DC/DC Input Bus Conditioner
FLHG-60 Series : 60W Power

Hi-Rel Grade

RoHS

Key features

- Ultra wide input range
- Hold-up function
- Inrush current limitation
- Integrated EMI filter
- Reverse polarity protection
- UnderVoltage Lock-Out

General characteristics

- Nominal power up to : 60 W
- Galvanic isolation input/output : No Isolation
- Dedicated for Avionics/Military Applications

1 - General

The input bus conditioner FLHG-60 designates a 60W input bus front-end that enables and eases construction of power architectures for military and avionic 24V and 28V applications. The FLHG-60 includes:

- An input EMI filter removing both common and differential conducted input noise to comply with MIL-STD-461 or DO160 Standards.
- An input spike & surge limiter to comply with MIL-STD-704, MIL-STD-1275, ABD100 and DO160 over-voltages.
- A reverse polarity protection.
- A soft start function.
- A hold-up function.

Leveraging many functions, the FLGH-60 advantageously replaces all the input stage components of a power architecture such as filters, voltage limiter, diodes, inrush current limiter and hold-up modules. As a single component, the FLHG-60 allows for a drastic reduction in space, as well as a simplification of the power architecture design. The FLHG-60 is designed to work with GAÏA Converter N input range of DCDC converters.

Thanks to its wide input range, the input bus conditioner operates with all standard batteries voltages, according to 3 modes of operation:
- Normal operation: when the input bus voltage is within its steady state range, the FLHG-60 acts like a buffer transmitting the input power to the DC/DC architecture with low losses and conducted noise filtering.
- High voltage transient operation: the FLHG-60 clamps the input transient, limiting its output voltage to the maximum voltage acceptable by the downstream DC/DC architecture.
- Hold-Up operation: hold-up operation occurs when the input bus drops below the voltage at which the hold-up capacitor was previously charged. In this case, the FLHG-60 connects the downstream converter input bus to the charged hold-up capacitor to continue operation during input bus drop.

The module is potted with a bi-component thermal conductive compound and packaged in a metallic case to ensure module integrity under severe environmental conditions.

1.1 - Product reference

Single output model : FLHG - 60 - [Input] - [Output] / [Options]

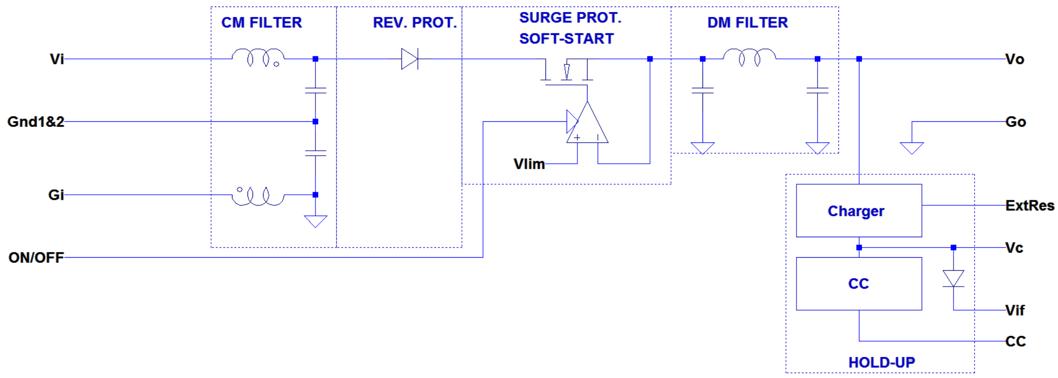
[Input]	**[Output]**
. M : 16 - 60 Vdc (100 Vdc / 100 ms)	. N : 9 - 80 Vdc (Single)

Consult factory for customized specifications

1.2 Product selection

Reference	Input voltage	Output voltage	Output current
FLHG-60-M-N	16 - 60 Vdc (Min. 11.2 Vdc /)	9 - 80 Vdc	

1.3 Block diagram



2 Modes of operation

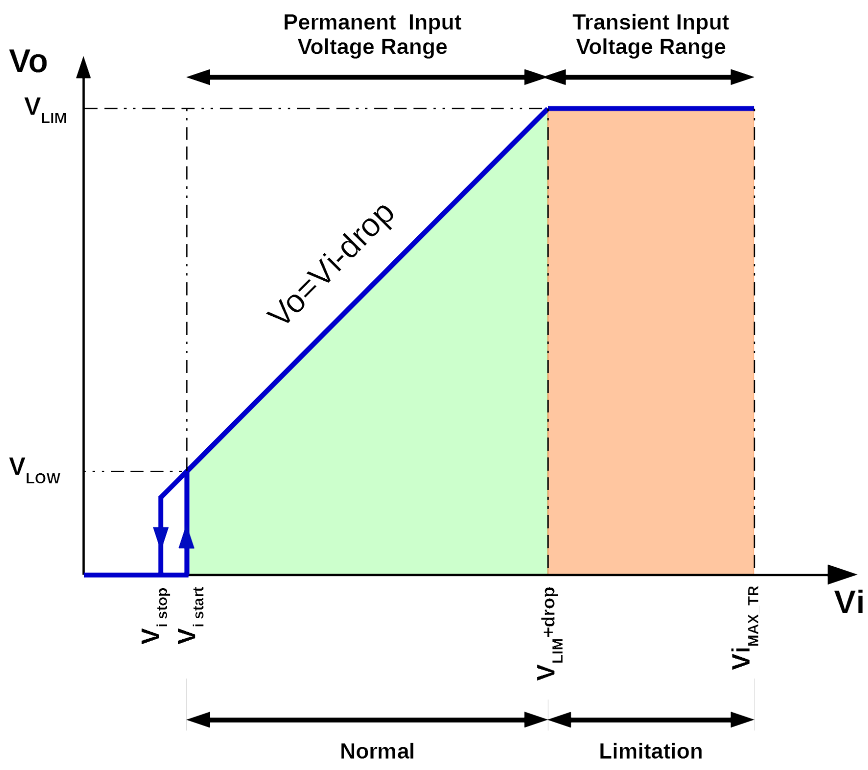
2.1 Modes of operation

The FLHG-60 operates according to different modes of operation depending on input voltage values:

Normal operation : when the rising input voltage reaches the minimum voltage Vi_{START}, the FLHG-60 is biased and connects its input Vi to output Vo through a unidirectional switch. Its output voltage Vo follows the input voltage minus series drops depending on current. The FLHG-60 is designed to work with GAÏA Converter N input range DCDC converters. Steady state operation at low input voltage is limited by power derating(see §3.5), but transient operation at full power is allowed, enabling the converters to power-up while the input voltage reaches the steady state conditions of standard 28V busses.
When input voltage falls to Vi_{STOP}, the input of FLH-G60 disconnects from the output. Vi_{START} and Vi_{STOP} are the FLHG-60 UVLO limits.
Power fail operation : power fail operation occurs when input voltage Vi drops below the voltage at which the hold-up capacitor is charged(Vc). In this case, the downstream converters are supplied by the hold-up capacitor as long as Vc>Vi. Reverse current flow to the input is blocked by an internal diode. Once Vc discharges to Vi, the ouput voltage Vo of the FLHG-60 is again supplied from Vi.
High voltage transient operation : when the input voltage bus is above V_{LIM}, the FLHG-60 clamps Vo to V_{LIM}. Operation in this mode must only be transient.
On/Off operation : when the On/Off pin is tied to Go, the FLHG-60 output is disconnected from the input. On/Off operation overrides normal operation and transient operation.

The figure below describes these modes of operation:

- Vi_{START} : starting voltage,
- Vi_{STOP} : stopping voltage,
- V_{LIM} : maximum input voltage in normal operation mode,
- Vi_{maxTR} : max allowed surge voltage,
- Vo_{LIM} : max output voltage.



2 Modes of operation

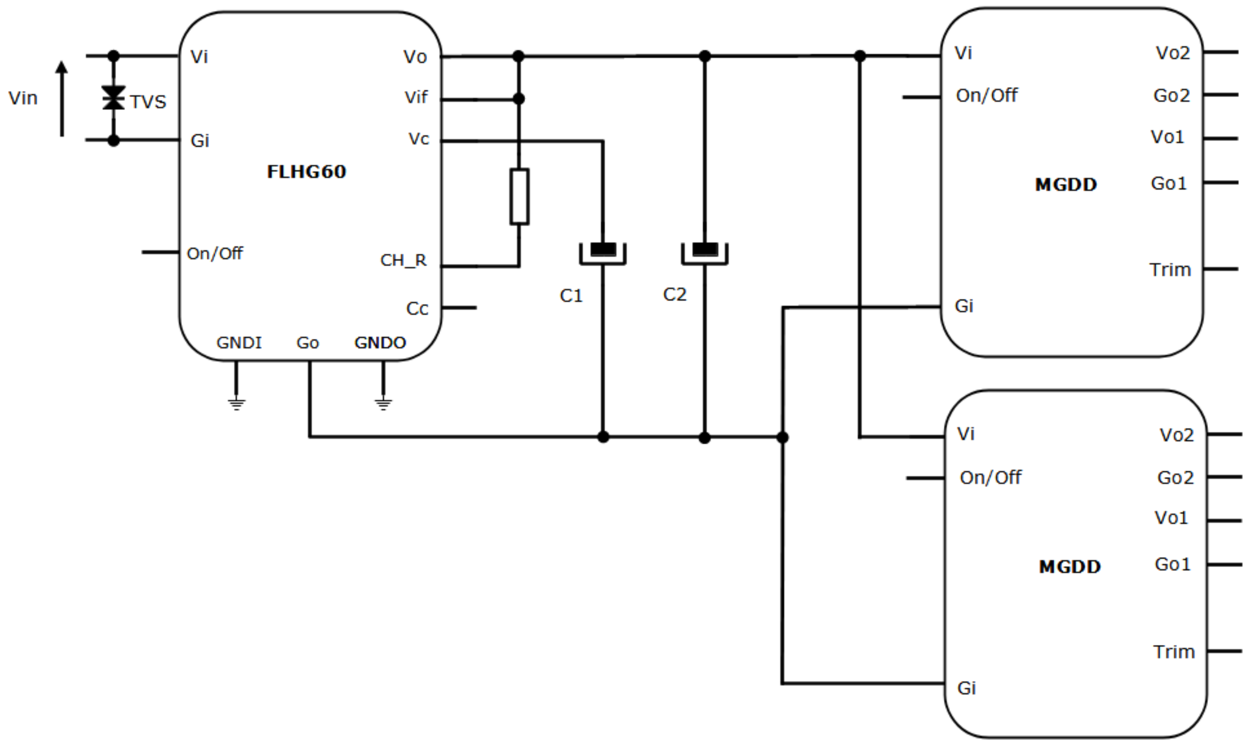
2.2 Application

Pin functions:
<u>Power Pins:</u>
Vi (input): input power pin referenced to Gi.
Gi (input): input power ground pin.
GNDI/GNDO (Chassis): terminals connected to an internal common mode capacitor to be connected to chassis.
Go (output): output power ground pin (this pin is internally connected to Gi through a common mode inductor).
Vo (output): output power pin referenced to Go.
Vif (Output): output power pin referenced to Go(to connect to Vo by deault).
Vc (output): charger output pin to be connected to Hold-up capacitor. This pin is referenced to Go.

<u>Control & Monitoring Pins:</u>
On/Off (input) : the FLHG-60 stops operation when the pin is tied to Go. When not used, the pin should be left unconnected.
CH_R (input): a resistor connected between this pin and Vo will limit the inrush current generated by the hold-up capacitor.
Cc (output): open drain output providing status on the hold-up capacitor.

As shown in the diagram below, the high level of front-end integration of the FLHG-60 makes it possible to build a complete power supply architecture, from the input connector to the output load. The FLHG-60 provides power supply reliability, standard compliance, and protection level in the simplest way.

C1 is the hold-up capacitor, C2 is the transition capacitor. The TVS type depends on input bus voltage. The architecture drawing below is a simplified diagram showing only the main components.



3 Electrical specifications

3.1 Input

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

Parameter	Condition	Limit or typical	Unit	Values
Absolute Max input voltage	Not operating	Typical	Vdc	150
Input voltage range	Steady state	Min. - Max.	Vdc	12.5 to 60
Transient input voltage (Vimax_tr)	Full load, Full temperature range	Max.	Vdc/ms	100/50
Input under voltage lockout (Vstart)	Turn-on voltage	Max.	Vdc	12.5
Input under voltage lockout (Vstop)	Turn-off voltage	Max.	Vdc	11.2
		Min.	Vdc	10
No load input current	28 Vdc input voltage	Typical	mA	5
	28 Vdc input voltage, Off	Max.	mA	1.8
Start up time on power-up	Full load, Full temperature range	Max.	ms	5
Input Voltage Surge	MIL-STD-1275 (A to E)	Max.	Vdc/ms	100/50
	DO160	Max.	Vdc/ms	80/100
Reverse input voltage	Full load, Full temperature range	Max.	Vdc	-100V

3.2 Output

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

Parameter	Condition	Output type	Output	Limit or typical	Unit	Values
Output voltage		S	N		Vdc	9 - 80
Nominal output voltage in normal operation	Full load, Full temperature range			Min. - Max.	Vdc	Ui-drop-out voltage
Maximum output clamping voltage	Full load, Full temperature range			Max.	Vdc	80
Voltage drop @ I max (1)	28 Vdc input voltage			Typical	Vdc	0.7
	16 Vdc input voltage			Max.	Vdc	1.3
Output power (2)	Ui min to Ui max			Max.	W	60
Output current	28 Vdc input voltage, Full temperature range			Max.	A	3.75
	80 Vdc input			Max.	A	0.75
	Low line transient			Max.	A/s	5.5 / 30

(1) Typical losses are 0.5+0.2xIout at Tcase=105°C.
(2) it is recommended to manage module cooling with heatsink or cold plate.

3.3 Hold-Up function

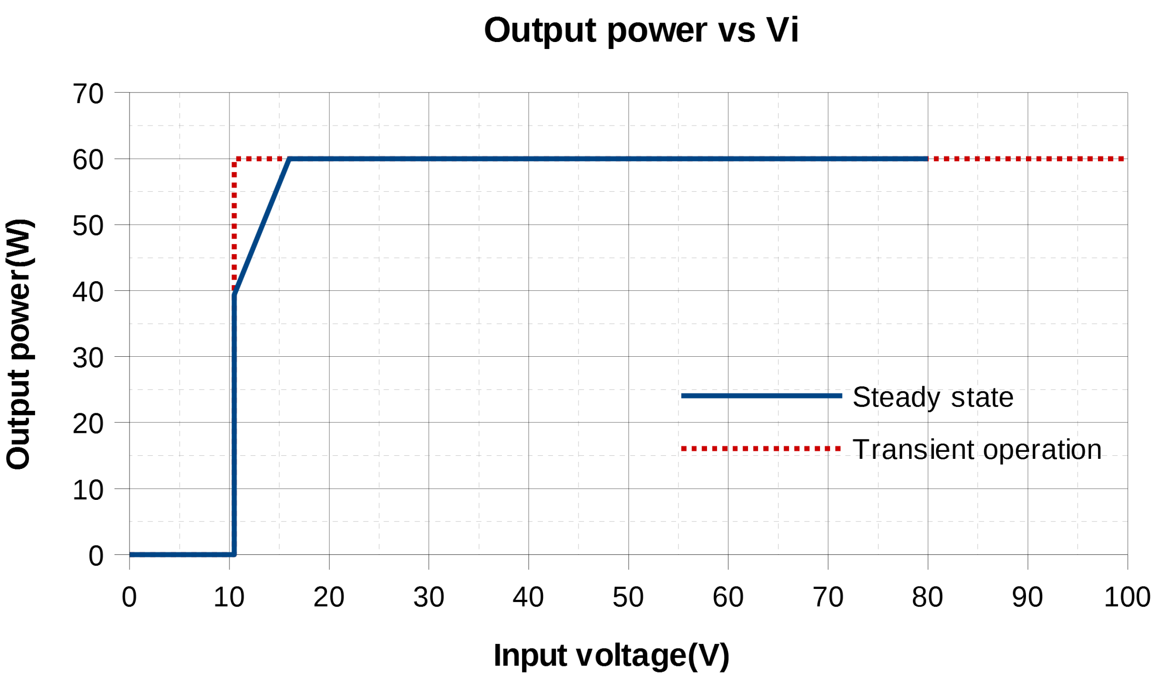
Parameter	Condition	Limit or typical	Unit	Values
Maximum hold-up capacitor voltage (Vc)	Full temperature range, Ui min to Ui max	Max.	Vdc	20
Admissible hold-up capacitance	Full load, Full temperature range	Max.	µF	100000
CC sink current		Max.	mA	20
Capacitor charged signal (CC) threshold	On	Typical	Vdc	18
	Off	Typical	Vdc	16

3.4 Protection functions

Parameter	Condition	Limit or typical	Unit	Values
On/Off module disable delay	Ui nominal	Max.	µs	150
On/Off module enable voltage	Ui nominal	Min. - Max.	Vdc	2 to 4.5
On/Off module disable voltage	Ui nominal	Min. - Max.	Vdc	0 to 0.5
On/Off module enable delay	Ui nominal	Max.	µs	350

3.5 Electrical plots

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



3.6 Isolation

Parameter	Condition	Limit or typical	Unit	Values
Isolation test voltage	Input to output	Typical		No Isolation
	Input to case	Min.	Vdc/s	500 / 60
	Output to case	Min.	Vdc/s	500 / 60
Isolation resistance	Input to Case(500Vdc)	Min.	MOhm	100
	Output to case	Min.	MOhm	100

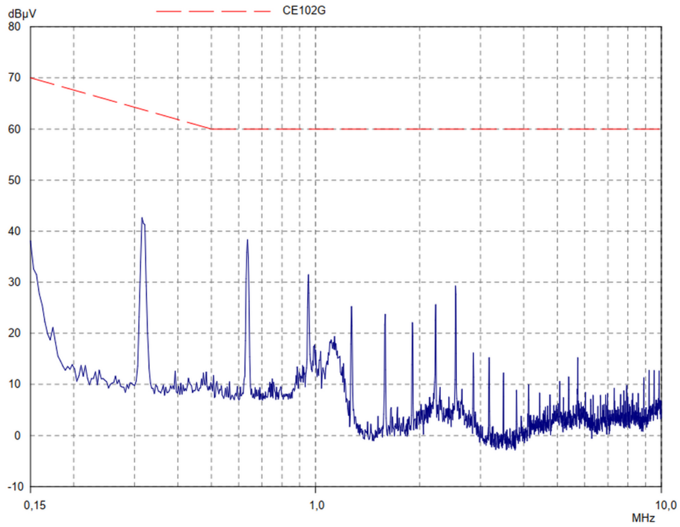
3.7 Reliability Data

Parameter	Condition	Limit or typical	Unit	Values
MTBF MIL-HDBK217 Reliability	Case at 40°C, Ground fixed (Gf)		Hrs	1 700 000
	Case at 85°C, Ground fixed (Gf)		Hrs	410 000
	Case at 40°C, Ground mobile (GM)		Hrs	780 000
	Case at 85°C, Ground mobile (GM)		Hrs	196 000

4 Electromagnetic interferences specifications

4.1 Compliance requirements

Electromagnetic Interference requirements according to MIL-STD-461 standards can be easily achieved as indicated in the following section.



Parameter	Standard	Level	Compliance
Conducted emission			
Conducted emission (CE) - Low frequency	MIL-STD-461D/E	CE101	Compliant module stand-alone
Conducted emission (CE) - High frequency	MIL-STD-461D/E	CE102	Compliant module stand-alone
Conducted susceptibility			
Conducted susceptibility (CS) - Low frequency	MIL-STD-461D/E	CS101	Compliant with external components
Conducted susceptibility (CS) - High frequency	MIL-STD-461D/E	CS114	Compliant with external components
Radiated emission (RE)			
Radiated emission (RE) - Magnetic field	MIL-STD-461D/E	RE101	Compliant module stand-alone
Radiated emission (RE) - Electrical field	MIL-STD-461D/E	RE102	Compliant module stand-alone
Radiated susceptibility (RS)			
Radiated susceptibility (RS) - Magnetic field	MIL-STD-461D/E	RS101	Compliant module stand-alone
Radiated susceptibility (RS) - Electrical field	MIL-STD-461D/E	RS103	Compliant module stand-alone

5 Thermal specifications

5.1 General

The following discussion will help designer to determine the thermal characteristics and the operating temperature.
Heat can be removed from the baseplate via three basic mechanisms:

- Radiation transfer: radiation is counting for less than 5% of total heat transfer in majority of case, for this reason the presence of radient cooling is used as a safety margin and is not considered.
- Conduction transfer: in most of the applications, heat will be conducted from the baseplate into an attached heatsink or heat conducting member; heat is conducted thru the interface.
- Convection transfer: convecting heat transfer into air refers to still air or forced air cooling.

In majority of the applications, heat will be removed from the baseplate either with :

- heatsink,
- forced air cooling,
- both heatsink and forced air cooling.

To calculate a maximum admissible ambient temperature the following method can be used. Knowing the maximum case temperature **Tcasemax** of the module, the input current and the series losses (vin-vout):

- determine the power dissipated by the module **Pdiss** that should be evacuated: **Pdiss = Iin x(Vin-Vout)** where Iin is the input current and Vin =Vi pin voltage and Vout=Vo pin voltage.
- determine the maximum ambient temperature :
  - **Ta = Tcasemax °C - Rth(b-a) x Pdiss** where Rth(b-a) is the thermal resistance from the baseplate to ambient.

This thermal Rth(b-a) resistance is the sum of :

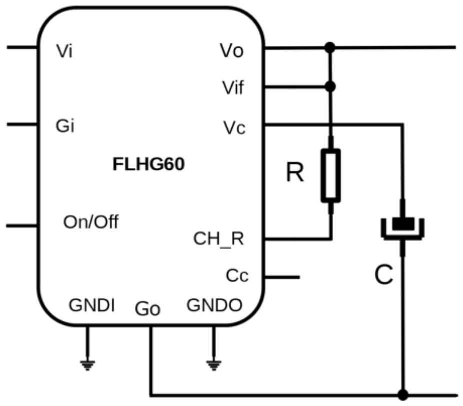
- **the thermal resistance of case to heatsink, Rth(b-h)**. The interface between baseplate and heatsink can be nothing or a conducting member, a thermal compound, a thermal pad.... The value of Rth(b- h) can range from 0.4 °C/W down to 0.1 °C/W for a thermal conductive member interface.
- **the thermal resistance of heatsink to ambient air, Rth(h-a)**, which is depending of air flow and given by heatsink supplier.

Parameter	Condition	Limit or typical	Unit	Values
Operating case temperature range	With heatsink	Min. - Max.	°C	-40 to 105
Storage temperature	Not operating	Min. - Max.	°C	-55 to 125
Thermal resistance		Typical	°C/W	17

6 Description of functions

6.1 Hold-Up function

The Hold-up section of the FLHG-60 charges an external bulk capacitor at a voltage Vc depending on the input voltage.
The hold-up mode of operation is described below:
1) During normal operation, the internal charger maintains the voltage across the hold-up capacitor as per graph opposite. During this phase the capacitor is not connected to the output pin of FLHG-60. The inrush current generated by the hold-up capacitor during its charge is limited by an external resistor R connected between the Vif and CH_R pins. The table below provides the recommended resistor values. An equivalent high surge power resistor can be used.
If no hold-up function is required, no resistor and capacitor are needed and the Vc pin should be left unconnected.



2) During input bus interruption or when the input voltage drops below the voltage at which the hold-up capacitor is charged, the bulk capacitor is connected to the output pin of the FLHG-60 through a diode and supplies the downstream converters.

3) When the input bus recovers above the voltage remaining at the hold-up capacitor, the converters are supplied again from the input bus and the capacitor recharges.
The size of the hold-up capacitor C for a given hold-up time T can be calculated with the formula below.

6.2 Hold-up capacitor selection

The table below provides examples of hold-up capacitor and charging resistor selection.

C = Hold-up capacitor value
P = Converter output power
T = expected hold-up time
Vc = Voltage at hold-up capacitor
Vth = Downstream DCDC UVLO turn-off threshold
eff = Converter efficiency(85% typ.)

$$C = \frac{2.P.T}{eff.(Vc^2 - Vth^2)}$$

Hold-Up Capacitor value selection				
Vth(V)	9	9	9	9
Output Power(W)	30	60	30	60
Input voltage (V)	28	28	28	28
Vc (V)	20	20	20	20
hold-up time: T(ms)	10	10	50	50
Hold-up capacitor value C(mF)	**2,2**	**4,7**	**11**	**22**
Resistor value(in Ohms)	**150**	**100**	**49,9**	**30**
Resistor type (or equivalent)	AC05 (Vishay)			
	PCAN2512 (Vishay)			

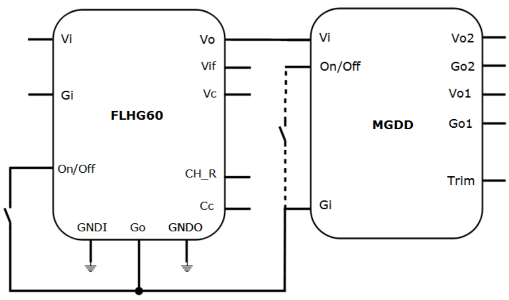
Resistor values and power can be adjusted according to needs. The 5 W resistor does not dissipate power in normal operation mode when hold-up capacitor is charged.

6.3 On/Off function

The On/Off pin can be used to control the FLHG-60 operation. This may be done with an open collector transistor, a switch, a relay or an optocoupler. Several input bus conditioners may be disabled with a single switch by connecting all On/Off pins together.

The FLHG-60 is disabled by pulling the On/Off pin low. When the FLHG-60 is in Off mode, its output is disconnected from the input. However, as the hold-up capacitor is always connected to the output through the charging resistor, the On/Off effect on the converters will be delayed by the hold-up time provided by the capacitor. If the On/Off action must be fast, it is necessary to also drive the On/Off pin of the converters as shown in dashed lines on the schematic opposite.

No connection or high impedance on the On/Off pin enables the input bus conditioner.



6.4 Reverse polarity protection

The FLHG-60 features a fast reverse polarity protection to protect the downstream DC/DC architecture from damage caused by static input bus reversal or negative spikes. The maximum negative voltage level is given in the characteristics section. When a reverse polarity is applied at the input of the FLHG-60, its output supplies the load from the hold-up capacitor.

6.5 Capacitor charged signal : CC

The FLHG-60 features an open drain Capacitor Charged(CC) pin that provides information on the charging status of the hold-up capacitor. The pin, active low is asserted when the voltage at the hold-up capacitor reaches its On threshold. It is de-asserted when the voltage drops below the Off threshold.

7 Mechanical specifications

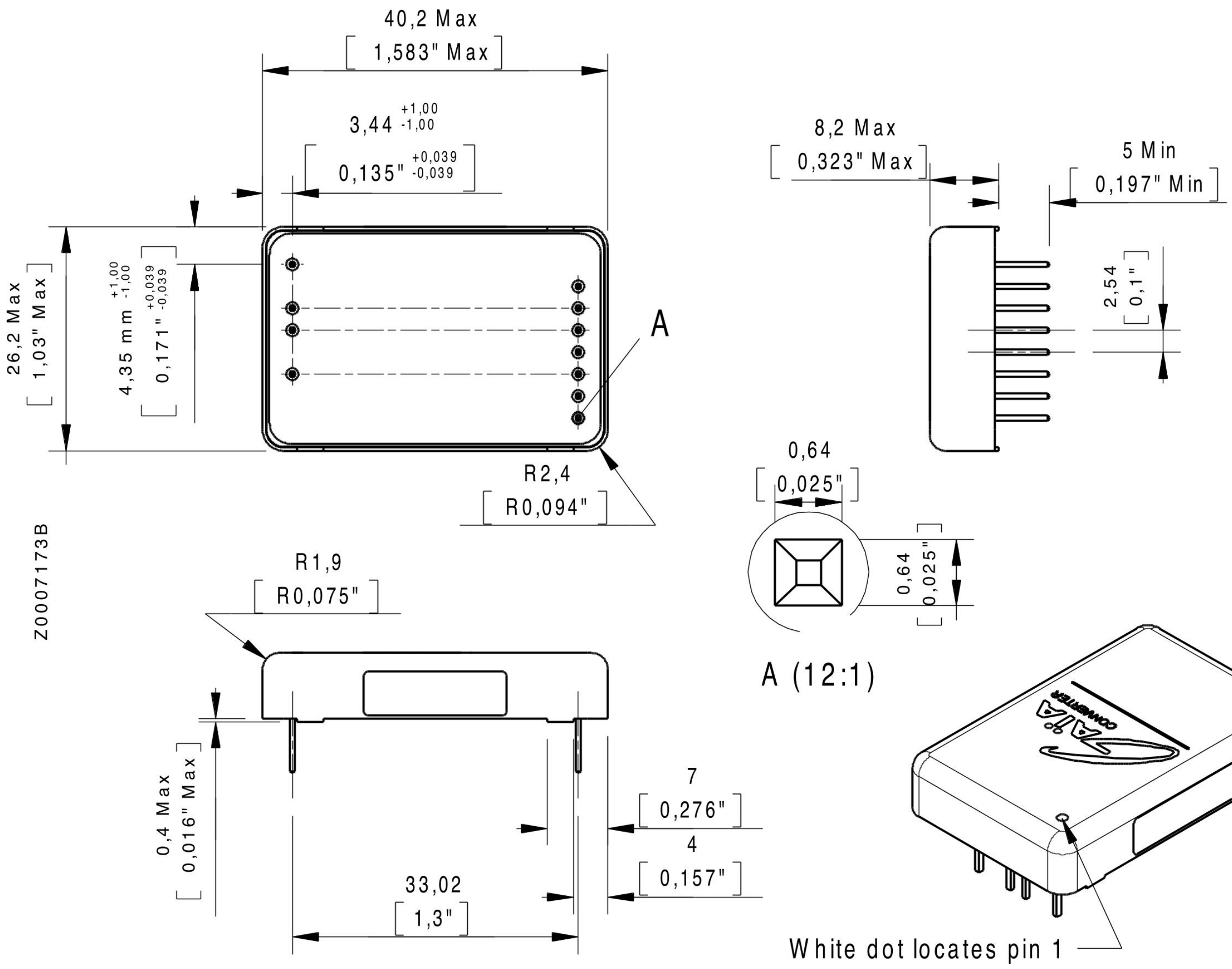
7.1 Dimensions

Dimensions are given in mm (inches). Tolerance : +/- 0,2 mm (+/- 0.01 “) unless otherwise indicated.

Parameter	Condition	Limit or typical	Unit	Values
Case dimensions		Max.	mm	40.2 x 26.2 x 8.2
Height		Max.	mm	8.2
Weight			Grams	23
	.		Oz	0.8
GAIA Overall package				2.0-1.6-0.5

DATASHEET

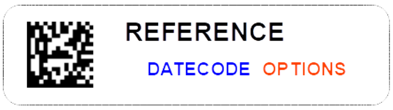
Dimensions are given in mm [inch].
General tolerance is +/- 0.2mm [+/-0,008"] unless otherwise indicated.
All dimensions specified "min" or "max" are not subjected to the general tolerance.



7.2 Materials

Parameter	Condition	Limit or typical	Values
Case material			Metallic black anodized coating
Pins			Gold flash over nickel

7.3 Product marking



Left side :

: GAIA internal product identification.

Right side

Line 1 : Product identification

REFERENCE: Product identification, according to Commercial reference, without options.
Depending on the dimensions of the product, the printed reference may exlude "-" characters.
Example : Catalog reference SERIES-10-J-C printed SERIES10JC

Line 2 : DateCode and Options

DATECODE: Code format YYXX (YY :Year ; XX : Week)

OPTIONS:

In this order for the marking :

- **L** : if leaded product (RoHs if absent)
- **P** : if prototype
- **/...** : Succession of integrated options, format "/letter", in alphabetical order, where letter is the standard code for the option (/M/T/...).
- **/XX** : derivative product from the standard family

Example of options marking : DATECODELP/M/S/XX

Particular marking for "/S" option :

In this case,

- The DataMatrix code is not present,
- The DATECODE is replaced by the SERIAL NUMBER of the product.

7.4 Connections

BOTTOM VIEW

Pin	Function
1	GI
2	GNDI
3	GNDO
4	VI
5	ON/OFF
6	GO
7	VIF
8	VO
9	CH R
10	VC
11	CC