_o = 0.5\,I_{o\,nom}$	3.25		3.35	5.05		5.15	VDC
$I_{o\,nom}$	Output current	20 IMX	$V_{i\,min}$ to $V_{i\,max}$		4.5			3.5		A
		40 IMX/110 IMY			4.5			3.5		
I_{o1L}	Current limit[2]		$V_{i\,nom}$, T_C = 25 °C $V_{o1} \le 93\%\ V_{o\,nom}$		6.0			4.6		
ΔV_o	Line/load regulation		$V_{i\,min}$ to $V_{i\,max}$, (0.1 to 1) $I_{o\,nom}$			±0.5			±0.5	%
$V_{o1/2}$	Output voltage noise		$V_{i\,min}$ to $V_{i\,max}$ $I_o = I_{o\,nom}$ [4]			100			100	mV_{pp}
			[5]			60			60	
$V_{o\,L}$	Output overvoltage limit.[3]			115		130	115		130	%
$C_{o\,ext}$	Admissible capacitive load			0		4000	0		4000	µF
$V_{o\,d}$	Dynamic load regulation	Voltage deviat.	$V_{i\,nom}$ $I_{o\,nom} \times 1/2\ I_{o\,nom}$ IEC/EN 61204		±250			±250		mV
t_d		Recovery time				1			1	ms
α_{Vo}	Temperature coefficient $\Delta V_o/\Delta T_C$		$V_{i\,min}$ to $V_{i\,max}$ (0.1 to 1) $I_{o\,nom}$			±0.02			±0.02	%/K

[1] All models -RG have a minimum case and operating temperature of –25 °C.
[2] The current limit is primary side controlled. In the event of a sustained overload condition the thermal protection may cause the unit to shut down (restart on cool-down).
[3] The overvoltage protection is via a primary side second regulation loop. It is not tracking with R control.
[4] BW = 20 MHz
[5] Measured with a probe according to EN 61204

Table 7b: Output data for -05-8R and -0503-8R models.

Output				**5.1 V**			**5.1/3.3 V**			
Characteristics			Conditions	min	typ	max	min	typ	max	Unit
V_{o1} V_{o2}	Output voltage		$V_{i\,nom}$ $I_o = 0.5\ I_{o\,nom}$	5.05		5.15	5.0 3.13		5.12 3.46	VDC
$I_{o\,nom}$	Output current [1]	20IMX	$V_{i\,min}$ to $V_{i\,max}$		2.3			2 x 1.35		A
		40IMX/110IMY			2.5			2 x 1.5		
I_{o1L} I_{o2L}	Current limit [2, 4]	20IMX	$V_{i\,nom}$, $T_C = 25\,°C$ $V_{o1} \leq 93\%\ V_{o\,nom}$		3.2			2.7 3.8		
I_{o1L} I_{o2L}		40IMX/110 IMY			3.6			2.9 4.0		
ΔV_o	Line/load regulation		$V_{i\,min}$ to $V_{i\,max}$, (0.1 to 1) $I_{o\,nom}$			±0.5				%
		5.1 V	$V_{i\,nom}$ (0.1 to 1) $I_{o\,nom}$						+3, –5	
		3.3 V							±4.5	
$V_{o1/2}$	Output voltage noise		$V_{i\,min}$ to $V_{i\,max}$ $I_o = I_{o\,nom}$ [5]			70			80	mV_{pp}
			[6]			40			40	
$V_{o\,L}$	Output overvoltage limit. [7]			115		130	115		130	%
$C_{o\,ext}$	Admissible capacitive load					4000			total: 4000 [3]	µF
$V_{o\,d}$	Dynamic load regulation	Voltage deviat.	$V_{i\,nom}$ $I_{o\,nom} \times {}^1/_2\ I_{o\,nom}$ IEC/EN 61204		±250			±150		mV
t_d		Recovery time				1			1	ms
α_{Vo}	Temperature coefficient $\Delta U_o/\Delta T_C$		$V_{i\,min}$ to $V_{i\,max}$ (0.1 to 1) $I_{o\,nom}$			±0.02			±0.02	%/K

[1] Flexible load distribution: 20IMX15-0503: 1.6 A max., and 40IMX15/110IMY15-0503 types: 1.8 A max. on one of the 2 outputs, the other output should not be loaded such that the total output power exceeds $P_{o\,nom}$ specified in the table: *Model Selection*.
[2] The current limit is primary side controlled. In the event of a sustained overload condition the thermal protection may cause the converter to shut down (restart on cool-down).
[3] For -0503-models: total capacitance of both outputs.
[4] For -0503-models: Conditions for specified output. Other output loaded with constant current $I_o = 0.5\ I_{o\,nom}$.
[5] BW = 20 MHz
[6] Measured with a probe according to EN 61204
[7] The overvoltage protection is via a primary side second regulation loop. It is not tracking with R control.

Table 7c: Output data for dual and double output models.

Output				**2 x 5 V**			**2 x 12 V**			**2 x 15 V**			**2 x 24 V**			Unit
Characteristics			Conditions	min	typ	max	min	typ	max	min	typ	max	min	typ	max	
V_{o1}	Output voltage		$V_{i\ nom}$, $I_o = 0.5\ I_{o\ nom}$	4.95		5.05	11.90		12.10	14.88		15.12	23.80		24.20	VDC
V_{o2}				4.94		5.06	11.88		12.12	14.85		15.15	23.75		24.25	
$I_{o\ nom}$	Output current [1]	20IMX	$V_{i\ min}$ to $V_{i\ max}$		2 x 1.3			2 x 0.65			2 x 0.50			2 x 0.32		A
		40IMX/110IMY			2 x 1.4			2 x 0.70			2 x 0.56			2 x 0.35		
I_{oL}	Current limit [2, 4]	20IMX	$V_{i\ nom}$, $T_C = 25°C$		3.0			1.6			1.3			0.85		
		40IMX/110IMY	$V_{o1} \leq 93\%\ V_{o\ nom}$		3.2			1.7			1.4			0.90		
ΔV_{o1}	Line/load regulation	V_{o1}	$V_{i\ min}$ to $V_{i\ max}$, $I_{o\ nom}$			±1			±1			±1			±1	%
ΔV_{o2}		V_{o2}	$V_{i\ nom}$ (0.1 to 1) $I_{o\ nom}$			±3			±3			±3			±3	
$V_{o1/2}$	Output voltage noise		$V_{i\ min}$ to $V_{i\ max}$, $I_o = I_{o\ nom}$ [5]			80			120			150			240	mV_{pp}
			[6]			40			60			70			120	
$V_{o\ L}$	Output overvoltage limit. [7]		Min. load 1%	115		130	115		130	115		130	115		130	%
$C_{o\ ext}$	Admissible capacitive load [3]				4000			680			470			180 µF		
$V_{o\ d}$	Dynamic load regulation	Voltage deviat.	$V_{i\ nom}$, $I_{o\ nom} \times {}^1/_2\ I_{o\ nom}$		±250			±300			±300			±600		mV
t_d		Recovery time				1			1			1			1	ms
α_{Uo}	Temperature coefficient $\Delta V_o/\Delta T_C$		$V_{i\ min}$ to $V_{i\ max}$ (0.1 to 1) $I_{o\ nom}$			±0.02			±0.02			±0.02			±0.02	%/K

[1] Flexible load distribution: With double or dual output units each output is capable of delivering 75% of the total output power. The other output should not be loaded such that the total output power exceeds $P_{o\ nom}$ according to table: *Model Selection*.
[2] The current limit is primary side controlled. In the event of a sustained overload condition the thermal protection may cause the unit to shut down (restart on cool-down).
[3] Measured with both outputs connected in parallel.
[4] Conditions for specified output. Other output loaded with constant current $I_o = 0.5\ I_{o\ nom}$.
[5] BW = 20 MHz
[6] Measured with a probe according to EN 61204
[7] The overvoltage protection is via a primary side second regulation loop, not tracking with Trim control.
[8] Minimum load of 10% on output 1 recommended to prevent the two output voltages to drop in unbalanced load conditions.

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Thermal Considerations

If a converter, mounted on a PCB, is located in free, quasi-stationary air (convection cooling) at the indicated maximum ambient temperature $T_{A\,max}$ (see table: *Temperature specifications*) and is operated at its nominal input voltage and output power, the case temperature T_C measured at the Measuring point of case temperature T_C (see: *Mechanical Data*) will approach the indicated value $T_{C\,max}$ after the warm-up phase. However, the relationship between T_A and T_C depends heavily on the conditions of operation and integration into a system. The thermal conditions are influenced by input voltage, output current, airflow, temperature of surrounding components and surfaces and the properties of the printed circuit board. $T_{A\,max}$ is therefore only an indicative value and under practical operating conditions, the ambient temperature T_A may be higher or lower than this value.

Caution: The case temperature T_C measured at the: Measuring point of case temperature T_C (see: *Mechanical Data*) may under no circumstances exceed the specified maximum value. The installer must ensure that under all operating conditions T_C remains within the limits stated in the table: *Temperature specifications.*

Output Overvoltage Protection

The output of single output units as well as -0503- and -05-05- types are protected against overvoltages by a second control loop. In the event of an overvoltage on one of the outputs the unit will shut down and attempt to restart approximately every 50 to 60 ms. Double and dual output units (with exception of the -0503- and -05-05- types) are protected against overvoltages by a Zener diode across the second output. Under worst case conditions the Zener diode will short circuit. Since with double output units both outputs track each other the protection diode is only provided in one of the outputs. The main purpose of this feature is to protect against possible overvoltages which could occur due to a failure in the feedback control circuit. The output overvoltage protection is not designed to withstand externally applied overvoltages.

Overtemperature Protection

The converters are protected from possible overheating by means of an internal temperature monitoring circuit. It shuts down the unit above the internal temperature limit and attempts to automatically restart every 50 to 60 ms. This feature prevents excessive internal temperature building up, which could occur during heavy overload conditions.

Short Circuit Behaviour

The current limit characteristic shuts down the converter whenever a short circuit is applied to its output. It acts self-protecting and automatically recovers after removal of the overload condition (hiccup mode).

Connection in Series

The outputs of one or several single or double output units can be connected in series without any precautions, taking into consideration that the highest output voltage should remain below 42 V to ensure that the output remains SELV.

Connection in Parallel

Double outputs of the same converter with equal output voltage (e.g. 5 V / 5 V) can be put in parallel and will share their output currents almost equally. Parallel operation of single or double outputs of two or more converters with the same output voltage may cause start-up problems at initial start-up. This is only advisable in applications where one converter is able to deliver the full load current as, for example, required in true redundant systems.

Typical Performance Curves

General conditions:
- T_A = 25 °C, unless T_C is specified.
- Shut down pin left open circuit.
- Trim or R input not connected.

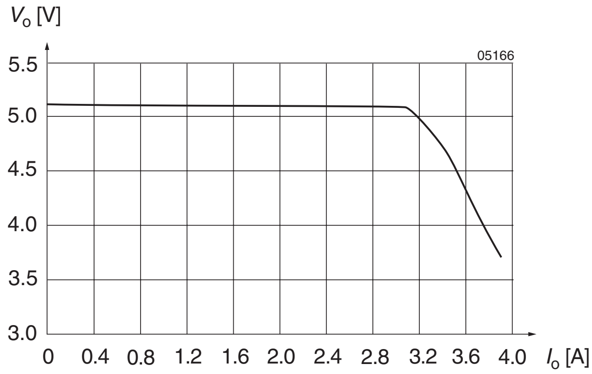

Fig. 7
V_o versus I_o (typ) of units with V_o = 5.1 V. (110IMY15-05-8R)

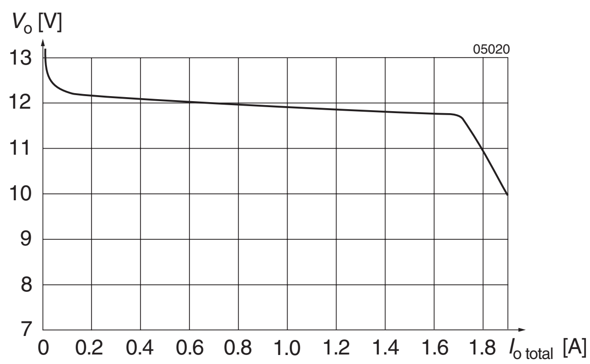

Fig. 8
V_o versus I_o (typ) of double output units (2 x 12 V), with both outputs in parallel. (110IMY15-12-12-8)

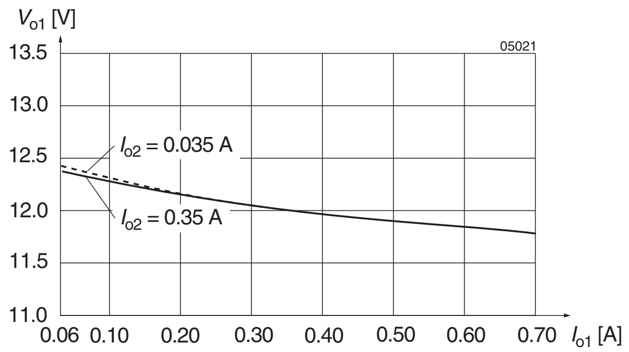

Fig. 9
Cross load regulation V_{o1} versus I_{o1} (typ) for various I_{o2} (2 x 12 V).

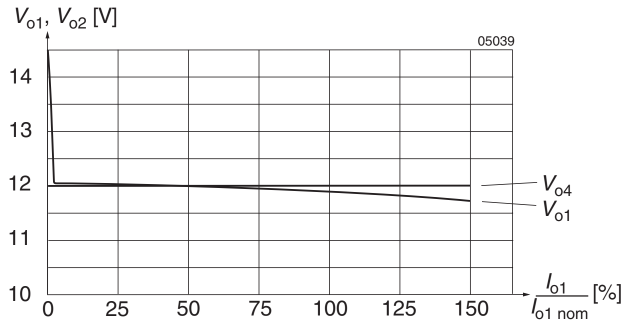

Fig. 12
Flexible load distribution on double outputs (2 x 12 V) with load variation from 0 to 150% of $P_{o1\ nom}$ on output 1. Output 2 loaded with 50% of $P_{o2\ nom}$.

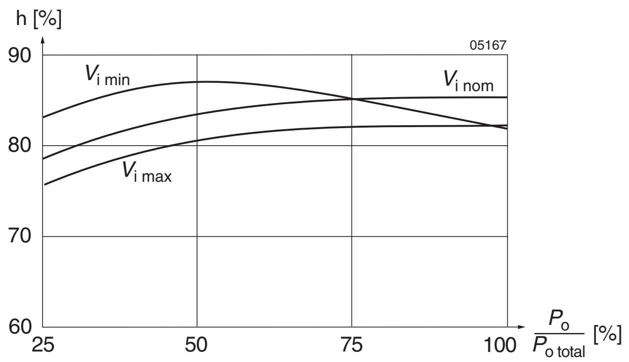

Fig. 10
Efficiency versus input voltage and load. Typical values 40IMX15-12-12-8

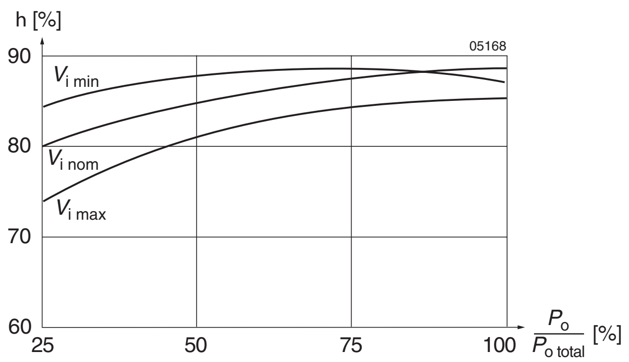

Fig. 13
Efficiency versus input voltage and load. Typical values 110IMY15-12-12-8

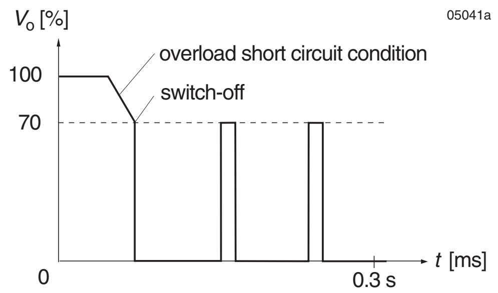

Fig. 11
Overload switch off (hiccup mode), typical values.

Auxiliary Functions

Shut Down Function

The outputs of the converters may be enabled or disabled by means of a logic signal (TTL, CMOS, etc.) applied to the shut down pin. If the shut down function is not required then it should be left open-circuit.

Converter operating: 2.0 to 20 V
Converter shut down: –10 to 0.7 V

Adjustable Output Voltage

– R input for single output models using synchronous rectification (G)
– R input for single output and -0503-models
– Trim input for double output models

As a standard feature, the single and double output units offer adjustable output voltage(s) by using the control input R or Trim. If the control input is left open-circuit the output voltage is set to $V_{o\ nom}$. For output voltages $V_o > V_{o\ nom}$, the minimum input voltage $V_{i\ min}$ (see: *Electrical Input Data*) increases proportionally to $V_o/V_{o\ nom}$.

Single output units using synchronous rectification (G):

The R input is referenced to the secondary side of the converter. Adjustment of the output voltage is possible by means of an external resistor connected between the R pin and either Vo+ or Vo–.

Note: For models with synchronous rectification V_o adjustment is different from the standard single output and -0503-models

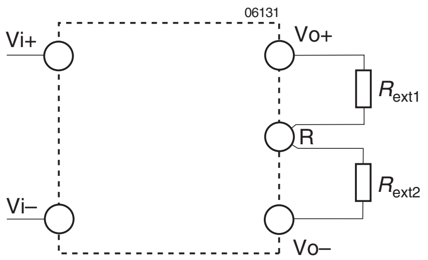

Fig. 14
Output voltage control for single output models with synchronous rectification.

Table 8: V_o versus V_{ext} approximate values

$V_{o\ nom}$ [V]	Typ. values of R_{ext1}		Typ. values of R_{ext2}	
	V_o [% of $V_{o\ nom}$]	R_{ext1} [kΩ]	V_o [% of $V_{o\ nom}$]	R_{ext2} [kΩ]
3.3	90 95 100	0.47 2.7 ∞	100 105 110	∞ 15 6.8
5.1	90 95 100	3.3 8.2 ∞	100 105 110	∞ 9.1 3.9

Single output and -0503-models fitted with option R:

The R input is referenced to the secondary side of the converter. Adjustment of the output voltage is possible by means of either an external resistor or a voltage source.

a) Adjustment by means of an external resistor R_{ext}.

Depending upon the value of the required output voltage, the resistor shall be connected.

either: Between the R pin and Vo– to achieve an output voltage adjustment range of approximately V_o = 80 to 100 % $V_{o\ nom}$.

$$R_{ext1} \sim 4\ k\Omega \bullet \frac{V_o}{V_{o\ nom} - V_o}$$

or: Between the R pin and Vo+ to achieve an output voltage range of approximately V_o = 100 to 105 % $V_{o\ nom}$.

$$R_{ext2} \sim 4\ k\Omega \bullet \frac{(V_o - 2.5V)}{2.5\ V \bullet (V_o/V_{o\ nom} - 1)}$$

b) Adjustment by means of an external voltage V_{ext} between Vo– and R pins.

The control voltage range is 1.96 to 2.62 V and allows for an adjustment in the range of approximately 80 to 105% of $V_{o\ nom}$.

$$V_{ext} \sim \frac{V_o \bullet 2.5\ V}{V_{o\ nom}}$$

Attempting to adjust the output below this range will cause the converter to shut down (hic-cup mode).

Note: Applying an external control voltage >2.75 V may damage the converter.

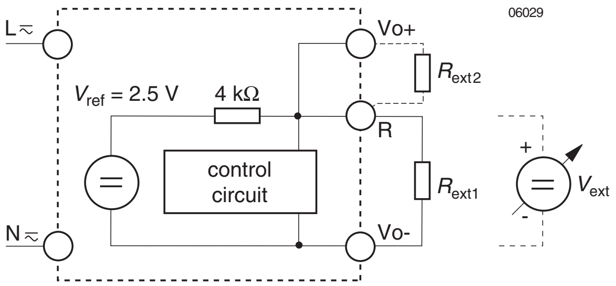

Fig. 15
Output voltage control for single output models, -0503-models and double output models fitted with option R by means of the R input.

Double output models with Trim input:

The Trim input is referenced to the primary side. The figure below shows the circuit topology. Adjustment of the output voltage is possible by means of either an external resistor R_{ext} in the range of 100 to 105% of $V_{o\ nom}$ or an external voltage source in the range of 75 to105% of $V_{o\ nom}$.

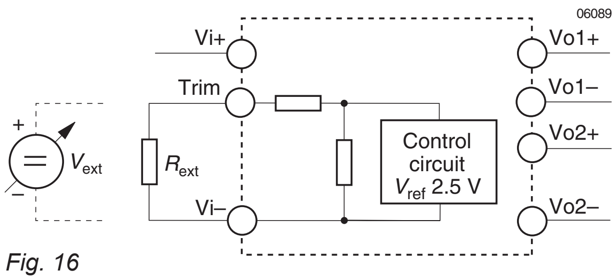

Fig. 16
Output voltage control for double output models by means of the Trim input.

a) Adjustment by means of an external resistor R_{ext}:

Programming of the output voltage by means of an external resistor R_{ext} is possible within a limited range of 100 to 105% of $V_{o\ nom}$. R_{ext} should be connected between the Trim pin and Vi–. Connection of R_{ext} to Vi+ may damage the converter. The following table indicates suitable resistor values for typical output voltages under nominal conditions ($V_{i\ nom}$, I_o = 0.5 $I_{o\ nom}$), with either paralleled outputs or equal load conditions on each outputs.

Table 9a: R_{ext1} for V_o > $V_{o\ nom}$; approximate values ($V_{i\ nom}$, $I_{o1,2}$ = 0.5 $I_{o1/2\ nom}$)

V_o [% $V_{o\ nom}$]	R_{ext} [kΩ]
105 to 108 (107 typically)	0
105	1.5
104	5.6
103	12
102	27
101	68
100	∞

b) Adjustment by means of an external voltage source V_{ext}.

For external output voltage programming in the range 75 to 105% of $V_{o\ nom}$ a (0 to 20 V) source V_{ext} is required, connected to the Trim pin and Vi–. The table below indicates typical V_o versus V_{ext} values under nominal conditions $V_{i\ nom}$, I_o = 0.5 $I_{o\ nom}$), with either paralleled outputs or equal load conditions on each output. Applying a control voltage >20 V will set the converter into a hic-cup mode. Direct paralleling of the Trim pins of units connected in parallel is feasible.

Table 9b: V_o versus V_{ext} for V_o = 75 to 105% $V_{o\ nom}$; typical values ($V_{i\ nom}$, $I_{o1/2}$ = 0.5 $I_{o1/2\ nom}$)

V_o [% $V_{o\ nom}$]	V_{ext} [V]
≥ 105	0
102	1.6
95	4.5
85	9
75	13

Electromagnetic Compatibility (EMC)

A suppressor diode together with an input filter forms an effective protection against high input transient voltages which typically occur in many installations, but especially in battery driven mobile applications.

Electromagnetic Immunity

Table 10: Immunity type tests

Phenomenon	Standard	Class Level	Coupling mode [2]	Value applied	Waveform	Source Imped.	Test procedure	In oper.	Per- [3] form.
Electrostatic discharge to case	IEC/EN 61000-4-2	2	contact discharge (R pin open)	4000 V_p	1/50 ns	330 Ω	10 positive and 10 negative discharges	yes	B
		3	air discharge (R pin open)	8000 V_p					
Electromagnetic field	IEC/EN 61000-4-3	3	antenna	10 V/m	AM 80% 1 kHz		26 to 1000 MHz	yes	A
	ENV 50204				PM, 50% duty cycle, 200 Hz resp. frequ.		900 MHz		
Electrical fast transient/burst	IEC/EN 61000-4-4	4	direct +i/–i	4000 V_p	bursts of 5/50 ns 5 kHz rep. rate transients with 15 ms burst duration and a 300 ms period	50 Ω	60 s positive 60 s negative transients per coupling mode	yes	B
Surge	IEC/EN 61000-4-5 [1]	3	+i/–i	2000 V_p	1.2/50 µs	2 Ω	5 pos. and 5 neg. impulses per coupling mode	yes	B
Conducted disturbancies	IEC/EN 61000-4-6	3	+i/–i	10 VAC (140 dBµV)	AM modulated 80%, 1 kHz	50 Ω	0.15 to 80 MHz 150 Ω	yes	A
Transient	ETR 283 (19 Pfl 1) [1]		+i/–i	150 V_p	0.1/0.3 ms	limited to <100 A	3 positive	yes	B

[1] External components required.
[2] i = input, o = output.
[3] A = normal operation, no deviation from specification, B = temporary deviation from specs. possible.

Conducted Emissions

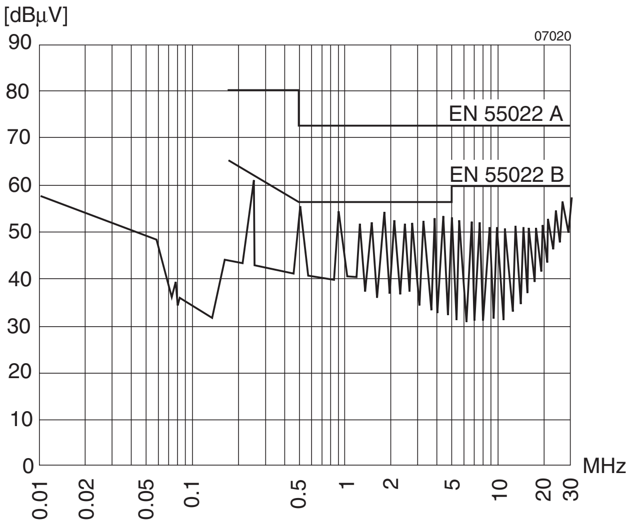

Fig. 17
Typical disturbance voltage (quasi-peak) at the input according to CISPR 11/EN 55011 and CISPR 22/EN 55022, measured at $V_{i\,nom}$ and $I_{o\,nom}$. Output leads 0.1 m, twisted. (40IMX15-05-8R)

Radiated Emissions

Electromagnetic emission requirements according to EN 55022, class B (radiated emmission) can be achieved by adding an external common mode choke and (for 20IMX15 types) an additional capacitor, see: *Input Data*. The filter components should be placed as close as possible to the input of the converter.

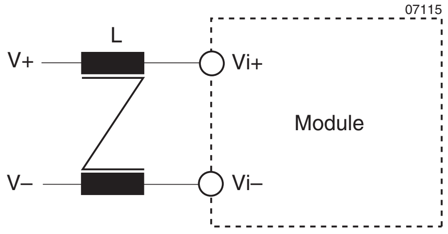

Fig. 18
Example for external circuitry to comply with CISPR22/EN 55022, level B, radiated

Table 11: Input filter components for EN 55022, level B, radiated.

Type	Current compensated choke
20IMX15 40IMX15 110IMY15	1 mH, 2 A

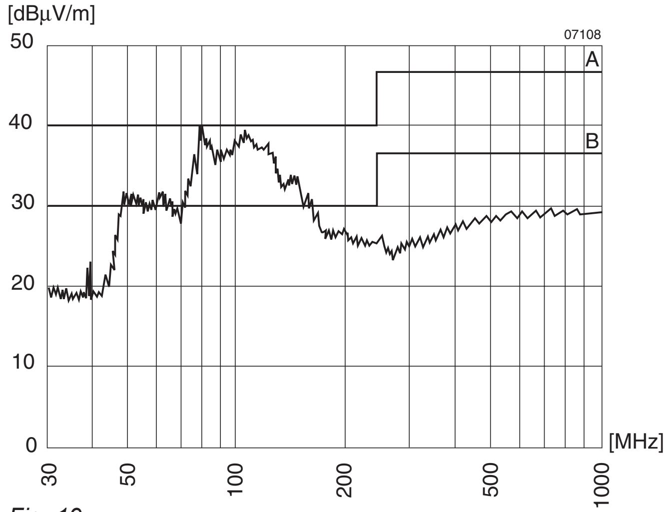

Fig. 19
Typical radio frequency-interference voltage at $V_{i\,nom}$, $I_{o\,nom}$, measured with an antenna (distance 10 m). Output leads 1 m, twisted.

Immunity to Environmental Conditions

Table 12: Temperature specifications

Valid for air pressure of 800 to 1200 hPa (800 to 1200 mbar)

Temperature			-9 (Option)		-8 (Standard)		Unit
Characteristics		Conditions	min	max	min	max	
T_A	Ambient temperature [1]	Operational [2]	–40 [4]	71	–40 [3, 4]	85	°C
T_C	Case temperature		–40 [4]	95	–40 [3, 4]	105	
T_S	Storage temperature [1]	Non operational	–55	100	–55	105	

[1] MIL-STD-810D
[2] See: *Thermal Considerations*
[3] Start up at –55 °C, except -RG models.
[4] –25 °C for all -RG models.

Table 13: MTBF and device hours

MTBF	Ground Benign	Ground Fixed		Ground Mobile
MTBF acc. to MIL-HDBK-217F	T_C = 40 °C	T_C = 40 °C	T_C = 70 °C	T_C = 50 °C
110IMY15-05-8R	485 000 h	255 000 h	167 000 h	223 000 h

Table 14: Mechanical stress

Test Method		Standard	Test Conditions		Status
Ca	Damp heat steady state	IEC/EN 60068-2-78 MIL-STD-810D section 507.2	Temperature: Relative humidity: Duration:	$40^{\pm 2}$ °C $93^{+2/-3}$ % 56 days	Converter not operating
Ea	Shock (half-sinusoidal)	IEC/EN 60068-2-27 MIL-STD-810D section 516.3	Acceleration amplitude: Bump duration: Number of bumps:	100 g_n = 981 m/s^2 6 ms 18 (3 each direction)	Converter operating
Eb	Bump (half-sinusoidal)	IEC/EN 60068-2-29 MIL-STD-810D section 516.3	Acceleration amplitude: Bump duration: Number of bumps:	40 g_n = 392 m/s^2 6 ms 6000 (1000 each direction)	Converter operating
Fc	Vibration (sinusoidal)	IEC/EN 60068-2-6 MIL-STD-810D section 514.3	Acceleration amplitude: Frequency (1 Oct/min): Test duration:	0.35 mm (10 to 60 Hz) 5 g_n = 49 m/s^2 (60 to 2000 Hz) 10 to 2000 Hz 7.5 h (2.5 h each axis)	Converter operating
Fda	Random vibration wide band reproducibility high	IEC/EN 60068-2-35	Acceleration spectral density: Frequency band: Acceleration magnitude: Test duration:	0.05 g_n^2/Hz 20 to 500 Hz 4.9 $g_{n\ rms}$ 3 h (1 h each axis)	Converter operating
Kb	Salt mist, cyclic (sodium chloride NaCl solution)	IEC/EN 60068-2-52	Concentration: Duration: Storage: Storage duration: Number of cycles:	5% (30 °C) 2 h per cycle 40 °C, 93% rel. humidity 22 h per cycle 3	Converter not operating

Mechanical Data

Dimensions in mm.

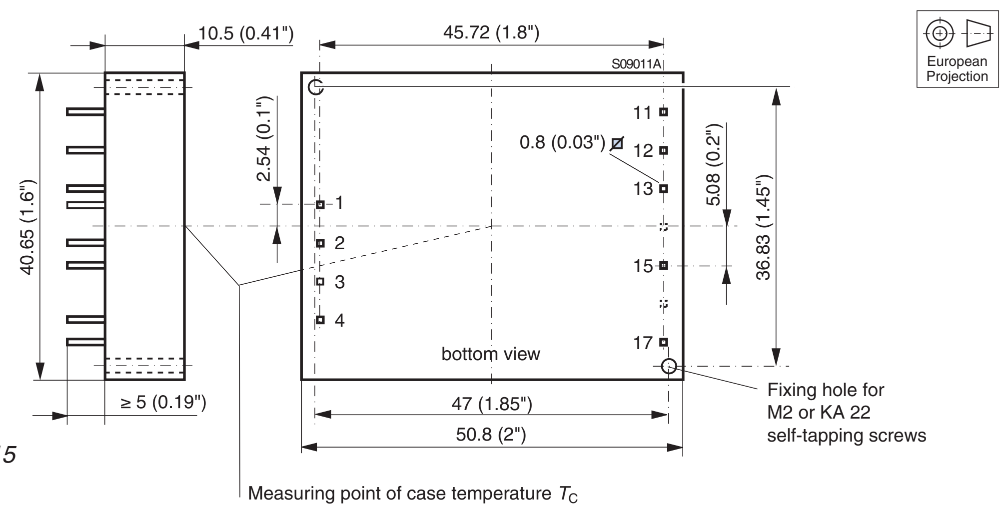

Fig. 20
Case IMX15, IMY15
Weight: <35 g

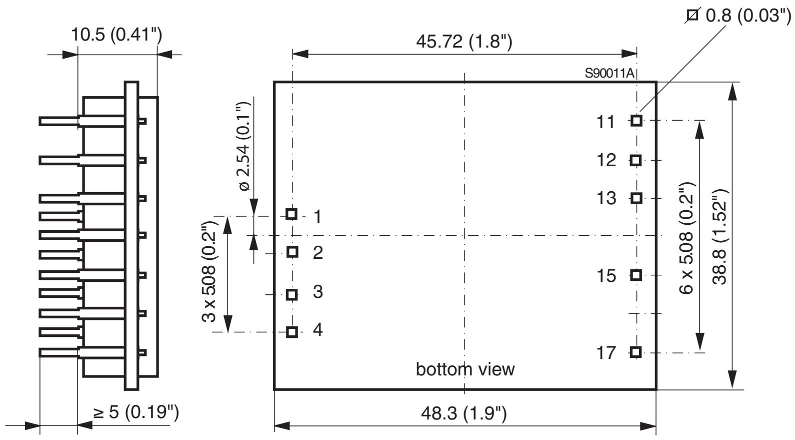

Fig. 21
Open frame (option Z)

Safety and Installation Instructions

Installation Instructions

Installation of the DC-DC converters must strictly follow the national safety regulations in compliance with the enclosure, mounting, creepage, clearance, casualty, markings and segregation requirements of the end-use application.

Connection to the system shall be made via a printed circuit board with hole diameters of 1.4 mm ±0.1 mm for the pins.

The units should be connected to a secondary circuit.

Check for hazardous voltages before altering any connections.

Do not open the module.

Ensure that a unit failure (e.g. by an internal short-circuit) does not result in a hazardous condition. See also: *Safety of operator accessible output circuit.*

Input Fuse

To prevent excessive current flowing through the input supply lines in case of a malfunction an external fuse should be installed in a non-earthed input supply line (See: *Table 4*).

Standards and Approvals

All DC-DC converters are approved by UL and TÜV according to UL 60950, CAN/CSA C22.2 No. 950-95 and IEC/EN 60950 standards.

The units have been evaluated for:
- Building in
- Supplementary insulation input to output, based on their maximum input voltage (IMX15 types)
- Reinforced insulation input to output, based on their maximum input voltage (IMY15 types)
- The use in a pollution degree 2 environment
- Connecting the input to a secondary circuit which is subject to a maximum transient rating of 1500 V (IMX15 models)
- Connecting the input to a primary circuit which is subject to a maximum transient rating of 2500 V (IMY15 types)

Table 15: Pin allocation

Pin	Standard and Option Z		
	single	double	-0503-
1	Vi+	Vi+	Vi+
2	Vi–	Vi–	Vi–
3	-	Trim	n.c.
4	$\overline{SD}$	$\overline{SD}$	$\overline{SD}$
5	-	-	-
6	-	-	-
11	-	Vo1+	Vo2+
12	-	Vo1–	Go
13	Vo+	Vo2+	Vo1+
15	Vo–	Vo2–	Go
17	R	n.c.	R

The converters are subject to manufacturing surveillance in accordance with the above mentioned standards.

Protection Degree

The protection degree of the converters is IP 40, except open-frame models (option Z).

Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids should be prevented, since the power supplies are not hermetical sealed.

However, the open-frame models (option Z) leave the factory unlacquered and may be cleaned and lacquered by the customer, for instance together with the mother board. Consult Power-One for the types of cleaning agents.

Isolation

The electric strength test is performed in the factory as routine test in accordance with EN 50116 and IEC/EN 60950, and should not be repeated in the field. Power-One will not honor any guarantee claims resulting from electric strength field tests.

Table 16: Electric strength test voltages

Characteristic	Input to output IMX15	IMY15	Output to output	Unit
Factory test 1 s	1.2	3.0	0.1	kVAC
Equivalent DC voltage	1.5	4.0	0.15	kVDC
Insulation resistance at 500 VDC	>100	>100	-	MΩ
Partial discharge extinction voltage	Consult Power-One		-	kV

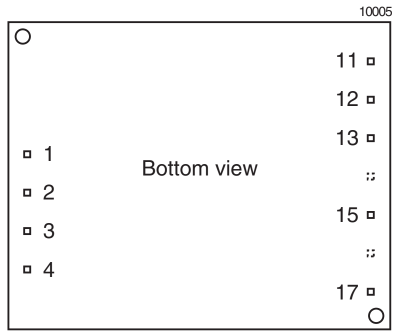

Fig. 22
Footprint

Safety of operator-accessible output circuits

If the output circuit of a converter is operator-accessible, it shall be an SELV circuit according to the IEC/EN 60950. The following table shows some possible installation configurations, compliance with which causes the output circuit to be an SELV circuit up to a configured output voltage (sum of nominal voltages, if in series or +/– configuration) of 42 V.

However, it is the sole responsibility of the installer to ensure the compliance with the relevant and applicable safety regulations.

Table 17: Insulation concept leading to an SELV output circuit

Conditions	Front end			DC-DC converter		Result
Supply voltage	Minimum required grade of isolation, to be provided by the AC-DC front end, including mains supplied battery charger	Maximum DC output voltage from the front end [1]	Minimum required safety status of the front end output circuit	Type	Measures to achieve the specified safety status of the output circuit	Safety status of the DC-DC converter output circuit
Mains ≤150 VAC	Operational (i.e. there is no need for electrical isolation between the mains supply voltage and the DC-DC converter input voltage)	≤150 V	Primary	IMY15	Double or reinforced insulation, based on 150 V AC and DC (provided by the DC-DC converter)	SELV circuit
Mains ≤250 VAC	Basic	≤60 V	Earthed SELV circuit [2]	IMX15 IMY15	Operational insulation (provided by the DC-DC converter)	
		≤75 V	Hazardous voltage secondary circuit	IMX15	Input fuse [3] output suppressor diodes [4], and earthed output circuit [2]	Earthed SELV circuit
		≤150 V		IMY15	Supplementary insulation based on 250 V AC and double or reinforced insulation, based on the maximum rated output voltage from the front end (provided by the DC-DC converter)	SELV circuit
	Double or reinforced	≤60 V	SELV circuit	IMX15 IMY15	Operational insulation (provided by the DC-DC converter)	
		≤75 V	Double or reinforced insulated unearthed hazardous voltage secondary circuit [5]	IMX15	Supplementary insulation based on the maximum rated output voltage from the front end (provided by the DC-DC converter)	
		≤120 V	TNV-2 circuit	IMY15	Double or reinforced insulation, based on the maximum rated output voltage from the front end (provided by the DC-DC converter)	
		≤150 V	Double or reinforced insulated earthed or unearthed hazardous voltage secondary circuit			

[1] The front end output voltage should match the specified input voltage range of the DC-DC converter.

[2] The earth connection has to be provided by the installer according to the relevant safety standard, e.g. IEC/EN 60950.

[3] The installer shall provide an approved fuse (type with the lowest rating suitable for the application) in a non-earthed input conductor directly at the input of the DC-DC converter (see fig.: *Schematic safety concept*). For UL's purpose, the fuse needs to be UL-listed. See also: *Tab. 4*.

[4] Each suppressor diode should be dimensioned in such a way, that in the case of an insulation fault the diode is able to limit the output voltage to SELV (<60 V) until the input fuse blows (see fig.: *Schematic safety concept*).

[5] Has to be insulated from earth by at least basic insulation according to the relevant safety standard, based on the maximum output voltage from the front end.

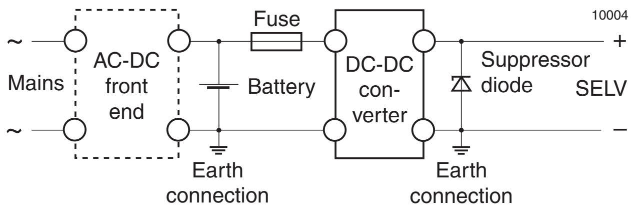

Fig. 23
Schematic safety concept. Use fuse, suppressor diode and earth connection as per table Safety concept leading *to an SELV output circuit.*

Description of Options

Table 18: Survey of options

Option	Function of option	Characteristic
-9	Temperature range NFND	T_A = –40 to 71 °C, –25 °C to 71 °C for -9RG models
R	R-input and magnetic feedback	
i	Inhibit	
Z	Open frame	See: *Mechanical Data*

Option -9 is not recommended for new designs.

Option -9 versus -8

Models with -9 (not for new designs) have a limited temperature range.

The standard models with suffix -8 are rated up to T_A =85 °C (see Table: *Temperature Specifications*).

The -8 models will provide the output power in the derating curve specified in the fig. below with free air convection cooling.

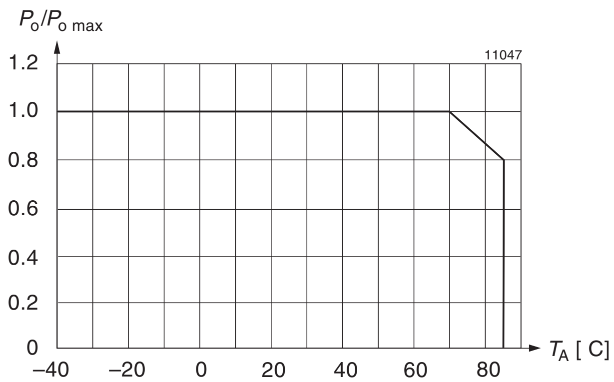

Fig. 24
Maximum allowed output power versus ambient temperature.

Option R

R specifies magnetic feedback from the output for closer regulation of the output voltages of double output units. (Standard feature for single output units and -0503- types.) It enables the adjustment of the output voltages via the R-input (pin 17) on the secondary side by an external resistor or an external voltage source in the range of approx. 75 to 105% of $V_{o\,nom}$. The function is described in *Auxiliary Functions*. With Option R the Trim input (pin 3) is not connected.

Option i: Inhibit

Excludes the shutdown function.

The output(s) of the converter may be enabled or disabled by means of a logic signal (TTL, CMOS, etc.) applied to the inhibit pin. No output voltage overshoot will occur, when the unit is turned on. If the inhibit function is not required, the inhibit pin should be connected to Vi– to enable the output (active low logic, fail safe).

Voltage on pin i:

Converter operating:	–10 V to 0.8 V
Converter inhibited:	2.4 V to $V_{i\,max}$ (<75 V) or pin i left open-circuit:

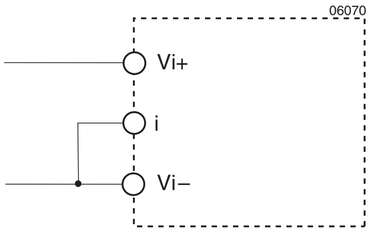

Fig. 25
If the inhibit function is not used the inhibit pin should be connected to Vi–.

EC Declaration of Conformity

We

Power-One AG
Ackerstrasse 56, CH-8610 Uster

declare under our sole responsibility that 20/40IMX15 and 110IMY15 DC-DC converters carrying the CE-mark are in conformity with the provisions of the Low Voltage Directive (LVD) 73/23/EEC of the European Communities.

Conformity with the directives is presumed by conformity with the following harmonised standards:

- EN 61204:1995 (= IEC 61204:1993, modified)
  Low-voltage power supply devices, DC output - Performance characteristics and safety requirements

- EN 60950:2000 (=IEC 60950:2000)
  Safety of information technology equipment.

The installation instructions given in the corresponding data sheet describe correct installation leading to the presumption of conformity of the end product with the LVD. All 20/40IMX15 and 110IMY15 DC-DC converters are components, intended exclusively for inclusion within other equipment by an industrial assembly operation or by professional installers. They must not be operated as standalone products.

Hence conformity with the Electromagnetic Compatibility Directive 89/336/EEC (EMC Directive) needs not to be declared. Nevertheless, guidance is provided in the data sheets on how conformity of the end product with EMC standards under the responsibility of the installer can be achieved, from which conformity with the EMC Directive can be presumed.

Uster, 5 Oct. 2005 Power-One AG

R. Baldauf J. Milavec

Rolf Baldauf
Vice-President Engineering

Johann Milavec
Director Projects and IP