



U.S. ARMY
RDECOM

***A Low Voltage
Command-Arm System
for Distributed Fuzing***



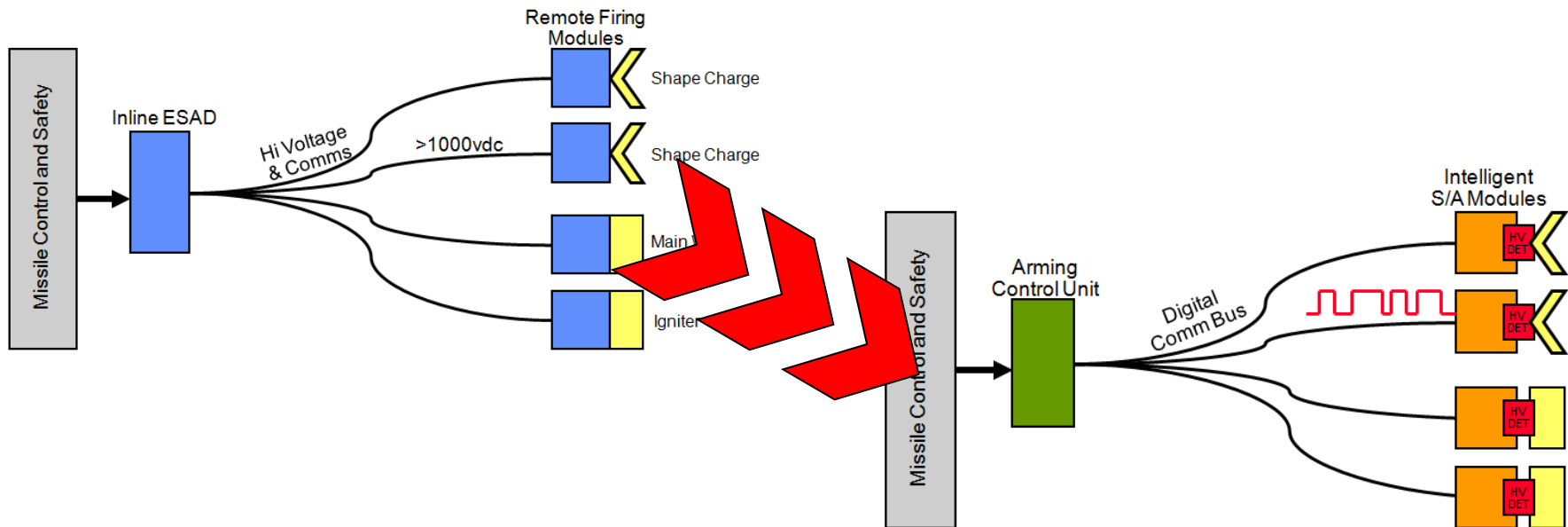
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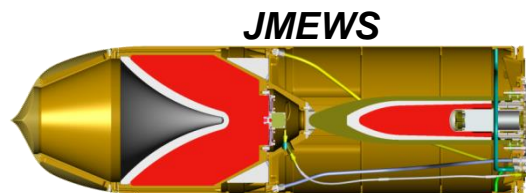
NDIA Fuze Conference
July 7-9, 2015
Baltimore, MD

Presented by:
Mark Etheridge
**U.S. Army Aviation and Missile Research,
Development, and Engineering Center**

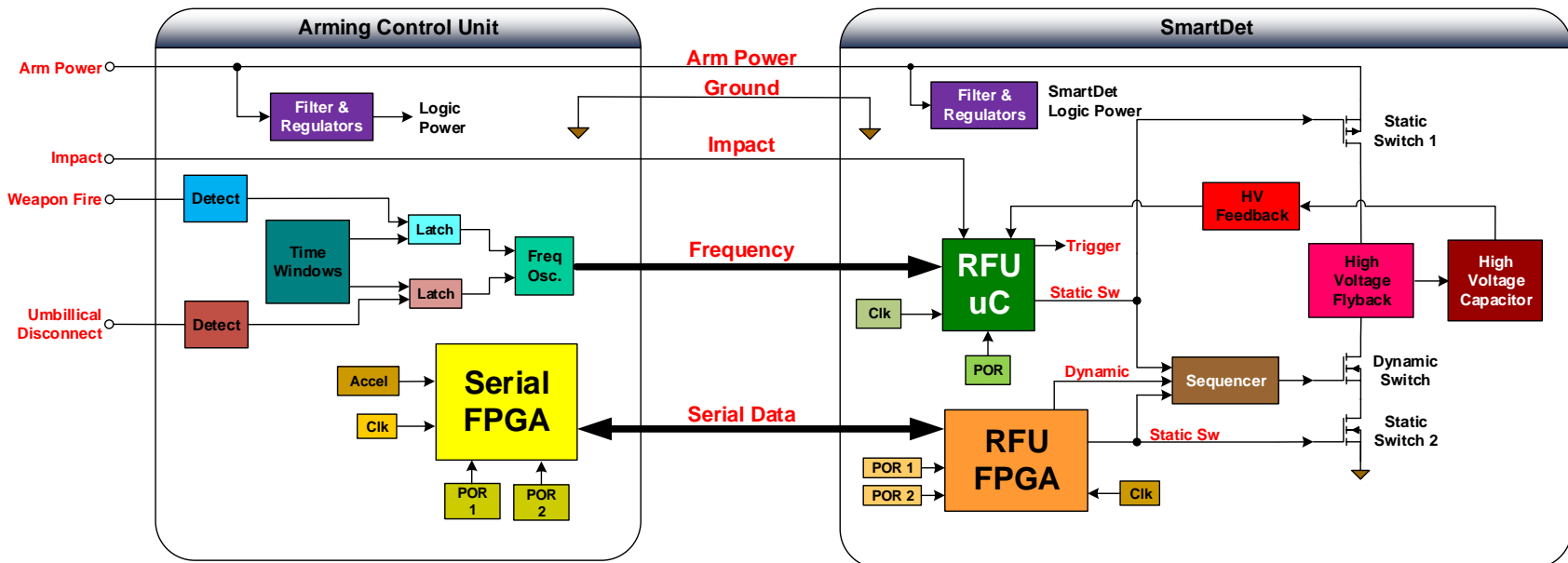
- This project is sponsored by the Joint Fuze Technology Panel (JFTP)
 - FATG II (Tailorable Effects)
- Paul Anderson, Naval Air Warfare Center
- Adedayo Oyelowo, Naval Surface Warfare Center



- **How complex is complex enough??**
- **The 6.2 JFTP sponsored project was successful in defining some minimal hardware & messaging guidelines.**
 - FESWG ‘approval’ in February, 2014.
 - JOTP document has been started.
- **A 6.3 program was accepted by the JFTP to pursue form, fit, and function designs targeting the following programs:**
 - Low-Cost Tactical Extended Range Missile (LC-TERM; Army).
 - Joint Multi-Effects Warhead System (JMEWS) program (Navy-China Lake).
 - High Reliability DPICM Replacement (Navy-Indian Head)



- **All designs will be based on the 6.2 Navy Architecture.**
 - Most compliant with the safety standards and feedback regarding low voltage signals.
 - JFTP recommendation to pursue a single design.
 - Goal is Initial Safety Certification or supportability statement from the Service Safety Review Authorities





Project Overview



- **Some unique aspects of the targeted applications...**
 - LC-TERM: will include warhead fuzing **and** rocket motor ignition.
 - HRDR: minimum 56 sub-munitions to arm; available sub-munition volume is very limited.
 - JMEWS: arming environment signals...airspeed thru pitot tube and turbogenerator sense signal
- **Block diagrams for all applications have been developed. In beginning stages of detailed designs.**

How complex is complex enough??

Proposed FESWG guidelines

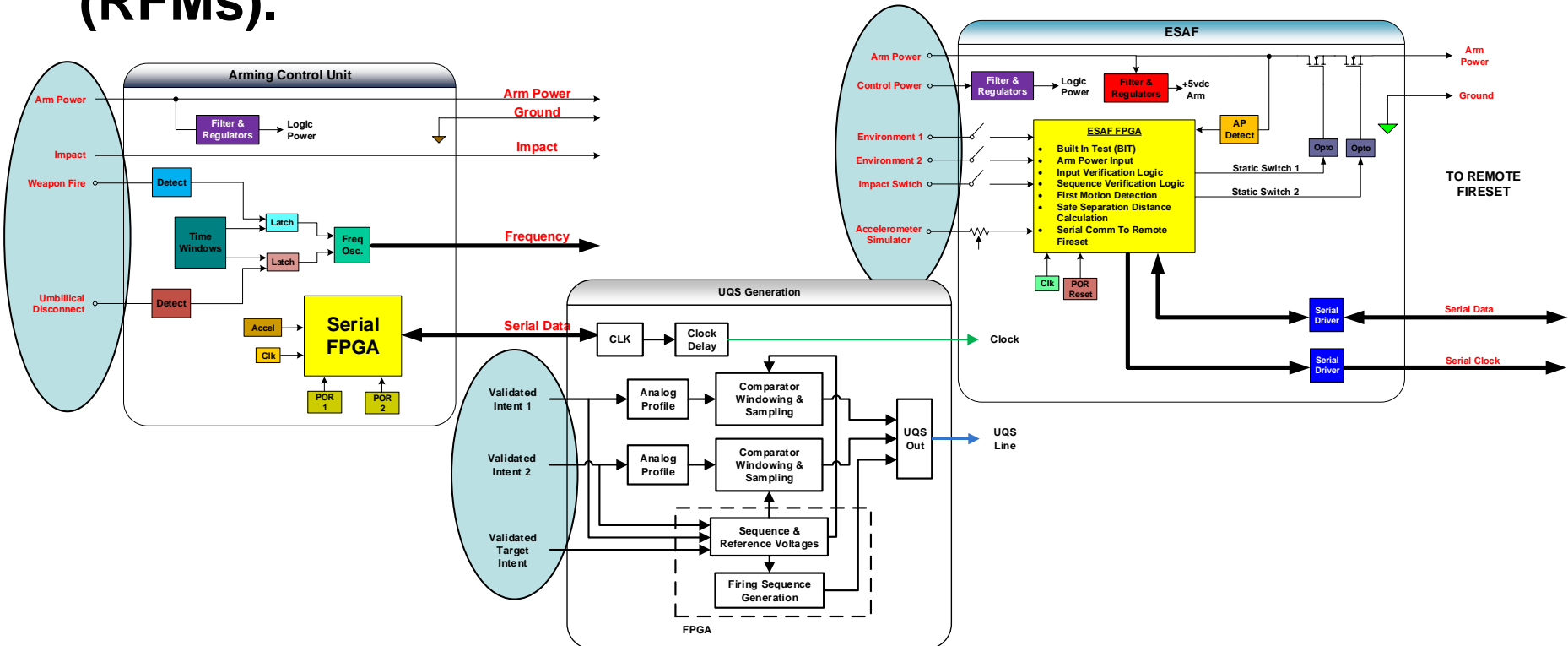
DISCLAIMER!!

The following slides are *proposed guidelines*.

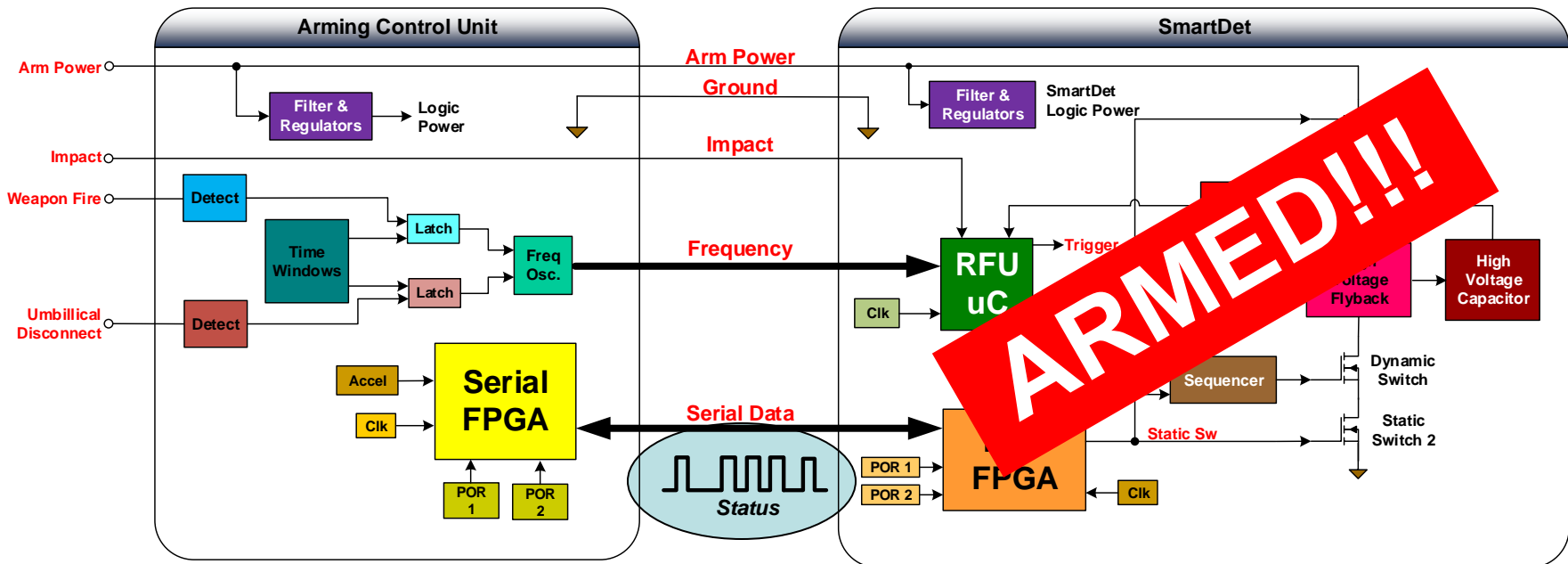
They have not been reviewed in detail by any fuze-related Safety Community organization (such as the FESWG)

Arming Control Unit (i.e. the Master S&A)

- The ACU *shall* directly sense, process, and validate the physical arming environments and transmit the subsequent arming signals to the remote firing modules (RFMs).

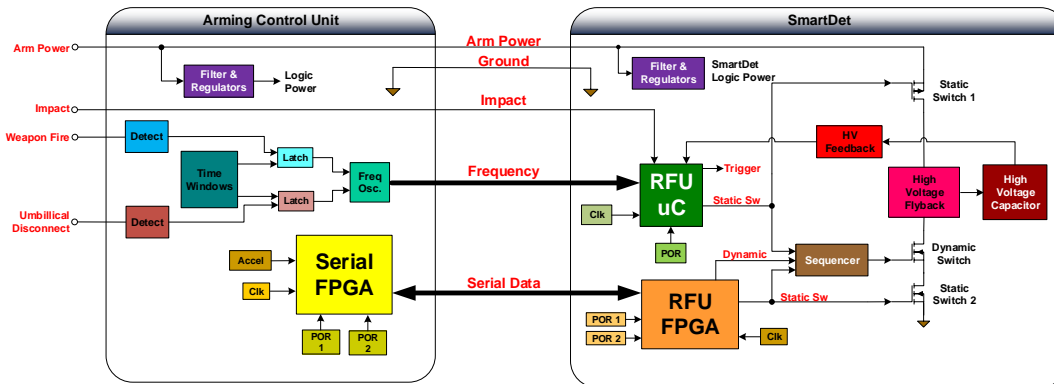


- The ACU *shall* maintain an active link with all RFMs that are in use after the fuze system is properly armed.

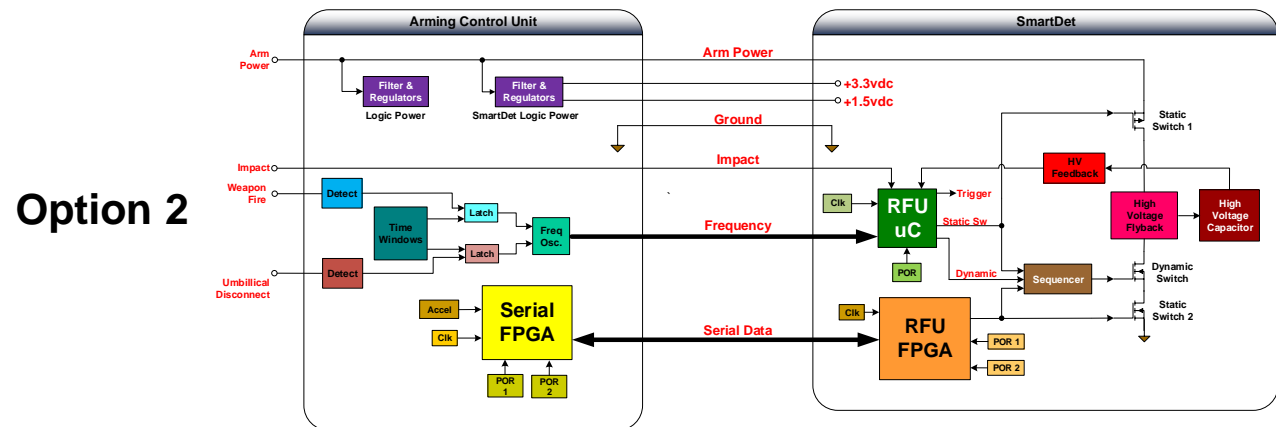


Proposed Guidelines

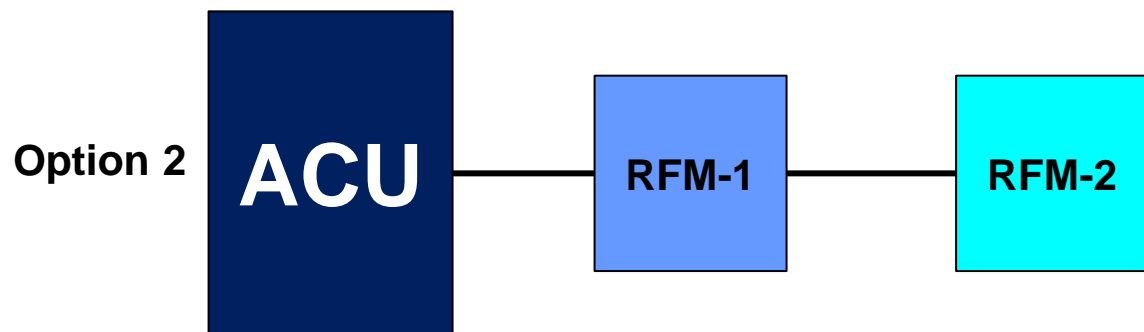
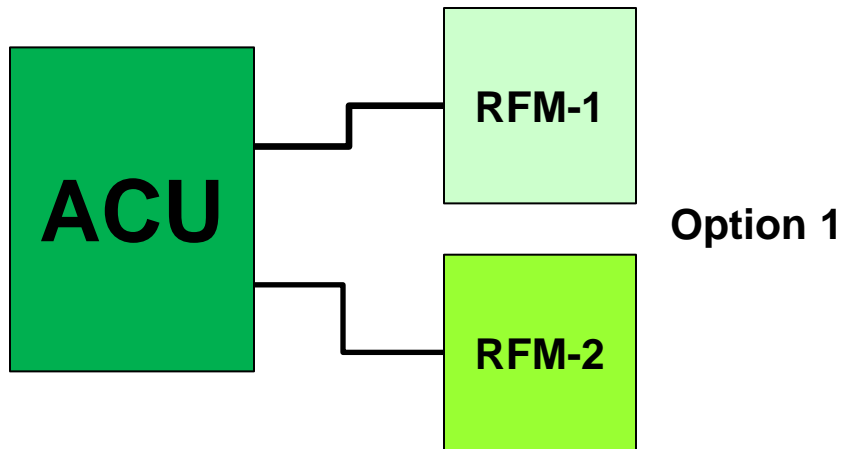
- The ACU *shall* source all power for the RFMs including Arm Power. All power slated for the RFM *should* be partitioned from other power such as ‘electronics’ power



Option 1

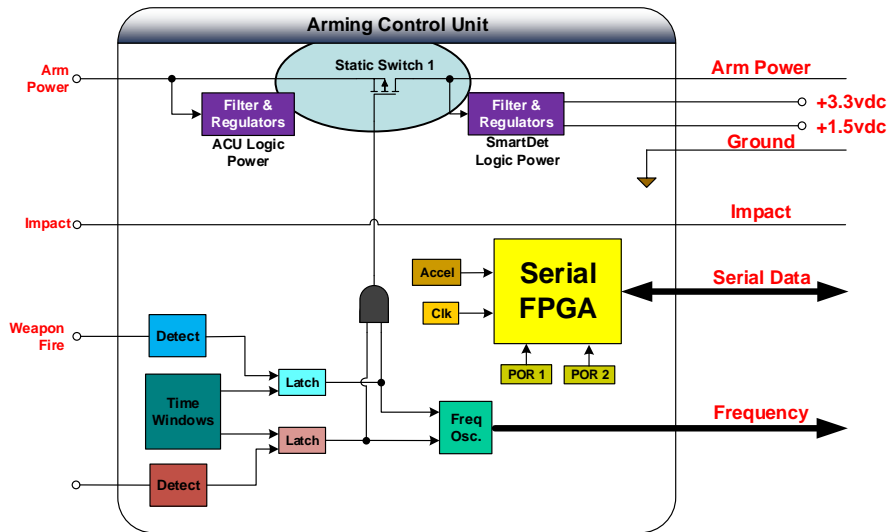


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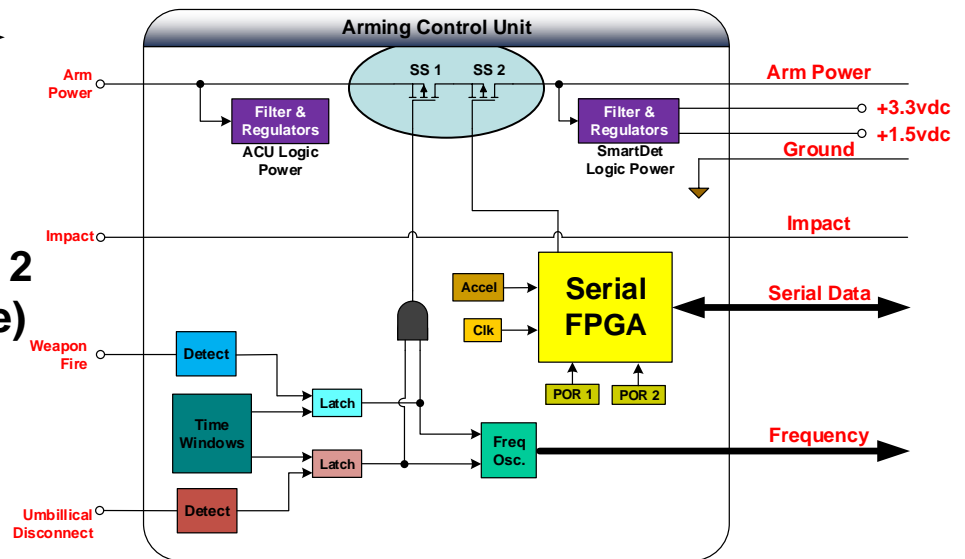
Proposed Guidelines

- The ACU may contain one or more 'static' safety feature(s) for the control of Arm Power to the RFM



Option 1
(Viable)

Option 2
(Maybe)





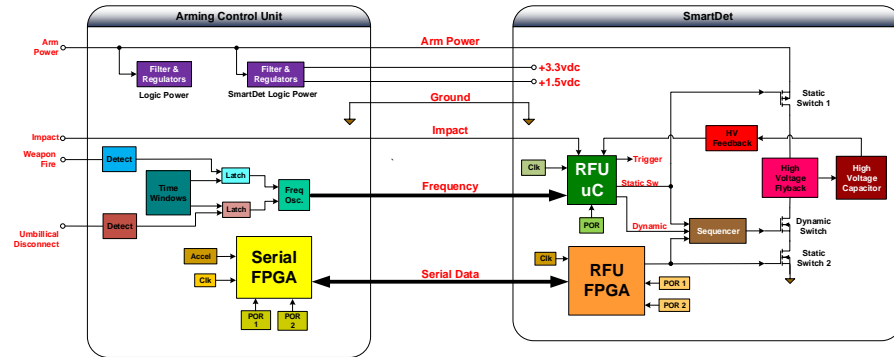
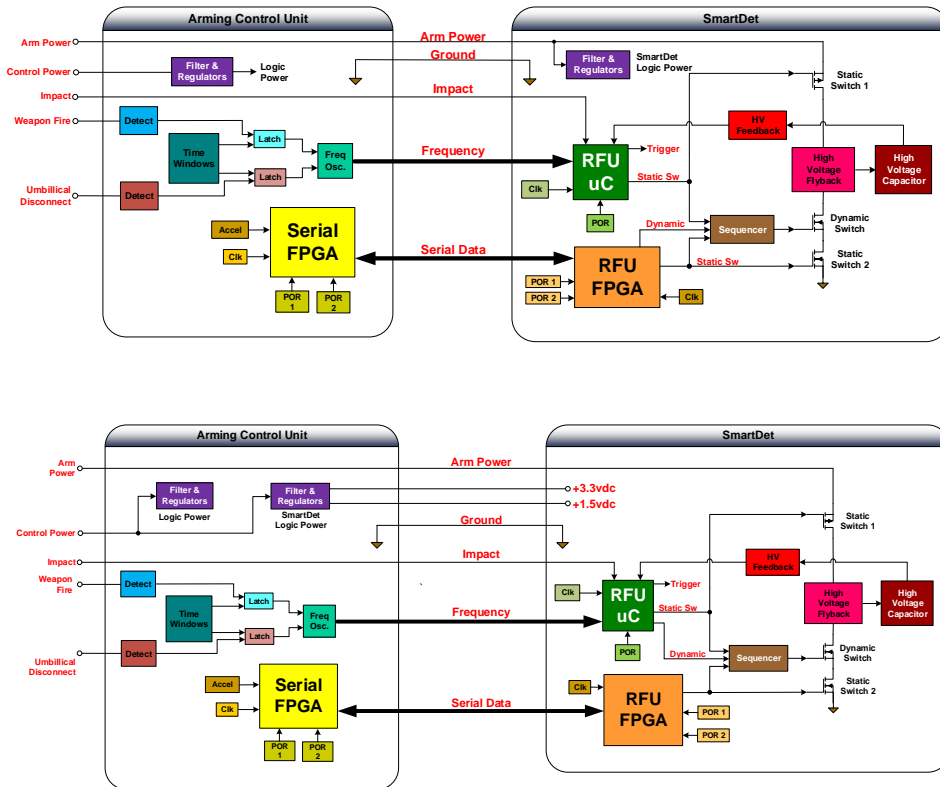
Proposed Guidelines



- There *shall* be no inadvertent release of any arming signals by the ACU during and after exposure to power transfers, transitions, and/or transients.
- There *shall* be no inadvertent release of any arming signals by the ACU during and after exposure to all credible electromagnetic environments that the applicable weapon system will be exposed to.

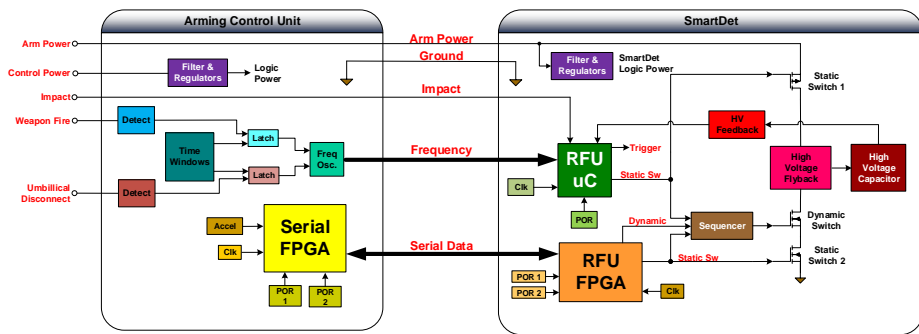
Remote Firing Module

- The RFM *may* be powered utilizing 'Arm Power' when practicable.

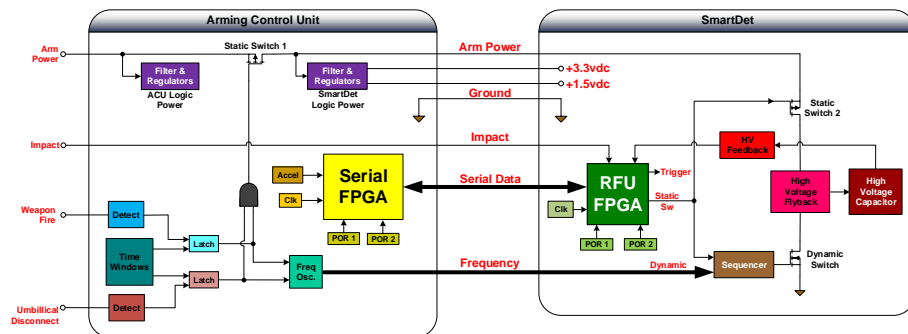


Proposed Guidelines

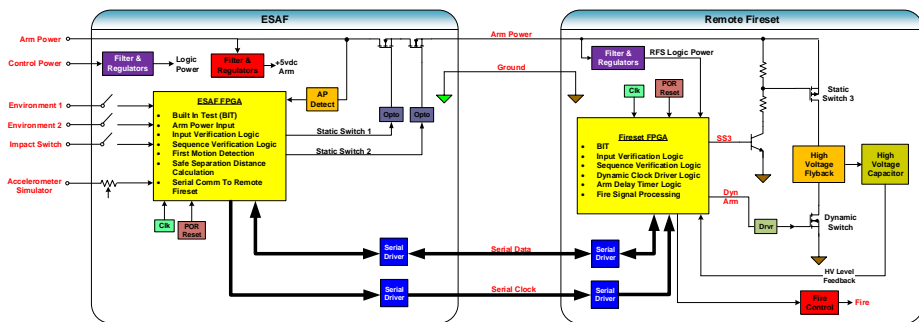
- The RFM shall contain at least one 'static' safety feature for interrupting energy to the high voltage transformer.



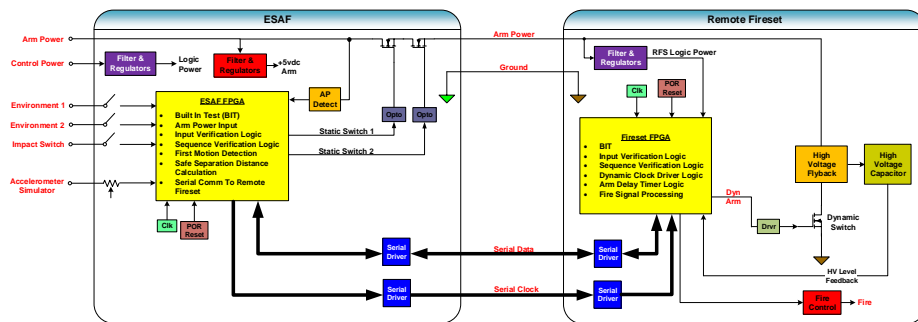
YES!!



YES!!



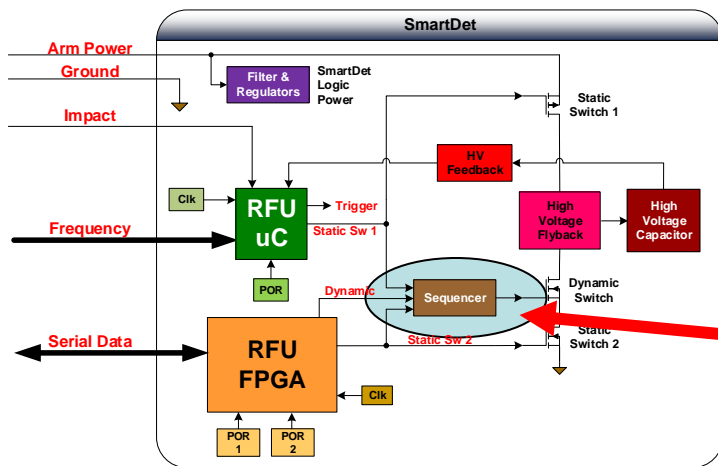
YES!!



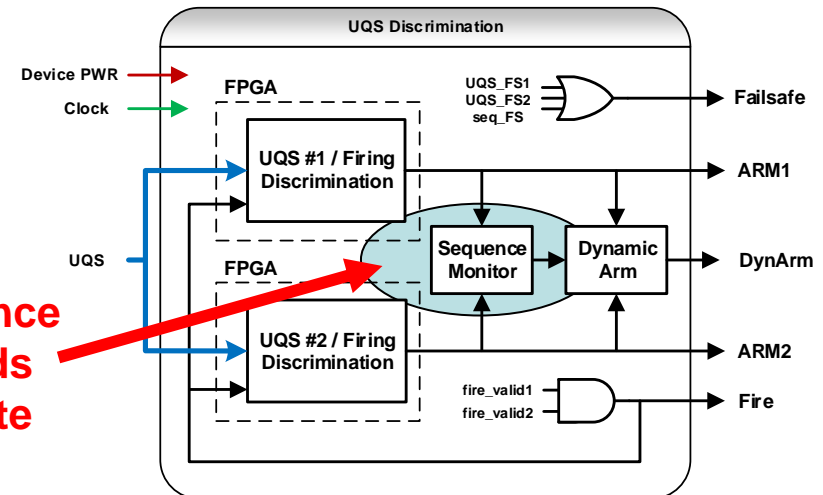
NO!!

Proposed Guidelines

- Power for the RFM *should* be applied as late in the launch sequence or operational deployment as practical.
 - Why?? Additional measure to mitigate the possibility of inadvertent release of low voltage arming signals
- Dynamic signal generation for driving the high voltage transformer *shall* be performed at the RFM.
- Sequence monitoring *shall* be performed at the RFM at a minimum.



Preference towards discrete



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Proposed Guidelines



- **There shall be no inadvertent activation of any safety features located on the RFM during and after exposure to power transfers, transitions, and/or transients.**
- **There shall be no inadvertent activation of any safety features located on the RFM during and after exposure to all credible electromagnetic environments that the applicable weapon system will be exposed to.**



Proposed Guidelines



Arming Signals/Commands

- There *shall* be a minimum of two arming signals transmitted to the RFM for proper arming of the fuze system.
- Each command message *shall* be unambiguous, to the extent possible, from any and all other command messages.
 - Ex: Navy Design utilizes frequency (actually frequency shift) and serial message (minimum 17 bits flipped between 'Arm!' and 'Safe' cmds)
- If practical, no more than one of the arming signals may be utilized for additional functions within the fuzing system.
 - Ex: Navy Design...utilizing the upper frequency of the frequency shift for the Dynamic signal

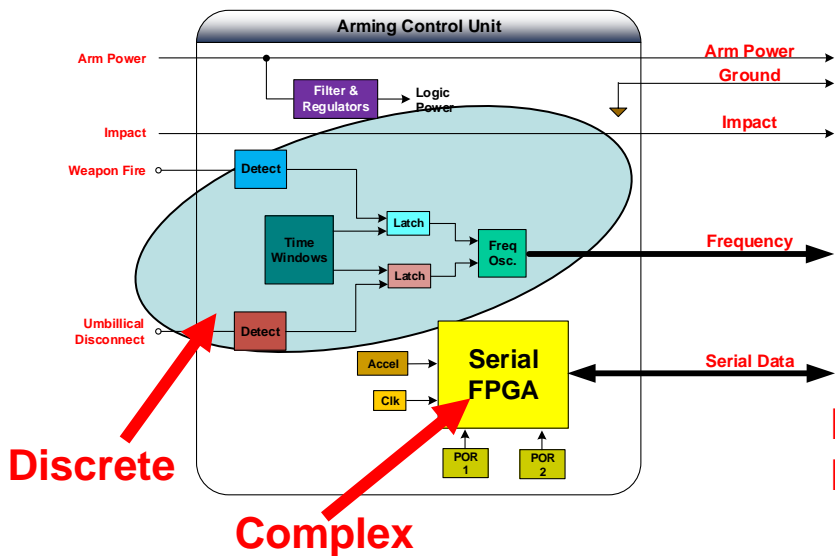


Proposed Guidelines

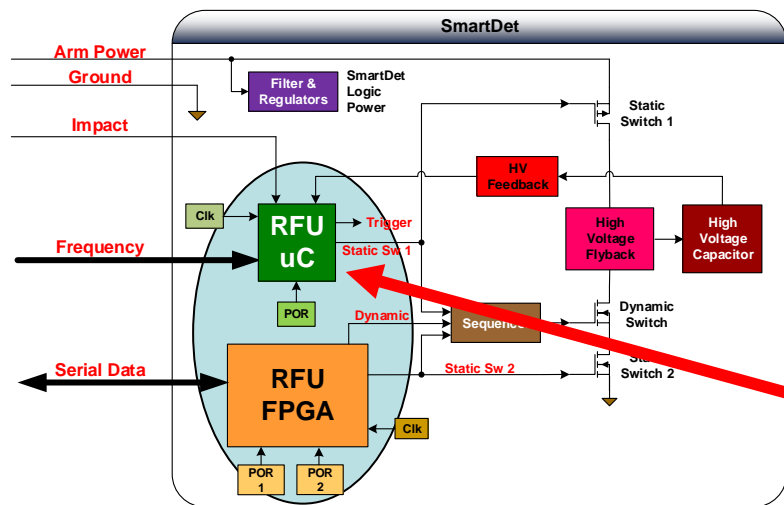
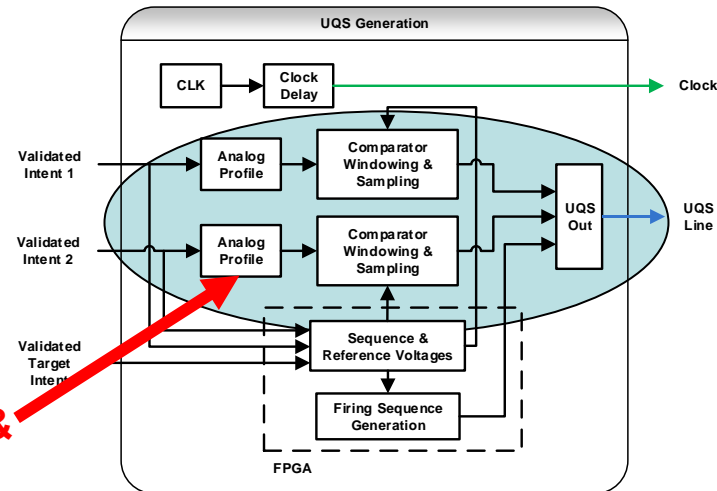


- The generation and transmission of the arming signals *shall* be implemented with independent logic devices that are physically and functionally partitioned from each other. Where *practical*, at least one arming signal shall be generated utilizing discrete components.
- The generation of the arming signals *shall* be implemented with dissimilar logic devices. The degree of dissimilarity *shall* be sufficient to ensure that any credible common cause susceptibility will not result in an inadvertent arming signal transmission in other logic devices.
- The requirements outlined above *shall* also apply to the processing of the received arming signal at the RFM and subsequent activation of any safety features contained within.

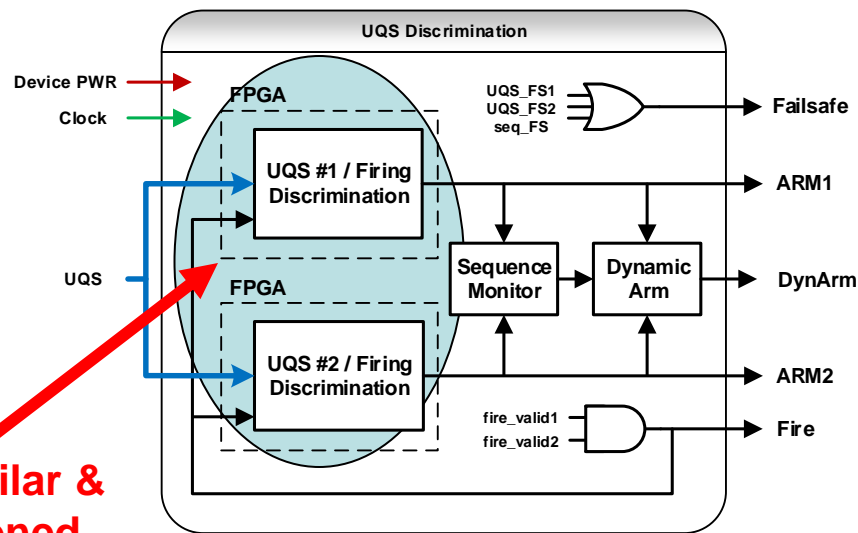
Proposed Guidelines



Dissimilar & Partitioned



Dissimilar & Partitioned





Proposed Guidelines



Serial Commands

- The length of a command message *shall* be 20 bits at the minimum. This does not include any start, stop, or message reliability bits..
- The *preferred* method for utilizing serial communications is to generate the command word based on events that occur throughout an arming environment. Transmission of the command word *will only occur* upon verification that the specific arming environment has been achieved..
 - Question becomes what is the maximum number of bits per event in order to build the message.



Proposed Guidelines



- **Where generation of the serial command *is not practicable*, pre-defined serial commands *may* be utilized. The commands must be further distinguished by a minimum of two additional features in order to mitigate the possibility of inadvertent release.**
 - Features could include multiple (more than two) messages, sequencing, sending each message at a different frequency
- **Susceptibility to improper serial data shall be characterized through sending a minimum of 100,000 randomly generated serial messages to the RFM and monitoring the status of all safety features. If the arming commands contain start, stop, and/or message reliability bits, those bits should be held in a static position within the randomly generated message.**



QUESTIONS?

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AMRDEC Fuze Office



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