RF Programmable Signal Processor System for Fuze Programming

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This presentation is about a radio frequency signal processor system for fuze programming.

Mixed Signal Integration is a Silicon Valley chip maker specializing in mixed signal CMOS based ASICS. Incorporated in 1997, Mixed Signal Integration specializes in analog and mixed-signal integrated circuits. MSI offers both standard products and custom ASICs in CMOS technologies. Consumer audio and video, wireless personal communications, automatic test equipment and medical are some of the markets where MSI enjoys excellent customer relationships.

Introduction

Electronic fuzing is moving to smaller cannon and even bullets.

- Design to program smaller munitions
- Need for fuze programming
- Proximity or Contact
  - Distance
    - for buried targets
    - hard targets
    - soft targets

One example of fuzing in a small projectile is the NAMMO M211 Multipurpose Ammunition in .50 caliber. Designed with a pyrotechnical ignition train for delayed reaction. This provides for penetrating hard targets before exploding.

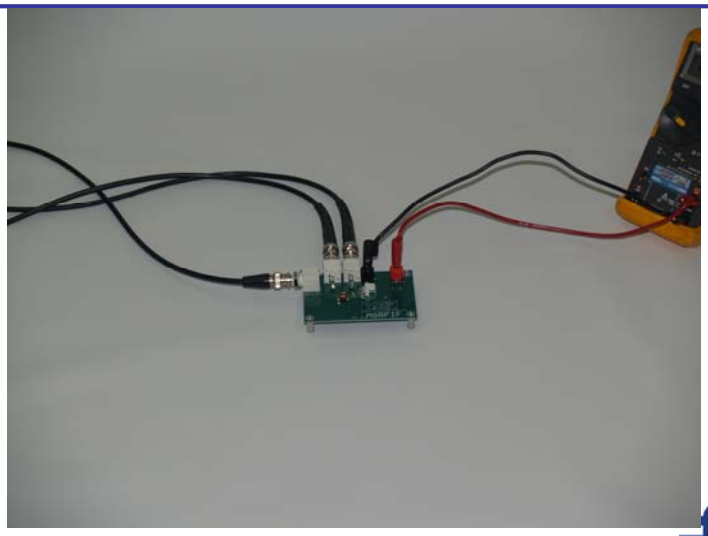
By adding fuze programmability, the projectile can be used for more than hard targets. Buried targets, that might require more delay can be programmed into the fuze, and in the case of soft targets, the projectile can be programmed to be set off above the target for maximum effect.

One Solution: RF Programming Benefits

- Smaller Antenna
- Programming Speed
- Smaller Electronics

By using radio frequency programming, rather than magnetic programming, the antenna is smaller. Also, with the higher carrier frequency, data rates can be increased for faster programming.

One Solution: RF Programming



This photograph is of the MSRFIF evaluation board. The MSRFIF is an integrated circuit with a high frequency charge pump, modulator and demodulator and power detect output. No power supply is needed. The received signal powers up the device and supplies up to 50 uA at 2.4V to other circuits. The device includes an AM and Bi-phase PSK demodulator. Low power microcontrollers can be powered by the MSRFIF.

For other applications, the received carrier can be modulated for a half-duplex communication link with the writer. Maximum frequency for the MSRFIF is 250 MHz. Maximum output voltage is clamped to 4V.

Comparison of RF to Magnetic

- RF Options
  - Smaller Antenna
    - Higher Frequency allows smaller antennas
  - Distance programming: inches, not contact
  - Programming speed
    - High carrier frequency for higher data rates
  - Writer size
    - As with the receiver, transmitter is smaller

Magnetic programming uses a collar around the fuze projectile. As the projectile gets smaller, this becomes less practical. Although one could redesign the chamber of the rifle to include the magnetic collar, this would require quite a bit of retrofitting. Also, it is unclear if the smaller magnetic collar would provide a strong enough signal to program the fuze

The magnetic signal would be limited to the data rate transmitted. Greater amount of information to the fuze would require more time than the RF option.

RF Options

- RF Options
  - Direct; stored for flight duration
  - Loaded to EE; for longer data storage

For radio frequency programming there are two approaches. One is to have the RF power up the device, store in a shift register and then fire. Depending upon the size of the capacitor on the VDD output, the data would be present for the entire flight of the projectile.

The other solution is to have a microcontroller with EEPROM, so data that is programmed can be stored for longer periods.

Technical Issues

- Getting the RF into the Bullet
- Programming Speed
- Antenna Size
  - Receiving enough RF energy in a short time
  - Forward acting antenna
- Unauthorized Programming
  - Can't program remotely; inches not feet
  - Encryption may be required for EEPROM
- Proving Safe and Arm not affected by RF

Since the smaller projectiles are usually all metal, it is more difficult to get the radio frequency to the antenna. Hornady is making polymer tipped bullets that should allow RF to penetrate the exterior of the bullet and reach the internal antenna. Another possibility is using a forward acting antenna that is placed on the ogive of the projectile.

Another question is whether the ammunition can be programmed just before firing or not. A fast rate of fire presents more technical challenges in getting the programming loaded in a timely manner.

Because the antenna and circuit can be designed to be less sensitive, the RF programming will not be the same as with a common RFID tag for retail applications which can be read 30 feet away. The fuze application calls for the writer antenna to be inches from the receiver. If the projectile contains memory, an encryption may need to be added to the microcontroller and memory.

Finally, there is some concern that the RF would set off the primers. Studies will be needed to show that the RF energy used to program is not enough to set off the primer.

Possible RF path: Writer to Cartridge

Since we didn't have a .50 caliber rifle in the safe, we went with a more difficult application for the RF projectile. Ares Defense Systems make a belt attachment for the AR15.

The photograph shows the programming distance is inches from the projectile and seconds before it is fed into the rifle.

Summary

Electronic fuzing is moving to smaller cannon and even bullets.

- Design to fit smaller munitions.
- RF approach provides smaller antennae, non-contact and faster programming.

Because the trend is to add fuzing to smaller projectiles, radio frequency programming will allow for smaller antennae, faster programming and non-contact programming.