

# Abstract

The FFA requires that high altitude sounding balloons possess two methods by which a flight might be terminated. With traditional latex sounding balloons the primary means of flight termination is that the balloon bursts at altitude. Recently low cost small payload zero pressure balloons have become available for use by higher educational ballooning programs. So for both systems, but particularly zero pressure systems there is a need to have user controlled flight termination systems. We present here the design for a timer based system and a radio controlled system employing a hotwire cutter.

# Trigger Control Switch Separation Device

### System Requirements

- An electrical system to close a switch
- Redundant autonomous and userinitiated triggers
- Electrically enabled device
- Mechanical or solid-state
- Needs to buffer trigger and separator
- Separates balloon from payload
- Balloon and payload connected by string – device needs to cut or release the string

# Switch

# Requirements

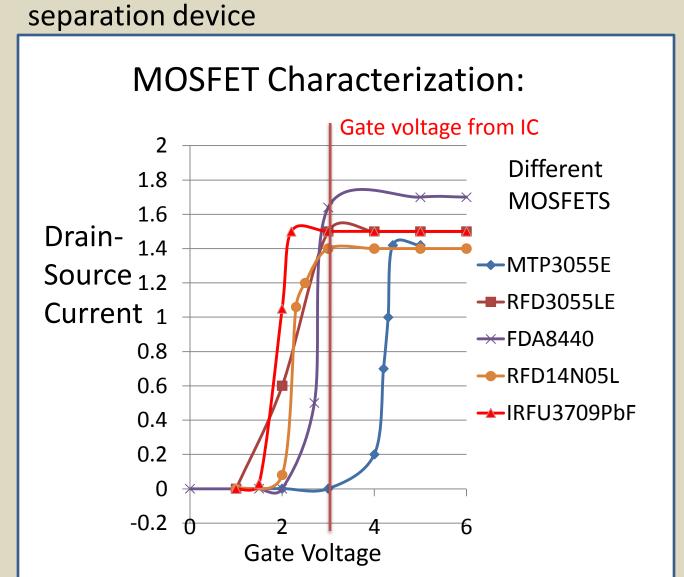
- Reusable
- Temperature Resilient
- High Current Load
- Easy to enable

## Potential Devices

- •Electro-mechanical -Reliability concern
- -Large Size
- -Requires more power
- Solid state
- -Reliable under low temperature
- -Smaller size -Low power requirements -Easier to integrate into IC controlled systems.

### Solid-State switch utilized

- Usage of a low gate-source voltage threshold MOSFET transistor allows control signals to be low power
- •MOSFET is controlled by an integrated circuit triggering system.
- •MOSFET buffers the control system from the



# Terminator – Flight Termination System for High Altitude Ballooning

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# Separation Device

### Requirements

- Lightweight mounted above parachute to avoid tangling issues
- Reliable at low temperature
- In-Line connecting line runs through system

### Potential devices:

Linear actuator, heating element, or pyrotechnic

#### Heating element

- Electric current is used to heat a wire to melt connecting line like incandescent light
- bulb or electric heater
- Lightweight a heating wire and battery for power source
- Reliable in low temperatures
- NiChrome wire typically used

#### **Linear Actuator**

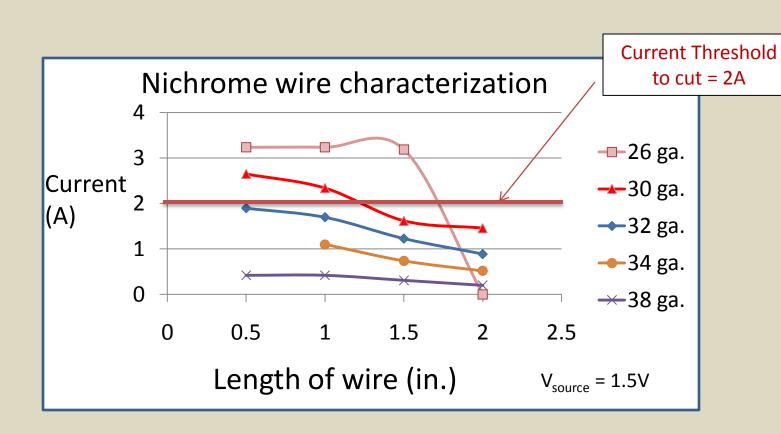
- Motor is used to release line, or to pull a pin to separate systems.
- Servo or mechanical arm

#### Pyrotechnic

- Explosive device used to destroy connecting line
- Dangerous, potentially difficult to control
- Potential legal issues

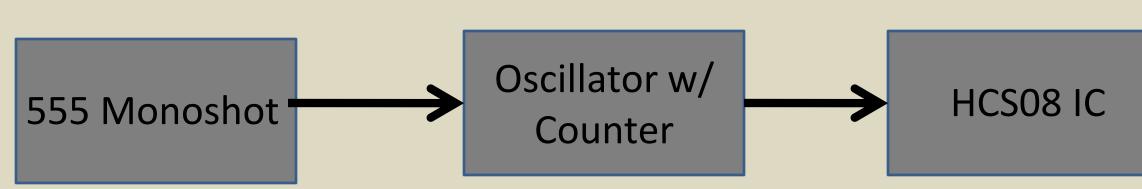
### Heating element is used in current design

- A heating wire is straightforward to implement with the MOSFET switch
- The heating element uses Nichrome wire wire size (length and gauge) determines the power required to bring the wire to a sufficient temperature to sever the line



# Autonomous

# Fixed-Timer Trigger System



 Impractical component

values required

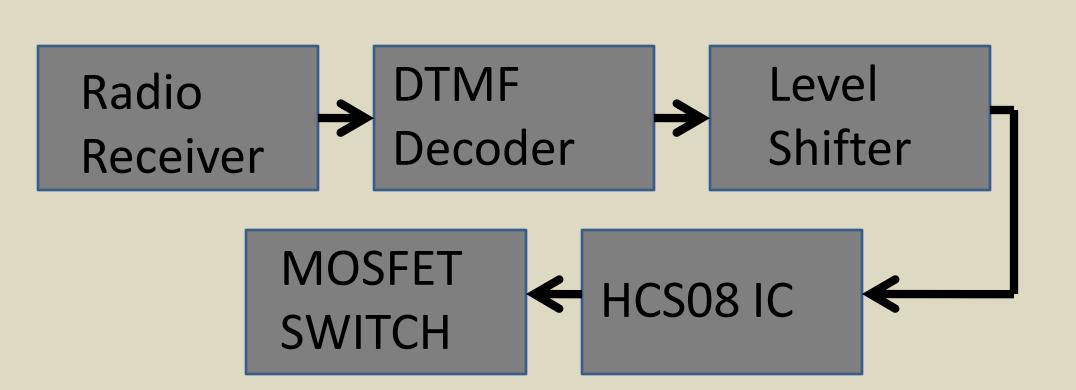
- 555 as oscillator
- RC timing
- -Temp. Sensitive
- Microcontroller Very reliable

Basic Nichrome System

- Internal oscillator

Mono-shot schematic **HCS08 IC Timer Schematic** 

# **User-Controlled** Radio Signaled System



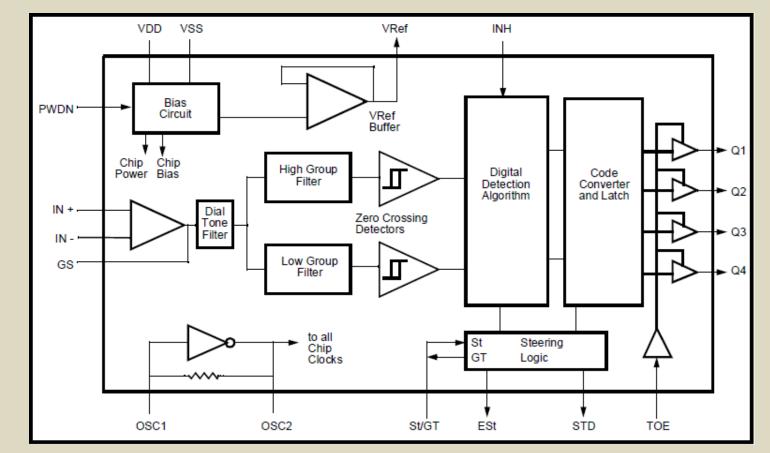
Block diagram of the user-controlled system

- Radio receives commands sent by user from ground, exports as waveform to DTMF decoder
- On-board tracking radio can be dual-purposed for receiver, or a separate radio can be used.
- DTMF is Dual Tone Frequency Modulation same signals as sounds made by phone keypad
- DTMF decoder transforms the analog DTMF signal into a digital binary signal. The digital signal can be easily interpreted by a microcontroller.
- HCS08 is a microcontroller that enables the switching MOSFET

### DTMF Decoder and Microcontroller

### DTMF Decoder

- MT8870DS DTMF decoder IC is a lowpower chip used to turn a DTMF tone into binary code.
- DTMF decoder receives DTMF tones from radio – a single DTMF tone corresponds to a unique 4-bit binary number.
- 4-bit binary values are transferred to HCS08 microcontroller
- MT8870 is 5V logic while HCS08 is 3.3V. -Requires level shifting to avoid damage to HCS08. • A combination of crystal oscillator and RC
- timing circuit provides sufficient temperature insensitivity for operating under high-altitude conditions.



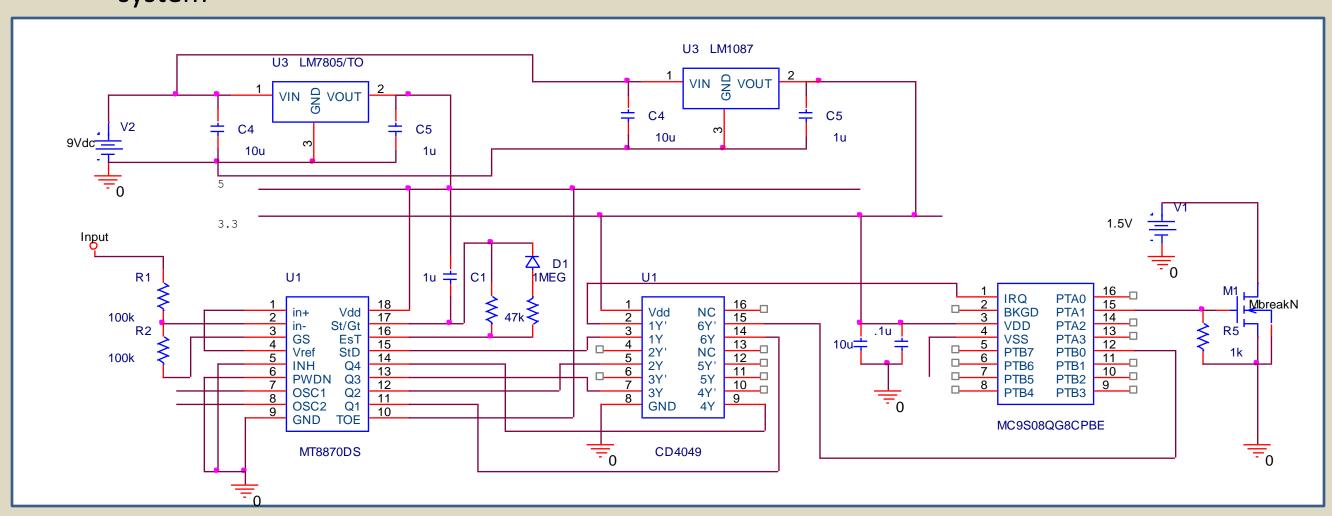
Functional block diagram of DTMF decoder IC [1].

### HCS08 IC Microcontroller

- A robust, low-power multi-task processor with a wide operating range.
- Responds to binary output of DTMF decoder able to be programmed for many possible
- Enables MOSFET switch HCS08 provides the necessary gate voltage.
- The MOSFET buffers the low-power microcontroller from the higher-power Nichrome wire system.

# Schematic of User-controlled Trigger System

- Entire system can be powered by 9V battery
- Voltage regulators convert 9V line into the 5V and 3.3V needed to operate system



References

[1] Mitel Semiconductor, "Integrated DTMF Reciever", ISO<sup>2</sup>-CMOS MT8870D/MT887D-1 datasheet, May 1995

### Acknowledgements:

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