



Hi-Rel AC/DC PFC MODULE HGMM-35 : 35W POWER

Hi-Rel
Grade ■■

**115 VAC/400Hz Active Power Factor Corrected
Variable Frequency 360-800Hz
Dual Isolated Output
Metallic Case**

- AC/DC Isolated Power Factor Corrected Module
 - 115 VAC single phase
 - Input range : 95 - 140 VAC
 - Variable frequency : 360 - 800 Hz
 - MIL-STD-704, ABD100 compliant
- Low input current harmonic distortion < 10%
- Output Power : 35W
- Active inrush current limitation
- Isolation : 1.500 Vrms
- Inhibition function



1- General

The GAIA Converter HGMM-35 series designates a family of active power factor corrected AC/DC isolated modules designed to be compatible with the latest airborne input bus with single phase 115VAC/400Hz variable frequency.

This module accepts a variable frequency input from 360 to 800 Hz in the range of 95 to 140Vac and an active power factor that enables a very low level of current and voltage harmonic distortion over the entire frequency excursion.

The HGMM-35 series is compliant with numerous avionics/military standards among them with :

- the latest Airbus standards ABD100 :
 - permanent input range : 108-122Vac
 - transient : 71Vac/15ms - 180Vac/100ms
 - variable frequency : 360 - 800 Hz
 - power factor : > 0.95
- the international standard DO-160D :
 - permanent input range : 100-122Vac
 - transient : up to 180Vac/100ms
- the US military standard MIL-STD-704E :
 - permanent input range : 108-118Vac
 - transient : 80Vac/10ms - 180Vac/100ms

The HGMM-35 series includes a soft start, a permanent short circuit protection and an inhibit function.

The soft-start allows current limitation and eliminates inrush current during start-up. The short circuit protection completely protects the module against short-circuits of any duration by a shut down and restores to normal when the overload is removed.

The HGMM-35 series includes a model available with dual 2 x 17 Vdc outputs serialisable/parallable 17 or 34 Vdc to optimize the use of hold-up capacitance.

The HGMM-35 series has to be used as front-end in conjunction with a capacitance for hold-up and DC/DC modules at the output.

The design has been carried out with surface mount components and is manufactured in a fully automated process to guarantee high quality. Every module is tested with a Gaia Converter automated test equipment. The modules are potted with a bi-component thermal conductive compound and packaged in a metallic case to ensure the module's integrity under high environmental conditions.

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2- Product Selection

HGMB - 35 - - (/T) and/or (/S)

(/T) : option for -55°C start up operating temperature.

(/S) : option for screening and serialization

Input Voltage Range

W : 95-140 VAC/400 Hz

Output

17 : 2 x 17 VDC

3- Electrical Specifications

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

| Parameter | Conditions | Limit or typical | Units | HGMB-35-W-17 |
|---|--|---|--------|----------------------|
| Input | | | | |
| Nominal input voltage | Full temperature range between phase and neutral | Nominal | VAC | 115 |
| Permanent input voltage range (Ui) | Full temperature range between phase and neutral | Min. - Max. | VAC | 95 - 140 |
| Transient input voltage | Full temperature range between phase and neutral | Min. - Max. | VAC/ms | 71 / 15 180 / 100 |
| Frequency range permanent | Full temperature range Ui min. to max. | Min. Max. | Hz | 360 - 800 |
| Frequency range transient | Full temperature range Ui min. to max. | Transient compliant with ABD100 | Hz/s | 320 / 0,3 |
| Power Factor (PF) | Ui nominal at 400Hz | At full load At half load At quarter load | / | 0.99 0.98 0.90 |
| Total Harmonic Distorsion (THD) | Ui min. to max. | from 50% to full load from 400Hz to 800Hz | % | < 10 |
| Individual current harmonic distorsion | Ui min. to max. from 360Hz to 800Hz | on all harmonics | / | see page 3 |
| Start up input voltage | Full load with nominal output | Minimum | VAC | TBD |
| Start up time | Ui min. to max., 400Hz at full load with resistive load | Maximum | ms | 60 |
| Inrush current | Ui nominal, 400Hz | Nominal | A | 1 |
| Input current in short circuit mode (Average) | Ui nominal, 400Hz Short-circuit | Maximum | mA | TBD |
| No load input current | Ui nominal, 400Hz No load | Maximum | mA | 45 |
| Current in inhibit mode | Ui nominal, 400Hz Inhibit | Maximum | mA | 30 |
| Output | | | | |
| Output voltage | Full temperature range Ui min. to max., Full load | Dual output Nominal Isolated | VDC | 2 x 17 VDC |
| Set point accuracy | Ambient temperature : +25°C Ui nominal, 75% load, 400Hz | | % | +/-4 |
| Output power | Full temperature range Ui min. to max. | Maximum | W | 35 |
| Output current | Full temperature range Ui min. to max. Ui nominal, 400Hz | Maximum | A | 1,05 |
| Ripple output voltage | Full load with 4.400µF output capacitor per output BW=20MHz | Maximum | mVpp | 200 |
| Line regulation | Ui min. to max., 400Hz Full load | Maximum | % | +/-1 |
| Load regulation | Ui nominal, 400Hz 25% to full load | Maximum | % | +/-4 |
| Efficiency | Ui nominal, 400Hz Full load | Typical | % | 84 |
| Maximum admissible capacitive load | Ui nominal, 400Hz Full load | Maximum per output | µF | 14.000 |

3- Electrical Characteristics (continued)

3-1 Power Factor (PF) Characteristics

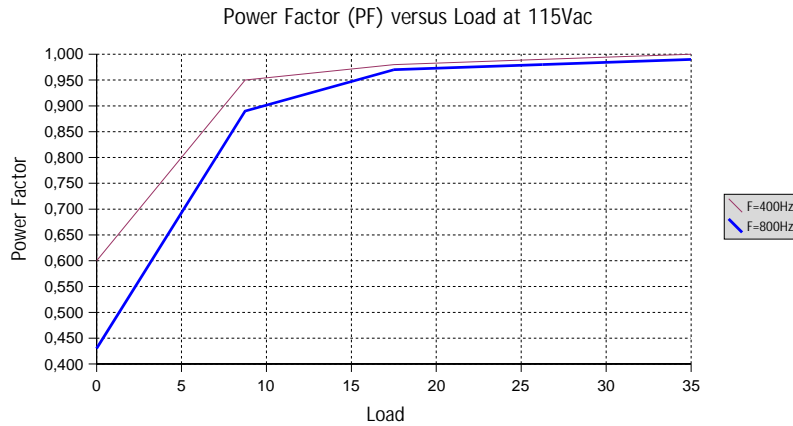
The Power Factor (PF) is the ratio of the «real» power to the apparent power.

The apparent power is the product of the rms volts measured with one meter and the rms amps measured with another meter (value in VA).

The «real» power is the time average of the instant product of voltage and current (value in Watts).

The «real» power cannot be measured directly with 2 meters as it has to integrate the phase shift between voltage and current. This phase shift between voltage and current reduces the effective power delivered.

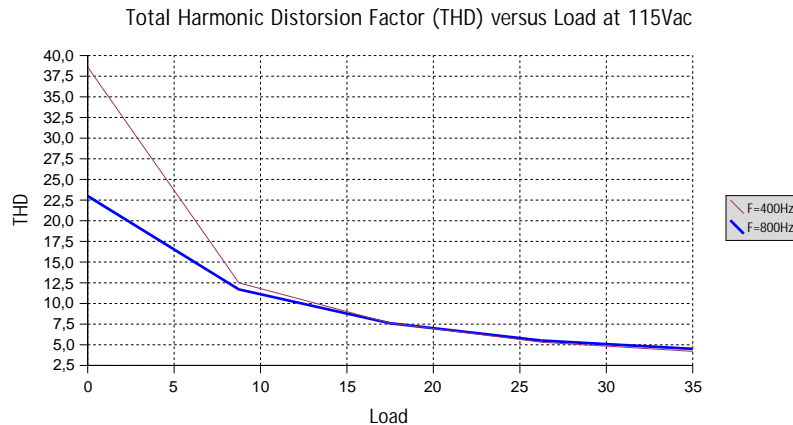
The Power Factor (PF) is a measure of the effectiveness with which an AC load can extract the usable power from an AC source.



3-2 Total Harmonic Distorsion Factor (THD) Characteristics

The Total Harmonic Distorsion (THD) is the ratio between the total energy contained in all row harmonic (except fundamental harmonic) by the fundamental harmonic wave.

The following curves represent the HGMM-35 Total Harmonic Distorsion Factor at frequency of 400 Hz and at frequency of 800 Hz.



3-3 Individual Current Harmonic Distorsion Characteristics

The individual current harmonic distorsion requirement is a very specific requirement defining for each harmonic row, the maximum admissible current in all functioning conditions.

This requirement induced the Total Harmonic Distorsion Factor (THD) defined above.

These requirements are defined by the aircraft manufacturers in proprietary (and confidential) standards.

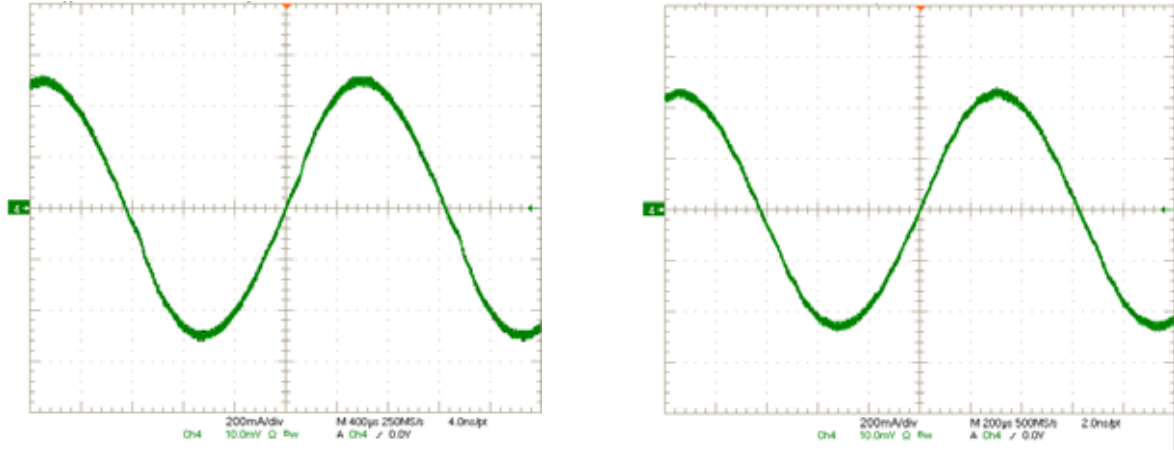
GAIA Converter HGMM series comply with individual current harmonic distorsion requirements of :

- AIRBUS ABD100 section 1.8 with specific limits on :
 - odd non triplen and odd triplen harmonics
 - even 2 & 4 and other even harmonics
- BOEING D6-44588 with specific limits on
 - odd non triplen and odd triplen harmonics
 - even harmonics

3- Electrical Characteristics (continued)

3-4 Anharmonic Input Current

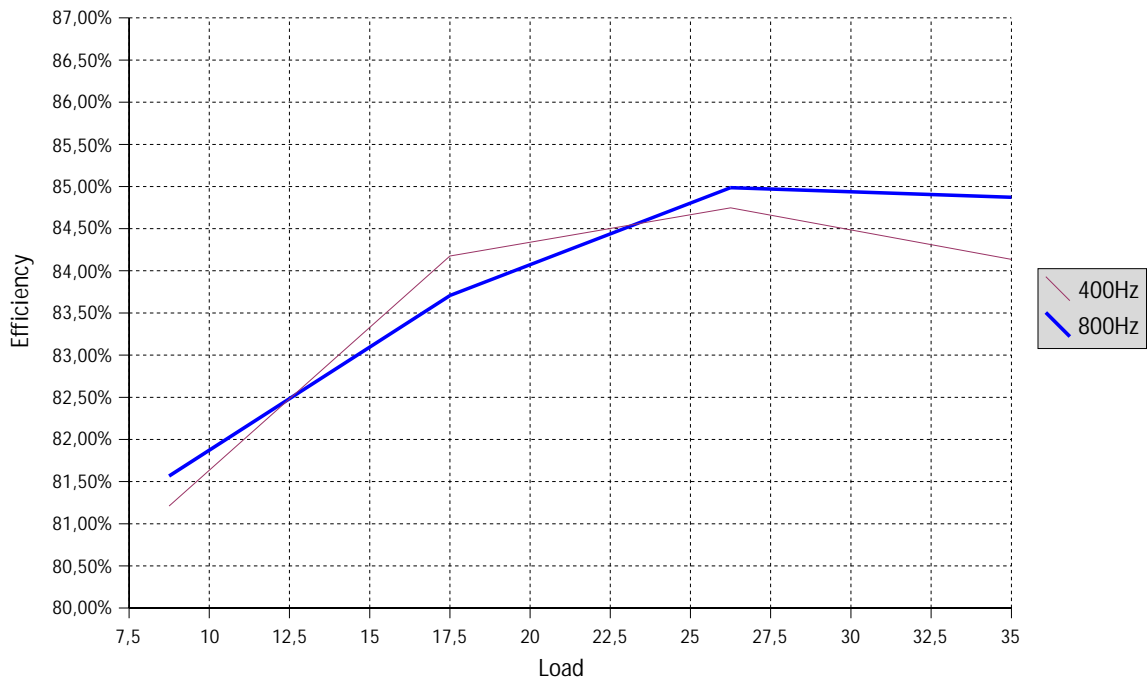
The anharmonic input current of the HGMM-35 series is given hereafter for 400 Hz and 800 Hz at 35W power.



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3-5 Efficiency

The efficiency of the HGMM-35 series is given hereafter for 400 Hz and 800 Hz at various load conditions.



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 | 160 KHz |

5- Isolation

| Parameter | Conditions | Limit or typical | Specifications |
|--------------------------------|-----------------|------------------|-------------------|
| Electric strength test voltage | Input to output | Minimum | 1.500 VAC / 1 min |
| | Input to case | Minimum | 1.500 VAC / 1 min |
| | Output to case | Minimum | 1.500 VAC / 1 min |
| Isolation resistance | 500 VDC | Minimum | 100 MOhm |

6- Protection Functions

| Characteristics | Protection Device | Recovery | Limit or typical | Specifications |
|---------------------------------------|-------------------------------------|--------------------|------------------|----------------|
| Output short circuit protection (SCP) | Hiccup circuitry with auto-recovery | Automatic recovery | Permanent | See section 11 |
| Output overvoltage protection (OVP) | Zener clamp | / | Maximum | 20 VDC |

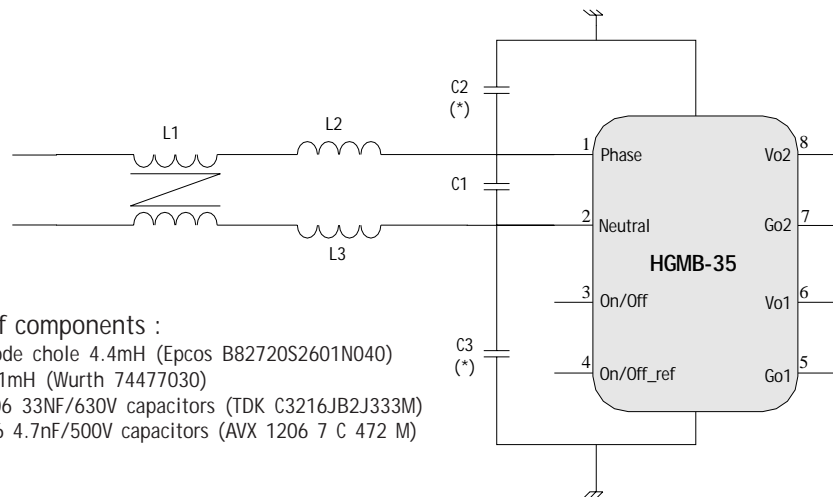
7- Reliability Data

| 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 | 730.000 Hrs 230.000 Hrs |
| | Airborne, Inhabited, Cargo (AIC) | Case at 40°C Case at 85°C | 415.000 Hrs 145.000 Hrs |
| Mean Time Between Failure (MTBF) According to IEC-62380-TR | Avionics Military Cargo | / | Consult factory |

8- Electromagnetic Interference

Electromagnetic interference requirements according to DO-160D or MIL-STD-461D/E can be easily achieved as indicated in the following table with the use of an additional external filter as described hereafter.

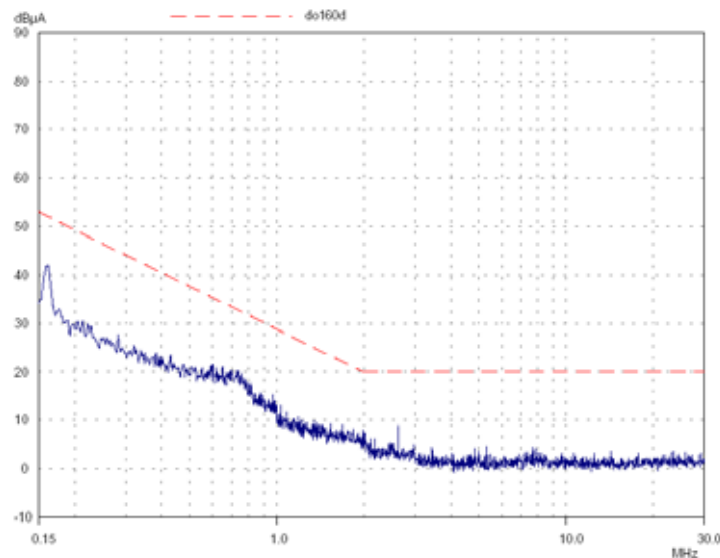
| Standards | DO-160D | MIL-STD-461E | Compliance |
|---|------------|------------------|--|
| Conducted emission (CE) : Low frequency High frequency | Section 21 | CE 101 CE 102 | compliant module stand alone compliant with additional filter |
| Conducted susceptibility (CS) : low frequency High frequency | Section 20 | CS 101 CS114 | compliant with additional filter compliant with additional filter |
| Radiated emission (RE) : Magnetic field Electrical field | Section 21 | RE 101 RE 102 | compliant module stand alone compliant module stand alone |
| Radiated susceptibility (RS) : Magnetic field Electrical field | Section 20 | RS 101 RS 013 | compliant module stand alone compliant module stand alone |



Recommended list of components :

- L1 : Common mode chole 4.4mH (Epcos B82720S2601N040)
- L2, L3 ... : Inductance 1mH (Würth 74477030)
- C1 : Ceramic 1206 33NF/630V capacitors (TDK C3216JB2J333M)
- C2, C3 ... : Ceramic 1206 4.7nF/500V capacitors (AVX 1206 7 C 472 M)

Fig : DO-160D Conducted Noise Emission



9- Thermal Characteristics

| Characteristics | Conditions | Limit or typical | Performances |
|-------------------------------------|--|--------------------|-------------------|
| Operating ambient temperature range | Ambient temperature * | Minimum Maximum | - 40°C + 85°C |
| Operating case temperature range | Case temperature | Minimum Maximum | - 40°C + 105°C |
| Storage temperature range | Non functioning | Minimum Maximum | - 55°C + 125°C |
| Thermal resistance | Rth case to ambient in free air natural convection | Typical | 6°C/W |

Note * : The upper temperature range depends on configuration, the user must assure a max. case temperature of + 105°C.

The HGMM-35 series operating **case** temperature must not exceed 105°C. The maximum **ambient** temperature admissible for the 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 Pdiss that should be evacuated :

$$Pdiss = Pout(1/\eta - 1)$$

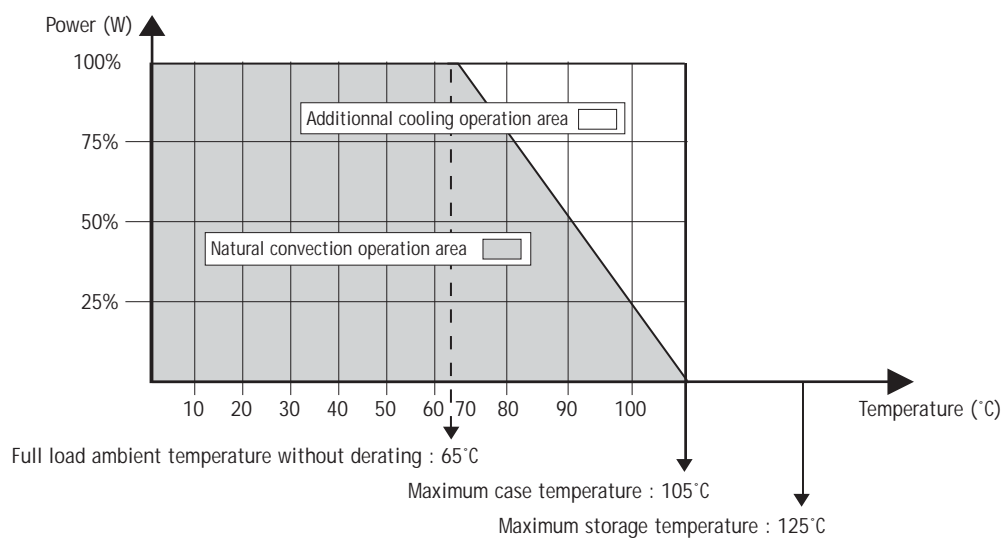
- determine the maximum ambient temperature :

$$Ta = 105^\circ\text{C} - Rth \times Pdiss$$

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



10- Environmental Qualifications

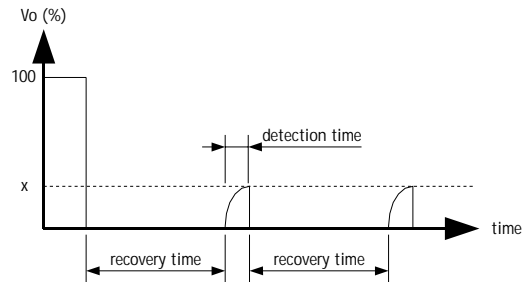
The modules have been subjected to the following environmental qualifications.

| Characteristics | Conditions | Severity | Test procedure |
|----------------------------------|---|---|------------------------------|
| Climatic Qualifications | | | |
| Life at high temperature | Duration Temperature / status of unit | 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 |

11- Description of Protections

11-1 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 1s recovery time). The overload detection threshold is typically 200% of maximum current with a detection time lower than 5ms.



11-2 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- Description of Functions

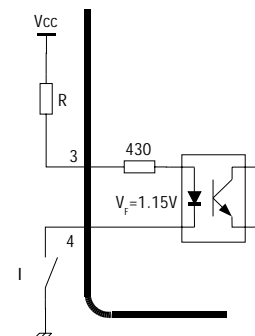
12-1 On/Off Function

The On/Off function is performed with an internal optocoupler.

It is driven through pins 3 and 4 :

- When the switch is open, the module is turned on
- When the switch is closed the module is turned off.

| Parameter | Unit | Min. | Typ. | Max. | Notes, conditions |
|-------------------------------|------|------|------|------|-------------------|
| On/Off module enable current | μA | / | / | 200 | |
| On/Off module disable current | mA | 2.5 | / | 20 | |
| On/Off module enable delay | Vdc | / | / | / | See start-up time |
| On/Off module disable delay | μs | / | / | 100 | Vin, full load |



13- Application Notes

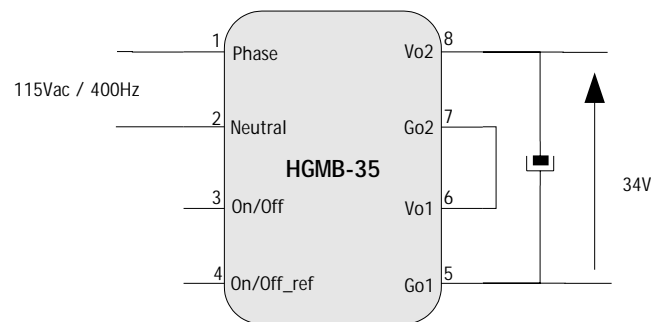
The HGMM-35 series can be connected in two ways :

- connection in parallel
- connection in series

In addition, the HGMM-35 series has to be used in conjunction with an external hold-up capacitance across the outputs to keep a good power factor and to limit the output voltage ripple. This hold-up capacitance is also used to achieve a transparency time > 50ms.

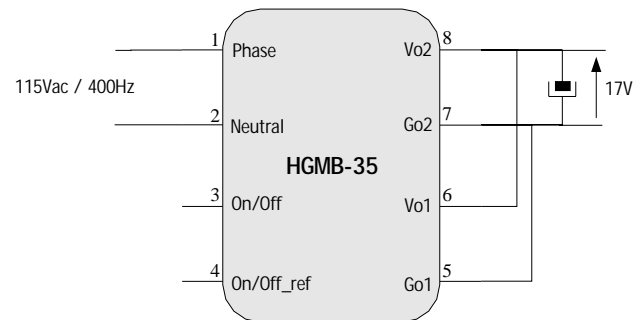
13-1 Connection of Outputs in Series to Achieve 34Vdc Output Voltage

The connection in series of both 17 Vdc outputs provides 34Vdc output voltage (at 35W power). With a connection in series, the HGMM-35 has to be used with any of GAIA Converter J inputs 16-40 Vdc to get an optimum voltage variation between 16 Vdc and 34 Vdc to minimize the size of the hold-up capacitance. Typical value of the hold-up capacitance is ranging from 2.200 μ F (minimum value to optimize output voltage ripple) up to 6.800 μ F to obtain 50 ms transparency time.



13-2 Connection of Outputs in Parallel to Achieve 17Vdc Output Voltage

The connection in parallel of both 17 Vdc outputs provides 17Vdc output voltage (at 35W power). With a connection in parallel, the HGMM-35 has to be used with any of GAIA Converter H inputs 9-36 Vdc to get an optimum voltage variation between 9 Vdc and 17 Vdc to minimize the size of the hold-up capacitance. Typical value of the hold-up capacitance is ranging from 8.800 μ F (minimum value to optimize output voltage ripple) up to 27.000 μ F to obtain 50 ms transparency time.



13- Application Notes (continued)

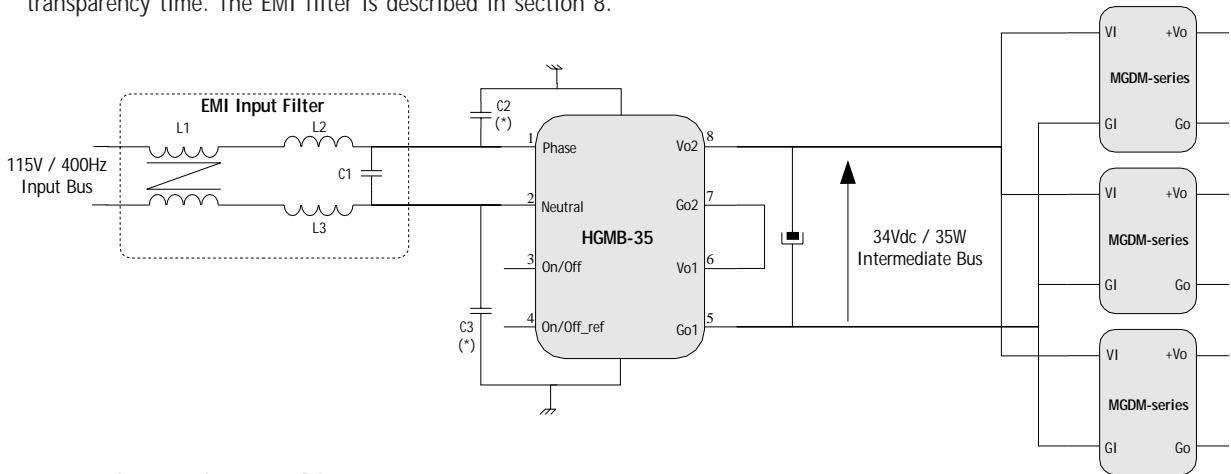
13-3 Using HGMM-35 Series for up to 70W Power Requiring Anharmonic Input Current

The HGMM-35 series can be used in 2 ways :

- single module connection to achieve 35W power
- double module connection to achieve 70W power

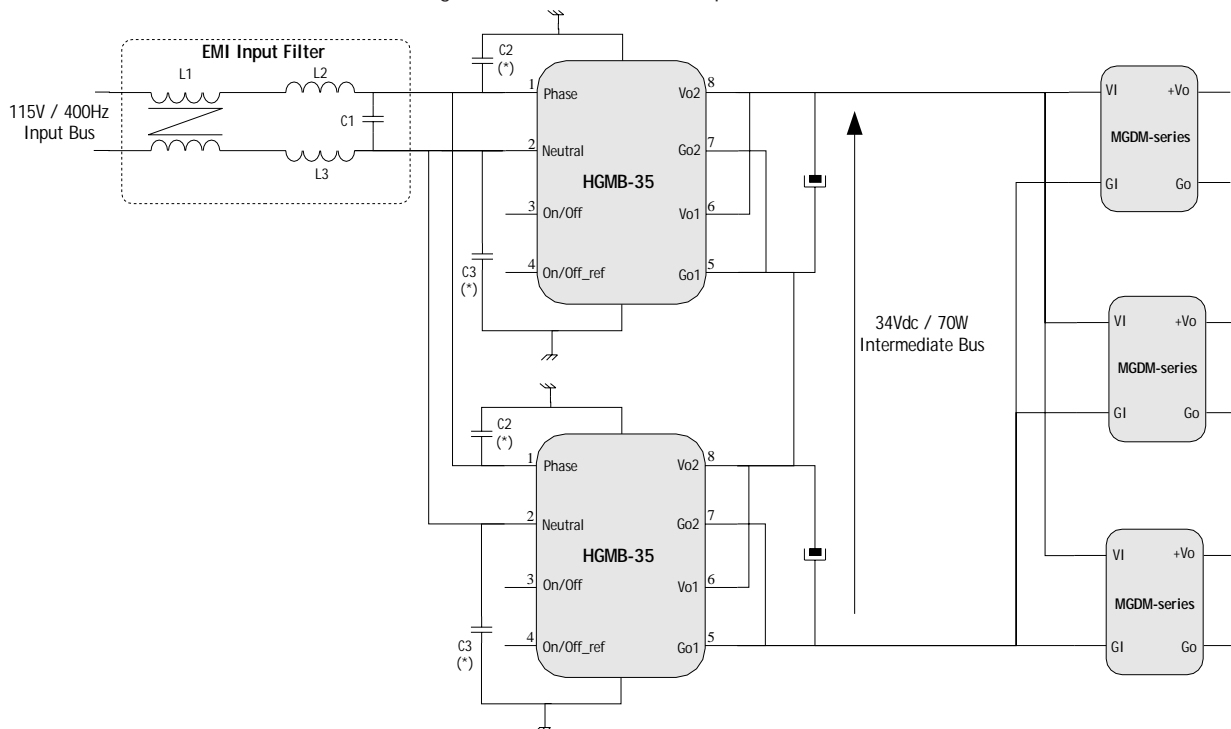
13-3-1 Connection to achieve 35W power

The connection in series of both 17 Vdc outputs of a single HGMM-35 allows a 35W power on a 34 Vdc intermediate bus output voltage. With a connection in series, the HGMM-35 has to be used with any of GAIA Converter J inputs (i.e 16-40 Vdc) to get an optimum voltage variation between 16 Vdc and 34 Vdc to minimize the size of the hold-up capacitance. Typical value of the hold-up capacitance is ranging from 2.200µF (minimum value to optimize output voltage ripple) up to 6.800 µF to obtain 50 ms transparency time. The EMI filter is described in section 8.



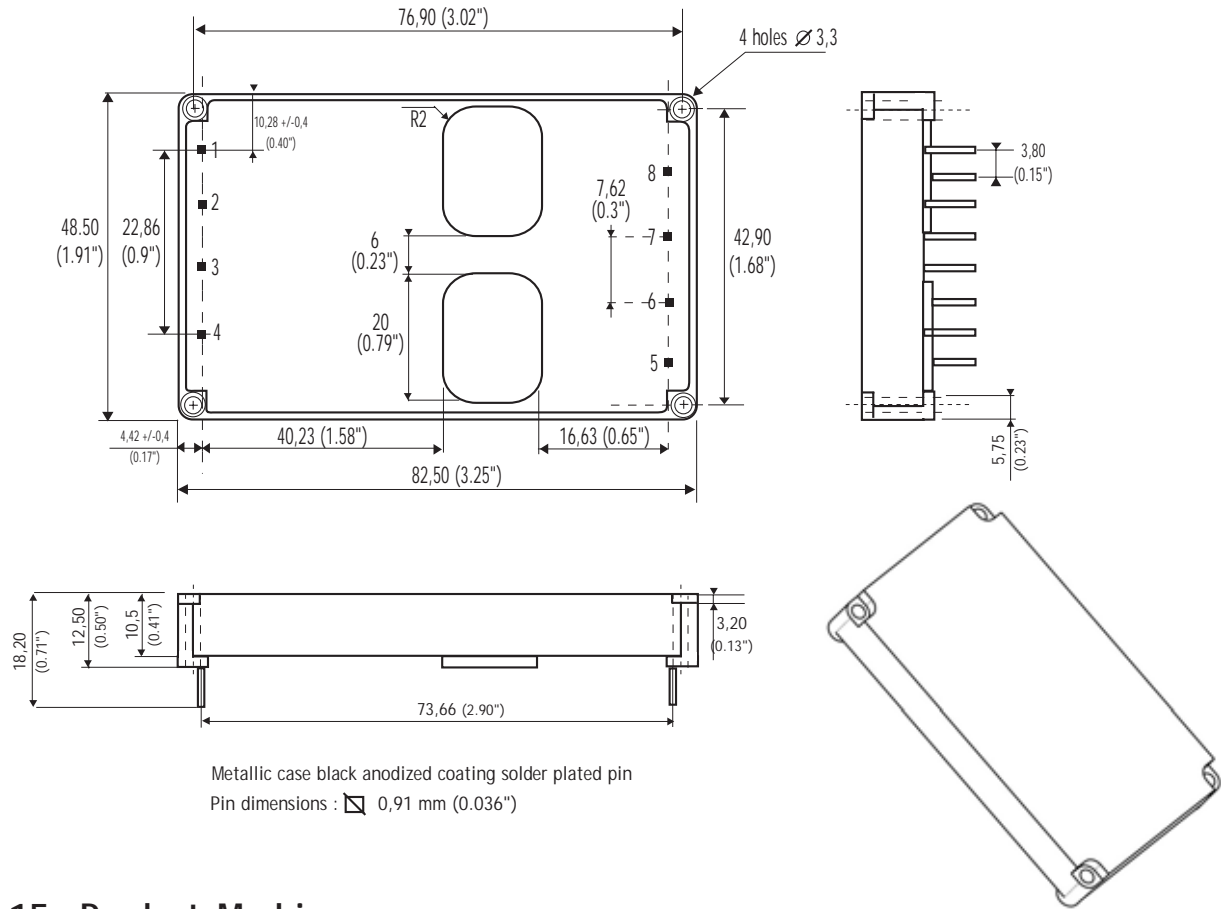
13-3-2 Connection to achieve 70W power

The connection in series of both 17 Vdc outputs of a each HGMM-35 module allows a 70W power on a 34 Vdc intermediate bus output voltage. With a connection in series, the HGMM-35 has to be used with any of GAIA Converter J inputs (i.e 16-40 Vdc) to get an optimum voltage variation between 16 Vdc and 34 Vdc to minimize the size of the hold-up capacitances. Typical value of the 2 hold-up capacitances have to be determined according to section 13-2 paragraph «Connection in Parallel to achieve 17Vdc output voltage». The EMI filter structure is the same as for a single module connection (see section 8), the three inductances have to be rated twice the current value as for a single module solution, the capacitor C1 is doubled, C2 and C3 remain the same.



14- Dimensions

Dimension are given in mm (inches). Tolerance : +/- 0,2 mm (+/- 0.01 ") unless otherwise indicated.
Weight : 80 grams (2.80 Ozs) max.

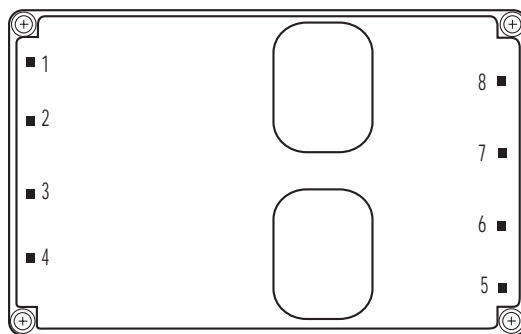


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15- Product Marking

Upper face : Company logo, module reference and pin-out recognition marks.
Side face : Date code : year and week of manufacturing.

16- Connections



| Pin | Bi-output |
|-----|----------------|
| 1 | Phase |
| 2 | Neutral |
| 3 | On/Off |
| 4 | On/Off ref. |
| 5 | Common 1 (G01) |
| 6 | Output 1 (V01) |
| 7 | Common 2 (G02) |
| 8 | Output 2 (V02) |



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