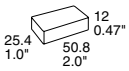
6...12 Watt DC-DC Converters

IMO Series

Input voltage range up to 72 V DC
1 or 2 outputs up to 30 V DC
1500 V DC I/O electric strength test voltage

- Input voltage range up to 4:1
- Input filter
- High efficiency up to 80%
- Outputs short-circuit proof
- No derating
- 2" × 1" metal case
- Low cost



Summary

The IMO series of DC-DC converters have been developed for powering commercial type of electronic circuits, e.g. telephone systems components, industrial controllers and small appliances. They are suitable for applications with standard battery voltages. The IMO converters feature good efficiency and good dynamic response to load changes and at start-up. The IMO modules are short-circuit and no-load proof.

Type Survey and Key Data

Table 1: Type survey

Output 1 $U_{o\,nom}$ [V]	Output 1 $I_{o\,nom}$ [mA]	Output 2 $U_{o\,nom}$ [V]	Output 2 $I_{o\,nom}$ [mA]	Output power T_A = 71°C $P_{o\,nom}$ [W]	Input voltage $U_{i\,min}$...$U_{i\,max}$ [V DC]	Efficiency $U_{i\,nom}$, $I_{o\,nom}$ η_{min} [%]	Type designation	Option
3.3	1500	-	-	5	10...36	63	24 IMO 6-03-2	-7
3.3	1500	-	-	5	18...72	63	48 IMO 6-03-2	
3.3	3000	-	-	10	18...60	70	24 IMO 12-03-2	
3.3	3000	-	-	10	35...75	70	48 IMO 12-03-2	
5	1000	-	-	5	10...36	68	24 IMO 6-05-2	
5	1000	-	-	5	18...72	70	48 IMO 6-05-2	
5	2400	-	-	12	18...60	70	24 IMO 12-05-2	
5	2400	-	-	12	35...75	70	48 IMO 12-05-2	
12	500	-	-	6	10...36	73	24 IMO 6-12-2	
12	500	-	-	6	18...72	75	48 IMO 6-12-2	
12	1000	-	-	12	18...60	76	24 IMO 12-12-2	
12	1000	-	-	12	35...75	76	48 IMO 12-12-2	
15	400	-	-	6	10...36	73	24 IMO 6-15-2	
15	400	-	-	6	18...72	76	48 IMO 6-15-2	
15	800	-	-	12	18...60	80	24 IMO 12-15-2	
15	800	-	-	12	35...75	80	48 IMO 12-15-2	
+5	500	–5	500	5	10...36	68	24 IMO 6-0505-2	
+5	500	–5	500	5	18...72	70	48 IMO 6-0505-2	
+12	250	–12	250	6	10...36	72	24 IMO 6-1212-2	
+12	250	–12	250	6	18...72	75	48 IMO 6-1212-2	
+12	500	–12	500	12	18...60	80	24 IMO 12-1212-2	
+12	500	–12	500	12	35...75	80	48 IMO 12-1212-2	
+15	200	–15	200	6	10...36	73	24 IMO 6-1515-2	
+15	200	–15	200	6	18...72	76	48 IMO 6-1515-2	
+15	400	–15	400	12	18...60	80	24 IMO 12-1515-2	
+15	400	–15	400	12	35...75	80	48 IMO 12-1515-2	

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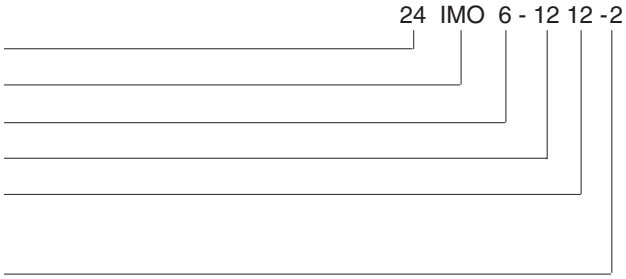
Type Key

Type Key

Nominal input voltage in volt ..... 24...48
Series ..... IMO
Nominal output power in watt 6, 12
Nominal output voltage for output 1 in volt ..... 03...15
Nominal output voltage for output 2 in volt ..... 05...15
Operational ambient temperature range T_A
Standard: –10...50 °C ..... -2
Option: –25...71 °C ..... -7



Functional Description

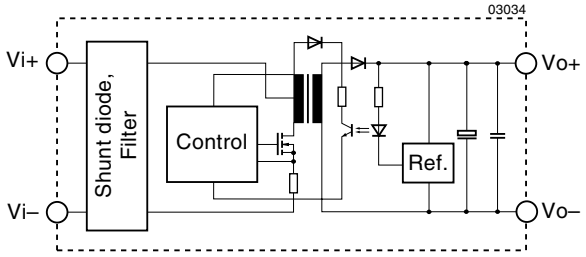


Fig. 1
Single output converter block diagram

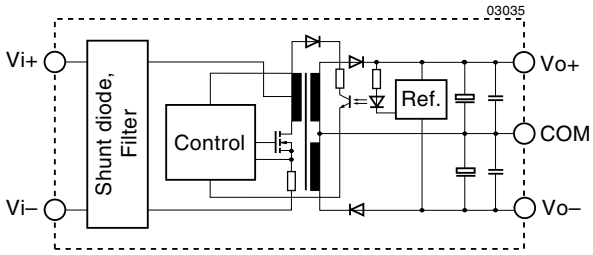


Fig. 2
Dual output converter block diagram

Electrical Input Data

General condition: T_A = 25 °C unless otherwise specified

Table 2: Input data

Input			24 IMO 6			24 IMO 12			48 IMO 6			48 IMO 12			
Characteristics		Conditions	min	typ	max	min	typ	max	min	typ	max	min	typ	max	Unit
U_i	Input voltage range	$T_{A\,min}$...$T_{A\,max}$ I_o = 0...$I_{o\,nom}$	10		36	18		60	18		72	35		75	V DC
$U_{i\,nom}$	Nominal input voltage			24			24			48			48		
U_i	Input voltage without damage		0		75	0		65	0		75	0		80	
$I_{i\,0}$	No load input current	$U_{i\,nom}$, I_o = 0		25			8			12			8		mA
$I_{i\,L}$	Input current limitation response	$U_{i\,nom}$, full load		1.5 $P_{i\,nom}$			1.25 $P_{i\,nom}$			1.5 $P_{i\,nom}$			1.25 $P_{i\,nom}$		W
$U_{i\,rev}$	Reverse input voltage protection	U_i = negative or reverse polarity	shunt diode use external fuse												

Electrical Output Data

General condition: T_A = 25°C unless otherwise specified

Table 3a: Output data for single output types

Output			IMO 6-03			IMO 6-05			IMO 6-12			IMO 6-15			
Characteristics		Conditions	min	typ	max	min	typ	max	min	typ	max	min	typ	max	Unit
U_o	Output voltage	$U_{i\,nom}$, $I_{o\,nom}$	3.24		3.36	4.90		5.10	11.76		12.24	14.70		15.30	V
$I_{o\,nom}$	Nominal output current	$U_{i\,min}$...$U_{i\,max}$		1500			1000			500			400		mA
u_o	Output voltage noise	$U_{i\,nom}$ $I_{o\,nom}$ (BW = 20 MHz)		100	150		100	150		100	150		100	150	mV_{pp}
$\Delta U_{o\,U}$	Static line regulation	$U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$			±1			±1			±1			±1	%
$\Delta U_{o\,I}$	Static load regulation	$U_{i\,nom}$ $I_{o\,nom}$...0		±2			±2			±2			±2		
t_r	Transient recovery time	$I_{o\,nom} \leftrightarrow {}^1/_2$		500			500			500			500		µs
α_{Uo}	Temperature coefficient	$U_{i\,nom}$ $I_{o\,nom}$			±0.02			±0.02			±0.02			±0.02	%/K
f_s	Switching frequency			200			200			200			200		kHz

Table 3b: Output data for single output types

Output			IMO 12-03			IMO 12-05			IMO 12-12			IMO 12-15			
Characteristics		Conditions	min	typ	max	min	typ	max	min	typ	max	min	typ	max	Unit
U_o	Output voltage	$U_{i\,nom}$, $I_{o\,nom}$	3.24		3.36	4.90		5.10	11.76		12.24	14.70		15.30	V
$I_{o\,nom}$	Nominal output current	$U_{i\,min}$...$U_{i\,max}$		3000			2400			1000			800		mA
u_o	Output voltage noise	$U_{i\,nom}$ $I_{o\,nom}$ (BW = 20 MHz)			150			150			240			300	mV_{pp}
$\Delta U_{o\,U}$	Static line regulation	$U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$			±1			±1			±1			±1	%
$\Delta U_{o\,I}$	Static load regulation	$U_{i\,nom}$ $I_{o\,nom}$...0		±2			±2			±2			±2		
t_r	Transient recovery time	$I_{o\,nom} \leftrightarrow {}^1/_2$		500			500			500			500		µs
α_{Uo}	Temperature coefficient	$U_{i\,nom}$ $I_{o\,nom}$			±0.02			±0.02			±0.02			±0.02	%/K
f_s	Switching frequency			200			200			200			200		kHz

Table 3c: Output data for dual output types

Output			IMO 6-0505			IMO 6-1212			IMO 6-1515			
Characteristics		Conditions	min	typ	max	min	typ	max	min	typ	max	Unit
U_o	Output voltage	$U_{i\,nom}$, $I_{o\,nom}$	±4.90		±5.10	±11.76		±12.24	±14.70		±15.30	V
$I_{o\,nom}$	Nominal output current	$U_{i\,min}$...$U_{i\,max}$		±500			±250			±200		mA
u_o	Output voltage noise	$U_{i\,nom}$ $I_{o\,nom}$ (BW = 20 MHz)		100	150		100	150		100	150	mV_{pp}
$\Delta U_{o\,U}$	Static line regulation	$U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$			±1			±1			±1	%
$\Delta U_{o\,I}$	Static load regulation	$U_{i\,nom}$ $I_{o\,nom}$...0		±5			±5			±5		
t_r	Transient recovery time	$I_{o\,nom} \leftrightarrow {}^1/_2$		500			500			500		µs
α_{Uo}	Temperature coefficient	$U_{i\,nom}$ $I_{o\,nom}$			±0.02			±0.02			±0.02	%/K
f_s	Switching frequency			200			200			200		kHz

Table 3d: Output data for dual output types

Output			IMO 12-1212			IMO 6-1515			Unit
Characteristics		Conditions	min	typ	max	min	typ	max	
U_o	Output voltage	$U_{i\,nom}$, $I_{o\,nom}$	±11.76		±12.24	±14.70		±15.30	V
$I_{o\,nom}$	Nominal output current	$U_{i\,min}$...$U_{i\,max}$		±500			±400		mA
u_o	Output voltage noise	$U_{i\,nom}$ $I_{o\,nom}$ (BW = 20 MHz)			240			300	mV_{pp}
$\Delta U_{o\,U}$	Static line regulation	$U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$			±1			±1	%
$\Delta U_{o\,I}$	Static load regulation	$U_{i\,nom}$ $I_{o\,nom}$...0		±5			±5		
t_r	Transient recovery time	$I_{o\,nom} \leftrightarrow {}^1/_2$		500			500		µs
α_{Uo}	Temperature coefficient	$U_{i\,nom}$ $I_{o\,nom}$			±0.02			±0.02	%/K
f_s	Switching frequency			200			200		kHz

Thermal Considerations

If a converter is operated, the relationship between the ambient temperature T_A and the case temperature 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. The specified maximum ambient temperature $T_{A\,max}$ 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.*

Connection in Parallel

The outputs of several units can be connected in parallel. However, the use of a single unit with a higher power rating is a better choice because of uneven power distribution among the outputs connected in parallel. It is recommended to select converters to be connected in parallel with very small output voltage differences at full load (i.e. <±1%). A decoupling diode is not required but recommended.

Connection in Series

The outputs of one or more units can be connected in series. No suppressor diodes are required. Power-One however recommends to protect each individual output with a Zener diode or preferably a suppressor diode, to avoid reverse polarity that may occur if the output voltages do not rise simultaneously.

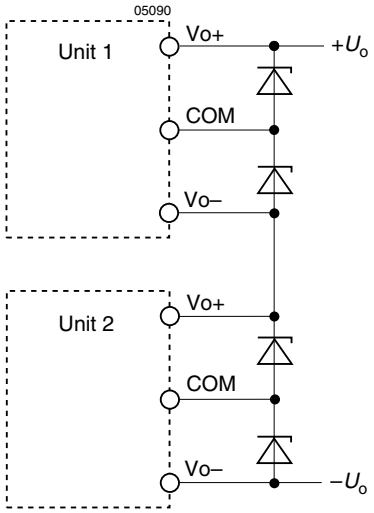


Fig. 3
Outputs connected in series

Electromagnetic Compatibility (EMC)

Filter recommendations for compliance with CISPR 22/EN 55022, class B

Electromagnetic emission requirements according to EN 55022, class B can be easely achieved by adding an external input filter consisting of additional capacitors and a choke.

The filter components should be placed as close as possible to the input of the converter.

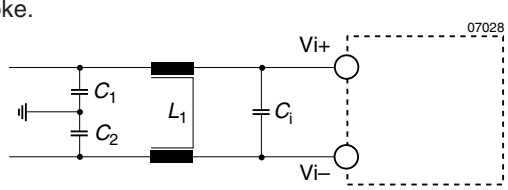


Fig. 4
Input filter arrangement for 24 and 40 V DC types

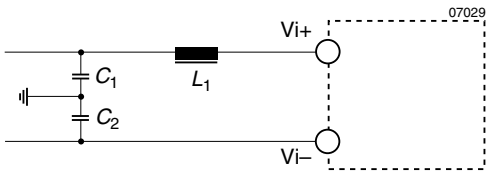


Fig. 5
Input filter arrangement for 48 V DC types

Table 4: Input filter components

Types	C_1	C_2	Type	L_1	Type	C_i	Type
24 IMO 6	2.2 µF 100 V	2.2 µF 100 V	Siemens B 32522-C1225-K	2.2 mH	Siemens B 82722-A2202-N1	2.2 µF 100 V	Siemens B 32522-C1225-K
48 IMO 6	1 µF [1] 100 V	1 µF [1] 100 V	Siemens B 32522-C1105-K	0.5 mH	Ticomel SO 17-0.63 –500	–	
24 IMO 12	3.3 µF 50 V	3.3 µF 50 V	Siemens B 32529-C5335-K	5.6 mH	Siemens B 82723 A2202-N1	3.3 µF 50 V	Siemens B 32529-C5335-K
48 IMO 12	2.2 µF [1] 100 V	2.2 µF [1] 100 V	Siemens B 32522-C1225-K	2.2 mH	Siemens B 82722 A2202-N1	1 µF 100 V	Siemens B 32522-C1105-K

[1] Only valid for input voltages up to 60 V DC.

Immunity to Environmental Conditions

Table 5: Temperature specifications, valid for air pressure of 800...1200 hPa (800...1200 mbar)

Temperature			Standard -2		Option -7		
Characteristics		Conditions	min	max	min	max	Unit
T_A	Ambient temperature	$U_{i\ nom}$	–10	50	–25	71	°C
T_C	Case temperature	$I_o = 0...I_{o\ nom}$	–25	80	–25	80	
T_S	Storage temperature	Non operational	–25	80	–40	100	

Mechanical Data

European Projection

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

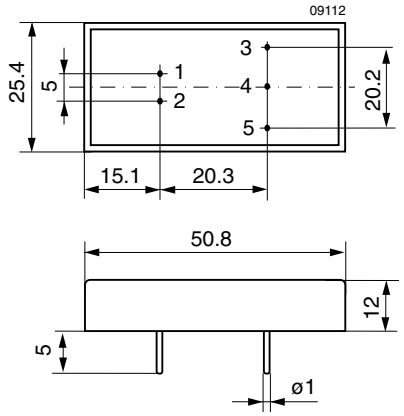


Fig. 6
Case 2" × 1"
Weight: 50 g

Safety and Installation Instructions

Installation Instruction

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 according to: *Mechanical Data*.

The units should be connected to a secondary circuit.

Check for hazardous voltages before altering any connections.

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.*

Standards and approvals

The units have been evaluated for:

- Building in
- Operational insulation input to output
- 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.

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 a non earthed input supply line.

We recommend a fast acting fuse

F1.6A for 24 IMO 6
F0.8A for 48 IMO 6
F3.15A for 24 IMO 12
F1.6A for 48 IMO 12

Isolation

The electric strength test is performed as factory test in accordance with IEC/EN 60950 and UL 1950 and should not be repeated in the field. Power-One will not honour any guarantee claims resulting from electric strength field tests.

Table 7: Electric strength test voltages, clearance and creepage distances

Characteristic	Input to output	Unit
Electric strength test voltage 1 s	1100	V_{rms}
	1500	V DC
Coupling capacitance IMO 6 types IMO 12 types	 ≈320 ≈2200	pF
Insulation resistance at 500 V DC	>1000	MΩ

Table 8: Pin allocation

Pin	Single output units	Dual output units
1	Vi+	Vi+
2	Vi–	Vi–
3	Vo+	Vo+
4	no pin	COM
5	Vo–	Vo–

Cleaning Agents

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

Protection Degree

The protection degree of the DC-DC converters is IP 40.

Safety of operator accessible output circuit

If the output circuit of a DC-DC converter is operator accessible, it shall be an SELV circuit according to IEC/EN 60950 related safety standards

The following table shows some possible installation configurations, compliance with which causes the output circuit of the DC-DC converter to be an SELV circuit according to IEC/EN 60950 up to a configured output voltage (sum of nominal voltages if in series or +/– configuration) of 30 V.

However, it is the sole responsibility of the installer to assure the compliance with the relevant and applicable safety regulations. More information is given in: *Technical Information: Safety*.

Table 9: 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	Measures to achieve the specified safety status of the output circuit	Safety status of the DC-DC converter output circuit
Mains ≤250 V AC	Basic	≤60 V	Earthed SELV circuit [2]	Operational insulation, provided by the DC-DC converter	SELV circuit
			ELV circuit	Input fuse [3] output suppressor diodes [4], and earthed output circuit [2]	Earthed SELV circuit
		>60 V	Hazardous voltage secondary circuit		
	Double or reinforced	≤60 V	SELV circuit	Operational insulation, provided by the DC-DC converter	SELV circuit
		>60 V	TNV-2 circuit	Earthed output circuit [2]	Earthed SELV
			Double or reinforced insulated unearthed hazardous voltage secondary circuit [5]	Input fuse [3] and output suppressor diodes [4]	SELV 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: *Input Fuse*.
[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 double or reinforced insulation according to the relevant safety standard, based on the maximum output voltage from the front end.

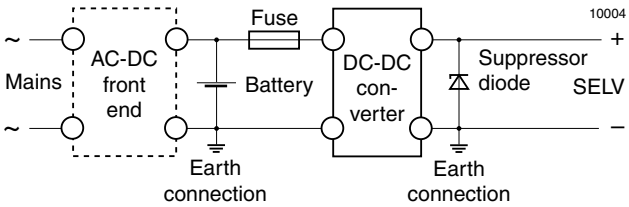


Fig. 7
Schematic safety concept. Use fuse, suppressor diode and earth connection as per table Safety concept leading to an SELV output circuit.