A Maxim Integrated Products Brand

73M1x66B/73M1x22
Low Voltage Transient Protection

APPLICATION NOTE

AN_1x66B_1x22_059 **April 2010**

Introduction

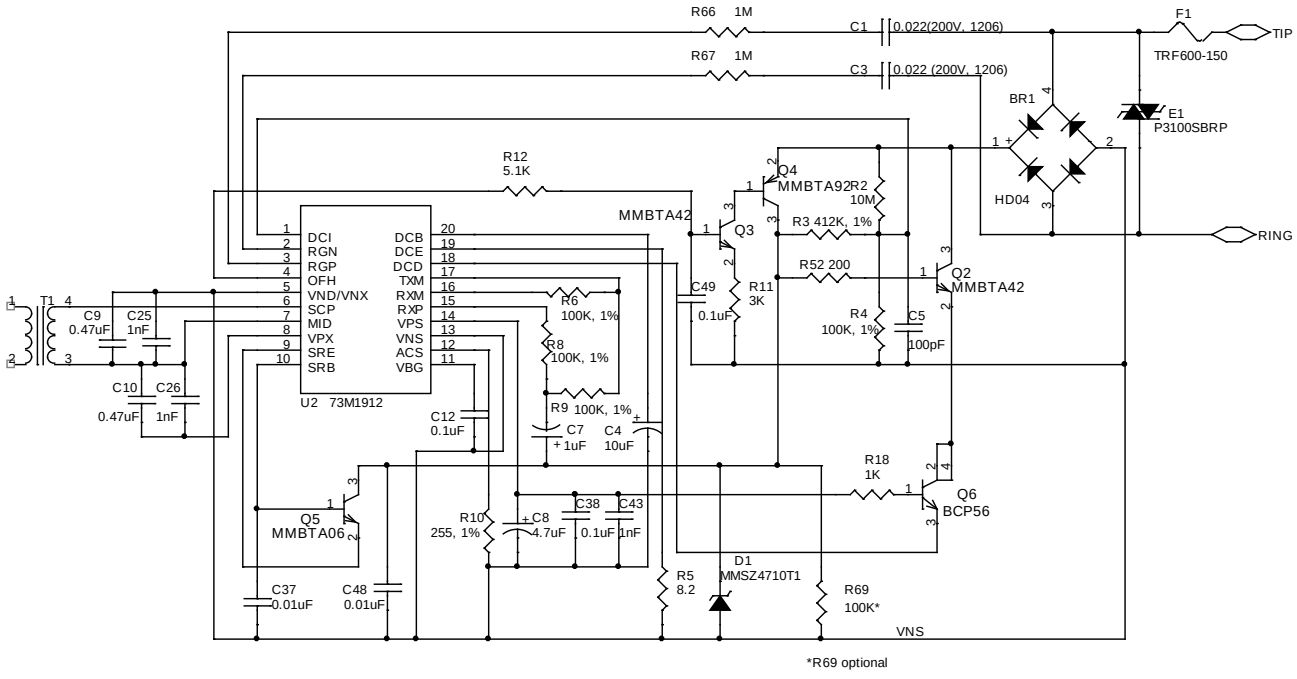
This application note provides guidance on circuit protection from voltage transients that are below the level protected by the normal higher voltage and current protection.

Most safety regulatory agencies require some sort of protection that is activated when voltages above approximately 275 V occur between the Tip and Ring connections to the PSTN. This minimum voltage trip level is required to prevent conducting under worst case ringing and battery voltage conditions. The fault conditions that occur above this voltage level can be caused by many factors, such as lightning, ESD from human body contact, and power cross to the electrical mains on a telephone pole or underground wiring. These conditions can cause injury to the equipment user as well as damage to the equipment itself, but these are generally considered "safety" issues. Equipment will typically have high voltage isolation provided by the transformer and capacitors that cross the isolation voltage barrier to protect the user. Protection to the DAA interface is needed to prevent the other components in the line side circuitry from being damaged by voltages and currents in excess of their rated limits.

There are also cases when there are requirements to protect the DAA interface against voltages that fall under the high voltage protection threshold. This application note specifically discusses these issues.

The Need for Layers of Protection

The transistors immediately behind the diode bridge looking from the line side are rated for 300 V Vce, therefore there is a TVS device (E1) that is activated by voltages over 275 V to protect them when they are turned off (on hook). These transistors in turn protect the other lower voltage devices from seeing voltages from the line that could be harmful when on hook.



The line side IC is a 3 V device, even though the voltages when off hook can be considerably higher than this (4 V to as much as 15 V). There are other devices that sit between the off hook voltage levels and the line side IC. Transistors Q5 and Q6 are rated for 80 V maximum and are protected from the line by Q2, Q3, and Q4. Once the line is in an off hook condition, the voltages inside the DAA are **normally** well within their voltage limits. When off hook, Q5 and Q6 protect the line side IC from the voltages on the line while the MicroDAA™ is operating. Capacitor C7 is between the receive input pin and the line, so it prevents the DC voltages on the line from reaching the IC through that path. This capacitor is rated at 25 V and can therefore easily tolerate the DC line voltages.

The ring detection and Caller ID path is similarly protected. There are capacitors and resistors that protect the RGP and RGN inputs from both AC and DC high voltages. These are “behind” the high voltage protection provided by E1, so the capacitors only need to be rated for 200 V or so since effectively they are in series with each other.

Low Voltage Protection

There are conditions that can arise that are not properly addressed by the protection that is provided by E1. E1 is a crowbar device, meaning that the TVS goes into a low impedance state, not just clamping the line to 275 V. When this device is tripped, it causes the voltage to be held to less than (typically) 20 V. In the case of the line being off hook, this means that the voltage ratings of the transistors Q5 and Q6 are not being exceeded except momentarily when the TVS is tripped. If, however, the voltage is less that the trip voltage of E1, the voltage across the components in the DAA are not affected by E1 and therefore the voltage is seen by C7, Q5 and Q6 and will be the full voltage up to the E1 trip voltage. This means the 115 V AC mains voltage, for example, will be unaffected.

The ringing voltage can also sometimes still be present for some period of time after the line is seized, and this can also wreak havoc with the DAA circuits. Highly inductive circuits have also been shown to cause large voltage transients in the DAA during switching transitions. Because the DC loop must respond slowly to fast voltage transitions on the line, some of these conditions are barely affected by the DAA, but can damage the devices with lower voltage ratings than the transient voltage.

The addition of a Zener diode or a low voltage TVS (D1) to the circuit between the switch transistors and VNS prevents voltages over 25 V from affecting the operation of the DAA circuit and prevents damage to the other components in the DAA. This added layer of protection is not required to pass most certification testing, but adds dramatically to the reliability of the MicroDAA’s operation.

It should be noted that competitive DAA solutions with a similar topology typically utilize a similar protection scheme. There are also similar designs that do not have these layers of protection, but in light of the preceding discussion, their reliability may be in question. To get the lowest BOM, some designers choose to only provide the minimum circuit protection for certification, rather than for a reliable and robust design.

Revision History

Revision	Date	Description
1.0	4/8/10	First publication.