

High Density - Low Profile Power Conditioner
Compatible with Mil/Aero 24 or 28Vdc Standard Input Buses
and Gaia Converter's Latest Generation MGDD series Converters

- High density low profile 8mm
- High efficiency
- Transient suppressor module from 10 to 100Vdc
 - MIL-STD-704A/D/E/F, EN2282, AIR2021E, ABD100
 - D0160E cat A, B and Z
 - MIL-STD-1275A/B/C/D/E
- Power range : up to 150W
- Hold-up function
- Inrush current limitation
- Reverse Polarity protection
- Input Synchronization
- DC/DC converter biphas drive
- RoHS process

1- General

The GAIA-Converter LHUG-150 designates a family of power conditioners.

The LHUG-150-N is an ultra compact Mil/Aero multi-standard, voltage and power conditioner dedicated to Gaia Converter's latest generation «N» DC/DC converters (i.e. with 9-60Vdc permanent input voltage). The LHUG-150-N is designed to comply with the additional input requirements of 24/28Vdc Mil/Aero buses such as:

- input inrush current limitation,
- transient input voltage,
- transparency due to brownout,
- +/-100V reverse protection.

Moreover, the LHUG-150-N allows setting the output power protection limit as well as reducing EMI thanks to Gaia Converter's bi-phase synchronisation drive of MGDD converter.

The LHUG-150-N has been designed to easily build complex multiple output architectures up to 120W .

It complies with followings standards :

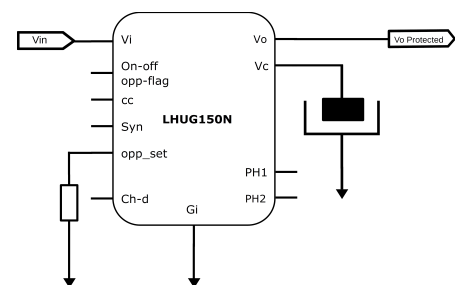
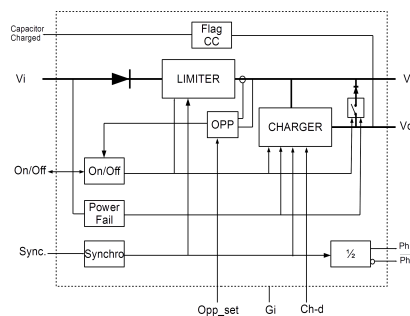
- MIL-STD-704A/D/E/F, MIL-STD-1275A/B/C/D/E, MIL-STD-461,
- EN2282, AIR2021E and many others

The combination of LHUG-150-N, MGDD «N» series of DC/DC converters and FGDS filter series, leads to size, thickness and weight optimization of Mil/Aero multiple outputs DC-DC power supplies.



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2- Block Diagram



3- Product Selection

LHUG -150 - N/ option

Options :

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

2- LHUG-150-N Modes of Operation

The figure hereafter shows the 3 modes of operation of LHUG-150-N conditioner which depend on the values of input voltage:

Normal mode : when the input voltage is above V_{start} and below V_{lim} , the LHUG-150-N connects the input to the output through an internal diode.

Power Fail (PF) Mode : When the input voltage is below V_{stop} and the Hold-up capacitor connected to V_c is charged, the LHUG-150-N opens its V_i to V_o link, and connects V_o to the charged capacitor through V_c .

Limitation Mode : when the input voltage exceeds V_{lim} , the LHUG150N enters into a limitation mode , in order to provide a constant output voltage equal to V_{lim} .

Warning : The Opp_set pin needs to be connected to G_i pin through a resistor or a short, for power limitation function to work properly. If the Opp_set remains unconnected, the LHUG-150-N power capability will be reduced to its minimum value.

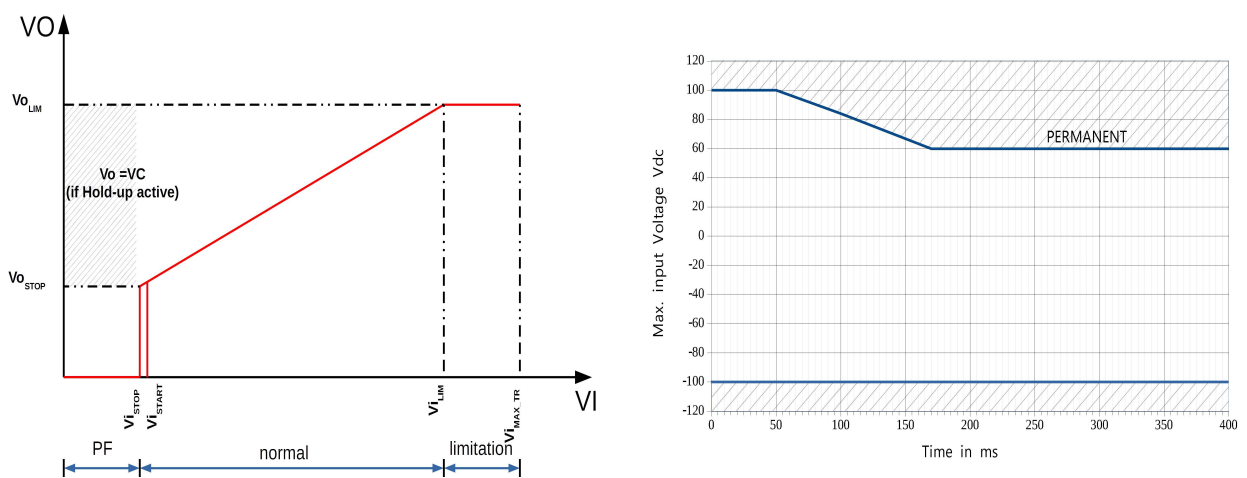


Figure 1 : Voltage Limitation and admissible input voltage

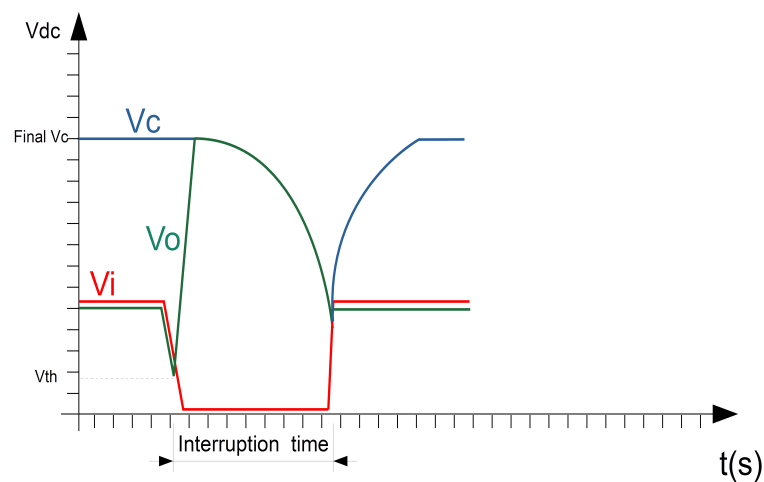


Figure 2 : Hold-up Sequence Diagram

3- LHUG-150-N Pin Functions and Applications

Control & Monitoring Pins :

OPP_set (input) : over Power Protection set: a resistor across this pin and Gi pin sets the power protection threshold.

Syn (input) : this pin allows to synchronize the internal signal generator to any external source.

Ph1 (output) : this pin provides a signal to synchronize any converter from the MGDD family.

Ph2 (output) : this pin provides a signal to synchronize any converter from the MGDD family. Ph2 and Ph1 have the same signal frequency, but phase shifted by 180°.

CC (open drain without pull-up) : this pin is at low level when the capacitor voltage is higher than 90% of the final capacitor voltage.

Ch-d (input) : this pin disable Hold-up capacitor charger, when tied to Gi.

On-off/opp-flag (input/output) : when tied to Gi, this pin disconnects Vi from Vo (switch off input bus). when modules triggers overpower level, this pin is pulled down.

Power Pins :

Vi (input) : Input power pin referenced to Gi.

Gi (input) : Power ground pin.

Vo (output) : Output power pin referenced to Gi.

Vc (output) : Charger output pin to connect to Hold-up capacitor. This pin is referenced to Gi.

Application to MGDD Power Architecture :

The LHUG-150-N is designed to power MGDD series based multi-standard multiple outputs power architecture. The LHUG-150-N embeds a bi-phase synchronization generator that can synchronize 2 groups of DC/DC converters with 180° phase shift in order to reduce switching noise. A fast capacitor charger is included into the LHUG-150-N along with a complete bypass circuit to manage efficiently the hold-up requirements of Military standards. The LHUG-150-N limits all the transients voltage surges specified by the following standards: MIL-STD-1275E, MIL-STD-704F, DO-160G, MIL-STD-461G and prior revisions to a voltage level under the maximum input voltage limit of MGDD serie with N input.

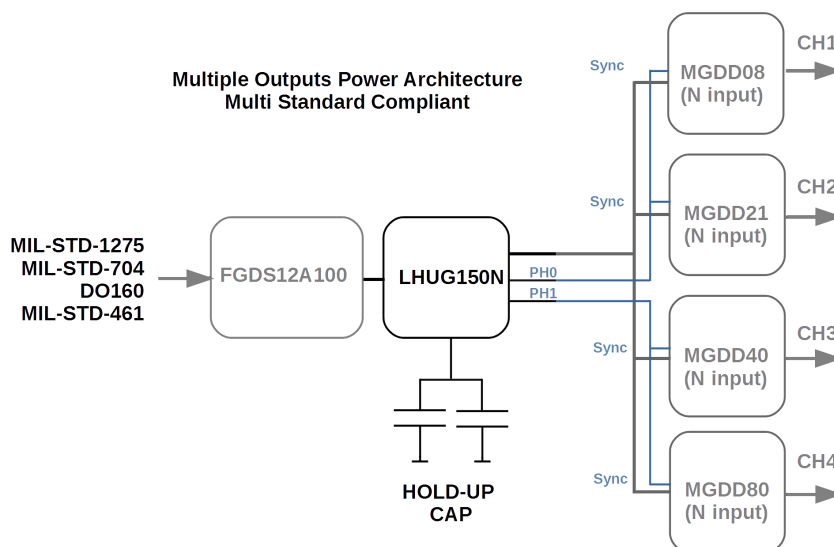


Figure 3 : Typical Architecture

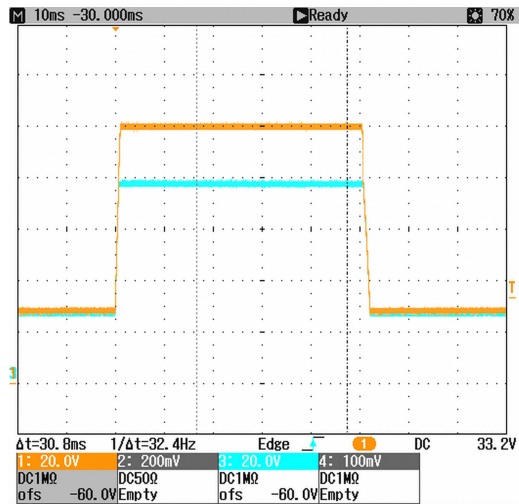
4- Electrical Specifications

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

Parameter	Conditions	Limit or typical	Units	LHUG-150-N
Input				
Permanent input voltage range (Ui)	Full temperature range Full load	Minimum (70% load) Minimum (full load) Maximum (ViLim)	Vdc	11 15 80
Transient input voltage		Minimum Maximum (ViMax_tr)	Vdc/ms Vdc/ms	10V/100 100/50
Reverse input voltage		Minimum	Vdc/ms	-100/100
Power fail voltage Vistart Power fail voltage Vistop	Hold- up thresholds	Maximum Minimum	Vdc Vdc	10.8 9.8
Compliance with standards voltage surge limit	Full temperature range	MIL-STD-704A/F AECMA EN2282 AIR2021E D0160E cat A/Z MIL-STD-1275A to E	V/ms	80/75 60/50 60/100 80/100 100/50
Start up time	Soft-Start at 28V hot plug	Maximum	ms	2
Input to output serie resistance	normal operation mode Ui nominal 28V	typical	mOhms	90
Dissipated Power	150W out, 25°C Ui=10.8V (transient) Ui=18V Ui=28V Ui=32V	typical	W	13 5 2.6 2
Inrush current	Ui nominal 28V*	Typical	A	12
No load input current	Ui nominal 28V No load	Maximum	mA	TBD
Output				
Nominal output voltage in normal operation	Ui < 60V Full load	Nominal	Vdc	Ui - losses
Nominal output voltage in transient protection mode	In transient Input voltage range	VoLim (Maximum)	Vdc	78
Output voltage slew rate	During start-up time	Typical	V/ms	40
Output current (steady state)	Full temperature range Ui min. to max.	Maximum	A	10 **
Output Power	Full temperature range Ui min. to max.	Maximum	W	150W **
Output Power Protection (toggle to Hic-up mode)	Ui = 28V Ropp = 0 ohms Ropp = 470ohms Ropp = 1 kohms Ropp = 1.8K kohms Ropp = open circuit	Typical	W	170 155 100 50 30
Hold-Up				
hold-up capacitor Final Voltage	Fixed (+/-2%)	Maximum	Vdc	65
Charging power	Full temperature range	Maximum	W	17
Capacitor Charged signal (CC)	active for Vc=90% of final Vc	active non active	/	Short Drain Open Drain
CC,sink current	active	Maximum	mA	20
max. voltage	non active	Maximum	Vdc	60
Admissible Hold up Capacitor		Maximum	(milliFarad)	100
Synchronization generator				
PH1 PH2 output signal level		low high	V	0 5
PH1 PH2 frequency (internal)		Typical (+/-5%)	KHz	290(tbd)
External synchronization frequency		Maximum Minimum	KHz	720 560

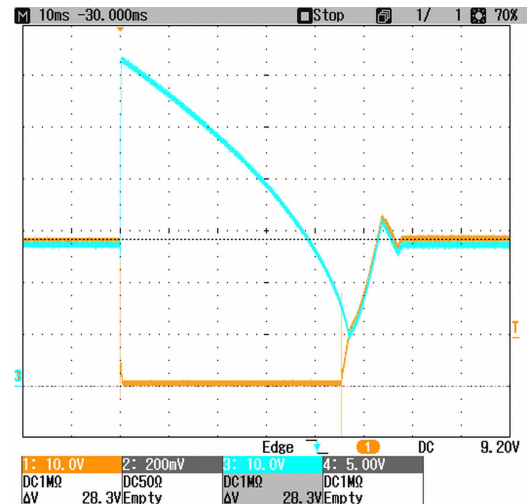
* Control of inrush current is achieved by maintaining a constant slope during output voltage rise. In consequence the inrush current depends on the total capacitive load value. ** max current can go up to 10A as long as output power < 150W.

4- Electrical Characteristics (continued)



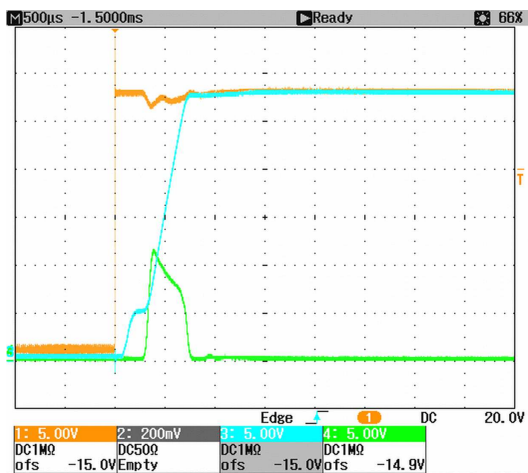
Ch1= input Voltage on Vi Ch3= output Voltage on Vo

Figure 4 : LHUG-150-N Mil-STD-1275E 100V Surge Limitation



Ch1= input Voltage on Vi Ch3= output Voltage on Vo

Figure 5 : LHUG-150-N Hold-Up Sequence



Ch1= input Voltage on Vi Ch3= output Voltage on Vo

Ch4 Inrush current 5A/div (with 47μF electrolytic capacitor on Vo)

Figure 6 : LHUG-150-N Inrush Current limitation

5- 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	TBD Hrs TBD Hrs
	Airborne, Inhabited, Cargo (AIC)	Case at 40°C Case at 85°C	TBD Hrs TBD Hrs
Mean Time Between Failure (MTBF) According to IEC-62380-TR	Civilian avionics, calculators	Ambient at 55°C 100% time on	TBD Hrs

6- Thermal Characteristics

Characteristics	Conditions	Limit or typical	Performances
Operating ambient temperature range at full load	Ambient temperature *	Minimum Maximum	- 40°C + 85°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

The LHUG-150-N series should operate below the maximum **case** temperature . The maximum **ambient** temperature admissible for the limiter will depend on :

- the maximum operating case temperature
- the ambient airflow,
- the mounting/orientation,
- the cooling features (heatsink, cold plate...)
- the dissipated power.

To calculate a maximum admissible ambient temperature the following formula can be used.

$$T_a = T_{cmax} - R_{th} \times P_{diss}$$

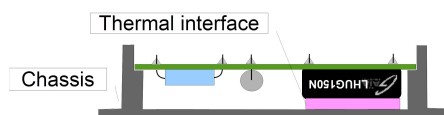
where **Rth** is the thermal resistance from the case to ambient.
Tcmax is the maximum case temperature.
Pdiss is the dissipated power .



Heat-sink usage



Free ai cooling



Chassis mount

7- Environmental Qualifications

The modules have been subjected to the following environmental qualifications.

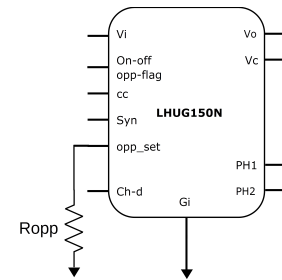
Characteristics	Conditions	Severity	Test procedure
Climatic Qualifications			
Life at high temperature	Duration Temperature / status of unit	Test D : 1 000 Hrs @ 105°C case, unit operating @ 125°C ambient, unit not operating	MIL-STD-202G Method 108A
Altitude	Altitude level C Duration Climb up Stabilization Status of unit	40 000 ft@-55°C 30 min. 1 000 ft/min to 70 000 ft@-55°C, 30 min. unit operating	MIL-STD-810E Method 500.3
Humidity cyclic	Number of cycles 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 Transfer 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 Transfer 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 2 000 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	2 000 Bumps in each axis 40 g 6 ms unit not operating	MIL-STD-810D Method 516.3

8- Application note

8-1 Output Power Protection (OPP)

The LHUG-150-N embeds an over power protection function that can be adjusted using the Ropp resistor connected as shown on the schematic diagram here opposite.

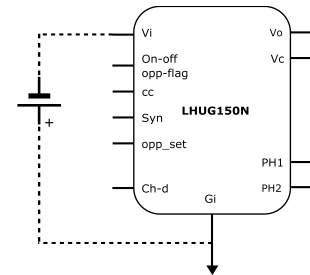
This Opp function is intended to protect the full architecture from overload, and needs to be set in accordance to the downstream MGDD series converter maximum power. See the LHUG-150-N electrical characteristics table for Ropp values.



8-2 Reverse polarity

The LHUG-150-N includes a reverse polarity protection circuit that prevents damage of limiter and downstream circuits under reverse input voltage.

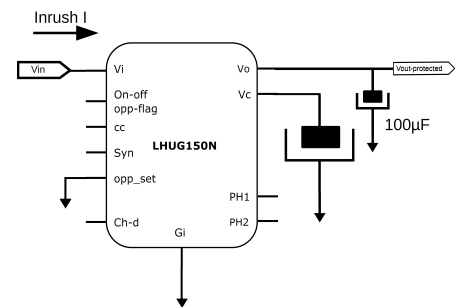
See electrical characteristics for the minimum input voltage supported.



8-3 Input Inrush current management

The LHUG-150-N features an internal circuit to limit the input inrush current below values imposed by standards. The function controls Vout rise in order to maintain a constant

$\frac{\Delta V}{\Delta t}$ accross the ouput capacitor and downstream Gaia Converter's MGDD architecture. The complete MGDD «N» architecture requires a 100µF / 100V capacitor on the protected bus for proper 150W operaion.



8-4 Hold-up operation

The Hold-up section of the LHUG-150-N features a 17W constant power charger that allows to charge a Hol-up capacitor with a total control of inrush current. The Charger power is calibrated to allow fast charging time below test repetition period imposed by some standards (1s for ABD100).

The Hol-up capacitor value is given by the following formula:

$$C = \frac{1000 * P * t}{2072}$$

Where :

C= capacitor value in µF

P= LHUG150N output power in Watts

t = interruption time in ms

The table below shows typical capacitors values for various interruption durations

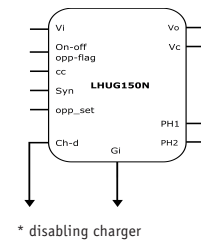
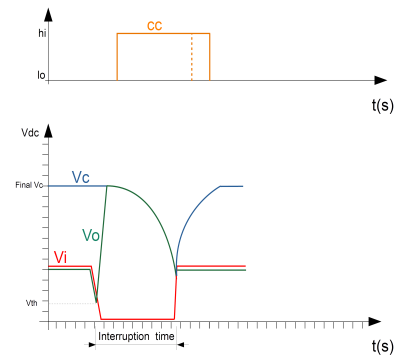
Characteristics	Parameters								
	50			100			200		
Interruption duration (ms)									
LHUG-150-N output power (Watt)	50	100	150	50	100	150	50	85	150
Hold-up Capacitor value (µF)	1 250	2 500	3 700	2 500	5 000	7 400	5 000	8 200*	14 800*

* for ABD100, 8200µF is the max capacitance that can be recharged within the 1s, the 14800µF requires 1.8s

8-4 Hold-up Operation

The LHUG-150-N hold-up function operates as follow :
when input voltage falls below the powerfail threshold value (see electrical characteristics table) the module operates 2 changes :

- 1) The Vc pin gets internally connected to the Vo pin while the input to output internal link (Vi to Vo) opens. Consequently, the Vo output supplies the converter architecture circuitry with the charged capacitor which starts its discharging phase.
- 2) The CC (capacitor charge) flag is set to high level. When the input voltage recovers its nominal voltage, Vo internally switches to Vi and disconnects from Vc. At the same time the charger starts recharging the capacitor with a constant power. During normal operation (Vo connected to Vin) the charger operates intermittently to maintain capacitor voltage. *If the hold-up function is not used, charger can be disabled by pulling the Ch-d pin to Gi.



8-5 Synchronization

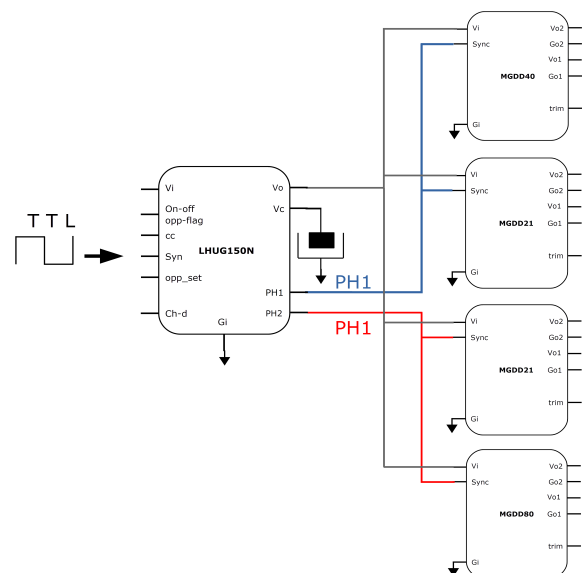
Synchronization Outputs :

The LHUG-150-N embeds a bi-phase synchronization generator to synchronize multiple Gaia converters from MGDD «N» serie with a phase shift of 180°. This synchronization scheme reduces the current noise at the fundamental switching frequency of each MGDD «N» converters. Using this function allows architectures to comply with Military EMC standards with a reduced size filter (FGDS12A100 or FGDS06A100).

To synchronize 2 groups of DC/DC converters, connect the PH1 and PH2 pins to Syn input pin of DC/DC like shown on figure opposite.

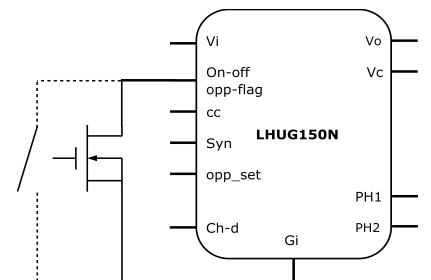
Synchronization Input :

The PH1 and PH2 outputs can be synchronized through an external signal applied to the Sync. The signal applied on pin sync should be a TTL compatible signal.



8-6 On/Off Function

A whole power architecture can be enabled/disabled using the on/off function of LHUG-150-N. This on/off function is active at low level, and can be driven by an open collector, an open drain, or a switch. In off mode, the whole architecture consumption will be low enough to comply with most of green energy standards. The On/off pin can also be used as Opp-flag : in this case, the level on this pin will fall to 0Vdc when conditioner enters in over-load mode.





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