Industrial DC/DC CONVERTER
MGDI-10 Standard Input : 10W POWER

Industrial Grade

2:1 Standard Input
Single & Bi Outputs
Metallic case - 1.500 VDC Isolation

- Low profile : 0,33 " (8.5mm)
- Nominal power of 10 W without derating
- Wide temperature range : -40°C/+95°C case
- High efficiency up to 83 %
- Soft start
- Galvanic isolation 1.500 VDC
- Integrated LC EMI filter
- Permanent short circuit protection
- No optocoupler for high reliability

1-General

The MGDI-10 series is a full family of DC/DC power modules designed for use in distributed power architecture and are particularly suitable for mobile or ground fixed applications in transportation, industry and télécommunication areas. These modules use a high frequency fixed switching technic at 480 KHz providing excellent reliability, low noise characteristics, high power density and a low profile package. Standard models are available with nominal input voltages as 5, 12, or 24 volts in range of 4,5-5,5 or 18-36 volts. The series include single and bi output voltage choices of 3,3, 5, 12, 15, +/-5, +/-12 or +/-15 volts.
No external heatsink is required for the MGDI-10 series to supply 10W output power over the case temperature range of -40°C up to 95°C.
The MGDI-10 series is designed in conformity with safety standards EN60950 and UL1950.

All the modules are designed with LC network filters to minimize reflected input current ripple and output voltage ripple according to EN55022 and FCC Part 15J standard.
The modules include a soft-start, an input undervoltage lock-out, a permanent short circuit protection and an output overvoltage protection to ensure efficient module protections. The soft-start allows current limitation and eliminates inrush current during start-up. The short circuit protection completely protects the modules against short-circuits of any duration by a shut-down and restores to normal when the overload is removed.
The design has been carried out with surface mount components and is manufactured in a fully automated process to guarantee high quality. Each module is tested and burned in with a GAIA Converter automated test equipment.

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2-Product Selection

Single output model : MGDSI-10- ☐ — ☐
Bi output model : MGDBI-10- ☐ — ☐

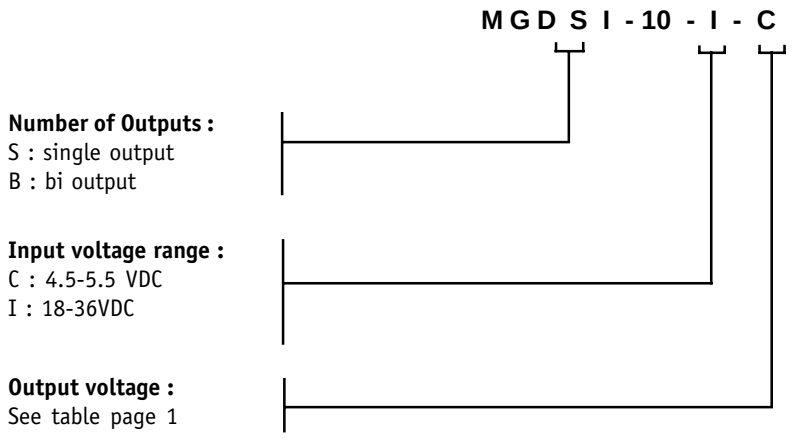
Input Voltage Range	Output
Permanent C : 4,5-5,5 VDC I : 18-36 VDC	B : 3.3 VDC C : 5 VDC or +/-5VDC E : 12 VDC or +/-12VDC F : 15 VDC or +/-15VDC

For locations, phone, fax, E-Mail see back cover

2- Product Selection (continued)

Input range	Output	Current	Reference	Options
4.5-5.5 VDC	3,3 VDC	2 A	MGDSI-10-C-B	/
4.5-5.5 VDC	5 VDC	2 A	MGDSI-10-C-C	/
4.5-5.5 VDC	12 VDC	0,80 A	MGDSI-10-C-E	/
4.5-5.5 VDC	15 VDC	0,65 A	MGDSI-10-C-F	/
4.5-5.5 VDC	+/- 5 VDC	+/- 1 A	MGDBI-10-C-C	/
4.5-5.5 VDC	+/- 12 VDC	+/- 0,40 A	MGDBI-10-C-E	/
4.5-5.5 VDC	+/- 15 VDC	+/- 0,33 A	MGDBI-10-C-F	/
18-36 VDC	3,3 VDC	2 A	MGDSI-10-I-B	/
18-36 VDC	5 VDC	2 A	MGDSI-10-I-C	/
18-36 VDC	12 VDC	0.80 A	MGDSI-10-I-E	/
18-36 VDC	15 VDC	0.65 A	MGDSI-10-I-F	/
18-36 VDC	+/- 5 VDC	+/- 1 A	MGDBI-10-I-C	/
18-36 VDC	+/- 12 VDC	+/- 0.40 A	MGDBI-10-I-E	/
18-36 VDC	+/- 15 VDC	+/- 0.33 A	MGDBI-10-I-F	/

Converter Selection Chart



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3- Electrical Specifications

Data are valid at +25°C, unless otherwise specified.

Parameter	Conditions	Limit or typical	Units	Single Output MGDSI- 10	
				10 - C	10 - I
Input					
Nominal input voltage	Full temperature range	Nominal	VDC	5	24
Permanent input voltage range (Ui)	Full temperature range	Min. - Max.	VDC	4,5- 5,5	18- 36
Undervoltage lock-out (UVLO)	turn-on/turn-off threshold	Minimum Maximum	VDC VDC	4 4,5	16 17,5
Start up time	Ui nominal Nominal output Full load : resistive	Maximum	ms	30	30
Reflected ripple current	Ui nominal, full load at switching freq. BW = 20MHz Decoupling capacitor 10µF	Maximum	mApp	50	30
Input current in short circuit mode (Average)	Ui nominal Short-circuit	Maximum	mA	50	30
No load input current	Ui nominal No load	Maximum	mA	50	30
Output					
Output voltage *	Full temperature range Ui min. to max. 75% load	Nominal Nominal Nominal Nominal	VDC VDC VDC VDC	3,3 5 12 15	3,3 5 12 15
Set Point accuracy	Ambient temperature : +25°c Ui nominal, 75% load	Maximum	%	+/- 2	+/- 2
Output power	Full temperature range Ui min. to max.	Maximum	W	10	10
Output current 3,3V output 5V output 12V output 15V output	Full temperature range Ui min. to max.	Maximum Maximum Maximum Maximum	A A A A	2 2 0,80 0,65	2 2 0,80 0,65
Ripple output voltage ** 3,3V and 5V output 12V output 15V output	Ui nominal Full load BW = 20MHz	Maximum Maximum Maximum	mVpp mVpp mVpp	50 100 150	50 100 150
Line regulation	Ui min. to max. Full load	Maximum	%	+/- 1	+/- 1
Load regulation ***	Ui nominal 25% to full load	Maximum	%	+/- 2,5	+/- 2,5
Efficiency	Ui nominal Full load	Typical	%	77	83
Maximum admissible Capacity load 3,3V and 5V output 12V and 15V output	Ui nominal Full load Per output	Maximum Maximum	µF µF	1.000 330	1.000 330

*Note * : For proper operation the MGDI-10 module requires to install a 22µF chemical or tantalum capacitance accross output terminals.*
*Note ** : The ripple output voltage is the periodic AC component imposed on the output voltage, an aperiodic and random component (noise) has also to be considered. This noise can be reduced by adding an external capacitor (typically 10nF/rated voltage depending on isolation requirement) connected between the pin Gin and the pin Gout of the converter. This capacitor should be layed-out as close as possible from the converter.*
*Note *** : For load regulation characteristics from 0% to full load, please contact factory.*

3- Electrical Specifications (continued)

Data are valid at +25°C, unless otherwise specified.

Parameter	Conditions	Limit or typical	Units	Bi Output MGDBI- 10	
				10 - C	10 - I
Input					
Nominal input voltage	Full temperature range	Nominal	VDC	5	24
Permanent input voltage range (Ui)	Full temperature range	Min. - Max.	VDC	4,5- 5,5	18- 36
Undervoltage lock-out (UVLO)	turn-on/turn-off threshold	Minimum Maximum	VDC VDC	4 4,5	16 17,5
Start up time	Ui nominal Nominal output Full load : resistive	Maximum	ms	30	30
Reflected ripple current	Ui nominal, full load at switching freq. BW = 20MHz Decoupling capacitor 10µF	Maximum	mApp	50	30
Input current in short circuit mode (Average)	Ui nominal Short-circuit	Maximum	mA	50	30
No load input current	Ui nominal No load	Maximum	mA	50	30
Output					
Output voltage *	Full temperature range Ui min. to max. 75% load	Nominal Nominal Nominal	VDC VDC VDC	+/- 5 +/- 12 +/- 15	+/- 5 +/- 12 +/- 15
Set Point accuracy	Ambient temperature : +25°c Ui nominal, 75% load	Maximum	%	+/- 2	+/- 2
Output power	Full temperature range Ui min. to max.	Maximum	W	+/- 5	+/- 5
Output current +/- 5V output +/- 12V output +/- 15V output	Full temperature range Ui min. to max.	Maximum Maximum Maximum	A A A	+/- 1 +/- 0,40 +/- 0,33	+/- 1 +/- 0,40 +/- 0,33
Ripple output voltage ** 5V output 12V output 15V output	Ui nominal Full load BW = 20MHz	Maximum Maximum Maximum	mVpp mVpp mVpp	50 100 150	50 100 150
Line regulation	Ui min. to max. Full load	Maximum	%	+/- 1	+/- 1
Load regulation ***	Ui nominal 25% to full load	Maximum	%	+/- 2,5	+/- 2,5
Cross load output regulation	Ui nominal + Vout nominal load - Vout from 25% to full load	Maximum	%	+/- 0,5	+/- 0,5
Efficiency	Ui nominal Full load	Typical	%	77	83
Maximum admissible Capacity load 3,3V and 5V output 12V and 15V output	Ui nominal Full load Per output	Maximum Maximum	µF µF	470 100	470 100

*Note * : For proper operation the MGDI-10 module requires to install a 22µF chemical or tantalum capacitance accross output terminals.*
*Note ** : The ripple output voltage is the periodic AC component imposed on the output voltage, an aperiodic and random component (noise) has also to be considered. This noise can be reduced by adding an external capacitor (typically 10nF/rated voltage depending on isolation requirement) connected between the pin Gin and the pin Gout of the converter. This capacitance should be layed-out as close as possible from the converter.*
*Note *** : For load regulation characteristics from 0% to full load, please contact factory.*

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4- Switching Frequency

Parameter	Conditions	Limit or typical	Specifications
Switching frequency	Full temperature range Ui min. to max. No load to full load	Nominal, fixed	480 KHz

5- Isolation

Parameter	Conditions	Limit or typical	Specifications
Electric strength test voltage	Input to output	Minimum	1.500 VDC / 1 min
Electric strength test voltage between outputs (for dual and triple outputs)	Output to output	Minimum	No isolation
Isolation resistance	500 VDC	Minimum	100 MOhm

6- Protection Functions

Characteristics	Protection Device	Recovery	Limit or typical	Specifications
Input undervoltage lock-out (UVLO)	Turn-on, turn-off circuit with no hysteresis	Automatic recovery	Threshold	See section 3
Output short circuit protection (SCP)	Hiccup circuitry with auto-recovery	Automatic recovery	Permanent	See section 11
Output overvoltage protection (OVP)	Zener clamp	/	Maximum Maximum Maximum Maximum	For 3.3v : 4v For 5v : 6v For 12v : 14v For 15v : 17v

7- Reliability Data

Characteristics	Conditions	Temperature	Specifications
Mean Time Between Failure (MTBF) According to MIL-HDBK-217F	Ground fixed (Gf)	Case at 40°C Case at 70°C	950.000 Hrs 380.000 Hrs
	Ground mobile (Gm)	Case at 40°C Case at 70°C	240.000 Hrs 105.000 Hrs
Mean Time Between Failure (MTBF) According to IEC-62380-TR	Telecom switchers	/	Consult factory

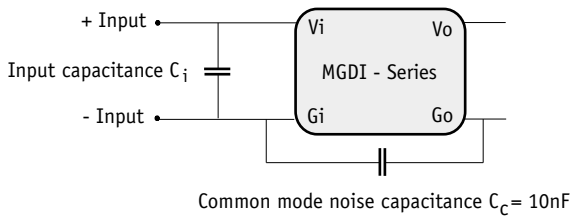
8- Electromagnetic Interference

Electromagnetic interference requirements according to EN55022 class A and class B can be easily achieved as indicated in the following table :

Electromagnetic Interference according to EN55022			
Conducted noise emission	Configuration / Models	With common mode capacitor C_c = 10nF and input capacitor C_i	With common mode capacitor C_C = 10nF and external filter
	4,5-5,5V input models	Class A, C_i =10µF/ 35 V tantalum	Class B
	18-36V input models	Class A, C_i =4.7µF / 50 V tantalum	Class B
Radiated noise emission	Configuration / Models	With common mode capacitor C_c = 10 nF	
	All models	Class B	

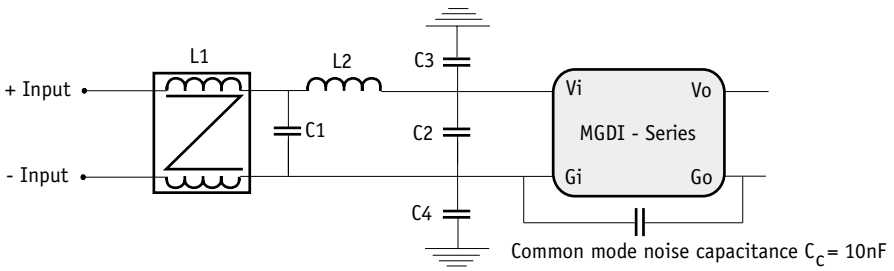
8-1 Module Compliance with EN55022 class A Standard

Electromagnetic interference requirements according to EN55022 class A can be easily achieved by adding an external input capacitance (C_I Value explained in previous table) and a common mode noise capacitance C_c (10 nF/rated voltage depending on isolation requirement) connected between Gin and Gout. This common mode noise capacitance C_c should be layed-out as close as possible from the DC/DC converter.



8-2 Module Compliance with EN 55022 Class B Standard

Electromagnetic interference requirements according to EN55022 class B can be easily achieved by adding an external input filter consisting of 4 capacitances, a common mode choke, and a differential mode inductance, together with a common mode noise capacitance (10 nF/rated voltage depending on isolation requirement) connected between Gin and Gout. Please consult EN55022 Class B EMI Filter design dote for further details.



9- Thermal Characteristics

Characteristics	Conditions	Limit or typical	Performances
Operating ambient temperature range at full load	Ambient temperature *	Minimum Maximum	- 40°C + 71°C
Operating case temperature range at full load	Case temperature	Minimum Maximum	- 40°C +95°C
Storage temperature range	Non functionning	Minimum Maximum	- 40°C + 105°C
Thermal resistance	Rth case to ambient in free air natural convection	Typical	12°C /W

*Note * : The upper temperature range depends on configuration, the user must assure a max. case temperature of + 95°C.*

The MGDI-10 series operating **case** temperature must not exceed 95°C. The maximum **ambient** temperature admissible for the DC/DC converter corresponding to the maximum operating case temperature of 95°C depends on the ambient airflow, the mounting/orientation, the cooling features and the power dissipated.

To calculate a maximum admissible ambient temperature the following method can be used. Knowing the maximum case temparature Tcase = 95°C of the module, the power used Pout and the efficiency η :

- determine the power dissipated by the module Pdiss that should be evacuated :

$$\mathbf{Pdiss = Pout(1/\eta - 1)}$$

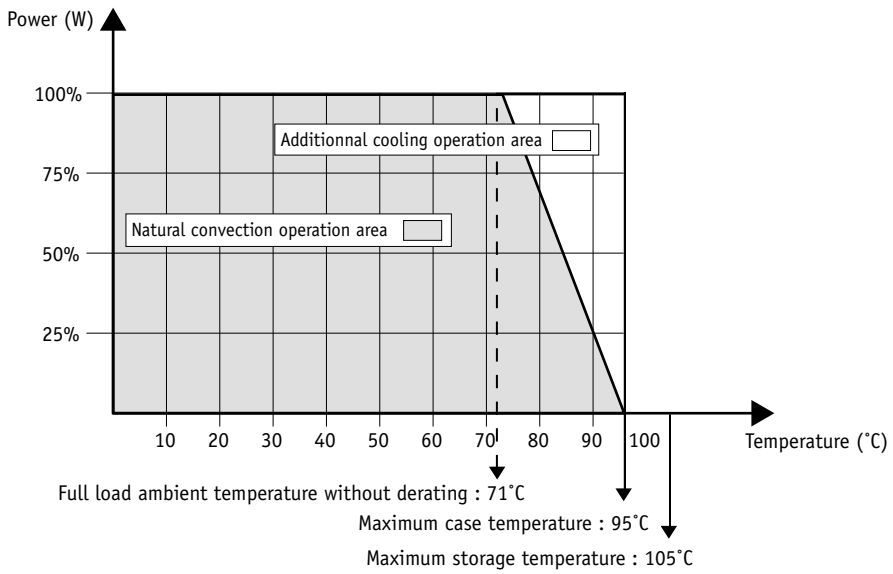
- determine the maximum ambient temperature :

$$\mathbf{Ta = 95°C - Rth \times Pdiss}$$

where **Rth is the thermal resistance from the case to ambient**.

The previous thermal calculation shows two areas of operation :

- a normal operation area in a free natural ambient convection (grey area in this following graph),
- an area with cooling features (air flow or heatsink) ensuring a maximum case temperature below the maximum operating case temperature of 95°C (white area in the following graph).



10- Environmental Qualifications

The modules have been subjected to the following environmental qualifications.

Characteristics	Conditions	Severity	Test procedure
Climatic Qualifications			
Life at high temperature	Duration Temperature Status of unit	1.000 Hrs 95°C case unit operating	IEC 68-2-2
Humidity steady	Damp heat Temperature Duration Status of unit	93 % relative humidity 40°C 56 days unit not operating	IEC 68-2-3 Test Ca
Temperature cycling	Number of cycles Temperature change Transfert time Steady state time Status of unit	200 -40°C / +71°C 40 min. 20 min. unit not operating	IEC 68-2-14 Test N
Temperature shock	Number of shocks Temperature change Transfert time Steady state time Status of unit	50 -40°C / +105°C 10 sec. 20 min. unit not operating	IEC 68-2-14 Test Na
Mechanical Qualifications			
Vibration (Sinusoidal)	Number of cycles Frequency : amplitude Frequency : acceleration Amplitude /acceleration Duration Status of unit	10 cycles in each axis 10 to 60 Hz / 0.7 mm 60 to 2000 Hz / 10 g 0.7 mm/10 g 2h 30 min. per axis unit not operating	IEC 68-2-6 Test Fc
Shock (Half sinus)	Number of shocks Peak acceleration Duration Shock form Status of unit	3 shocks in each axis 100 g 6 ms 1/2 sinusoidal unit not operating	IEC 68-2-27 Test Ea
Bump (Half sinus)	Number of bumps Peak acceleration Duration Status of unit	2000 bumps in each axis 25 g 6 ms unit not operating	IEC 68-2-29 Test Eb
Electrical Immunity Qualifications			
Electrical discharge susceptibility	Number of discharges Air discharge level Contact discharge level Air discharge level Contact discharge level	10 positive & 10 negative discharges 4 kV : sanction A 2 Kk : sanction A 8 Kk : sanction B 4 kV : sanction B	EN55082-2 with : EN61000-4-2 IEC 801-2
Electrical field susceptibility	Antenna position Electromagnetic field Wave form signal Frequency range	at 1 m 10 V/m AM 80%, 1 kHz 26 MHz to 1 GHz	EN55082-2 with : EN61000-4-3 IEC801-3
Electrical fast transient susceptibility	Burst form Wave form signal Impedance Level 1 Level 3	5/50 ns 5 kHz with 15 ms burst duration period 300 ms 50 Ohm 0,5 kV : sanction A 2 kV : sanction B	EN55082-2 with : EN61000-4-4 IEC801-4

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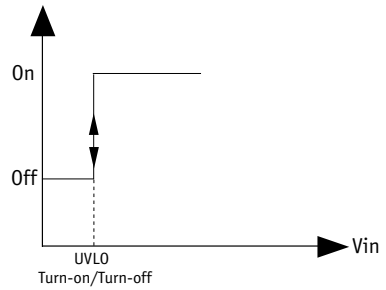
11- Description of Protections

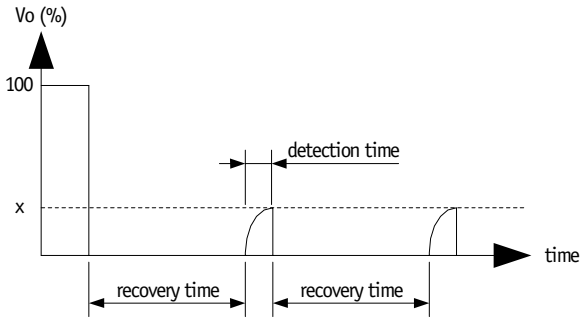
11-1 Input Undervoltage Lock-out (UVLO)

The input undervoltage lock-out protection device turns-on and turns-off the output voltage when the input bus voltage reaches the undervoltage lock-out threshold. There is no hysteresis cycle at turn-on and turn-off.



11-2 Output Short Circuit Protection (SCP)

The short circuit protection device protects the module against short circuit of any duration and restores the module to normal operation when the short circuit is removed. It operates in «hiccup» mode by testing periodically if an overload is applied (typically every 200ms recovery time). The overload detection threshold is typically 200% of maximum current with a detection time lower than 5ms.



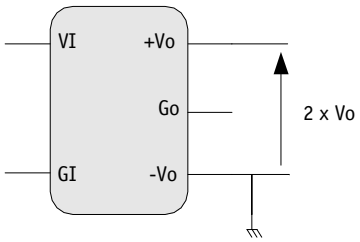
11-3 Output Overvoltage Protection (OVP)

The output overvoltage protection device protects external components against high voltage or possible overvoltages which can be supplied by the module (i.e in case of internal failure). It consists of a zener diode clamping the output voltage; under worst case conditions this zener diode will short-circuit.
The output voltage protection is not designed to withstand externally applied output overvoltages to protect the module itself.

12- Application Notes

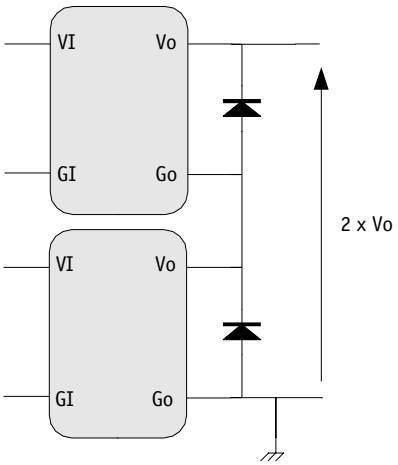
12-1 Connection of Outputs in Series

Any of the bi output converters can be configured to produce an output of 10V (+/-5 output models), 24V (+/-12V output models), or 30V (+/-15V output models) by connecting the load across the output (+) and the output (-) with either output grounded, and leaving the common pin floating.



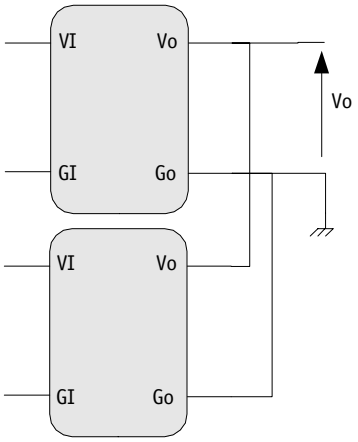
12-2 Connection of Modules in Series

The output of single output units can be connected in series without any precautions to provide higher output voltage level.
Nevertheless, GAIA Converter recommends to protect each individual output by a low power shottky diode rated with the maximum current of the converter to avoid reverse polarity at any output.
Reverse polarity may occur at start up if the output voltages do not rise at the same time.



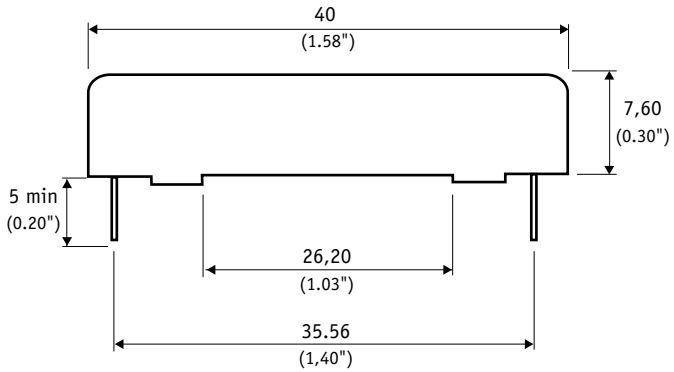
12-3 Connection of Modules in Parallel

Several converters with equal output voltage can be connected in parallel to increase power. Nevertheless some cares have to be taken in particular as the output voltage of each converter is slightly different, when paralleling, the converter with the highest output voltage will source the most current.
However the GAIA Converter modules are designed with a "soft" output voltage versus current characteristic. This causes the output voltage of each converter to automatically adjust downward as its current increases so each converter very approximately shares the total output current. It is important that each converter has approximately the same impedance between their output and the common load.

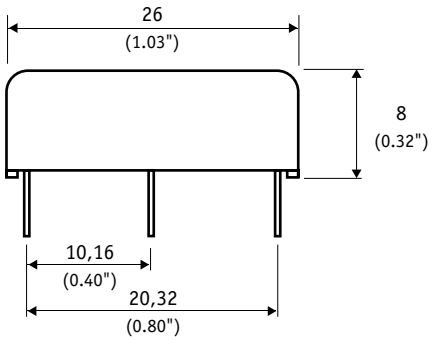


13- Dimensions

Dimensions are given in mm (inches). Tolerance : +/- 0,2 mm (+/- 0.01 ") unless otherwise indicated.
Weight : 20 grams (0.7 Ozs) max.



Pin dimensions : Ø 0,73 mm (0.03 ")



Metallic case black anodized coating
Matte tin plating finished pin

14- Product Marking

Upper face : Company logo, location of manufacturing.
Side face : Module reference, option, date code : year and week of manufacturing.

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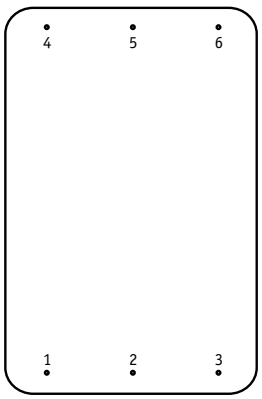
15- Connections



Bottom view

Pin	Bi Output	Single Output
1	+ Input (Vi)	+ Input (Vi)
2	No pin	No pin
3	- Input (Gi)	- Input (Gi)
4	Output + (+Vo)	Output (Vo)
5	Common (Go)	No pin
6	Output - (-Vo)	Common (Go)

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