# AN1295
# APPLICATION NOTE

## A DEVELOPMENT BOARD TO DRIVE A TRIAC WITH ST52X420 DIRECTLY FROM THE MAINS

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### 1. INTRODUCTION

In this application note we intend to provide the user with a flexible and programmable tool to drive a Triac directly from the mains by using the ST52x420 microcontroller and the VB409 VIPower device acting as a 5.2V power supply.

We present an electrical schematic representing a general purpose application to use the fuzzy microcontroller ST52x420 without the need of external components with the exception of the VB409. By using the external connectors it is possible to manage the microcontroller's peripherals including digital I/O, A/D converter and Timers.

In particular, we will provide an example, written in the high level language of FUZZYSTUDIO™4.0, to drive a load in phase angle partialization mode (see also AN1221: "A Simple Method to Drive a Triac With ST52x420 Directly From the Main").

The following figure describes the configuration of the board used in this application note:

**Figure 1. Board Configuration**
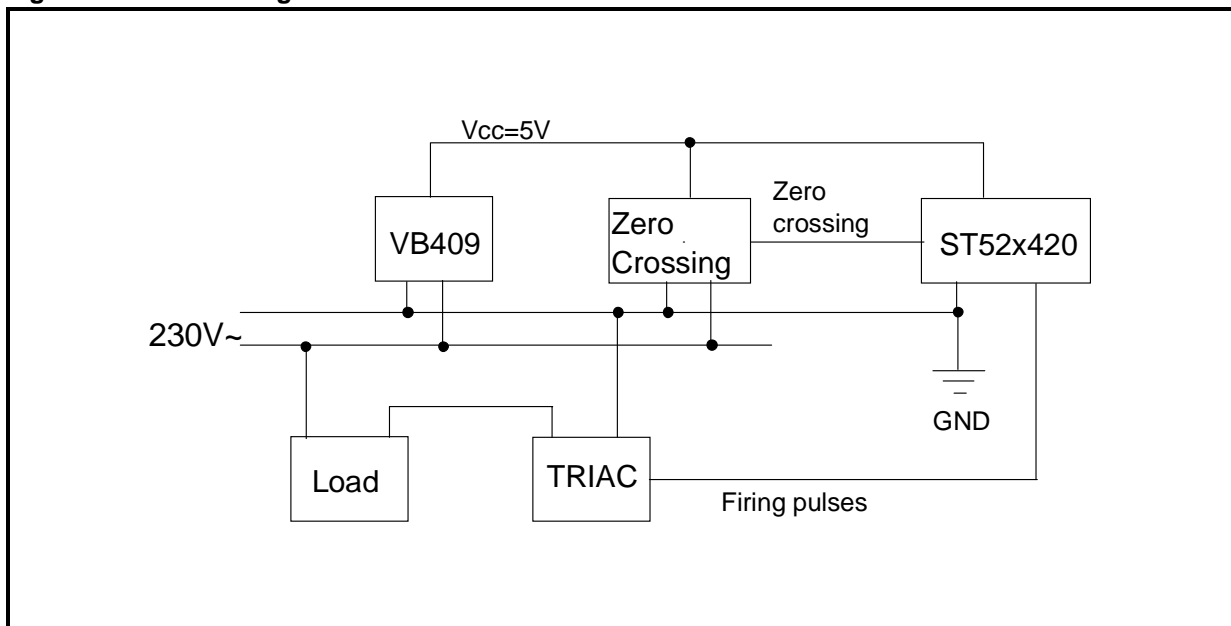


The blocks are:

- ST52xx: a member of a ST52 microcontroller family
- VB409: a VIPower device to obtain a 5.2V power supply direcly from the mains
- Zero Crossing: a simple circuit to detect the zero crossing of the mains voltage
- Triac: a device to switch on the load
- Load: a generic resistive or inductive load

## 2. ELECTRIC SCHEMATIC

To have a complete idea of the connection between the various devices present on the board we can refer to the following schematic:

**Figure 2. Electric schematic**



In our application we have also placed a micropower voltage supervisor TS831 that acts as a power-on reset generator for the microcontroller and as a power failure detector.

The zero crossing circuit is realized with only two resistors and two diodes: R6 to limit the current, R3 to pull-up to 5V the zero crossing signal, D2 to cut a half-wave and D1 (a signal diode) to clamp to ground the zero crossing signal when it goes under the ground. The zero crossing signal is used to sincronize the microcontroller to mains voltage through the external interrupt pin PC0/INT.

The VB409 is a fully protected positive voltage regulator. The device is well suited for applications powered from the AC mains and requiring a 5.2V DC regulated output voltage without galvanic isolation.

The ST52x420 fuzzy microcontroller can be used to drive the Triac in phase angle partialization mode (see ST52x420 datasheet). To implement this, we need only the zero crossing signal: by triggering this signal with the external interrupt pin (PC0/INT) it is possible, by using the internal Timer, to generate the appropriate firing pulses to switch on the Triac. Note that to have enough current capability in order to fire the triac we use two pins of the microcontroller (PC1 and PC2) connected together (see AN 1221).

To fully exploit the potentialities of ST52x420, some connectors have been inserted:

- **J4:** to access the digital I/O PORT_A (or the Timer0 signal when configured in alternate function).

- **J10:** to access the digital I/O PORT_B (or the A/D inputs when configured in alternate function).

- **J8:** a switch to connect the PORT_B Pin0 to an on-board NTC device instead of the connector J10.

- **J9:** a switch to connect the PORT_B Pin1 to an on board Trimmer device instead of the connector J10.

- **J6:** to access directly the digital I/O PORT_C Pin3 (or the Timer2 output when configured in alternate function).

- **Dev-PB0:** with this jumper it is possible to connect the pin PB0 to the connector J10 or to the on-board NTC sensor.

- **Dev-PB1:** with this jumper it is possible to connect the pin PB0 to the connector J10 or to on-board trimmer R5.

- **VB409:** in this section will be considered the capability of the VB409 to supply an appropriate current to the devices. The behaviour of the VB409 will be described starting with an external capacitor of 47$\mu$F. The theoretical maximum current the device can supply, can be derived considering that the minimum value on the CAP pin, at the end of the half-period in which the mains is not rectified, must be at least $V_{out}$(5V)+$V_{dropout}$(2V). During this period there is a discharge of the external capacitor at constant current, so the voltage variation on it is linear. Thus, the theoretical maximum current the device can supply is:

$$I_{max}=C*\Delta V_{capmax}/(T/2)$$

In this case T/2=10ms, $\Delta V_{capmax}$=12.8-7=5.8V, C=47$\mu$F and then $I_{max}$=27mA.

Considering the current required to drive the linear part of the device it is possible to say that $I_{max}$=23mA. With this configuration we have measured the maximum temperature on the device (without heatsink) to be lower than 65°C.

If we consider an external electrolytic capacitor of 100mF the maximum theoretical current is about $I_{max}$=55mA, but practically only 40mA must be considered because at this current value the thermal shutdown acts.

For further information about VB409, please refer to the relative datasheet.

- **TRIAC:** with the power supply configuration used it is necessary to use a standard Triac in order to fire it by applying a negative pulse to respect the ground (and therefore respect to A1 Triac pin) through the derivative effect of C6.

## 3. CONCLUSION

In this application note we propose a general purpose board with the goal to have a flexible interface towards the application. This allows to:

- generate the firing pulses for a Triac

- have a synchronization with an external sinusoidal voltage

- generate up to 8 bit PWM signals

- read analog or digital sensors

- measure the period of an external signal (like a tachometer)

- exploit the computation capability of the ST52x420 microcontroller

An example on the management of the board (an1295.fs4) can be found on the ST52 Microcontrollers web site:

www.st.com/stonline/prodpres/