Agenda

• Selective Switch History
• ControlFire Advanced Switch System
• Applications
• System Overview
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• Benefits and Features
• Developments
• Track Record
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Selective Switch History

• **1960’s Rotary Select-Fire Switch**
  – Negative power to switch
  – Positive power to fire
  – 10-11 guns per run
  – Dart activation to cut thru wires and seal the tandem sub
  – Skip over capability

• **1970’s, Dart and Diode Switches**
  – Reduce the maintenance issues associated with Rotary Systems
  – Dart would cut thru wires and provide grounding for the detonator
  – Diodes kept the next gun in the string from firing
  – System had a history of not providing positive grounding resulting in miss-run
  – Miss-run required guns to be retrieved from the well for repair

• **1980’s, EBS Pressure Activated Piston and Diode Switch**
  – System uses a pressure activated piston and diodes to provide the connection to the detonator and provide the seal between guns.
  – Switch can be used with gun of any length, size, or shot density
  – Short coming is it is a sequentially operated system, if a failure occurs in the fire sequence the gun must be retrieved from the well for repair
Optimal Selective Switch Solution

- **Added level of Safety** – detonator is never electrically connected until specific software command is sent
- **Non Sequential Operation** – independent switch that does not rely on previous gun success
- **Skip over Capabilities** – provide valuable time savings as perforating operations can continue in the case of a gun misfire
- **Positive Shot Indication** – confirmation of firing, especially in deep, horizontal well conditions
- **User Friendly System** – avoid user positive/negative wiring mistakes leading to off depth perforations
- **Eliminate Premature Activation** – gun flooding causing piston activation leading to off depth perforations
- **Operational Confirmation** – gun string confirmation throughout the descent into the wellbore providing real time confirmation before critical operations commence
ControlFire Advanced Switch System

ControlFire® is a digital switch technology that utilizes unique logic to enable selective operations.

Applications

- Selective Perforating
- Single Trip Plug and Perforating Operations
- Pumpdown Perforating
- Tractor Perforating
- Selective Downhole Tool Control
The ControlFire system consists of four primary components:

- ControlFire software
- Perforating Command and Control Panel
- ControlFire switch
- VeriFire®
ControlFire Software

- Switch commands fully automated with software controlled command and control panel
- ControlFire Gun Control operation window
- Graphical display of each switch status
- ControlFire Job Setup window
- User friendly, Graphical User Interface (GUI) software
- Compatible with Windows XP/7
Perforating Command and Control Panel

- Perforating Command and Control Panel connects the shooting panel and wireline
- Fully automated software driven panel
- Relay disconnect when switch communications are not in progress
- On/Off key for power off confirmation
- Gun Communication Limits:
  - Max Voltage: -600VDC
  - Max Current: 100mA
- Available as a portable box, rack mount or integrated into the Titan Shooting Power Supply rack
ControlFire switch circuit consist of 3 primary components:

- **Intelligent Micro Processor** – Controls the switch position and communicates state
  - Transmitter
  - Receiver
- **Detonator Switch** – remains in open state until Enable Fire command is received to connect to the detonator/igniter
- **Wireline Switch** – remains in open state until communication is establish and command is received to close
VeriFire® Switch Tester

- Portable ControlFire switch tester
- Enables the surface testing of the entire gun string before attaching to the wireline (armed or unarmed)
- Performs switch safety checks and reports failed switch test
- Gun string saved to USB drive for upload into ControlFire software for gun string verification
- User friendly graphical interface
- Improved confidence before running in hole
ControlFire Gun Wiring
ControlFire Gun/Plug Shoot Wiring

To Gun Above

To Setting Tool
ControlFire Safety Benefits

- ControlFire switches add an additional layer of safety to perforating operations:
  - Each ControlFire switch must be activated with specific software command to establish continuity to the detonator/igniter
  - Aids in the prevention of potential surface detonation due to power remaining on the wireline
  - Automatically aborts the firing sequence and shuts down in the event a circuit fault is detected or an inappropriate command is received
  - Automatically times out, if the user does not perform require action in a given time period
ControlFire Operational Benefits

- Unique switch logic enables skip over capabilities providing valuable time savings in the case of misfire
- Eliminates potential off-depth perforating events due to improper mechanical switch wiring and/or premature activation due to gun flooding
- Increased reliability and efficiency of electronic switch over conventional mechanical components
- Switch communication verification prior to, and during, decent into the wellbore
- Improved confidence prior to pumping operations
- Reduced maintenance through fully expendable switch system
ControlFire Features

- Real time surface shot verification with voltage/current plot
- Shoot 100+ guns in a single run
- Integrates into existing perforating gun carrier systems
- Compatible with resistorized and RF safe detonators
- Complete event log stored on file
- Compatible with long wireline cables
- Can be run in combination with perforating gamma ray tools
- Reliable operations up to 347°F (175°C)
- No need for dedicated computer at surface
- Software compatible with Windows XP/7
RF-Safe System

**RF-Safe ControlFire Assembly (CFA)**

ControlFire technology combined with Austin Powder resistorized detonator for completely RF Safe ControlFire Assembly (CFA)

- Added level of safety
- No need for radio silence prior to arming
- Immune to stray voltage up to 500 VDC
- Immune to human-borne electrostatic discharge energy

- No need for PX-1 or high voltage firing
- Low cost compared to EFI and EBW detonators
Operational Summary

• Four year track record
  • ~750,000 switches run in wells
  • .0005% switch failure rate (better than 1 in 200,000)

• 2014 Track record:
  • ~170,000 switches run in wells including 100,000 RF-Safe Assemblies

• 2015 Track record:
  • ~170,000 switches run in wells including 100,000 RF-Safe Assemblies

• 2016 Track record:
  • ~180,000 switches run in wells including H1 and CFA
# ControlFire Specifications

## ControlFire® Switch Specifications

<table>
<thead>
<tr>
<th><strong>ENVIRONMENTAL</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temperature Range</td>
<td>-20 °F (-29 °C) to 347 °F (175 °C)</td>
</tr>
<tr>
<td>Survival Temperature</td>
<td>-68 °F (-50 °C) to 392 °F (200 °C)</td>
</tr>
<tr>
<td>Max Thermal Change</td>
<td>9 °F (5 °C) / Minute</td>
</tr>
<tr>
<td>Vibration Compliant</td>
<td>Compliant to all hollow carrier gun systems</td>
</tr>
<tr>
<td>Vibration (3 axis)</td>
<td>50 g RMS @ Sweep Frequency 50-1000 Hz</td>
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</table>

<table>
<thead>
<tr>
<th><strong>ELECTRICAL</strong></th>
<th></th>
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<tbody>
<tr>
<td>Operating Voltage Range</td>
<td>-5 VDC to -550 VDC</td>
</tr>
<tr>
<td>Operating Current – Standby</td>
<td>&gt;1mA</td>
</tr>
<tr>
<td>Current – Communicating</td>
<td>10mA at Surface 30mA Downhole</td>
</tr>
<tr>
<td>Bi-directional Communications</td>
<td>Bi-directional</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th><strong>COMPATABILITY</strong></th>
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<tbody>
<tr>
<td>Detonators – Hot Wire</td>
<td>50 ohms or higher (single or double resistor types)</td>
</tr>
<tr>
<td>Igniters – Setting Tools</td>
<td>50 ohms or higher</td>
</tr>
<tr>
<td>RF Safe Detonators</td>
<td>PX-1/EBW, RED (all versions)</td>
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## Titan Part Numbers

<table>
<thead>
<tr>
<th>ControlFire® Switch System</th>
<th>Part Number</th>
</tr>
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<tbody>
<tr>
<td>ControlFire Switch v1.8</td>
<td>9002-013-120-1.8</td>
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<tr>
<td>Command and Control Panel (portable)</td>
<td>9002-013-510</td>
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<tr>
<td>Command and Control Panel (rack mount)</td>
<td>9002-013-550</td>
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<tr>
<td>VeriFire Panel</td>
<td>9002-013-210</td>
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<tr>
<td>Wireline Switch Simulator Panel</td>
<td>9002-013-610</td>
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<tr>
<td>Panel External Test Block</td>
<td>9002-013-320</td>
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<tr>
<td>Cable Kit</td>
<td>9002-013-017</td>
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<tr>
<td>EBFire Feed Thru w/ Ground</td>
<td>9400-EBTW-WG</td>
</tr>
<tr>
<td>EBFire Feed Thru</td>
<td>9400-EBTW</td>
</tr>
<tr>
<td>Retainer Nut – ¼” ID w/ Ground</td>
<td>9400-EBRN-WG</td>
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<tr>
<td>Retainer Nut – ¼” ID</td>
<td>9400-EBRN-250</td>
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## RF-Safe ControlFire® System (with Austin Powder detonator selection)

<table>
<thead>
<tr>
<th>Description</th>
<th>Part Number</th>
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<tbody>
<tr>
<td>RF-Safe Switch with A-85 Detonator</td>
<td>DETO-CFA-A85-T</td>
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<tr>
<td>RF-Safe Switch with A-96L Detonator</td>
<td>DETO-CFA-A96L-T</td>
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<tr>
<td>RF-Safe Switch with A-105 Detonator</td>
<td>DETO-CFA-A105-T</td>
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<tr>
<td>RF-Safe Switch with A-105-100 Detonator</td>
<td>DETO-CFA-A105100-T</td>
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<tr>
<td>RF-Safe Switch with A-140 Detonator</td>
<td>DETO-CFA-A140-T</td>
</tr>
<tr>
<td>RF-Safe Switch with A-140F Detonator</td>
<td>DETO-CFA-A140F-T</td>
</tr>
<tr>
<td>RF-Safe Switch with A-140S Detonator</td>
<td>DETO-CFA-A140S-T</td>
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</tbody>
</table>

## Titan Shooting Power Supply

<table>
<thead>
<tr>
<th>Description</th>
<th>Part Number</th>
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</thead>
<tbody>
<tr>
<td>ControlFire Shooting Power Supply</td>
<td>9002-013-810-1</td>
</tr>
</tbody>
</table>
Contact

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