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Drive Pyrotechnic Igniters From A Microprocessor Port

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Certain irreversible operations (like releasing a parachute, cutting a rope, or starting a solid combustible missile engine) may be performed by pyrotechnic igniters. These devices generally consist of an electrically controlled igniter, some chemical (such as gunpowder) to produce high-pressure gas after firing, and some mechanical assembly to perform the desired operation.

Igniters contain a filament in an explosive mixture. When a current flows through the filament, its temperature increases until reaching the ignition temperature of the flammable chemical, thereby igniting the device.

Igniter characteristics are generally described in terms of filament resistance (e.g., 1O) and energy (some level of millijoules) to supply in a maximum time period (i.e., milliseconds) to start the device. Another parameter usually specified is the maximum current you can safely supply to the device for measurement purposes without igniting it. Operating such a device with an MCU port requires some important considerations:

- Avoid unwanted operations (i.e., some unpredictable port status during the startup that may trigger the device).
- You should be able to check the device status using the same port.
- Implement the requirements in terms of current (high), energy, and device timing without disturbing the electronics.

Figure 1 shows the block diagram of the fire-starter interface. The current through the filament is controlled by a power MOSFET (Q1). A charge pump connected to the MCU port through C1 operates Q1's gate. This will avoid:

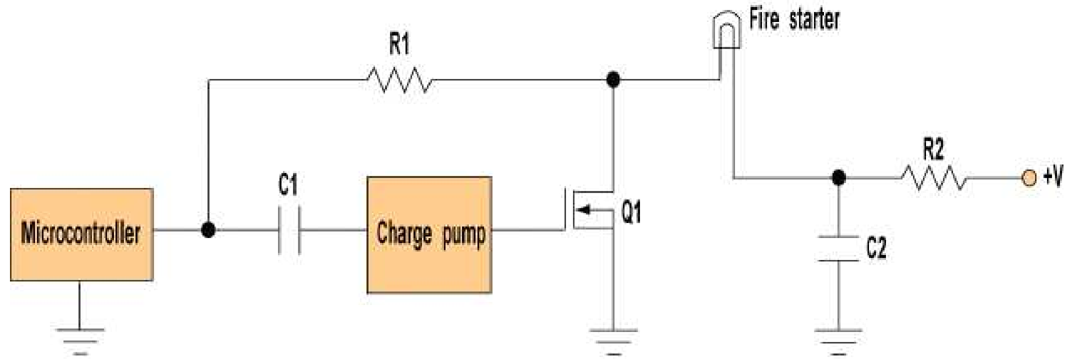
- An unwanted port level operating Q1 (dc is decoupled by C1).
- A single spike operating Q1 (several transitions are required, depending on the charge-pump features, to increase the gate level).
- The strong current through the filament affecting the power supply (C2 is chosen to supply the right amount of energy to the filament, and it's slowly charged by R2).

Figure 2 shows the schematic of a working circuit that implements the requirements in the following manner. A charge pump drives the power MOSFET (M1). Several transitions are needed on the MCU port to cause M1 to saturate. As a result, the system is insensitive to spikes and unwanted level changes.

By looking at the filament resistance, you can detect the igniter status. R4 and R5 accomplish this by bringing the MCU port (used as an input) near to +5 V with an intact filament and to 0 V with a burnt filament.

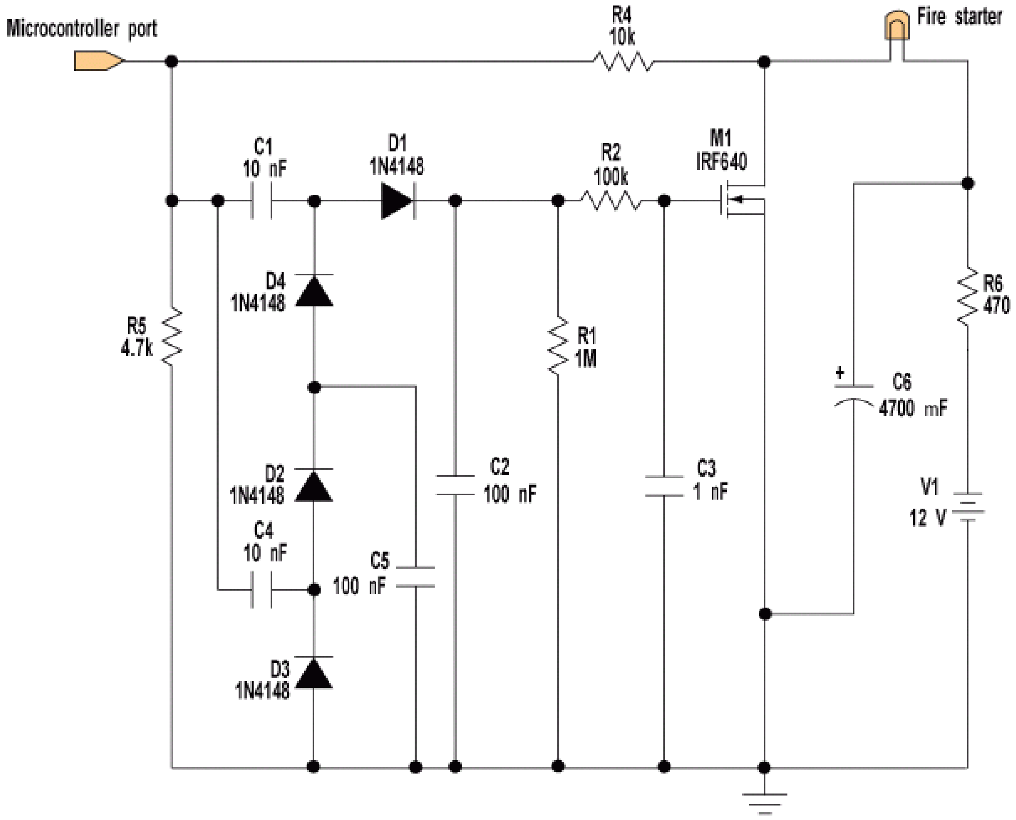
M1 discharges capacitor C6 through the filament, supplying the required amount of energy. The igniters used (Daveyfire N28BR) require a minimum of 2 ms at 1 A to ignite (or 1.1 mJ/O). The microprocessor port is supposed to be an input when it's not sending oscillations. A high-level signal is returned before the burst (igniter new) and a low-level signal after the igniter is burnt. The circuit well exceeds the minimum requirements in terms of current and energy/resistance needed to ignite the Daveyfire igniter.

Figure 1



1. A charge pump driven from an MCU port controls conduction through Q1, which ignites the fire starter. Resistor R1 is used to read filament continuity.

Figure 2



2. This fully functional igniter circuit is based on the Figure 1 block diagram. Several transitions are needed on the MCU port before the ac-coupled charge pump causes M1 to saturate. This makes the system insensitive to spikes and unwanted level changes.