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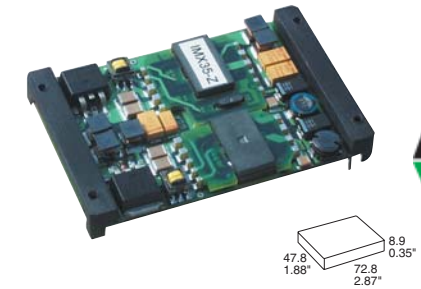
Changing the Shape of Power



RoHS Compliant

Features

Wide input voltage ranges up to 150 VDC
4 outputs up to 60 VDC
1200 to 1800 VAC I/O electric strength test

- RoHS lead solder exemption compliant
- Extremely wide input voltage ranges
- Electrical isolation I/O, also between outputs
- Emissions below EN 55022, level B
- Immunity to IEC/EN 61000-4-2,-3,-4,-5 and -6
- Programmable input undervoltage lockout
- Shut down/inhibit input
- Output voltages adjustable with flexible load distribution
- Frequency synchronization
- Outputs no-load, overload, and short-circuit proof
- Operating ambient temperature from –40 to 85 ˚C
- Thermal protection
- 3" x 2.5" case with 10.5 mm profile or 8.9 mm open frame
- Basic insulation
- Flexible output possibilities between 5 V and 60 V

Description

The IMX35 Series of board-mountable, 35 Watt DC-DC converters has been designed according to 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 9 V up to 150 V with four different models. The units are available with up to quadruple outputs (electrically isolated) from 5 V to 60 V, externally adjustable and with flexible load distribution. 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 IMX35 models provide basic insulation.

The circuit is comprised of two planar magnetics devices, 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 without using any potting material allows operation at full load up to an ambient temperature of 71 °C in free air, operation up to 110 °C with airflow. For extremely high vibration environments the case has holes for screw mounting.

Table of Contents

Model Selection

Table 1: Model Selection

Output 1		Output 2		Output 3		Output 4		Input voltage	Eff.	Model	Trim[1]	Opt.[2]
$V_{o\ nom}$ [VDC]	$I_{o\ nom}$ [A]	$V_{o\ nom}$ [VDC]	$I_{o\ nom}$ [A]	$V_{o\ nom}$ [VDC]	$I_{o\ nom}$ [A]	$V_{o\ nom}$ [VDC]	$I_{o\ nom}$ [A]	$V_{i\ min}$ to $V_{i\ max}$ [VDC]	η_{typ} [%]			
5	1.35	5	1.35	5	1.35	5	1.35	9 to 36	86	20IMX35D05D05-8		
5	1.4	5	1.4	5	1.4	5	1.4	18 to 75	87	40IMX35D05D05-8	primary	
5	1.4	5	1.4	5	1.4	5	1.4	40 to 121	86	70IMX35D05D05-8		
5	1.4	5	1.4	5	1.4	5	1.4	60 to 150	86	110IMX35D05D05-8		
12	0.65	12	0.65	12	0.65	12	0.65	9 to 36	86	20IMX35D12D12-8		
12	0.7	12	0.7	12	0.7	12	0.7	18 to 75	88	40IMX35D12D12-8	primary	
12	0.7	12	0.7	12	0.7	12	0.7	40 to 121	88	70IMX35D12D12-8		
12	0.7	12	0.7	12	0.7	12	0.7	60 to 150	88	110IMX35D12D12-8		
15	0.55	15	0.55	15	0.55	15	0.55	9 to 36	88	20IMX35D15D15-8		
15	0.6	15	0.6	15	0.6	15	0.6	18 to 75	89	40IMX35D15D15-8	primary	i
15	0.6	15	0.6	15	0.6	15	0.6	40 to 121	88	70IMX35D15D15-8		Z
15	0.6	15	0.6	15	0.6	15	0.6	60 to 150	88	110IMX35D15D15-8		
5	1.35	12	0.65	12	0.65	5	1.35	9 to 36	88	20IMX35D05D12-8		
5	1.4	12	0.7	12	0.7	5	1.4	18 to 75	89	40IMX35D05D12-8	primary	
5	1.4	12	0.7	12	0.7	5	1.4	40 to 121	88	70IMX35D05D12-8		
5	1.4	12	0.7	12	0.7	5	1.4	60 to 150	88	110IMX35D05D12-8		
5	1.35	15	0.55	15	0.55	5	1.35	9 to 36	88	20IMX35D05D15-8		
5	1.4	15	0.6	15	0.6	5	1.4	18 to 75	89	40IMX35D05D15-8	primary	
5	1.4	15	0.6	15	0.6	5	1.4	40 to 121	88	70IMX35D05D15-8		
5	1.4	15	0.6	15	0.6	5	1.4	60 to 150	88	110IMX35D05D15-8		

[1] The Trim input (pin 5) on the primary side influences all outputs simultaneously on equal voltage models (e.g., D12D12); for unequal voltages (e.g., D05D12) Trim1 influences only the first power train Vo1/Vo4.

[2] For minimum quantity and lead times contact Power-One.

Part Number Description

20 IMX35 D05 D05 -8 i Z

Input voltage range V_i
- 9 to 36 VDC 20
- 18 to 75 VDC 40
- 40 to 121 VDC 70
- 60 to 150 VDC 110

Series IMX35

Outputs 1 and 4 of quad types D05, D12, D15

Outputs 2 and 3 of quad types D05, D12, D15

Operating ambient temperature range
- T_A = –40 to 85 °C (110 °C) ..... -8

Options:
- Inhibit ..... -i
- Open frame ..... Z

Product Marking

Basic type designation, input and output voltages and currents, applicable safety approval and recognition marks, Power-One patent numbers, company logo, date code, and serial number.

Functional Description

The IMX35 converters consist of two feedback-controlled interleaved-switching flyback power trains using current mode PWM (pulse width modulation).

Each converter consists of four electrically isolated outputs from two power trains. Vo1, Vo4 derive from the first power train and Vo2, Vo3 from the second one Thus, each pair of outputs is independent from the other one.

Voltage regulation for each pair of outputs is achieved with passive transformer feedback from the main transformer of the power train. Each pair of outputs has the same output voltage (i.e. D05, D12, etc.). If both power trains have the same output voltage (e.g., D12D12), all outputs may be simultaneously adjusted by the Trim input (pin 5). In case of different output voltages (e.g., D05D15), the Trim1 input influences only Vo1 and Vo4.

Current limitation is provided by the primary circuit for each power train and limits the possible output power for each pair of outputs. In the case of an overload on either of the power trains, which causes the output voltage to fall less than typically 60% of $V_{o\ nom}$, the entire converter will shut down and automatically restart in short intervals (hiccup mode).

Overtemperature protection is provided; this will shut down the converter in excessive overload conditions with automatic restart.

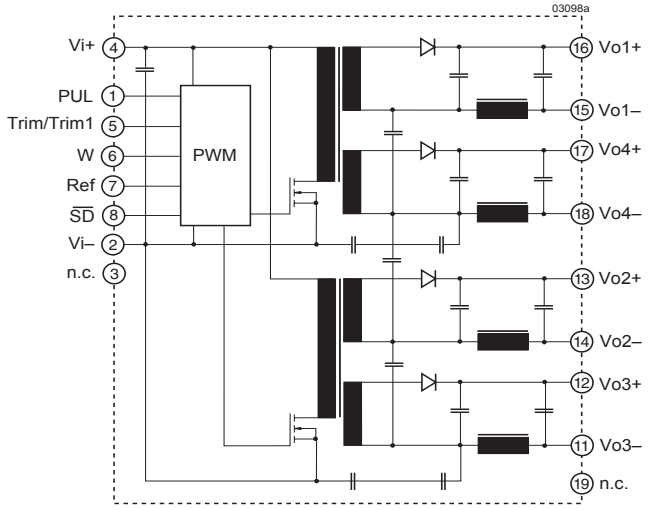


Fig. 1
Block diagram of quad output models

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Electrical Input Data

General conditions:
T_A = 25 °C, shut down and Trim pin left open-circuit (not connected), unless specified.

Table 2: Input Data

Input				20IMX			40IMX			Unit
Characteristics			Conditions	min	typ	max	min	typ	max	
V_i	Input voltage range [1]		$T_{A\,min}$ to $T_{A\,max}$ I_o = 0 to $I_{o\,nom}$	9 [2]		36	18 [2]		75	VDC
$V_{i\,nom}$	Nominal input voltage				20			40		
$V_{i\,sur}$	Repetitive surge voltage		Abs. max input (3 s)			40			100	
$t_{start\,up}$	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	s
		SD high				0.1			0.1	
t_{rise}	Rise time [3]		$V_{i\,nom}$ resist load		3			3		ms
			$I_{o\,nom}$ capac. load		6	12		6	12	
$I_{i\,o}$	No load input current		I_o = 0, $V_{i\,min}$ to $V_{i\,max}$			70			50	mA
I_{irr}	Reflected ripple current		I_o = 0 to $I_{o\,nom}$			30			30	mA_{pp}
$I_{inr\,p}$	Inrush peak current [4]		V_i = $V_{i\,nom}$			8			9	A
C_i	Input capacitance		for surge calculation		2			1.3		µF
$V_{\overline{SD}}$	Shut down voltage		Converter shut down		–10 to 0.7			–10 to 0.7		VDC
			Converter operating		open circuit or 2 to 20			open circuit or 2 to 20		
$R_{\overline{SD}}$	Shut down input resistance		For current calculations		approx. 10			approx. 10		kΩ
$I_{\overline{SD}}$	Input current at shut down		$V_{i\,min}$ to $V_{i\,max}$			12			6	mA
f_s	Switching frequency		$V_{i\,min}$ to $V_{i\,max}$, I_o = 0 to $I_{o\,nom}$		approx. 220			approx. 220		kHz
$u_{i\,RFI}$	Input RFI level, conducted		EN 55022 [5]		B [6]			B [6]		

Input				70IMX			110IMX			Unit
Characteristics			Conditions	min	typ	max	min	typ	max	
V_i	Input voltage range [1]		$T_{A\,min}$ to $T_{A\,max}$ I_o = 0 to $I_{o\,nom}$	40 [2]		121	60 [2]		150	VDC
$V_{i\,nom}$	Nominal input voltage				70			110		
$V_{i\,sur}$	Repetitive surge voltage		Abs. max input (3 s)			150			170	
$t_{start\,up}$	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	s
		SD high				0.1			0.1	
t_{rise}	Rise time [3]		$V_{i\,nom}$ resist load		3			3		ms
			$I_{o\,nom}$ capac. load		6	12		6	12	
$I_{i\,o}$	No load input current		I_o = 0, $V_{i\,min}$ to $V_{i\,max}$			30			20	mA
I_{irr}	Reflected ripple current		I_o = 0 to $I_{o\,nom}$			30			30	mA_{pp}
$I_{inr\,p}$	Inrush peak current [4]		V_i = $V_{i\,nom}$			7			7	A
C_i	Input capacitance		for surge calculation		0.5			0.5		µF
$V_{\overline{SD}}$	Shut down voltage		Converter shut down		–10 to 0.7			–10 to 0.7		VDC
			Converter operating		open circuit or 2 to 20			open circuit or 2 to 20		
$R_{\overline{SD}}$	Shut down input resistance		For current calculations		approx. 10			approx. 10		kΩ
$I_{\overline{SD}}$	Input current at shut down		$V_{i\,min}$ to $V_{i\,max}$			3.5			4	mA
f_s	Switching frequency		$V_{i\,min}$ to $V_{i\,max}$, I_o = 0 to $I_{o\,nom}$		approx. 220			approx. 220		kHz
$V_{i\,RFI}$	Input RFI level, conducted		EN 55022 [5]		B [6]			B [6]		

[1] $V_{i\,min}$ will not be as stated if V_o is increased above $V_{o\,nom}$ by use of Trim input. If the output voltage is set to a higher value, $V_{i\,min}$ will be proportionately increased.
[2] Input undervoltage lockout at typ. 85% of $V_{i\,min}$.
[3] Measured with resistive and max. admissible capacitive load.
[4] Source impedance according to ETS 300132-2, version 4.3.
[5] Measured with a lead length of 0.1 m, leads twisted.
[6] Requires an external input capacitor 4.7 µF (50 V for 20IMX, 100 V for 40IMX, 200 V for 70/110IMX).

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.

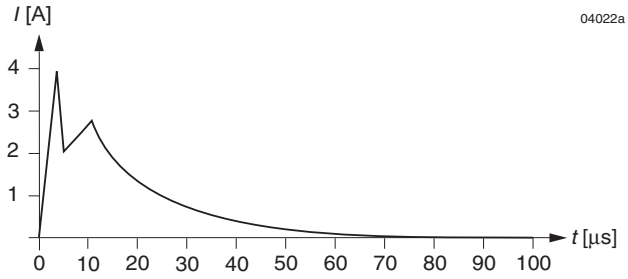

Fig. 2
Typical inrush current at $V_{i\,nom}$, $P_{o\,nom}$ versus time (40IMX35). Source impedance according to ETS 300132-2 at $V_{i\,nom}$.

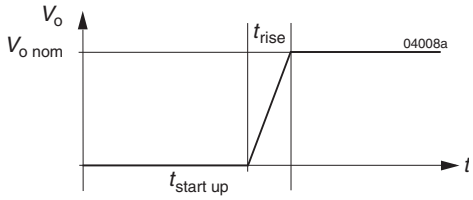

Fig. 3
Converter start-up and rise time

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 3: Recommended external fuses

Converter model	Fuse type
20IMX35	F8.0A
40IMX35	F4.0A
70IMX35	F2.0A
110IMX35	F1.5A

Input Transient Voltage Protection

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

Table 4: 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]
20IMX35	39	1500	22
40IMX35	100	1500	9.7
70IMX35	151	600	2.9
110IMX35	176	600	2.5

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 below.

Table 5: Components for external circuitry for IEC/EN 61000-4-5, level 2

Model	Inductor (L)	Capacitor (C)	Diode (D)
20IMX35	22 µH/5 A	470 µF/40 V	1.5 k E47A
40IMX35	68 µH/2.7 A	2 x 100 µF/100 V	-
70IMX35	100 µH/1 A	2 x 82 µF/200 V	-
110IMX35	150 µH/0.8 A	2 x 82 µF/200 V	-

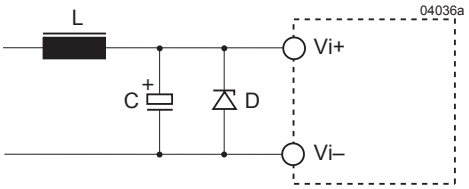

Fig. 4
Example for external circuitry to comply with IEC/EN 61000-4-5; the diode D is only necessary for 20IMX35 models.

Electrical Output Data

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

Table 6: Output data for double output power trains (Vo1/Vo4 or Vo2/Vo3, i.e. each power train has 2 outputs)

Output					**2 x 5 V**			**2 x 12 V**			**2 x 15 V**			
Characteristics		Conditions			min	typ	max	min	typ	max	min	typ	max	Unit
V_{o1} V_{o2}	Output voltage			$V_{i\,nom}$ I_o = 0.5 $I_{o\,nom}$	4.95 4.94		5.05 5.06	11.88 11.86		12.12 12.14	14.85 14.82		15.15 15.18	VDC
$I_{o\,nom}$	Output current		20IMX	$V_{i\,min}$ to $V_{i\,max}$	2 x 1.35			2 x 0.65			2 x 0.55			A
			40IMX		2 x 1.4			2 x 0.70			2 x 0.60			
			70IMX		2 x 1.4			2 x 0.70			2 x 0.60			
			110IMX		2 x 1.4			2 x 0.70			2 x 0.60			
I_{oL}	Current limit [1]		20IMX	$V_{i\,nom}$, T_C = 25 °C				3.5			1.8			1.5
			40IMX	V_o = 93% $V_{o\,nom}$		3.8			2.0			1.7		
			70IMX			3.8			2.0			1.7		
			110IMX			3.8			2.0			1.7		
$\Delta V_{o\,U}$	Line regulation			$V_{i\,min}$ to $V_{i\,max}$, $I_{o\,nom}$			±1			±1			±1	%
$\Delta V_{o\,I}$	Load regulation			$V_{i\,nom}$ I_o = (0.1 to 1) $I_{o\,nom}$			±3			±3			±3	
$V_{o1/2}$	Output voltage noise			$V_{i\,min}$ to $V_{i\,max}$ [2] I_o = $I_{o\,nom}$ [3]			80 40			120 60			150 70	mV_{pp}
$V_{o\,L}$	Output overvoltage limit. [4]			Min. load 1%	115		130	115		130	115		130	%
$C_{o\,ext}$	Admissible capacitive load						4000			470			330	µF
$V_{o\,d}$	Dynamic load regulation	Voltage deviat.		$V_{i\,nom}$ $I_{o\,nom} \leftrightarrow {}^1/_2\, I_{o\,nom}$			±250			±480			±520	mV
t_d		Recovery time					0.75			0.75			0.75	ms
α_{Vo}	Temperature coefficient $\Delta V_o/\Delta T_C$			$V_{i\,min}$ to $V_{i\,max}$ I_o = (0.1 to 1) $I_{o\,nom}$			±0.02			±0.02			±0.02	%/K

[1] 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).
[2] BW = 20 MHz
[3] Measured with a probe according to EN 61204
[4] The overvoltage protection is via a primary side second regulation loop, not tracking with Trim control.

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 the surfaces and 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.*

The converters provide the specified output power with free air convection cooling. In the upper temperature range the output power derating below should be observed.

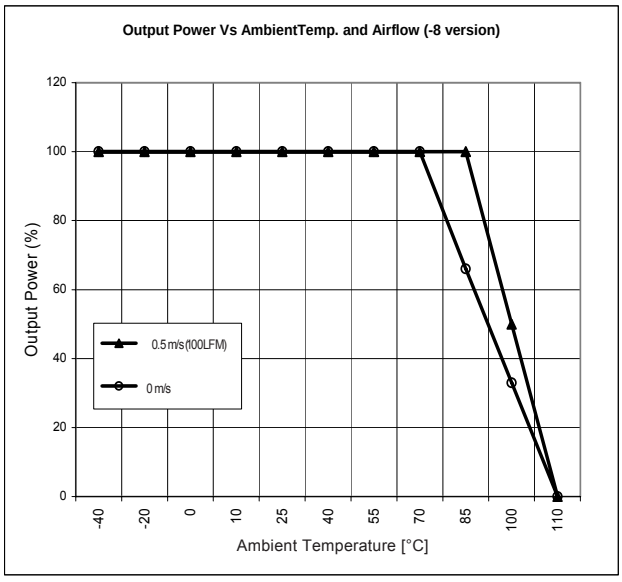

Fig. 5
Maximum allowed output power versus ambient temperature.

Short Circuit Behavior

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

Overtemperature Protection

The converter is protected against 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. This feature prevents excessive internal temperature building up which could occur under heavy overload conditions.

Connection in Series

The outputs of one or several double output power trains may be connected in series without any precautions.

Connection in Parallel

Several 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.

If outputs from the same unit are being paralleled together it is recommended that outputs from the same power trains are connected together first.

Note: A separate application note is available for uses when all outputs are paralleled together.

Parallel operation of several 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 is required in true redundant systems. It is recommended not to parallel more than three units at full load.

Typical Performance Curves

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

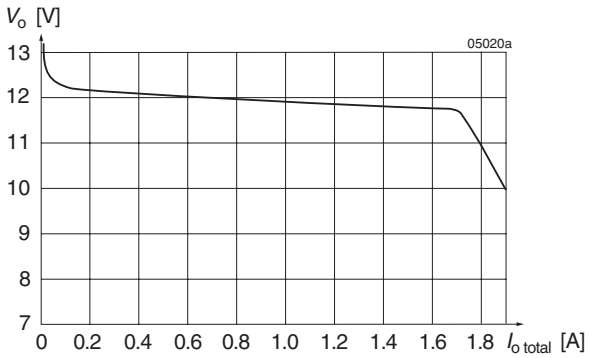

Fig. 6
$V_{o1/2}$ versus $I_{o1/2}$ of double output power trains (i.e. 2 x 12 V). See block diagram fig. 1

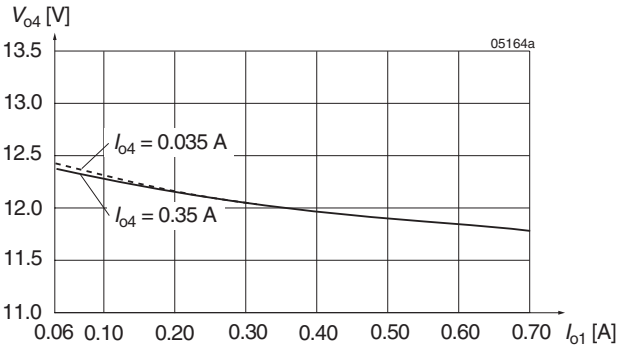

Fig. 7
Cross load regulation V_{o4} versus I_{o1} (typ) for various I_{o4} for Vo1, Vo4 on power train 1. See: See block diagram fig. 1

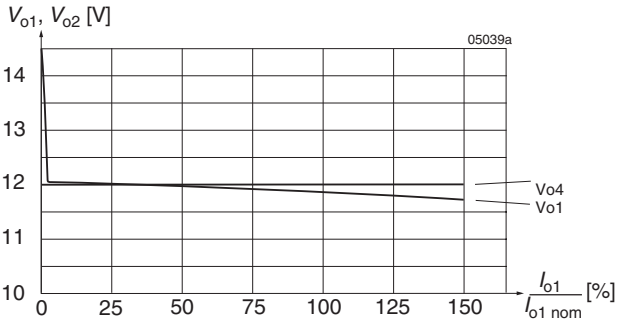

Fig. 8
Flexible load distribution on power train 1 of a 40IMX35D12D12-8 (4 x 12 V) with load variation from 0 to 150% of $P_{o1\,nom}$ on output 1 (Vo1). Vo4 loaded with 50% of $P_{o4\,nom}$.

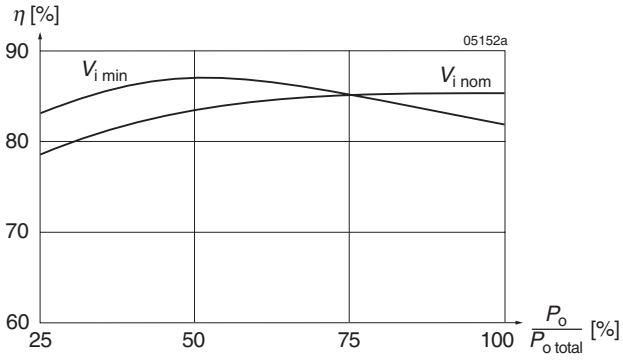

Fig. 9
Efficiency versus input voltage and load. Typical values (40IMX35D12D12-8)

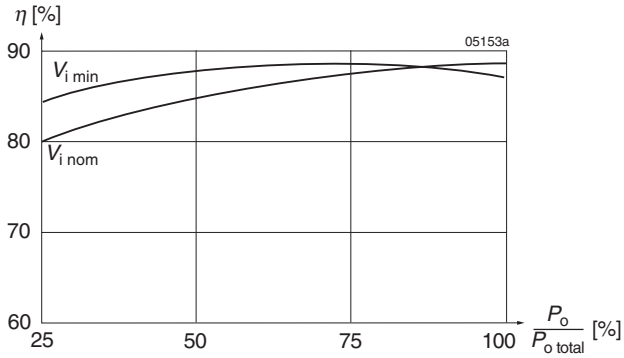

Fig. 10
Efficiency versus input voltage and load. Typical values (20IMX35D12D12-8)

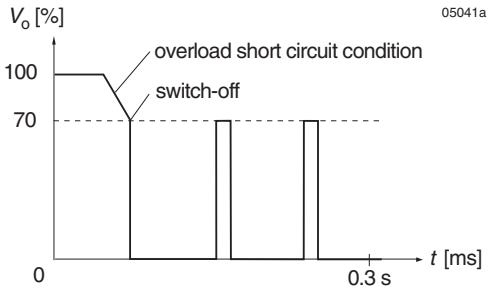

Fig. 11
Overload switch off (hiccup mode), typical values.

Auxiliary Functions

Adjustable Output Voltage

As a standard feature, the IMX35 offer adjustable output voltages in the range of 85 to 105% of $V_{o\,nom}$ by use of the Trim or Trim1 control pin, offered on primary side of the converter.

Quad Output Adjustment

The quadruple output units are shown in block diagram (fig. 1). All models with equal output voltages have the trim function connected to pin 5 referenced to the primary side, which influences all outputs simultaneously. However, the Trim1 input of models with different output voltage for each power train influences only the first power train. The schematic is shown in Fig. 12 below.

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

Adjustment of the output voltage by means of an external resistor R_{ext} is possible within the range of 100 to 105% of $V_{o\,nom}$. R_{ext} should be connected between Trim (pin 5) and Vi– (pin 2). 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 $I_{o\,nom}$).

Table 7: R_{ext1} for $V_o > V_{o\,nom}$; approximate values ($V_{i\,nom}$, I_o = 0.5 $I_{o\,nom}$)

V_o [% $V_{o\,nom}$]	R_{ext} [kΩ]	
	Trim [kΩ]	Trim1 [kΩ]
105 to 108 (107 typically)	0	0
105	10	17
102	62	110
100	∞	∞

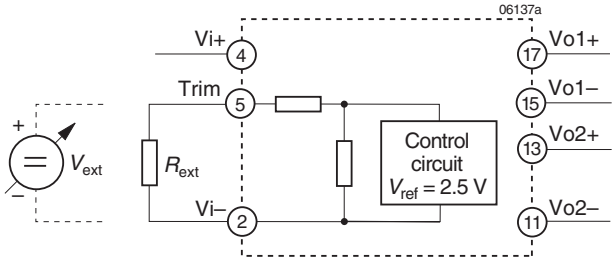

Fig. 12
Output voltage control by means of the Trim input

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

For external output voltage adjustment in the range 85 to 105% of $V_{o\,nom}$ a voltage source V_{ext} (0 to 20 V) is required, connected to Trim or Trim1 (pin 5) and Vi–. The table below indicates typical values V_o versus V_{ext}. Applying a control voltage of 15 to 20 V will set the converter into a hiccup mode. Direct paralleling of the Trim pins of converters of the same type connected in parallel is feasible.

Table 8: V_o versus V_{ext} for V_o = 85 to 105% $V_{o\,nom}$; typical values ($V_{i\,nom}$, I_o = 0.5 $I_{o\,nom}$)

V_o [% $V_{o\,nom}$]	V_{ext} [V]	
	Trim [V]	Trim 1 [V]
>105	0	0
102	1.8	1.5
100	2.5	2.5
95	4.3	4.25
90	6.2	6.2
85	8	8

Synchronization (W)

It is possible to synchronize the switching frequency of one or more converters to an external symmetrical clock signal. Consult factory if this option is required, for full application details.

This logic input can be used to synchronize the oscillator to an external frequency source. This pin is edge triggered with TTL thresholds, and requires a source frequency of 490 to 540 kHz (duty cycle 10 to 90%). The external source frequency is internally divided by 2 to define the switching frequency for the converter. If unused, this pin can be connected to V1– (pin 2) or left open-circuit.

Reference Output (Ref)

The signal output provides a stable 5 V (±0.1 V) reference signal on pin Ref. It is protected by a 1 kΩ resistor. This signal may be used also in conjunction with the Trim input (pin 5) as a limited external voltage reference.

It is recommended to connect a filter capacitor (0.1 µF) between Ref and Vi–, if Ref is used.

Shut Down Function

The outputs of the converters may be enabled or disabled by means of a logic signal (TTL, CMOS, etc.) applied to shut down (pin 8). If the shut down function is not required, then pin 8 should be left open-circuit:

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

Option i: Inhibit (negative shutdown logic)

The output of the converter may be enabled or disabled by means of a logic signal (TTL, CMOS, etc.) applied to the inhibit pin 8. No output voltage overshoot will occur, when the converter is turned on. If the inhibit function is not required the inhibit (pin 8) should be connected to Vi– to enable the output (active low logic, fail safe). Voltage on pin 8:

Converter operating:	–10 V to 0.8 V
Converter disabled:	2.4 V to 20 V or left open-circuit

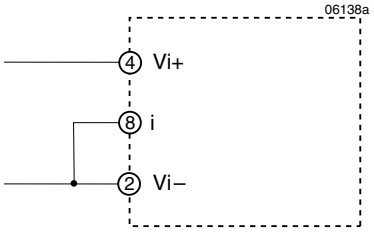

Fig. 13
If the inhibit is not used, the inhibit pin should be connected to Vi–.

Progr. Input Undervoltage Lockout PUL

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

Table 9: Turn on and turn off voltage

Type	Trigger level	Hysteresis	Unit
20IMX35	7 to 8	<0.5	V
40IMX35	14 to 15.5	<1	
70IMX35	31 to 34	<3	
110IMX35	42 to 50	<8	

The under voltage lockout levels may be programmed by use of an external resistor R_{PUL} to increase the pre-set levels as indicated in the table below.

Table 10: Typical values for R_{PUL} and the respective lockout voltage for input voltage.

20IMX35		40IMX35	
R_{PUL} [kΩ]	$V_{i\,min}$ [V]	R_{PUL} [kΩ]	$V_{i\,min}$ [V]
∞	≤ 8	∞	≤15.5
39	10	43	22
19	12	16	26
13	14	10	28
9.1	16	0	32

70IMX35		110IMX35	
R_{PUL} [kΩ]	$V_{i\,min}$ [V]	R_{PUL} [kΩ]	$V_{i\,min}$ [V]
∞	31	∞	42
270	40	270	50
110	50	120	60
80	55	51	75

Electromagnetic Compatibility (EMC)

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

Electromagnetic Immunity

Table 11: Immunity type tests

Phenomenon	Standard	Class Level	Coupling mode [1]	Value applied	Waveform	Source Imped.	Test procedure	In oper.	Per-form. [2]
Electrostatic discharge to case	IEC/EN 61000-4-2	2	contact discharge (Trim pin open)	4000 V_p	1/50 ns	330 Ω	10 positive and 10 negative discharges	yes	B
		3	air discharge (Trim pin open)	8000 V_p					
Electromagnetic field	IEC/EN 61000-4-3	3 [3]	antenna	10 V/m	AM 80% 1 kHz	n.a.	80 to 1000 MHz	yes	A
		3	antenna	10 V/m	PM, 50% duty cycle, 200 Hz repetition frequ.	n.a.	900 MHz	yes	A
Electrical fast transients/burst	IEC/EN 61000-4-4	4	direct +i/–i	4000 V_p	bursts of 5/50ns 2.5/5 kHz over 15 ms, burst period 300 ms	50 Ω	60 s positive, 60 s negative transients per coupling mode	yes	B
Surges	IEC/EN 61000-4-5	3 [4]	+i/–i	2000 V_p	1.2/50 µs	2 Ω	5 pos. and 5 neg. surges	yes	B
	EN 50155: 2001	A [5]	+i/c, –i/c	1800 V_p	5/50 µs	100 Ω		yes	B
		B [6]	+i/c, –i/c	8400 V_p	0.05/0.1 µs	100 Ω		yes	B
RF Conducted immunity	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

[1] i = input, o = output.
[2] A = normal operation, no deviation from specification, B = temporary deviation from specs. possible.
[3] Corresponds to EN 50121-3-2:2000, table 9.1
[4] External components required.
[5] Corresponds to EN 50155:1995, waveform D
[6] Corresponds to EN 50155:1995, waveform G

Electromagnetic Emission

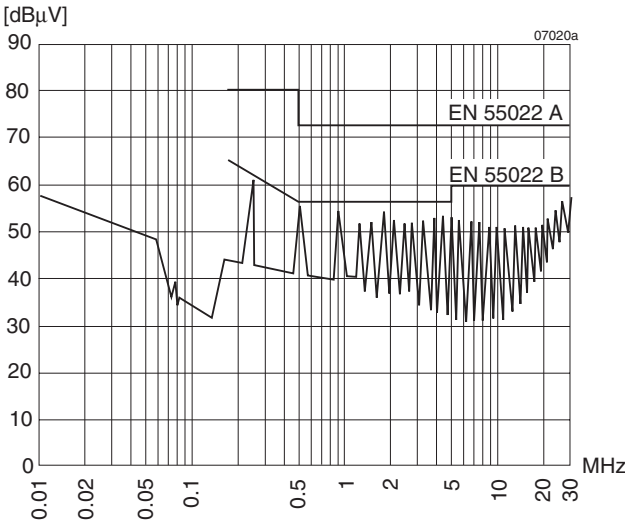

Fig. 14
Typical disturbance voltage (quasi-peak) at the input according to EN 55011/22, measured at $V_{i\ nom}$ and $I_{o\ nom}$. Output leads 0.1 m, twisted (40IMX35D12D12-8).

Radiated Emissions (EN 55011/22)

Radiated emission requirements according to EN 55011/22, class B, can be achieved by adding an external common mode choke and for 20IMX35 models an additional capacitor (4.7 µF/ 50 V). The filter components should be placed as close as possible to the input of the converter (see figure below).

Table 12: Input filter components for EN 55011/22, level B, radiated (30 to 1000 MHz)

Type	Current compensated choke
20 IMX 35	Murata PLH1OA series 7003R6P02
40 IMX 35	Murata PLH1OA series 1612R1P02
70 IMX 35	Murata PLH1OA series 2911R2P02
110 IMX 35	Murata PLH1OA series 3711R0P02

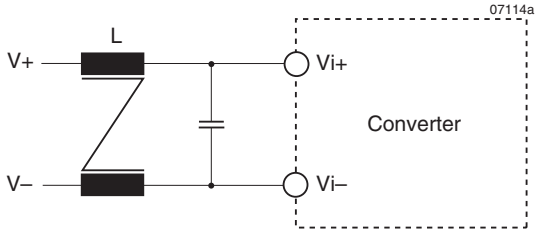

Fig. 15
Example for external circuitry to comply with EN 55011/22, level B, radiated

Table 13: Temperature specifications, valid for air pressure of 800 to 1200 hPa (800 to 1200 mbar)

Temperature			**-8**		
Characteristics		Conditions	min	max	Unit
T_A	Ambient temperature	Operational [1]	–40 [2]	85 [1]	°C
T_C	Case temperature		–40 [2]	110	
T_S	Storage temperature	Non operational	–55 [2]	110	

[1] See: *Thermal Considerations*
[2] Start up at – 55 °C

Immunity to Environmental Conditions

Temperatures

Reliability

Table 14: MTBF

MTBF (nominal load)	**Ground Benign**	**Ground Fixed**		**Ground Mobile**
40 IMX35 (MIL-HDBK-217F)	336 000 h (T_C = 40 °C)	141 000 h (T_C = 40 °C)	86 000 h (T_C = 70 °C)	110 000 h (T_C = 50 °C)
110 IMX35 (Bellcore)	1372 000 h (T_A = 25 °C)			
Device hours	396 000 h			

The device hours are based upon the IMX35 series field failure rate recorded between 2000 and 2005.

Environmental Tests

Table 15: Environmental testing

Test Method		Standard	Test Conditions		Status
Ca	Damp heat steady state	IEC/EN 60068-2-78 MIL-STD-810D sect. 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 [1] MIL-STD-810D sect. 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 sect. 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	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
Fn	Vibration broad-band random (digital control)	IEC/EN 60068-2-64	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

[1] Covers also EN 50155/ EN 61373 (Category 1, body mounted Class B)

Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.

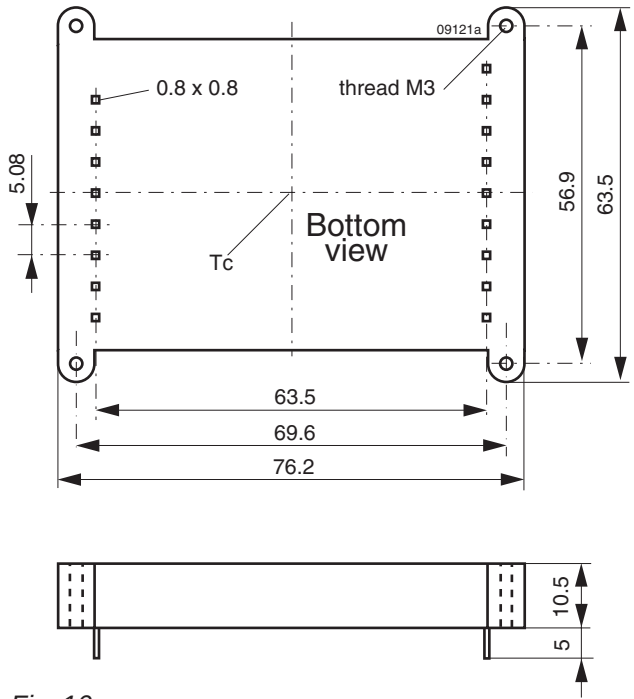

Fig. 16
Case IMX35 (Standard)
Weight: approx. 67 g

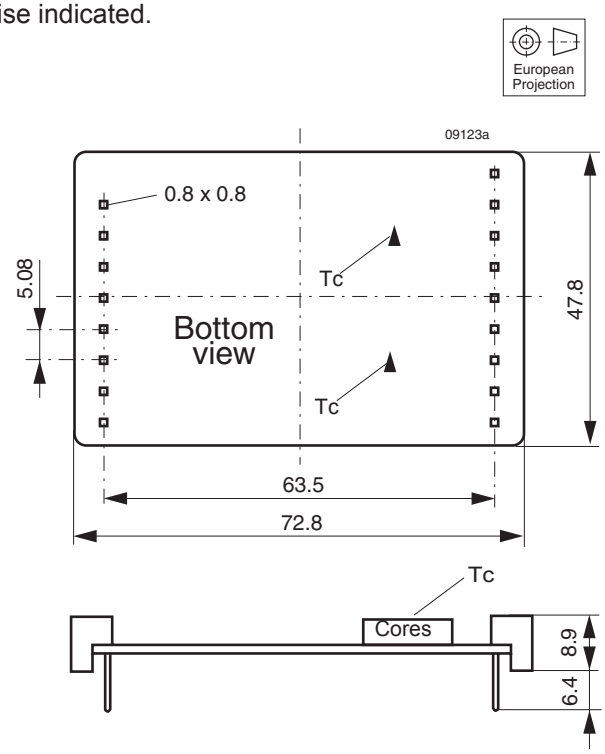

Fig. 17
Case IMX35 open frame (option Z)
Weight: approx. 43 g

Safety and Installation Instructions

Pin allocation

Table 16: Pin allocation

Pin No.	Quadruple output
1	PUL
2	Vi–
3	n.c.
4	Vi+
5	Trim or Trim1
6	W
7	Ref
8	$\overline{SD}$
11	Vo3–
12	Vo3+
13	Vo2+
14	Vo2–
15	Vo1–
16	Vo1+
17	Vo4+
18	Vo4–
19	n.c.

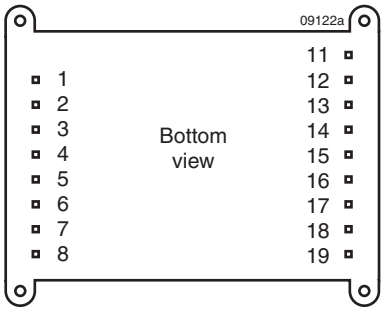

Fig. 18
Footprint. The holes in the PCB should have a diameter of 1.5 mm.

Installation Instructions

Installation of the 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 1.5 mm for the pins.

The converters should be connected to a secondary circuit.

Do not open the converter.

Ensure that a converter failure (e.g., by an internal short-circuit) does not result in a hazardous condition.

Input Fuse

To prevent excessive current flowing through the input supply line in case of a short-circuit across the converter input, an external fuse should be installed in the non-earthed input line. We recommend a fast acting fuse F8.0A for 20 IMX35 models, F4.0 A for 40 IMX35 models, and F2.0 A for 70 IMX35 and 110 IMX35 models.

Standards and Approvals

All converters are approved by UL and TÜV according to the standards UL 60950, CAN/CSA C22.2 No. 950-95 and IEC/EN 60950-1:2001. CB test reports are available on request.

The converters have been evaluated for:

- Building-in
- Basic insulation input to output, based on their maximum input voltage
- Pollution degree 2
- Connecting the input to a secondary circuit, which is subject to a maximum transient rating of 1500 V.

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

Railway Applications

To comply with Railway standards, all components are coated with a protective lacquer (except for option Z).

Protection Degree

The protection degree is IP 30 (not for option Z).

Cleaning Agents

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

However, open cased units (option Z), which leave the factory unlacquered, may be cleaned and lacquered

by the customer.

Isolation

The electric strength test is performed in the factory as a routine test in accordance with EN 50116, EN 60950 and UL 60950 and should not be repeated in the field. Power-One will not honor any warranty claims that result from electric strength field tests.

Table 17: Electric strength test voltages

Characteristic	Input to (outputs+case) 20/40IMX35 [1]	Input to (outputs+case) 70/110IMX35 [1]	Outputs to case all models [1]	Between outputs all models	Unit
Factory test >1 s	1.2	1.8	0.5	0.15 [2]	kVAC
Equivalent DC voltage	1.5	2.5	0.7	0.2 [2]	kVDC
Insulation resistance at 500 VDC	>100	>100	—	—	MΩ

[1] For open-frame models (option Z), only the insulation input to outputs is tested.
[2] The test voltage between outputs is not applied as a routine test. For higher isolation between outputs, contact Power-One.

Options

Table 18: List of Options

Option	Function of option	Description
i	Inhibit: Negative shutdown logic	See *Auxiliary Functions*
Z	Open frame	See *Mechanical Data*

EC Declaration of Conformity

We

Power-One AG
Ackerstrasse 56, CH-8610 Uster

declare under our sole responsibility that 20/40/70/110IMX35 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 60950-1:2001 (=IEC 60950-1:2001)
  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, 14 Nov. 2005 Power-One AG

Rolf Baldauf
Vice-President Engineering

Johann Milavec
Director Projects and IP