SGS-THOMSON MICROELECTRONICS

TRIAC + MICROCONTROLLER
# SAFETY PRECAUTIONS FOR DEVELOPMENT TOOL

Ph. Rabier

The goal of this paper is to analyse the different ways to configure a micro-controller and a development tool during the debugging phase. The major problem is due to the direct connection of the computer I/O lines with the mains power. Some precautions have to be taken during the emulation in order to avoid destruction.

I - LOW COST POWER SUPPLY

In most low cost applications the step down transformer is not used and the power supply delivers low current, as shown for example in figure 1.

Figure 1 : Uninsulated power supply.
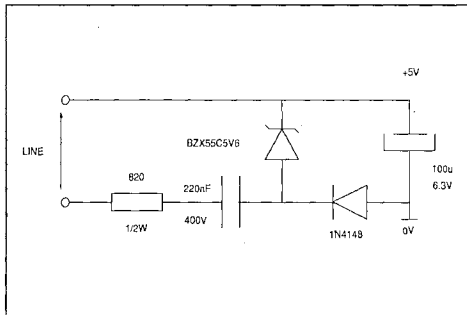
In domestic appliance applications, one of the most important power switches is the triac.

The function of driving the triac becomes more and more complex. For this reason, microcontrollers are becoming more and more common. Furthermore, sensitive triacs with high commutation parameters, for example LOGIC LEVEL triacs can be triggered directly by the microcontroller without any buffer. Sensitive triacs and microcontrollers allow decrease in power consumption.

In this way the power supply can be optimized to reduce the cost. Optimisation can be achieved by removing the transformer.

The consequence is that there is no insulation, the microcontroller is connected directly on the line !

When the software is emulated on the application board, the output port (RS232 port) of the computer is connected on the line via the emulator.

If some precaution is not taken "something" will be destroyed !

Figure 2 gives an example of an application using a triac and a microcontroller.

**Figure 2 : Triac and microcontroller on the line.**
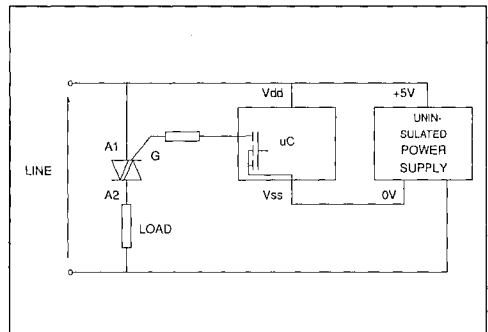
In this case the micro-controller is supplied by an uninsulated +5 V power supply connected directly to the line, and a low level (0V) on the output ports of the micro-controller is needed to trigger the triac.

II - USE OF A DEVELOPMENT TOOL

During the debuging phase, the micro-controller is removed and is replaced by the emulation probe. The circuit corresponding to the emulation phase of the previous example is shown in fig. 3.

The line is connected directly to the +5V of the emulator and a high (destructive) current can flow through the emulator and/or the computer.

Figure 3 : Circuit without protection
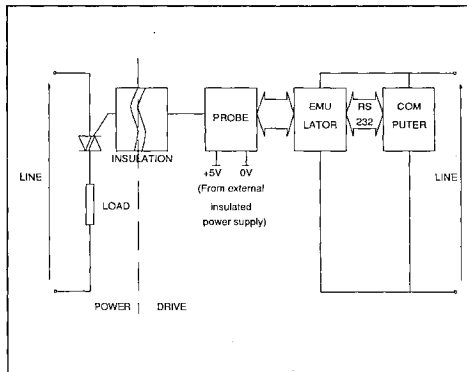Beware : this circuit is dangerous).
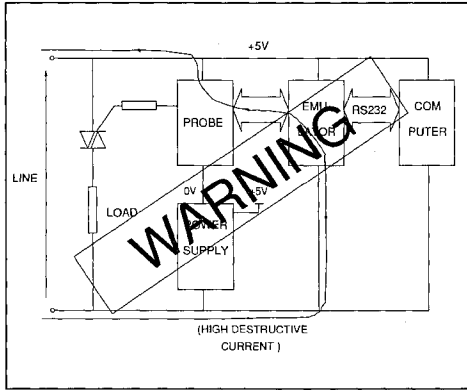
III - INSULATED SYSTEM

To avoid destruction of the development tool it is necessary to have an insulation between line and probe. This insulation can be achieved by optocouplers, pulse transformers, or insulation transformers.

Figure 4 shows the topology of the most common insulation.

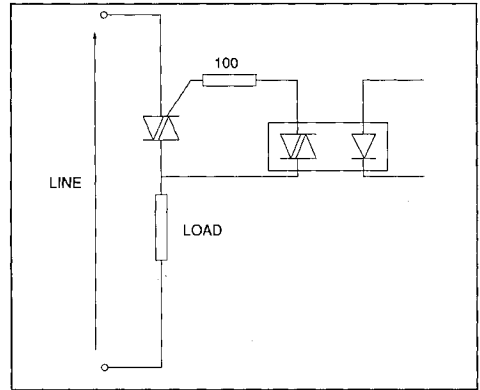### Figure 4 : Conventional insulation.

1/ Optotriac

Figure 5 shows the circuit with triac and optotriac.

The triac is working in the 1st and in the 3rd quadrants.

Figure 5 : Optotriac drive.

The main advantage of a such system is the low cost of the optotriac, but it needs an isolated auxiliary power supply.

For a zero crossing optotriac, the triac is triggering with a gate current equal to the gate trigger current with a very low dI_G/dt. This does not allow high di/dt at turn on. That is to say the control of high current resistive load is not recommended with this method.

2/ The pulse transformer

Figure 6 shows the circuit with a triac and a pulse transformer.

The triac is working in the 2nd and 3rd quadrants.

Figure 6 : Pulse transformer insulation.
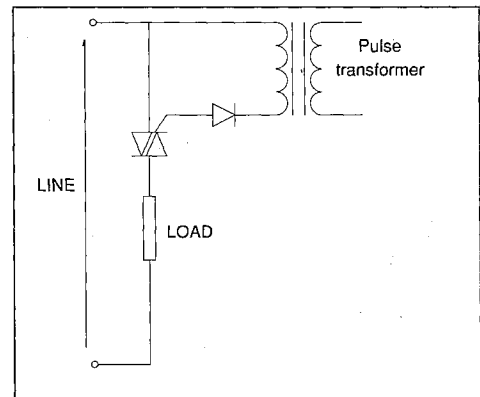
This system is simple to use when the triac was initially driven by a buffer transistor, but it needs an external power supply. The high dI$_G$/dt through the gate allows high current resistive loads to be driven. Due to the saturation of the magnetic material, this system cannot drive small loads because the gate current is cancelled before the latching current has been reached.

For more information refer to the application note "Triac control by pulse transformer".

3/ The line insulation transformer

In the previous examples,the insulation was between the triac and the microcontroller.

Another solution is to supply each equipment connected to the board from the mains through an insulation transformer.

If an oscilloscope is used, it also has to be separately insulated.

The main advantage of this system is that we do not need to modify the target system during the debuging phase and it can be used with the microcontroller.

When a transformer is used between line and triac it should be noted that the line impedance is modified and then the behaviour of the triac, load and line set can be different (waveform of current).

Figure 7: Insulation with transformers.
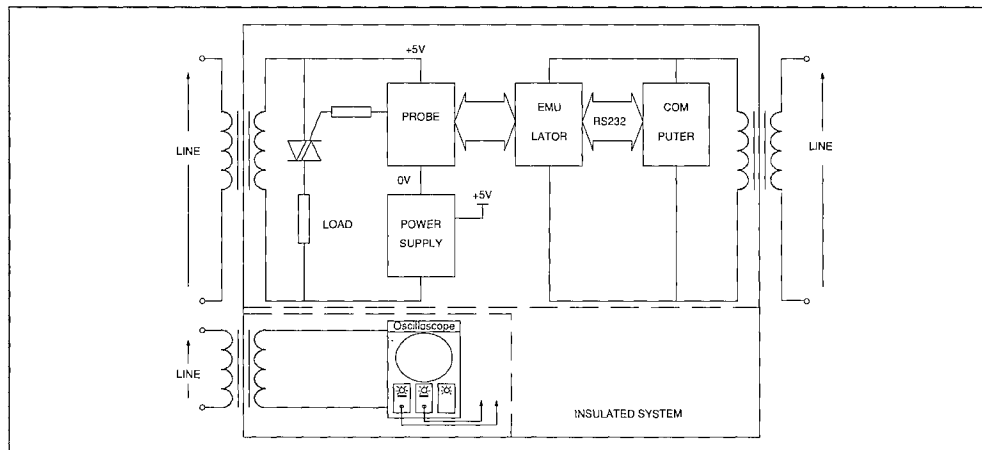
IV - SUMMARY

New LOGIC LEVEL and SNUBBERLESS triacs can be connected directly to the microcontroller without buffers or insulation. Furthermore, low cost power supplies without a transformer are becoming more common. There is an increasing number of applications supplied directly from the mains, and the microcontroller is directly connected to it.

During the debuging phase when connecting the development tool, a galvanic insulation is absolutely necessary.

This insulation can be done in 3 ways :

- With optotriacs :
  • Need modifications on the target system
  • Need external power supply
- With pulse transformer :
  • Need modifications (transistor to drive the pulse transformer)
  • Need an external power supply
  • Cannot drive small loads
- With insulation transformer :
  • No modification on the application board.
  • Modification of the line impedance due to the transformer between line and load.

Therefore a microcontroller operating on the mains with a triac may be directly connected to the line.

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