Using Modular DC/DC Converter for Industrial/Electricity Related Applications

1- General

1-1 Introduction

This application note underlines the different requirements in electronic systems used in Electrical Power Plant, High Voltage Substations, Telecontrol Centers or Low Voltage Distribution Controls.

Electronic systems in such applications are subjected to harsh environment constraints from electrical, electromagnetic interference and susceptibility up to isolation areas.

Those constraints are described in various standards developed by :

- International Standardization Bodies (IEC, ...),
- National Standardization Authorities : (BSI : British Electrotechnical Committee, DKE: Deutsche Elektro. Kommission, CEI : Comitato Electronico Committee, ..),
- or even Company standardization department like Electricity of France (EDF), French Railways (SNCF)....

Those standards can be divided into three general categories :

- Basic Publications
- Generic Standards
- Specific Standards

Basic publications specify the general and fundamental rules, conditions, measurements to the environment disturbing phenomena. Basic publications are not dedicated to product, type of applications or market area.

Generic standards specify requirements and levels to be achieved by the equipment or systems in a general market area (residential area, industrial area,...).

Specific standards specify requirements and levels for specific products or systems.

This application note refers to some of these applicable standards.

The following areas of constraints describe in this application note are as follow :

- Input requirements, including permanent range, transient, spikes and surges, dips and interruptions,
- Electromagnetic compatibility requirements, both for emission, susceptibility in conducted and radiated mode,
- Isolation requirement.

For each point GAIA Converter compares the different requirements with the actual performance of the modules and details the different solutions to fulfil the specifications.

2- Compliance with Input Bus Requirements

Electronic systems used in industrial/electricity related applications shall sustain wide input excursions both for permanent operations, voltage dips and interruption, transient and spikes operations.

Those requirements are described in different standards such as :

- Basic Publications
  - EN60038, amend 2 : "IEC standard voltages".
  - EN50082-2: "Generic Immunity Standards for Industrial Environment".
  - EN61204 : "Low voltage power supply, DC output".
  - EN 61000-4-5 : "Immunity Standard - Surge Immunity".
  - EN 61000-4-29 : "Immunity Standard - Voltage Dips, Short Interruptions and Voltage Variations on DC input power port Immunity Tests".

- Specific standards
  - HN-46-R01 : "General guidelines for the design and manufacturing of control, protection and telecommunication equipment for electrical network".

  - IEC60870-2-1 : "Telecontrol equipment and systems Part 2 : Operating condition Sect. 1 Power supply and electromagnetic compatibility".

As a resume, there are 4 main requirements to sustain :
- The permanent input voltage range,
- The transient range,
- The spikes excursion,
- The voltage dips and interruption.

The permanent input range requirements are commonly achieved by the majority of standard DC/DC converters.

The transients requirements are more aggressive and achieved by dedicated wide input range DC/DC converters.

The spikes excursion is very aggressive and necessitate external active filters to protect the DC/DC converters.

The voltage dips or brown-out requirements can be achieved by using DC/DC converter with wide input range capabilities.

The voltage interruption requirements are achieved by the adjunction of external «hold-up» capacitance.

Description of the different levels and proposed solutions are resumed in the following sections.

2-1 Permanent, Transients and Voltage Dips Requirements

The table hereafter specifies for each nominal input voltage (Vin) provided directly from power source, the permanent input excursion, and the abnormal variation.
Abnormal variations described hereafter are transient or dips. Surges or interruptions are described in the following section.

	EN5082-2		HN-46-R01		IEC60870-2-1 Class D4	GAÏA Converter modules
Nominal input	Permanent input range	Voltage dips 100ms	Transient	Voltage Dips		Transient
12 V	9,6-14,4 V	4,8 V	/	/		/
24 V	19,2-28,8 V	9,6 V	/	/		36V/permanent
48 V	38,4-57,6 V	19,2 V	68V/10ms	28V/10ms		75V/permanent 175V/100ms
110 V	88-132 V	44 V	/	/		175V/100ms
125 V	100-150 V	50 V	165V/10ms	85V/10ms		175V/100ms
250 V	200-300 V	100 V	/	/		/

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2-2 Surges Requirements (see section 3-6)

2-2-1 General

Surges are short term high transient voltage on the input bus that are mainly generated by lightning strokes, arcing faults, load changing or short circuits.
A surge may be of either polarity. The effective value of the source impedance will depend upon the manner of its generation but will in many circumstances be very low and energetic.
Industrial/Electricity related electronic equipment shall be protected from surges such that no damage or failure occurs during operations.
The magnitude, duration and source impedance of these surges for design purposes are defined in the international standard IEC-801-5 renamed EN61000-4-5 and HN46-R01 as follow :

- EN61000-4-5 : «Electromagnetic, compatibility, Immunity Standard - Surge Immunity".

- HN-46-R01 : "General guidelines for thedesign and manufacturing of control, protection and Telecommunication equipement for electrical network".

The standard EN61000-4-5 specifies that the input voltage supply shall be present.
The HN-46R01 specifies that no input voltage supply shall be present during the test.

2-2-2 EN61000-4-5 Standard

This standard specifies two different surge wave forms :
- one with a rise time of 1.2µs and a time to half value of 50µs
- the other with a rise time of 10µs and a time to half value of 700µs.

The source impedance for the 1.2/50µs is 2 Ohm for line to line coupling and 12 Ohm for line to earth coupling. The 10/700µs surge impedance is 42 Ohm both for line to line coupling and line to earth coupling.
Coupling for both waveforms is performed via a coupling/decoupling network with coupling capacitors of 0.1, 0.5, 9 or 18 µF, or with arrestors, depending on the kind of lines to be tested.The following levels are applied :

Test level	Open circuit test voltage KV	Impedance
1	0.5 KV	2W or 12W
2	1 KV	2W or 12W
3	2 KV	2W or 12W
4	4 KV	2W or 12W

2-2-2 HN-46-R01 Standard

This standard specifies a surge wave forms with a rise time of 5µs and a time to half value of 50µs. The source impedance is 500W and the following levels applied depending of the class of equipement.

Class	Level line earth	Level line to line	Impedance
A1	8 KV	8 KV	500W
A2	5 KV	5 KV	500W
B	5 KV	5 KV	500W
C1	5 KV	5 KV	500W
C2	3 KV	3 KV	500W
D	1 KV	1 KV	500W
E	0.5 KV	0.5 KV	500W

2-3 Voltage Dips and Interruption (see section 3-11)

Industrial/Electricity related electronic equipment shall be protected from interruption caused by fault in the network or installation.
The duration of dips or interruption to provide safety back up is described for design purpose in the international EN61000-4-29. The most commonly used levels are :
- Voltage dips ; 70% of nominal input Voltage
- Voltage interruption : 0 VDC

Duration are indicated in the following table.
The typical duration is 20ms, but this one should be specified for each application.

	Voltage Dips 70% of nominal input Voltage
5 ms	5 ms
10 ms	10 ms
20 ms	20 ms
50 ms	50 ms

To provide safety back-up, the use of additional external capacitance allows to store the energy and re-route it in case of input voltage interruption.
The capacitance value has to be calculated depending on output voltage, power ...

3- Compliance with Electromagnetic Interference Requirements

3-1 General

Electromagnetic interferences are divided into two classes :

- Electromagnetic emission
- Electromagnetic susceptibility

3-1-1 Electromagnetic Emissions

Electromagnetic emission is the phenomenon by which electromagnetic energy emanates from a source.
The electromagnetic emission is generated by the switching devices. These disturbances can couple to other components in the power supply, producing noise sources radiating over a broad frequency spectrum.
It is usual to measure disturbances at low frequencies (150 kHz up to approx. 30 MHz) as voltages between the supply lines and earth (conducted disturbances) and at higher frequencies (above approx. 30 MHz) as field strength or power (radiated disturbances).

3-1-2 Electromagnetic Susceptibility

Electromagnetic immunity is the ability of a device, equipment or system to perform without degradation in the presence of electromagnetic disturbances. Electromagnetic susceptibility is the inability to perform without degradation, i.e. susceptibility is the lack of immunity.
The aim of basic immunity standards is to provide test procedures and test levels to verify electromagnetic immunity. Both conducted and radiated phenomena are considered. The results of tests are classified in terms of the loss of function or degradation of performance of the equipment under test.

3-1-3 Standards and Publications

The aim of electromagnetic compatibility standards is to avoid or minimize the influence of electromagnetic phenomena on a device, equipment or system. To achieve this, methods of measurement and test, as well as limits and levels of electromagnetic emission and of electromagnetic immunity are defined in a large number of EMC publications.

- **Basic Publications**
  - EN55011 : Industrial, scientific and medical (ISM) radio-frequency equipment - Electromagnetic disturbance characteristics - Limits and methods of measurement.
  - EN55022 : Limits and methods of measurement of radio disturbance characteristics of information technology (IT) equipment.
  - EN61000-4 : Electromagnetic compatibility (EMC) Part 4 Testing and Measurement techniques.

- **Generic Standards**
  - EN50081-1 "Generic emission standard for residential, commercial and light-industrial environments".
  - EN50081-2 «Generic emission standard for industrial environment»
  - EN50082-1 «Generic immunity standard for residential, commercial and light-industrial environment»
  - EN50082-2 «Generic immunity standard for industrial environment»

- **Specific Standards**

There are also a lot of specific standards adapted per type of systems or application that defined more specific levels; in general the levels are those described in the Basic Publications EN55011,EN55022 and EN61000-4.
  - HN-46-R01 : "General guidelines for the design and manufacturing of control, protection and telecommunication equipement for electrical network".
  - IEC60870-2-1 : "Telecontrol equipment and systems Part 2 : Operating condition Sect. 1 Power supply and electromagnetic compatibility".
  - IEC60834-1 : "Teleprotection equipment of power systems Part 1 : Command system".
  - IEC60255-6 : "Electrical relays and protection equipment".

The section 3-2 resume the levels to achieve in the Generic Standards.

3-2 Compliance with Generic Standards

The following table resumes the different levels for both electromagnetic emission and electromagnetic susceptibility defined in the **EN50081-1/2 and EN500082-1/2 Generic Standards** together with GAÏA Converter DC modules compliance. The module compliance have to be considered module stand-alone with no external additional components unless otherwise specified.

Table 1 : Generic EMC Emission Standards (only parts relevant to DC/DC Converter)

	EN 50081-1 : **Electromagnetic compatibility - Generic standards - Emission standard for residential, commercial and light-industrial environments**		EN 50081-2 : **Electromagnetic compatibility - Generic standards - Emission standard for industrial environments**		**Stand-alone GAÏA Converter modules performance unless otherwise specified**
	Referenced basic publication	Frequency range and required limit	Referenced basic publication	Frequency range and required limit	
Emission	EN 55022	Signal and DC input 0.15...30 MHz, Curve class B	EN 55011	Signal and DC input 0.15...30 MHz, Curve class A	class A with external filter (see section 3-3)
		Envelope 30...1000 MHz,Curve class B		Envelope 30...1000 MHz, Curve class A	class B with external filter KG9502

Table 2 : Generic EMC Immunity Standards (only parts relevant to DC/DC Converter)

Referenced basic standards	**Port**	**Requirements of Generic Standard EN 50082-1 : Electromagnetic compatibility-Generic standards- Immunity standard for : residential, commercial and light-industrial environments**	**Requirements of Generic Standard EN 50082-2 : Electromagnetic compatibility -Generic standards- Immunity standard for : industrial environments**	**Criteria**	**Stand-alone GAIA Converter modules performance unless otherwise specified**
EN 61000-4-2 : Electrostatic discharge	Enclosure (case)	±4 kV contact discharge	±4 kV contact discharge	B	criteria B
		±8 kV air discharge	±8 kV air discharge		
EN 61000-4-3 ENV 50204 : Electromagnetic field	Enclosure (case)	3 V/m, 80... 1000MHz, AM 80%, 1kHz,	10 V/m, 900MHz, 200Hz,	A	10 V/m : criteria A
EN 61000-4-4 : Fast transients burst	DC Input and output	±0.5 kV, 5 kHz, direct injection	±2 kV, 5 kHz, direct injection	B	0.5 kV : criteria A 2kV : criteria B
EN 61000-4-5 : Surges	DC Input and output	±0.5 kV line to earth, ±0.5 kV line to line,	±0.5 kV line to earth, ±0.5 kV line to line,	B	0,5 kV : criteria B
EN 61000-4-6 : Common mode conducted disturbances	DC Input and output	3V, 0.15...80 MHz, AM 80%, 1kHz	10V, 0.15...80 MHz, AM 80%, 1kHz	A	10 V : criteria A
EN 61000-4-8 Power frequency magnetic field immunity	Enclosure	No relevant to power supply 3A/m, 50 Hz	No relevant to power supply 30A/m, 50 Hz	A	/
En 61000-4-12 oscillatory waves	Enclosure	Not applicable	Applicable in HN-46-R01 2,5 kV common 1 kV differential	A	2,5 kV : criteria A 1 kV : criteria A
EN 61000-4-9 : Pulse magnetic field	DC input and output	Not applicable (only in electrical power plants)	Not applicable (only in electrical power plants)	/	/
EN 61000-4-10 : Damped oscillatory magnetic field	DC input and output	Not applicable (only in high voltage substations)	Not applicable (only in high voltage substations)	/	/
EN 61000-4-29 : Voltage dips and interruption	DC input	Voltage dips : different levels 40% or 70% of Unom during 10 ms, 20 ms, 50 ms, ..	Voltage dips : different levels 40% or 70% of Unom during 10 ms, 20 ms, 50 ms, ...	A	Hold-up capacitance criteria A
		Voltage interruption : 0V during 10 ms, 20 ms, 50 ms, ...	Voltage interruption : 0V during 10 ms, 20 ms, 50 ms, ...	A	Hold-up capacitance criteria A

Performance Criteria

A Normal performance within limits specified by the manufacturer.
B Temporary loss of function or degradation of performance which ceases after the disturbance ceases.
C Temporary loss of function or degradation of performance, the correction of which requires operator intervention or system reset.
D Loss of function or degradation of performance which is not recoverable, due to damage of hardware or software or loss of data.

3-3 GAIA Converter Recommended Schematics

To sustain these different levels , GAIA Converter recommend the following schematics.
This schematics is derivated from the GAIA Converter KG9503 filter (see datasheet KG9503) with the following changes :

- only one transil diode to sustain the different spike levels (instead of 4 proposed in KG9503)
- Additionnal hold up capacitance to comply with voltage interruption : value depend on hold up time
- No fuse
- Additionnal capacitance C3=1nF and C4=1nF

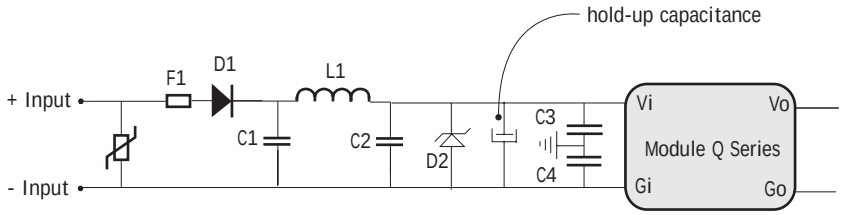

Table 1 : EMC Emission Standards

Emission	Standard	Requirements of HN-46-R01	Levels achieved with GAÏA Converter modules and filter
Conducted	EN 55022	Signal and DC input 0.15...30 MHz, Curve class A	class A
Radiated	EN55022	at 10 m 30...1000 MHz, Curve class A	Class A

Table 2 : EMC Immunity Standards

Referenced Basic standard	Port	Requirements of HN-46-R01	Performance criteria	Levels achieved with GAIA Converter modules and filter
EN 61000-4-2 : Electrostatic discharge	enclosure (case)	±4 kV contact discharge ±8 kV air discharge	B	Qualified : 4KV criteria A Qualified : 8KV
EN 61000-4-3 ENV 50204 : Electromagnetic field	Enclosure (case)	10 V/m, 900MHz, 200Hz,	A	Qualified : 10 V/m criteria A
EN 61000-4-4 : Fast transients burst	DC Input and output	4 kV, 2,5 kHz, direct injection	A	Qualified : 4 kV criteria A
EN 61000-4-5 : Surges 1,2µs/50µs power on	DC Input and output	2 kV common mode, 1 kV differential mode,	B	Qualified : 2 KV criteria A Qualified : 1 KV criteria A
HN-46-R01-6 Surges 1,2/50µs power off	DC input	5 kVAC under 500 Ohm common mode 3 kv under 500 Ohm differential mode	A	Qualified : 5KV criteria A Qualified : 3KV criteria A
EN 61000-4-6 : Common mode conducted disturbances	DC Input and output	10V, 0.15...80 MHz, AM 80%, 1kHz	A	Qualified : 10V criteria A
En 61000-4-12 oscillatory waves	Enclosure	2,5KV common mode 1 KV differential mode	A A	Qualified : 2,5KV criteria A Qualified : 1 KV criteria A
EN 61000-4-29 : Voltage dips and interruption	DC input	Voltage interruption : 0V during 20 ms	/	External hold-up capacitance, criteria A

Performance Criteria

A Normal performance within limits specified by the manufacturer.
B Temporary loss of function or degradation of performance which ceases after the disturbance ceases.

4- Basic Publications : Electromagnetic Susceptibility Levels

This section resumes the different levels of susceptibility described in the Basic Publication EN61000-4.

4-1 EN 61000-4-2 : Electrostatic discharge (ESD)

Static electricity discharges is present in environments with low relative humidity, using low-conductivity such as carpets, fibers, etc...
This standard specifies requirements and tests for the immunity of electrical or electronic equipment which are subject to electrostatic discharge.
The discharge shall either be applied in direct contact or over a short air distance to parts of the device under test which can be touched by persons during normal use.
The following levels are applied :

Contact discharge			Air discharge		
Test level	Test voltage kV	Peak current A	Test level	Test voltage kV	Peak current A
1	2	7.5	1	2	
2	4	15	2	4	7.5
3	6	22.5	3	8	15
4	8	30	4	15	30
x	special		x	special	56

4-2 EN 61000-4-3 : Radiated, radio-frequency, electromagnetic field

Most electronic equipment is affected by electromagnetic radiation which is generated by hand-held radio transceivers, fixed-station radio transmitters and various industrial electromagnetic sources.
The radiated immunity test is applicable to all products, where radio frequency fields are present.
The test is performed by applying an electromagnetic far field of defined strength while varying the frequency in the range 80...1000 MHz. The table gives the field strength of the unmodulated signal. For testing, this signal is 80% amplitude modulated with a 1 kHz sine wave.

Test level	Test field strength V/m
1	1
2	3
3	10
x	special

4-3 EN 61000-4-4 : Electrical fast transient

The fast transients test is applicable to products which are connected to AC or DC power systems. It is intended to demonstrate immunity to transient disturbances such as those originating from switching transients (interruption of inductive loads, relay contact bounce, etc...).

The waveform of a single transient is characterized by a rise time of 5 ns, a time to half-value of 50 ns and a maximum energy of 4 mJ at 2 kV into a 50 Ohm load. The impedance of the transient source is 50 Ohm. The repetition frequency of the transients is a function of the test level. Burst duration is 15 ms and burst period 300 ms. Coupling is performed via a coupling/decoupling network with coupling capacitors of 33 nF for power supply ports and via a capacitive coupling clamp with a capacitance of 50...200 pF for signal, data and control ports.

Test level	On AC and DC power supply ports		On signal, data and control ports	
	Open-circuit peak voltage kV	Repetition frequency kHz	Open-circuit peak voltage kV	Repetition frequency kHz
1	0.5	5	0.25	5
2	1	5	0.5	5
3	2	5	1	5
4	4	2.5	2	5
x	special	special	special	special

4-4 EN 61000-4-5 : Surge

Surges are mainly generated by switching transients or by lightning strokes injecting high currents producing voltages or inducing high voltages/currents via electromagnetic fields. Switching transients can be generated by power system switching, load changes, short circuits or arcing faults to the earthing system of the installation. The standard specifies two different open-circuit surge waveforms : One with a rise time of 1.2 µs and a time to half-value of 50 µs, and the other with a rise time of 10 µs and a time to half-value of 700 µs. The source impedance for the 1.2/50 µs surge, is 2 Ohm for line to line coupling and 12 Ohm for line to earth coupling. The 10/700 µs surge impedance is 42 Ohm.

Coupling for both waveforms is performed via a coupling/decoupling network with coupling capacitors of 0.1, 0.5, 9 or 18 µF, or with arrestors, depending on the kind of lines to be tested.

Test level	Open circuit test voltage kV
1	0.5
2	1
3	2
4	4
x	special

4-5 EN 61000-4-6 : Conducted disturbances, induced by radio-frequency fields

The source of conducted disturbance is basically an electromagnetic field, emamating from RF transmitters, that may act on the whole length of cables connected to installed equipment.
The conducted immunity test is applicable to products operating in environments where radio frequency fields are present and which are connected to mains supplies or other networks (signal or control lines).
The test is performed by applying a voltage of a defined value to the port to be tested while varying the frequency in the range 150 kHz...80 MHz. The signal is 80% amplitude modulated with a 1 kHz sine wave. The table gives the field strength of the unmodulated signal. The impedance of the test generator is 50 Ohm. The waveform is coupled to each of the n lines of the port to be tested (common mode) via a coupling/decoupling device with an impedance of 100 Ohm per line or via an injection clamp.

Test level	Open circuit test voltage (ms)	
	V	dB (µV)
1	1	120
2	3	130
3	10	140
x	special	special

4-6 EN 61000-4-9 : Pulse magnetic field

Pulse magnetic fields are generated by lightning strokes on buildings and metal structures including aerial masts, earth conductors and earth networks and by initial fault transients in low voltage, medium voltage and high voltage systems.
This test is mainly applicable to products to be installed in electrical power plants (e.g. telecontrol centres in close proximity to switchgear). It is not relevant for distribution network equipment.
The test is performed by applying 6.4/16 µs magnetic field pulses of defined strength to the equipment to be tested.

Test level	Pulse magnetic field strength A/m (peak)
1	not defined
2	not defined
3	100
4	300
5	1000
x	special

4-7 EN 61000-4-10 : Damped oscillatory magnetic field

The damped oscillatory magnetic field is generated by the switching of high voltage bus-bars by isolators.
This test is mainly applicable to products to be installed in high voltage substations.
The test is performed by applying damped oscillatory magnetic field (sinusoid waves) of defined strength to the equipment to be tested.

Waveform specification	Low frequency	High frequency
Oscillation frequency	0.1 MHz	0.1 MHz
Decay rate	50% of the peak value after 3 to 6 cycles	
Repetition rate	≥ 40Hz	≥ 400Hz
Test duration	2 s	2 s

Test level	Damped oscillatory magnetic field strength A/m (peak)
1	not defined
2	not defined
3	10
4	30
5	100
x	special

4-8 EN 61000-4-29 : Voltage dips, short interruptions and voltage variations

Voltage dips and short interruptions are caused by faults in the network or in installations or by a sudden large change of load. Voltage variations are caused by the continuously varying loads connected to the network.
The test for immunity to voltage dips and short interruptions is performed by an abrupt change of the supply voltage of the equipment under test.
Preferred test levels and duration for voltage dips and short interruptions :

	Test level as a % of nominal input	Duration
Voltage variation	80 120	100 ms 200 ms 500 ms 1 s 2 s 5 s
Voltage dips	40% 70% X	10 ms 20 ms 50 ms 100 ms 200 ms X
Voltage interruption	0	1 ms 2 ms 5 ms 10 ms 20 ms 50 ms 100 ms X

4-9 EN 61000-4-12 : Oscillatory waves immunity test.

This standard specifies tests to simulate two phenomena :
The ring wave (non-repetitive) appears at the terminals of equipment as a consequence of switching in power and control lines, as well as a consequence of lightning. The ring wave test is applicable to equipment connected to AC mains in certain countries (e.g. the mains network in the USA).
The damped oscillatory wave (repetitive) appears at theterminals of equipment as a consequence of switching with restricting of the arc.
The damped oscillatory wave test is applicable to equipment used in high voltage substations (static relays).
Coupling is performed via a coupling/decoupling network with coupling capacitors of 0.5, 3 or 10 µF, depending on the output impedance of the test generator.

Wave specification	Ring wave	Damped oscillatory wave
Open circuit peak voltage	250 to 4000 V	250 to 2500 V
Oscillation frequency	100 kHz	100 kHz and 1 MHz
Decay rate	60% of the preceding peak value	50% of the peak value between the third and sixth periods
Repetition rate	1 to 60 per minute	≥ 40 Hz for 100 kHz and ≥ 400 Hz for 1 MHz
Output impedance	12 Ohm, 30 Ohm and 200 Ohm	200 Ohm
Coupling mode	Common mode and differential mode	Common mode and differential mode
Test duration per port and coupling mode	≥ 5 positive and ≥ 5 negative transients	≥ 2s

	Ring wave voltage kV (peak)			
Test level	Common mode	Differential mode	Common mode	Differential mode
1	0.5	0.25	0.5	0.25
2	1	0.5	1	0.5
3	2	1	2	1
4	4	2	-	-
x	special	special	special	special

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5- Compliance with Dielectric Strength Voltage and Isolation Voltage Requirements

Basically DC/DC converter are isolated devices. The isolation is the electrical separation between the input and the output of a DC/DC converter by means of a transformer. The isolation is usually expressed in megohms.

To evaluate the efficacity of this isolation, voltages are applied; in general 2 voltages can be defined :

- The dielectric strength voltage
- The rated working isolation voltage

The dielectric strength voltage or dielectric breakdown voltage is defined as the minimum AC or DC voltage for a fixed time period which, when applied accross an isolation barrier of a power converter, can cause a direct short to the outputs or the case.
The dielectric strength voltage depends on DC/DC converter mechanical construction (distances, type of material, type of insulator, ...).
Exceeding a converter's dielectric strength voltage will permanently degrade performance.

The rated working isolation voltage is the maximum voltage that can be sustained accross the isolation barrier without causing stress to the isolation barrier. This rated working voltage is much lower than the isolation voltage and is virtually impossible to accurately test. To assess this matter, Internationnal Bodies (through the standard EN60950) defines a tabular form converting dielectric strength voltage to working rated voltage together with stringent conditions of clearance, physical separation, ..).

Guidelines, method tests and levels for isolation are described in many different standards among which :

- EN60950 : "Safety of information technology equipment, including electrical business equipment"

- HN-46-R01 : "General guidelines for the design and manufacturing of control, protection and Telecommunication equipment for electrical network".

- IEC60870-2-1 : "Telecontrol equipment and systems- Part 2 Operating conditions Section 1 Power supply and electromagnetic compatibility".

- EN60255-5 : "Electrical Relays- Part 5 Insulation".

- IEC61204 : "Low voltage power supplies- DC output -Part 7 Product Safety Standard"

Majority of these standards are specifing either a dielectric strengh voltage or an isolation voltage.

Theses voltage values are generally defined within 3 areas of applications :

- input to output
- input to case
- output to case

Values are defined during a specified application time in general 60 seconds.

	HN-46-R01			EN60870-2-1			EN60950			GAÏA Converter module performance
	Class	Input/Output levels	Input/Case levels	Class	Input/Output levels	Input/Case levels	Grade	Input/Output levels	Output/Case levels	
	Class A1 Class A2 Class B Class C1 Class C2 Class D Class E	2 KVrms 2 KVrms 2 KVrms 2 KVrms 1.5 KVrms 500 Vrms 500 Vrms	4 KVrms 2 KVrms 2 KVrms 2 KVrms 1.5 KVrms 500 Vrms 500 Vrms	Class VW1 Class VW2 Class VW3	0.5 KVrms 1 KVrms 2.5 KVrms	0.5 KVrms 1 KVrms 2.5 KVrms	Operational Basic, Supplementary Reinforced	1 KVrms 1 KVrms 2 KVrms	0.5 KVrms No test No test	Basic version : 1,5 KVdc /Y Version : 2 KVrms
	Time : 60 sec. Under isolation resistance : 100 Mw category 1 10 Mw category 2			Time : 60 sec. Under isolation resistance : 100 Mw			Time : 60 sec. Under isolation resistance : 100 Mw			Time : 60 sec. Under isolation resistance 100 Mw

Important Note : In certain standards, and in case of using EMI filter including capacitance connected between line and earth, instead of applying AC voltage for isolation an equivalent square root 2 time DC voltage can be applied.

For more detailed specifications and applications information, contact :

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