

## ARCAP-50



### ***Phase angle thyristor control module***

The ARCAP-50 is a universal phase angle control module. It enables to drive up to 2 thyristors and is suitable for all types of assemblies: rectifiers, power controllers or switch gates, one, two or three-phase. No configuration needed. The synchronization is automatically done on the input voltage of the converter. There is thus no need to set the phase difference or the tracking of the phase order.

- ✓ **High levels of insulation**
- ✓ **Network voltage from 48Vac to 400Vac**
- ✓ **Power supply from 12 to 24Vdc**
- ✓ **Progressive starting**
- ✓ **Up to 1A peak per output**
- ✓ **0-10V and 0-20mA control**



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## 1. GENERAL POINTS

The ARCAP-50 is a small sized potted module which can be fixed by means of two M5 screws onto an 80 mm centre-distance. It enables to drive up to two thyristors with a firing angle proportional to a 0-10V or 0-20mA setting. It can be supplied by a non-regulated direct voltage included between 12 and 24V.

Owing to its synchronisation system to the network it can be used directly on the AC inputs of 48Vac to 690Vac converters, thus suppressing any problem of rotation and/or of phase order.

The use of one to three ARCAP-50 modules makes it possible to cover, without any previous setting or configuration, the whole range of AC/DC and AC/AC converters, whether they are dual or all thyristors, one, two or three-phase.

The control command of the thyristors is carried out by a stream of highly radiant current pulses which enables to limit the thermal stress of the triggers as well as to suppress all breakdown risk and consequently the need for follower pulses.

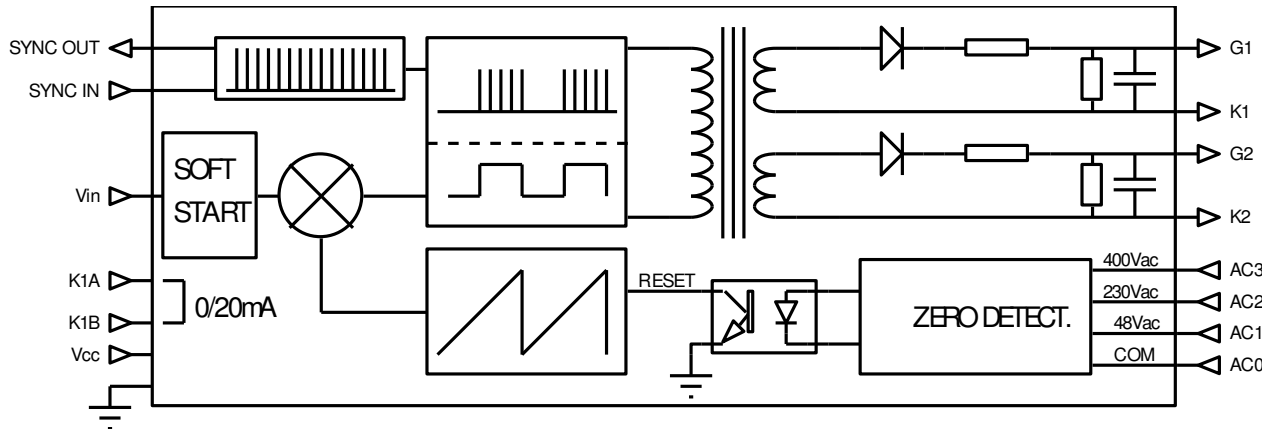
The insulation is ensured by a pulse transformer on the driver side and by a 5KVRMS optocoupler on the side of the network synchronization.

In addition the ARCAP-50 has a system of progressive starting and restarting which makes it compatible with the high capacitance continuous buses (soft load) or the wave train applications (heating for example). Once the launching phase is over, there won't be any delay between the instruction and the exits.

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## 2. SYNOPTICAL DIAGRAM



Outline 1 : Synoptic of the ARCAP-50

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### 3. ELECTRICAL SPECIFICATIONS

Unless otherwise specified, all data are given for 25°C.

#### 3.1. Maximum Specifications

Symbol	Parameter	Min.	Max.	Unit
VCC	Power supply (with reference to the exposed conductive part)	-0.5	25	VDC
VIN	Control input	0	VCC	VDC
IG	Peak trigger current per output	0	1.1	A
VG	Off-load trigger voltage	0	VCC	VDC
PG	Average power per output		2	W
VISO <sub>1</sub>	Insulation test voltage control/triggers <sup>i</sup>		3000	Veff
VISO <sub>2</sub>	Insulation test voltage control/AC inputs <sup>ii</sup>		5000	Veff
VAC <sub>1</sub>	Operating voltage on AC0-AC1 inputs		53	Veff
VAC <sub>2</sub>	Operating voltage on AC0-AC2 inputs		250	Veff
VAC <sub>3</sub>	Operating voltage on AC0-AC3 inputs		440	Veff
TA	Operating temperature	-20	+70	°C
TS	Storage temperature	-40	+85	°C

#### 3.2. Synchronization inputs to the network

Symbol	Parameter	Min.	Typ.	Max.	Unit
VAC	Rated power supply <sup>iii</sup>	48V input	48	53	Veff
		230V input	230	250	
		400V input	400	440	
RAC	Impedance input	48V input	12		KΩ
		230V input	36		
		400V input	72		
FAC	Synchronism frequency <sup>iv</sup>		50		Hz

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### 3.3. Control outputs of the thyristors

Symbol	Parameter	Min.	Typ.	Max.	Unit
V <sub>G</sub>	Off-load output voltage		V <sub>CC</sub>		V <sub>DC</sub>
I <sub>G</sub>	Peak current of trigger <sup>v, vi</sup>	0.55		1.1	A
T <sub>R</sub>	Current rising time (10-90%) <sup>v</sup>			2	μs
T <sub>F</sub>	Current downing time (10-90%) <sup>v</sup>			1	μs
F <sub>SW</sub>	Pulse repetition frequency <sup>vii</sup>		4		KHz
T <sub>sw</sub>	Pulse duration		25		μs

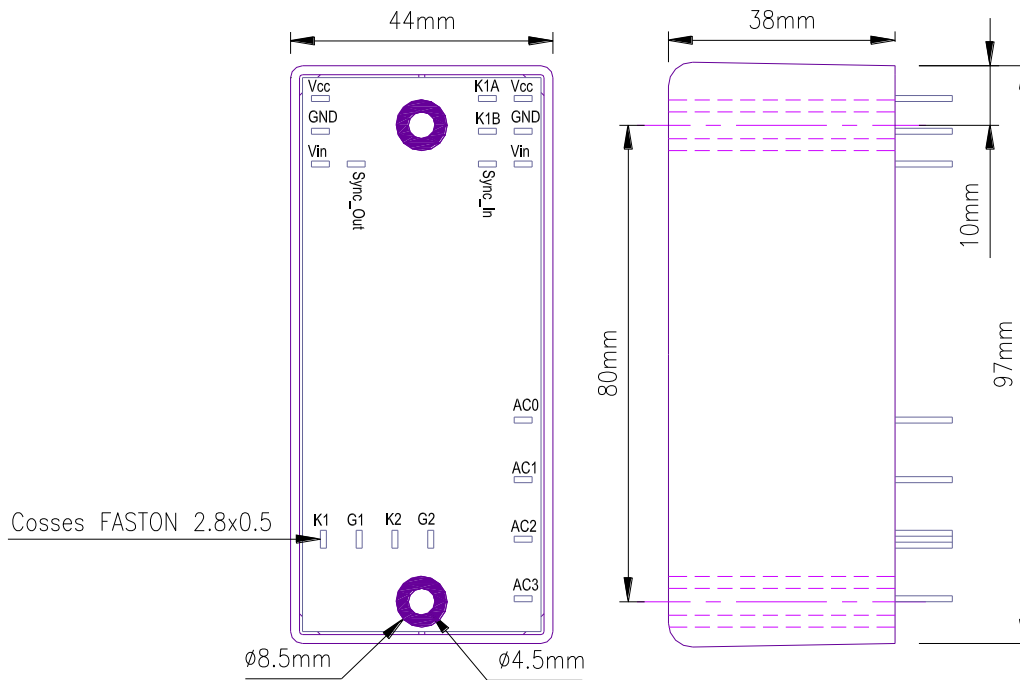
### 3.4. Control part

Symbol	Parameter	Min.	Typ.	Max.	Unit
V <sub>CC</sub>	Rated power supply <sup>viii</sup>	11.5		24.5	V <sub>DC</sub>
I <sub>DD0</sub>	Total off-load supply current		2.5		mA
I <sub>DD1</sub>	Total on-load supply current <sup>ix</sup>		170		mA
V <sub>I0</sub>	Control voltage for α=0%	0.6		0.9	V
V <sub>I100</sub>	Control voltage for α=100%	9.5		9.9	V
R <sub>IV</sub>	Impedance of control input <sup>x</sup>		10		KΩ
I <sub>I0</sub>	Control current for α=0% <sup>xi</sup>	1.2		1.8	mA
I <sub>I100</sub>	Control current for α=100% <sup>xi</sup>	19		19.8	mA
R <sub>II</sub>	Impedance of control input <sup>xi</sup>		500		Ω
V <sub>ST</sub>	Reset voltage of the "soft-start"		0.25		V
T <sub>ST</sub>	Total starting time		4.5		s
T <sub>SR</sub>	Duration of soft start 0 - 100% <sup>xii</sup>		3.5		s

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## 4. MECHANICAL SPECIFICATIONS

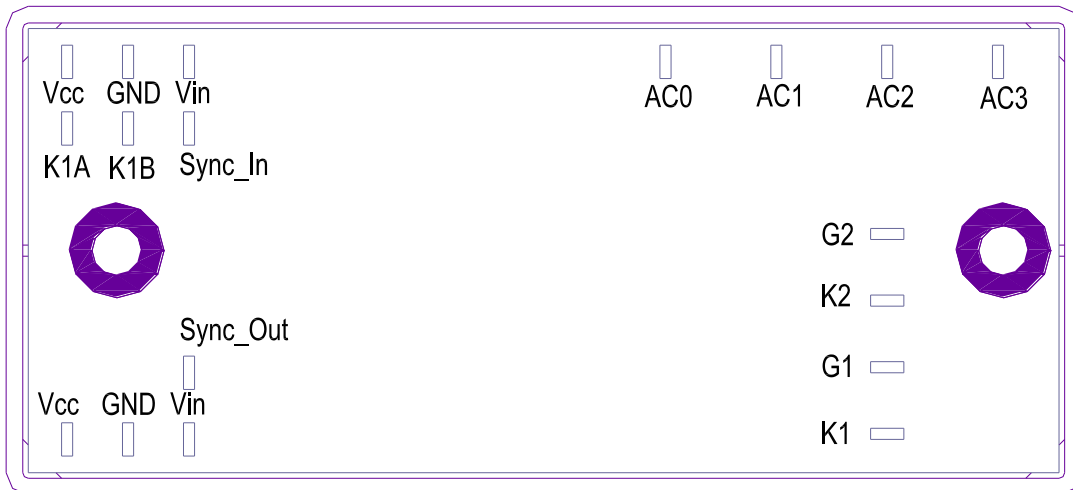


Antistatic polycarbonate housing UL94-V0 / Polyurethane resin UL94-V0.

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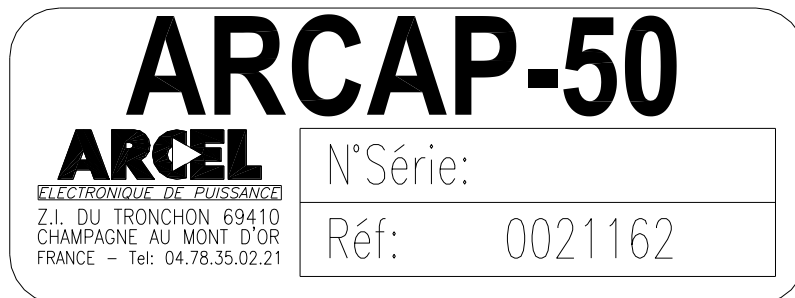
## 5. PIN CONFIGURATION



Outline 2 : Pin configuration of the ARCAP-50

## 6. MARKING / TRACEABILITY

### 6.1. Serial number



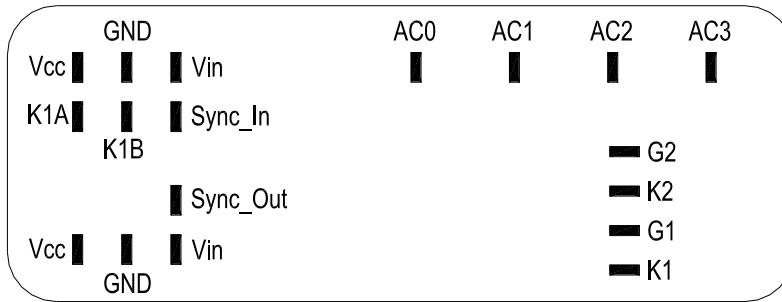
The serial number includes the year and the week of manufacturing, followed by a unique three-digit code and the index number of the product. This serial number, which is unique for each product, ensures a complete traceability. Each product is tested individually after manufacturing.

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## 6.2. Tracking

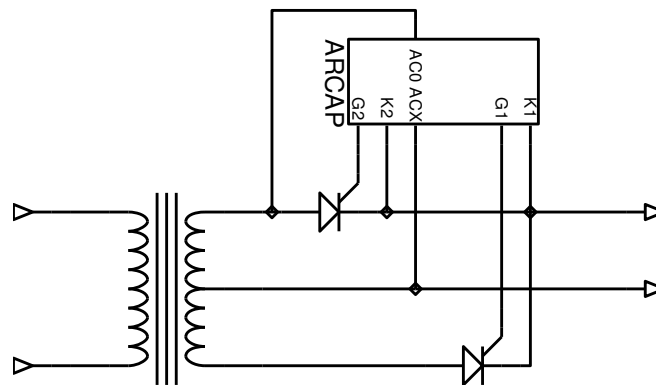
A tracking label is located on the side of the housing :



## 7. IMPLEMENTATION – POWER PART

The following figures show you how to connect the ARCAP-50 modules on the power side for the most common types of converters.

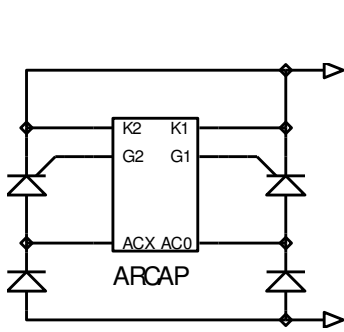
### 7.1. Rectifiers



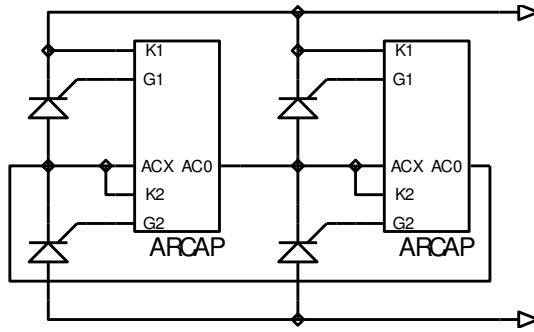
Outline 3 : M2C

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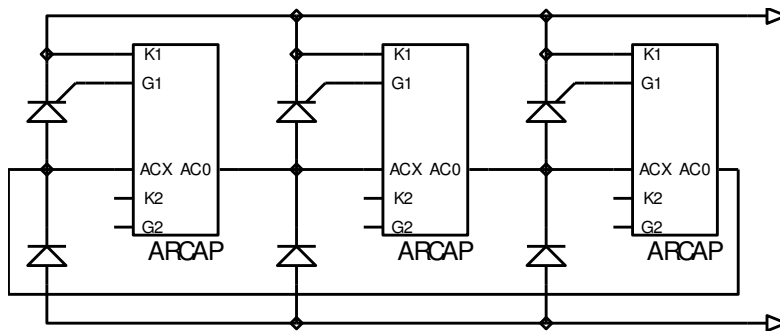




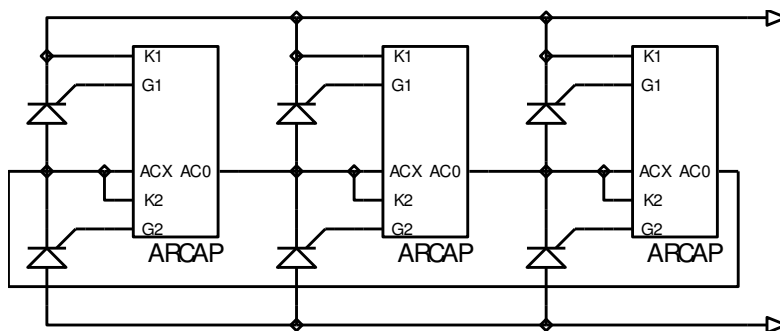
Outline 4 : B2H



Outline 5 : B2C



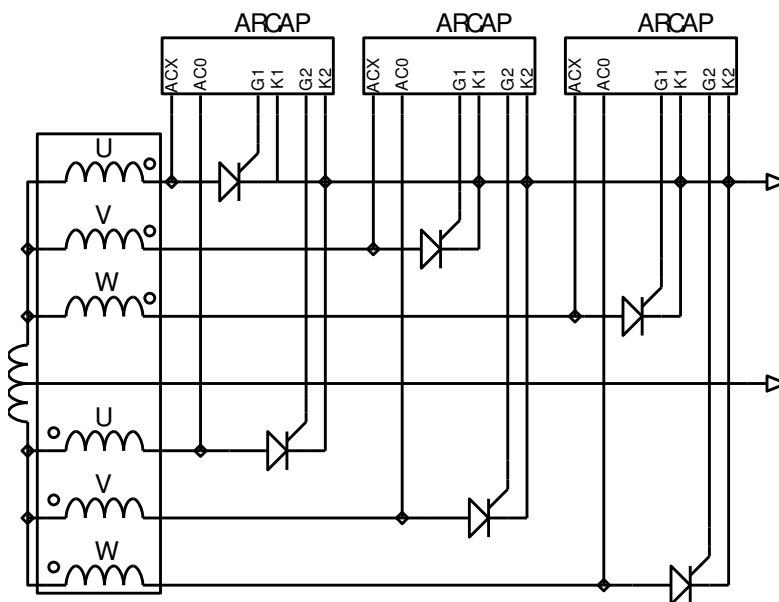
Outline 6 : B6H



Outline 7 : B6C

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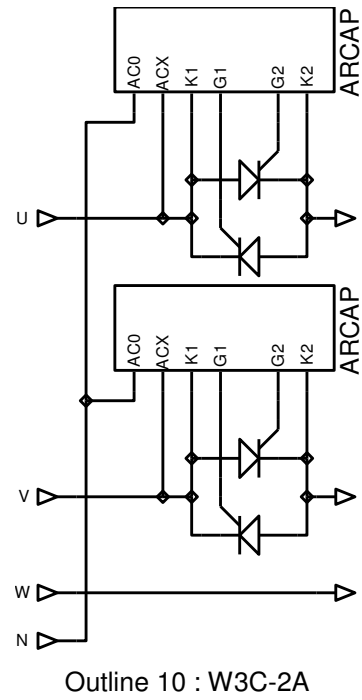
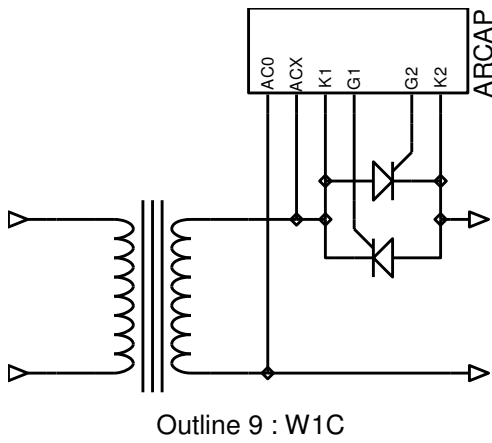


Outline 8 : (M3C)2K

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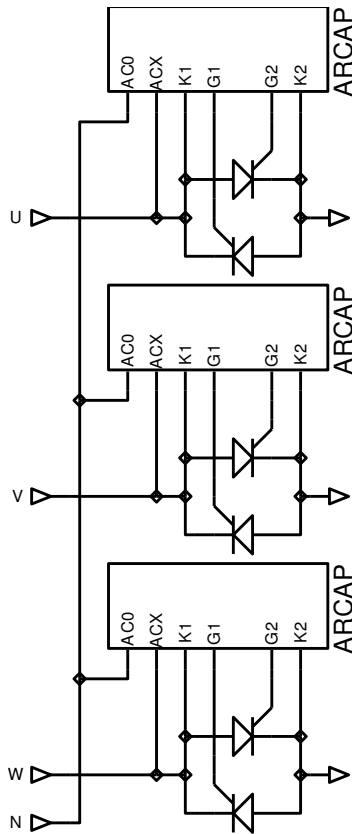


**7.2. Power controllers and switch gates**

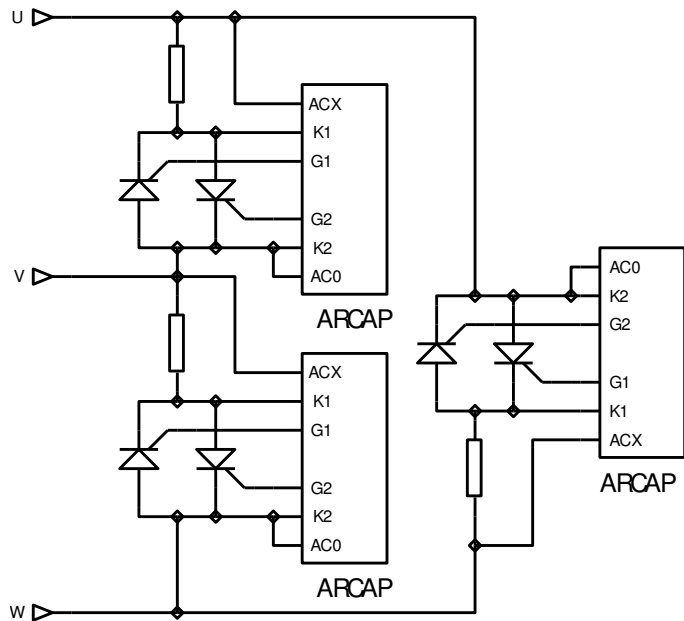


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Outline 11 : W3C-3A



Outline 12 : W3C-3D

### 7.3. Configuration

No configuration is needed for the power part of the ARCAP-50 module. However, the synchronization pins which will be used (AC0 to AC3) will have to be selected according to the operating voltage:

Network voltage - U	Used pins
$U \leq 48\text{VAC}$	AC0 – AC1
$48\text{VAC} < U \leq 230\text{VAC}$	AC0 – AC2
$230\text{VAC} < U \leq 400\text{VAC}$	AC0 – AC3

N.B.: The AC0 pin is the common terminal.

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NOTE: If requested, it is possible to configure the ARCAP-50 for lower synchronization voltages (refer to *Specific configurations, low-voltage alternatives*).

#### 7.4. Thyristor driving circuit

The power supply of the thyristor gates is directly subtracted from the general power supply of the board (Vcc). The applied gate current therefore depends on the Vcc and on the VGK voltage of the driven thyristor. The thyristor internal driving circuit is equivalent to a 22Ω resistor. The gate current value is therefore calculated as followed:

$$I_G = \frac{V_{CC} - V_{GK}}{22} \quad (A)$$

We recommend to link independently the G-K drives and the AC inputs of the ARCAP-50 to the converter. If you don't do so, the synchronization to the network could interfere with the drive pulses of the thyristors.

#### 7.5. Use for network voltages higher than 400V

The ARCAP-50 module can be used for network voltages higher than 400VAC. In order to do that, you just have to connect a resistor in series with the AC3 pin. The value of this resistor must be equal to 18KΩ/0.6W for each 100VAC section above 400VAC.

For a 690VAC network for example, the resistor which has to be connected in series with the AC3 pin will be equal to:

$$R_{AC} = \frac{(690 - 400)}{100} \times 18000 = 52K\Omega$$

And its power:

$$P_{RAC} = \frac{(690 - 400)^2}{52000} = 1.7W$$

In theory the RAC resistor has no upper limit and can be of carbon layer, metallic or coil type. The user must nevertheless be careful about the isolation voltage to be observed according to the standard in use (refer to: Maximum Specifications) and to the voltage stability of the selected resistors.

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The AC0 to AC3 pins are not polarised. In case of a connexion with neutral however, we recommend to link the AC0 pins to it.

## 8. IMPLEMENTATION – DRIVING PART

### 8.1. Configuration

The only possible configuration on the driving part is on the input impedance of the  $V_{IN}$  pin. Normally the input impedance (K1A-K1B not linked) is about  $10K\Omega^x$ . If you link the K1A and K1B contact plates, the input impedance will be forced to  $500\Omega$ , which gives a 0-20mA input on the variation range of  $V_{IN}$  (0-10V).

### 8.2. "Soft-Start"

The ARCAP-50 module is equipped with a progressive starting circuit called "Soft-Start". This progressive starting enables to use the ARCAP-50 on highly capacitive loads without bothering about the generation of the soft start and therefore about the inrush current when starting the bridge.

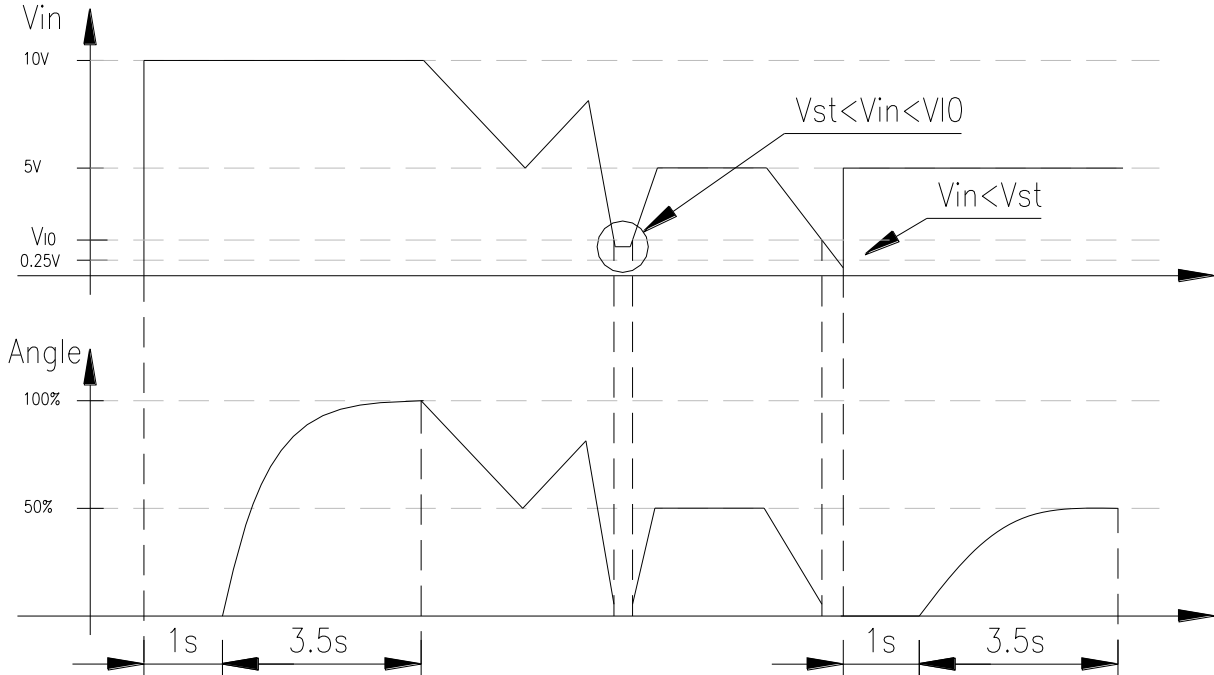
The "Soft-Start" circuit engages as soon as the  $V_{in}$  driving voltage is lower than  $V_{ST}$  (typically 0.25V). As soon as the  $V_{in}$  voltage exceeds the  $V_{ST}$ , the driving angle of the thyristors will increase progressively up to the value corresponding to the new set point.

Once the progressive starting is over, the "Soft-Start" circuit is deactivated in order to avoid introducing any additional delay in the driving chain. The dynamic imposed by the user's regulation system is therefore well observed.

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The following diagram is a symbolic representation of the "Soft-Start":



Outline 13 : Functioning of the "Soft-Start".

NOTE: If requested, it is possible to configure the ARCAP-50 without "soft-start" (refer to *Specific configurations, Alternative without progressive starting*).

### 8.3. Synchronization to the network

The ARCAP-50 module has been designed to function on a 50Hz network. However it can also work on networks of higher frequencies. The dynamic of the grid voltage will then be reduced according to the frequency increase. For a 60Hz network for example, the grid voltage for a full angle control of the thyristors will be :

$$V_{IN}' = \frac{50}{60} \times V_{IN} = 8.33V$$

- The dynamic reduction doesn't affect the control loops or the « On-Off » control commands.

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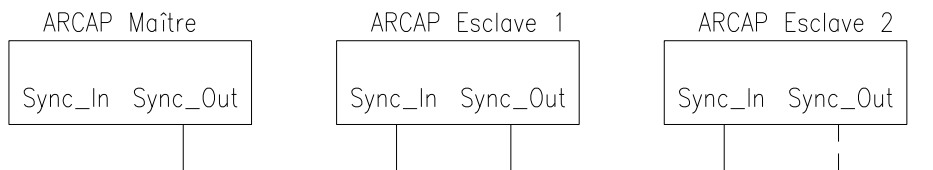
#### 8.4. « On-Off » control command

If requested, it is possible to configure the l'ARCAP-50 in such a way that it will operate as a "On-Off" trigger (Refer to *Specific configurations, DTR operating*).

#### 8.5. Use of several ARCAP-50 modules on a same converter

If several modules are used for the same converter, it is imperative to synchronize them. *If you don't do so, unwanted aborts of the converter could occur.*

The synchronization is done by chaining the "Sync\_Out" outputs to the "Sync\_In" inputs of the modules as indicated on the following diagram:



Outline 14 : Synchronization of several ARCAP-50

The first module (the one for which the "Sync\_In" input is free) is the "master". It's on this one that the other modules will be synchronized.

To make the wiring simpler, the Vcc, GND and Vin terminals can also be chained.

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## 9. SPECIFIC CONFIGURATIONS

If requested, the ARCAP-50 can be configured in a special way so as to meet the user's requirements.

### 9.1. *Low voltage alternative*

This alternative enables to use the ARCAP-50 for lower alternating voltages, thus ensuring a better dynamic calibration for these specific conditions.

Network voltage - U	Used pins
$U \leq 24\text{VAC}$	AC0 – AC1
$24\text{VAC} < U \leq 72\text{VAC}$	AC0 – AC2
$72\text{VAC} < U \leq 144\text{VAC}$	AC0 – AC3

### 9.2. *Alternative without progressive starting*

In this configuration, the "soft-start" is inhibited. The phase angle therefore immediately matches the Vin control voltage, provided that the power supply voltage is high enough. This configuration can be useful in case the ARCAP-50 is not supplied permanently and in case the control output of the thyristors has to respond immediately to the rise of the power supply voltage.

### 9.3. *DTR*

In this configuration, there is no synchronization (therefore no need to wire AC0, AC1, AC2 and AC3). The pulses are sent with a 100% angle as soon as Vin gets higher, at about 5,6V. Vin can be linked to Vcc by means of a contact. In this case, as soon as the ARCAP-50 is supplied ( $V_{cc} > V_{cc\ min}$ ), the pulses are sent permanently; should the power supply be stopped, the pulses will then stop immediately.

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## 10.NOTES

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- 
- i Insulation by means of a pulse transformer. Test realized for 100% of the transformers at 50Hz-1min.
  - ii Insulation by means of an optocoupler. Sample test at 50Hz-1min.
  - iii Minimum voltage ensuring a good synchronization on the supply system and maximum voltage not to be exceeded.
  - iv This frequency fits with the optimal configuration of the ARCAP-50. But the ARCAP-50 can also work with higher frequencies. Please refer to the corresponding section.
  - v G-K outputs in short circuit.
  - vi Minimum value :  $V_{CC}=12V$  and maximum value :  $V_{CC}=24V$ .
  - vii This frequency also fits with the system resolution, i.e. a  $250\mu s$  pitch.
  - viii As the ARCAP-50 is equipped with an internal controller, the  $V_{CC}$  voltage doesn't necessarily need to be regulated. The  $V_{GK}$  voltage however reflects the power supply (no regulation).
  - ix For  $V_{CC}=24V$  and  $I_G=1A$  on each output.
  - x With 0-10V configuration. For a  $V_{in}$  voltage lower than 12V.
  - xi With 0-20mA configuration.
  - xii For a 0 to 100% step on the driving input.

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