



Hi-Rel HOLD-UP MODULE HUGD-50 : 50W POWER

Hi-Rel
Grade ■ ■

Hold-Up Solution 16-40V & 9-36V DC/DC Converter Compatible Metallic Case

- Unique Product for Hold-Up Solution
- Reduce Capacitance by 80%
- High efficiency (98%)
- Power range : from 4W to 50W
- Compatible with 9-36 or 16-40VDC Converter
- Include monitoring signals
- Programmable inrush current limitation
- RoHS or Leaded process option



1-General

The GAIA Converter Hold up device HUGD-50 provides a state-of-the-art solution to the problem of maintaining electronic system in operation during input bus drop-out with enough time. Usually this approach uses very large capacitors because they are only charged at the voltage at which power fail. The Gaia Converter HUGD-50 module provides an alternative solution to reduce the amount of capacitance needed by charging the hold up capacitor at a high voltage (typically 38V) while limiting the input current.

The HUGD-50 needs to be connected between the line source and DC/DC modules (if an EMI filter and /or a pre-regulator are used, the HUGD-50 is connected between them and the converters). Basically the HUGD-50 charges the external capacitor to 38V while powering the DC/DC converters. If the power fails, the HUGD-50 generates a signal and the converters are powered from the external capacitor. The HUGD-50 can be used either with 16-40V or 9-36V input voltage DC/DC converters since the «power fail voltage» is externally adjustable between 8.8V and 15.3V by the user.

The HUGD-50 features 3 modes of operations:

- Charging operation mode : when the input voltage ramps-up and reaches the start-up charge threshold (which is set at 1Vdc above

the «power fail voltage»), the HUGD-50 begins to charge the external capacitor at 38 VDC while powering the dc/dc converter. the charging current is controled and externally adjustable between 100mA and 2A by a resistance. The capacitor charging time depends on the charging current. When the capacitor voltage reaches 34V, (representing 90% of charge) the signal (active, floating output collector) «capacitor charged» is activated and the HUGD-50 enters in the normal operation mode.

- Normal operation mode : in normal operation mode with the capacitor charged and the input bus is between the «output power fail» and 40VDC, the HUGD-50 consumes only power to keep the capacitor charged (i.e. less than 1W. The voltage drop between input and output is lower than 150mV in the worst case (50W power and 9 VDC input voltage) The HUGD-50 will operate indefinitely until the input voltage drops below the «power fail voltage» threshold.

- Power fail mode : when the input voltage drops below the «power fail voltage» threshold a «power fail» signal is activated and the HUGD-50 disconnects input and output and connects the hold-up capacitor to the output. At this point the DC/DC converters are powered by the capacitor. When 90% of the usable stored energy in the capacitor is activated and operation will stop as the energy reaches zero.

2-Product Selection

HUGD - 50 - / option - suffix

Options :

/T : option for -55°C start up operating temperature
/S : option for screening and serialization

Suffix :

nothing : RoHS process
-L : leaded process (available in N. America)

3- Block Diagram

The HUGD-50 module includes 3 main circuits :

- An input monitoring circuit
- An hold-up charger circuit
- A hold-up monitoring circuit

• **Input monitoring Circuit :**

The input monitoring circuit monitors the value of the input bus voltage and compares it to the power fail threshold voltage (V_{th}) set externally through a resistor. Depending on this comparison, the circuit allows the activation of the hold-up switch and the hold-up charger and generates an isolated power fail flag (PF).

• **Hold-up Charger :**

The hold-up charger is used to feed the hold-up capacitor with a constant $V_c=38V$ voltage. The design of this charger has been optimized to minimize the input inrush current which can be set externally through the V_{cl} input by a resistor.

• **Hold-up monitoring Circuit :**

The hold-up monitoring circuit monitors the charging status of the hold-up capacitor.

The circuit generates 2 isolated flags : the capacitor charged flag (CC) and the capacitor discharged flag (CD).

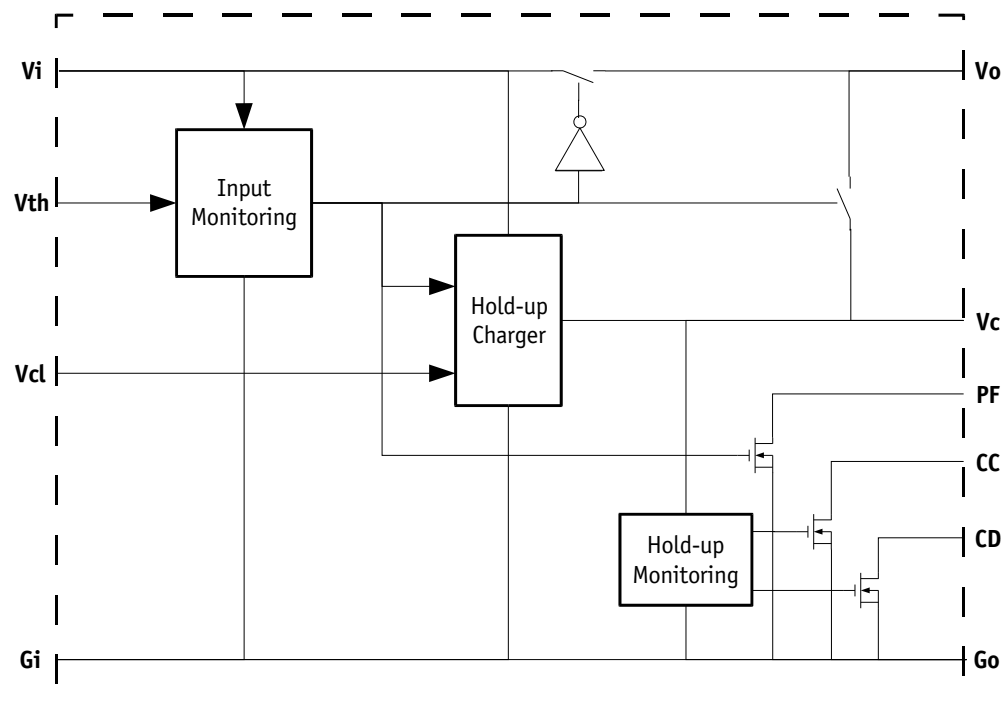
These flags can be used at system level for management of power interruption (VME system, PCI, ...)

The HUGD-50 features 3 modes of operations :

- Charging operation mode
- Normal operation mode
- power fail mode

The following figure represents the HUGD-50 series block diagram.

HUGD-50 Block Diagram



4- Electrical Specifications

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

Parameter	Conditions	Limit or typical	Units	HUGD-50
Input				
Permanent input voltage range (Ui)	Full temperature load Full load	Minimum Maximum	VDC VDC	9 40
Transient input voltage	Full temperature load Full load	Maximum	VDC/ms	50/100
Power fail voltage threshold (Vfail)	with the setting Vth unconnected	Minimum Typical Maximum	VDC VDC VDC	15 15,3 15,6
Power fail voltage threshold (Vfail)	with the setting Vth connected to ground	Minimum Typical Maximum	VDC VDC VDC	8,6 8,8 9
Input current consumption during charging at 28V	min: Vcl unconnected max: Vcl connected to ground	Minimum Maximum	A A	0,1 1,5
Input current consumption during charging at 16V	min: Vcl unconnected max: Vcl connected to ground	Minimum Maximum	A A	0,1 2,2
Output				
Output admissible power	Full temperature load Full load	Maximum	W	50
Dissipated power	Vin @ 9V, full power	Maximum	W	1
Voltage drop input/ouput	Vin @ 9V, full power	Maximum	mV	160
Capacitor charged signal threshold		Minimum Maximum	VDC VDC	33,8 34,8
Capacitor discharged signal threshold	with setting Vth unconnected	Minimum Maximum	VDC VDC	15,9 16,7
Capacitor discharged signal threshold	with setting Vth connected to ground	Minimum Maximum	VDC VDC	9,4 10,2
Maximum admissible hold-up capacitor		Minimum Maximum	μF μF	470 30.000
Hold-up time at full load	Vth unconnected Vth connected to ground	Minimum Minimum	μs/μF μs/μF	11,2 12,8
Hold-up time at 10W load	Vth unconnected Vth connected to ground	Minimum Minimum	μs/μF μs/μF	55,6 64,4

5- Switching Frequency

Parameter	Conditions	Limit or typical	Specifications
Switching frequency	Full temperature range Ui min. to max. No load to full load	Nominal, fixed	200 KHz

6- Isolation

Parameter	Conditions	Limit or typical	Specifications
Electric strength test voltage	Input to output	/	No isolation

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 85°C	1.500.000 Hrs 590.000 Hrs
	Airborne, Inhabited, Cargo (AIC)	Case at 40°C Case at 85°C	730.000 Hrs 300.000 Hrs
Mean Time Between Failure (MTBF) According to IEC-62380-TR	Avionics Military Cargo	/	Consult factory

8- Thermal Characteristics

Characteristics	Conditions	Limit or typical	Performances
Operating ambient temperature range at full load	Ambient temperature *	Minimum Maximum	- 40°C + 90°C
Operating case temperature range at full load	Case temperature	Minimum Maximum	- 40°C +105°C
Storage temperature range	Non fonctionning	Minimum Maximum	- 55°C + 125°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 + 105°C.

The HUGD-50 series operating **case** temperature must not exceed 105°C. The maximum **ambient** temperature admissible for the DC/DC converter corresponding to the maximum operating case temperature of 105°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 temperature Tcase = 105°C of the module, the power used Pout and the efficiency η :

- determine the power dissipated by the module P_{diss} that should be evacuated :

$$P_{diss} = P_{out} / (\eta - 1)$$

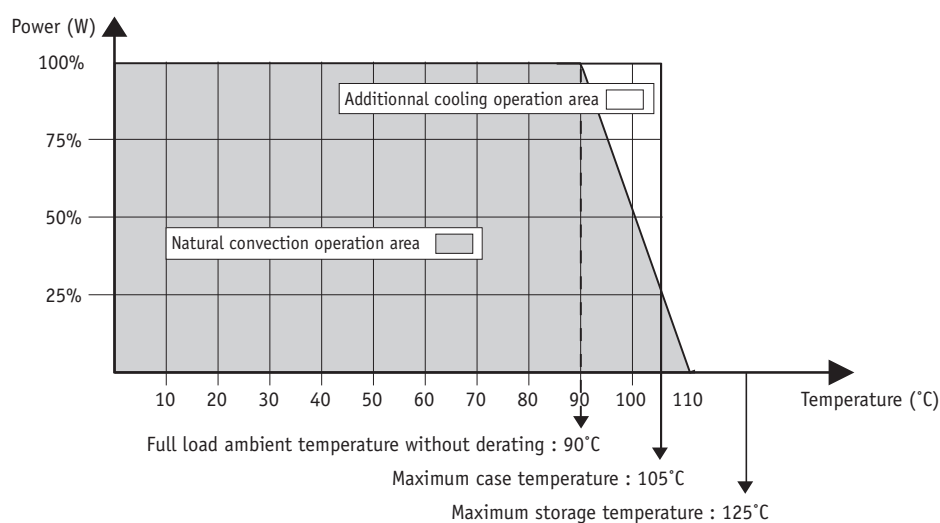
- determine the maximum ambient temperature :

$$T_a = 105^{\circ}\text{C} - R_{th} \times P_{diss}$$

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 105°C (white area in the following graph).



9- 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	Test D : 1.000 Hrs @ 105°C case, unit operating @ 125°C ambient, unit not operating	MIL-STD-202G Method 108A
Altitude	Altitude level C Duration Climb up Stabilization Status of unit	40.000 ft@-55°C 30 min. 1.000 ft/min to 70.000 f@-55°C, 30 min. unit operating	MIL-STD-810E Method 500.3
Humidity cyclic	Number of cycle Cycle duration Relative humidity variation Temperature variation Status of unit	10 Cycle I : 24 Hrs 60 % to 88 % 31°C to 41°C unit not operating	MIL-STD-810E Method 507.3
Humidity steady	Damp heat Temperature Duration Status of unit	93 % relative humidity 40°C 56 days unit not operating	MIL-STD-202G Method 103B
Salt atmosphere	Temperature Concentration NaCl Duration Status of unit	35°C 5 % 48 Hrs unit not operating	MIL-STD-810E Method 509.3
Temperature cycling	Number of cycles Temperature change Transfert time Steady state time Status of unit	200 -40°C / +85°C 40 min. 20 min. unit operating	MIL-STD-202A Method 102A
Temperature shock	Number of shocks Temperature change Transfert time Steady state time Status of unit	100 -55°C / +105°C 10 sec. 20 min. unit not operating	MIL-STD-202G Method 107G
Mechanical Qualifications			
Vibration (Sinusoidal)	Number of cycles Frequency / amplitude Frequency / acceleration Duration Status of unit	10 cycles in each axis 10 to 60 Hz / 0.7 mm 60 to 2000 Hz / 10 g 2h 30 min. per axis unit not operating	MIL-STD-810D Method 514.3
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	MIL-STD-810D Method 516.3
Bump (Half sinus)	Number of bumps Peak acceleration Duration Status of unit	2000 Bumps in each axis 40 g 6 ms unit not operating	MIL-STD-810D Method 516.3

10- Application Notes

10-1 General on Input Bus Shut-Down Requirements

During bus power drop-out, avionics and military systems require a maintain of operation for saving data and controlling the shut-down.

The duration of this shut-down operation is defined in different standards and can last up to 7 secondes.

10-1-1 Capacitor Stand-Alone Solution

To maintain operation during this power drop-out, the traditional approach is the use of a bulk capacitor connected at the input of the converters to power them when power drops-out. The capacitor needed depends on the system specifications, the load and the efficiency of the DC/DC converters and the amount of capacitor for a given hold-up time. The value of the capacitance is determined by the following formula :

$$C1 = \frac{(2 \times P \times Dt)}{\{h \times (V1^2 - V2^2)\}}$$

where :

- C : is the required capacitor (in farads)
- P : is the power at the load (output of converter) (in watts)
- h : is the efficiency of the converter at rated load
- Dt : is the required hold up time (in seconds)
- V1 : is the initial charged capacitor voltage (in volts)
- V2 : is the low line voltage of DC/DC converter

For a typical hold-up time of 50 ms with 50W power (at the input of the DC/DC converter with 80% efficiency) plugged on a MIL-STD-704D 28V bus that can range down to 22V and considering the minimum permanent input voltage of GAIA Converter module at 16V, the required capacitance is a huge with value of 18.000 µF/40V rated.

10-1-2 Capacitor with Hold Up Module Solution

To reduce drastically the size of this capacitor, GAIA Converter proposes the hold up module HUGD-50 that will charge the capacitor at a much higher voltage (typically 38V).

Moreover this module allows a selection of the minimum threshold voltage at which the capacitance will begin to power the converters. In this case the amount of capacitance needed for a given hold up time is determined by the following formula :

$$C2 = \frac{2 \times P \times (Dt + 0.01)}{\{h \times (38^2 - V2^2)\}}$$

where :

- C : is the required capacitor (in farads)
- P : is the power to the load (output of converter) (in watts)
- h : is the efficiency of the converter at rated load
- Dt : is the required hold up time (in seconds)
- V2 : is the low line voltage of DC/DC converter (in volts).

For a typical hold-up time of 50 ms with 50W power (at the input of the DC/DC converter with 80% efficiency) plugged on a MIL-STD-704D 28V bus and using the hold up module the capacitance required will decrease down to value of 5.000 µF/40V rated.

10- Application Notes (continued)

10-2 Hold-up Capacitor Selection with HUGD-50 Solution

The external capacitor supplies the energy for the DC/DC converters operation during failure.

The capacitance should not exceed 30.000μF, and should be higher than 470μF.

The amount of capacitance for a given hold up time is given by the formula :

$$C = \frac{2 \times P (Dt + 0.01)}{38^2 - V_L^2}$$

where

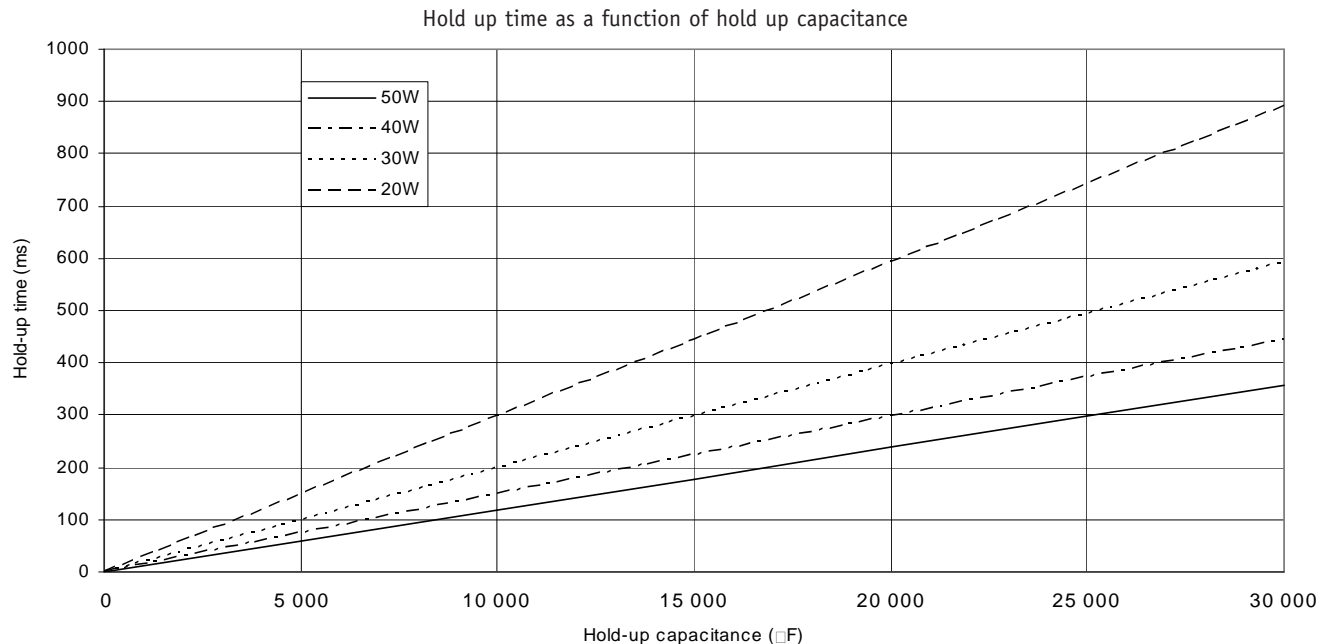
C : is the required capacitance (in Farads)

P : is the power consumed by the DC/DC converters (in Watts)

Dt : is the required hold-up time (in seconds)

V_L : is the lower admissible voltage of DC/DC converters (in volts)

The following curve gives the capacitor value as a function of the required hold up time. Gaia Converter recommends a high CV low ESR and extended temperature capacitor.



10- Application Notes (continued)

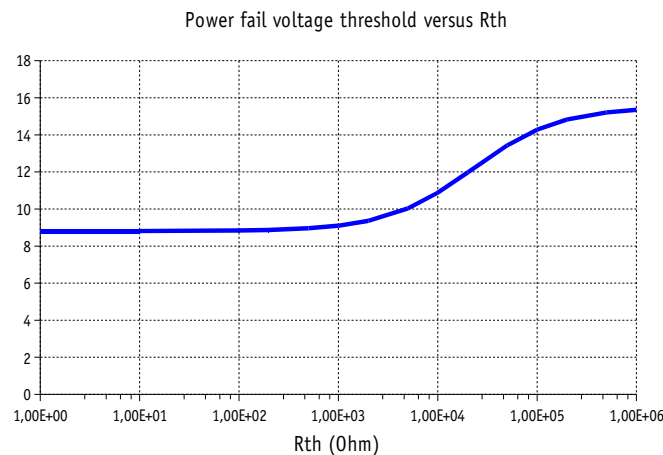
10-3 Power Fail Voltage Threshold : Vth

The «power fail voltage» threshold determines the operation mode of the HUGD-50.

This threshold has to be set up in conjunction with the type of modules used (i.e. 9-36 VDC or 16-40 VDC input voltage type of modules) and can be adjusted between 8,8VDC and 15,3VDC by external resistance Rth connected between the Vth pin and Gout pin.

Vth unconnected will set up the threshold at 15,3VDC valid for 16-40Vdc input modules, Vth connected to ground will set up the threshold at 8,8VDC valid for 9-36Vdc input modules.

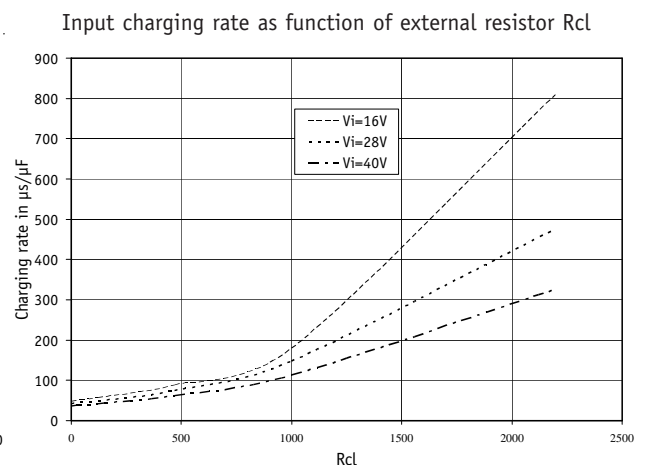
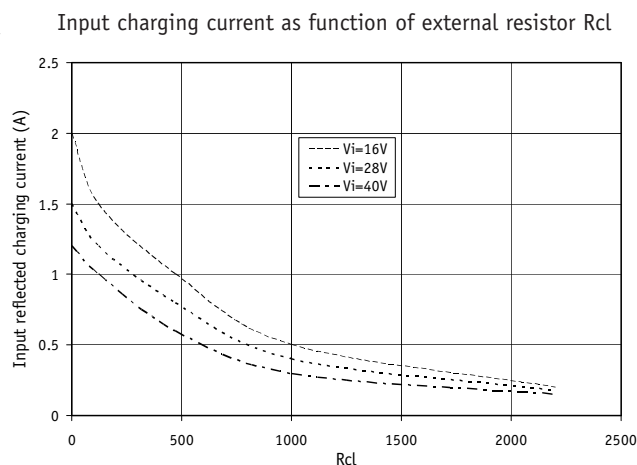
If the HUGD-50 is used with the PGDS-50-N-K, Vth has to remain unconnected; with the PGDS-50-O-K, Vth has to be connected to Go. The following curve determines the function of Vth threshold as a function of the resistor Rth.



10-4 Charging Current Setting : V_{CL}

The HUGD-50 controls the inrush current (charging current) to remain between 100 mA to 2A by an external resistance Rcl connected between the Vcl pin and the Gout pin. This charging current is a direct function of the charging time

knowing that the capacitor is charged at 38VDC. The following curve gives the resistance Rcl value as a function of current & charging time.



10- Application Notes (continued)

10-5 Power Fail Signal : PF

The «power fail» output signal is activated when the voltage drops below the power fail voltage threshold. the PF signal is an open collector output active low.

10-7 Capacitor Discharged Signal : CD

The «capacitor discharged» signal is activated when the voltage at the capacitor pins reaches 16.3 VDC (or 9.8 VDC) corresponding to a remaining energy of about 20% of it's full charge.

The CD signal is an open collector output active low.

10-6 Capacitor Charged Signal : CC

The «capacitor charged» signal is activated when the voltage at the capacitor pins reaches 34 VDC corresponding to an energy stored of about 90% of it's full charge.

The CC signal is an open collector output active low.

10-8 Transition Capacitor

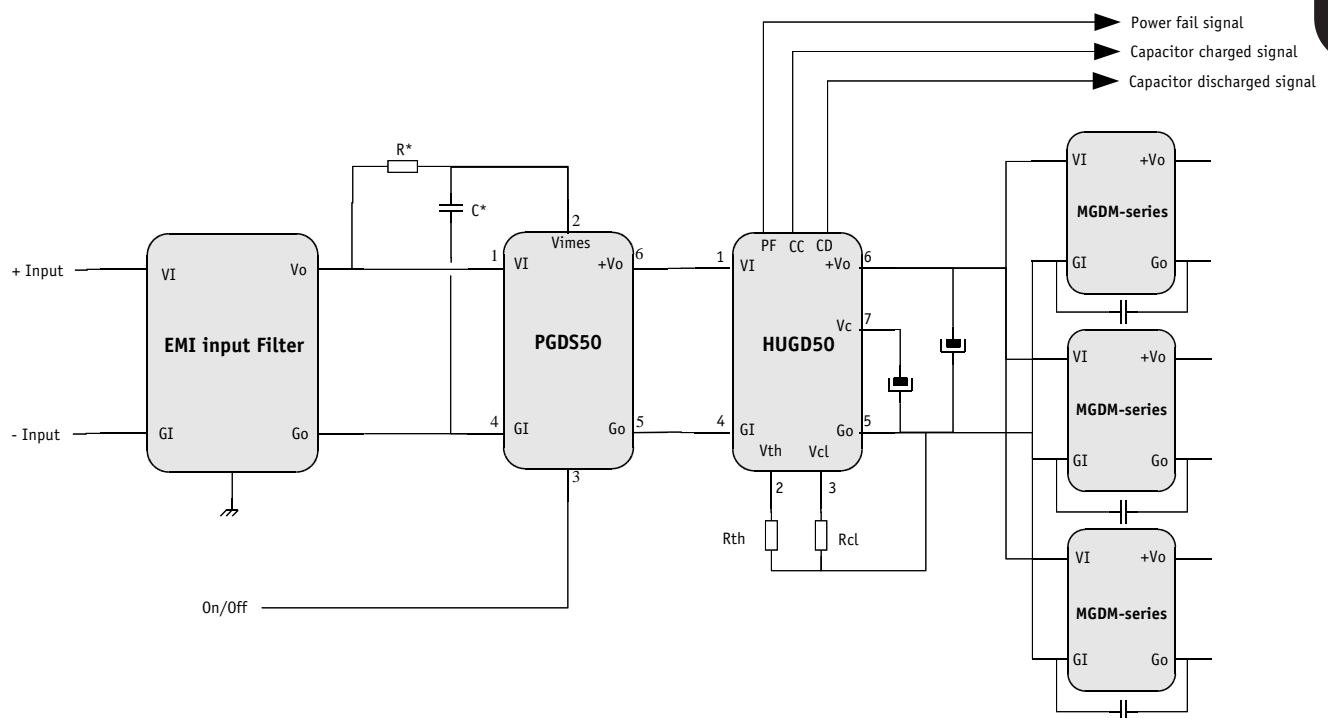
To help transitionning the system in the different operating mode, GAÏA Converter recommends the use of a transition capacitor. This capacitor is used to maintain output voltage during the HUGD-50 commutation from input line to hold up capacitor. A 100 μ F electrolytic capacitor is enough for a 50W load, and this value can be reduced for lower loads.

The table below gives the minimum required values versus output power :

Output power (W)	10	20	30	40	50
Capacitance value (μ F)	22	47	68	82	100

10-9 Typical Schematics

This typical application schematics includes an EMI filter, a PGDS-50 pre-regulator, the hold-up module and an assembly of standard DC/DC converters. Additionnal details are given in the EMI filters application notes and PGDS-50 datasheet.



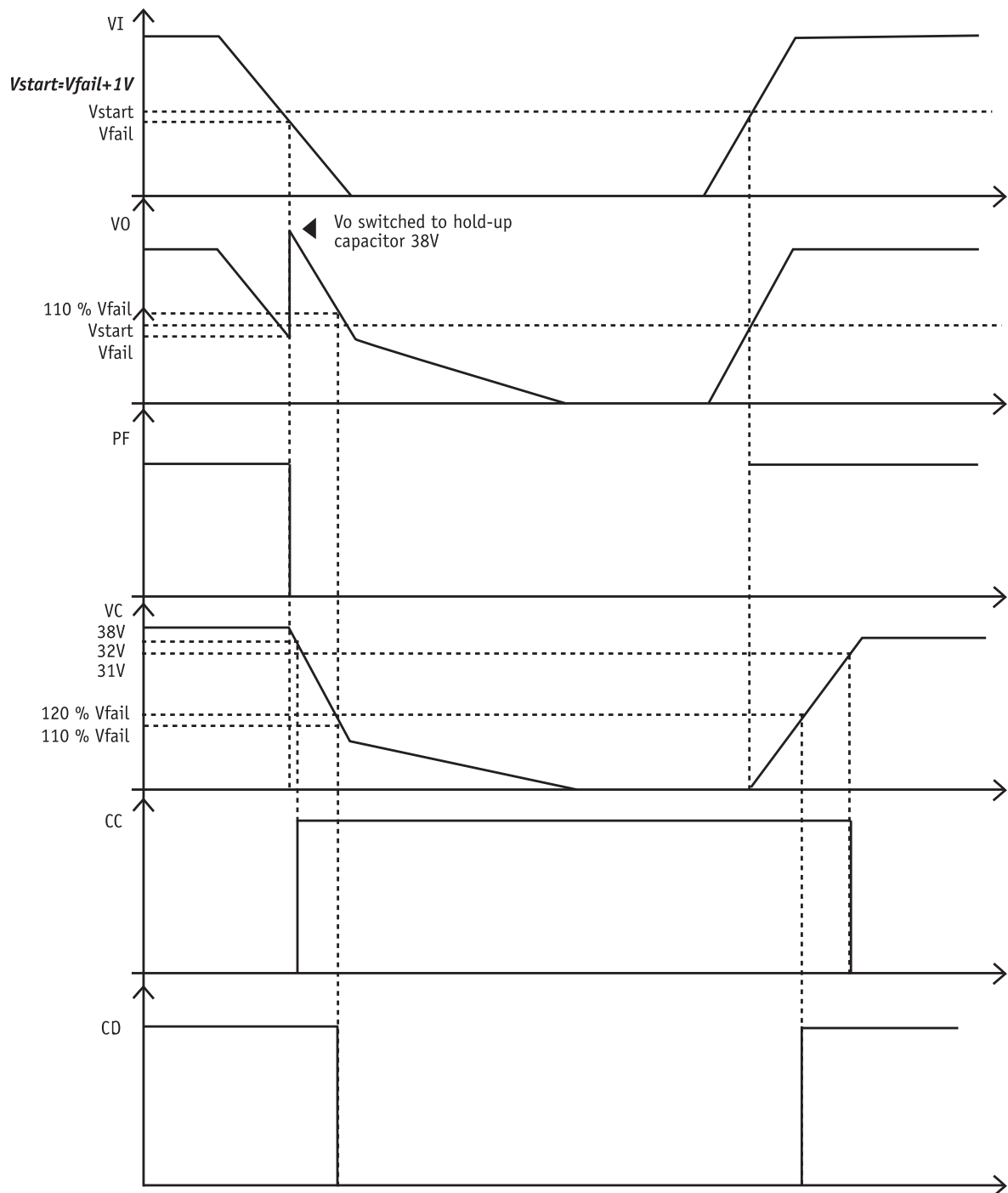
Note * : Due to possible oscillations caused by surges or fast transients at the input voltage level, it is recommended to implement a RC filter on the VIMES signal; several implementations as shown in the above figure can be tested to optimize the design. Typical values for the resistor R is 470 Ohm and for the capacitance C is 1 μ F.

10- Application Notes (continued)

10-10 Timming Diagram

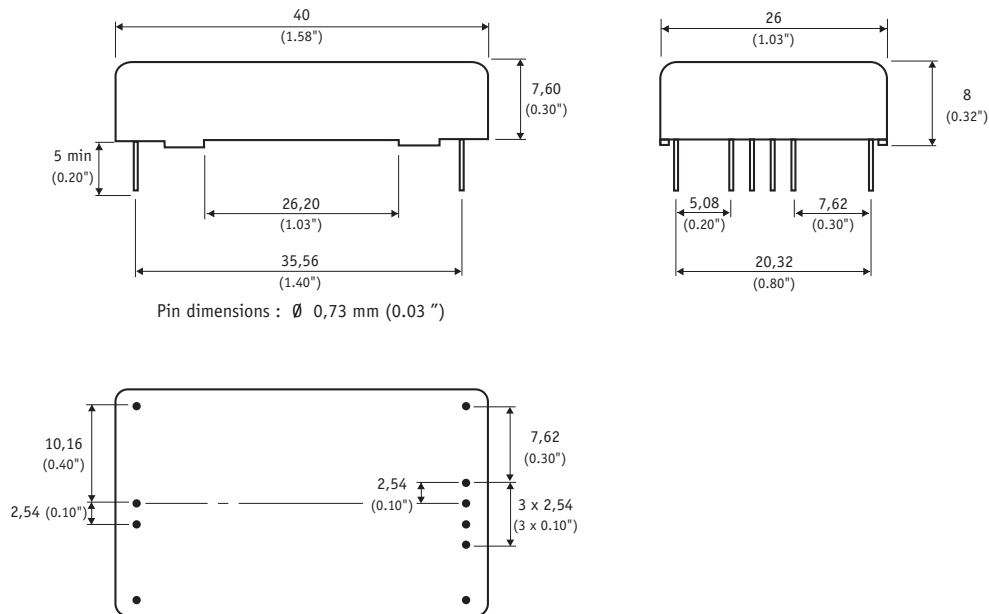
The following diagram describes the HUGD-50 output signals through the different operation modes :

- Input voltage (V_i)
- Output voltage to DC/DC converter (V_o)
- Power Fail signal (PF)
- Capacitor voltage (V_c)
- Capacitor charged signal (CC)
- Capacitor discharge signals (CD)



11- Dimensions

Dimension are given in mm (inches). Tolerance : $\pm 0,2$ mm (± 0.01 ") unless otherwise indicated.
Weight : 20 grams (0.7 Ozs) max.



12- Materials

Case : Metallic black anodized coating.

Pins : Plated with pure matte tin over nickel underplate.

13- Product Marking

Upper face : Company logo, location of manufacturing.

Side face : Module reference : HUGD-50.

Date code : year and week of manufacturing, suffix, /option.

14- Connections



Bottom view

Pin	HUGD-50
1	+ Input (Vi)
2	Power Fail Threshold (Vth)
3	Voltage Current Level (Vcl)
4	- Input (Gi)
5	Common (Go)
6	Output (Vo)
7	Voltage Capacitor (Vc)
8	Power Fail Signal (PF)
9	Capacitor charged signal (CC)
10	Capacitor discharged signal (CD)



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