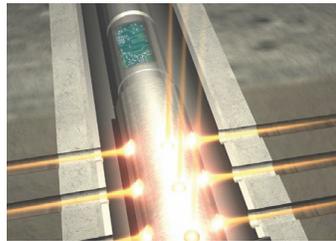


# MaxFire<sup>®</sup> Electronic Firing Systems

**FLEXIBILITY AND RELIABILITY FOR CHALLENGING AND COMPLEX WELLS**



**JRC**

**JET RESEARCH CENTER<sup>®</sup>**

# Four MaxFire® EFS Options Improve Safety and Performance

The Halliburton MaxFire® electronic firing system (EFS) has numerous built-in features that enable explosive tools to be deployed and initiated safely. Halliburton makes four versions of the MaxFire system – one for tubing-conveyed perforating (TCP), one for slickline (SL) and coiled tubing (CT), one for RELAY™ digital slickline (DSL), and a Command MaxFire Multi-Shoot SL system for RELAY DSL. Regardless of conveyance, the MaxFire systems have become synonymous with safety, precision and flexibility. These systems are available in different pressure ratings (40,000 psi vs. 20,000 psi, or 276 MPa vs. 138 MPa) and outside diameters (2.125 in. vs. 1.69 in., or 53.98 mm vs. 42.93 mm). Depending on the specific need of the operation, different options exist for key capabilities and features, such as triggering mechanisms (pressure sequence, time, motion, RELAY DSL command), data recording ability, speed of deployment, and select-fire capabilities (see comparisons on pages 4, 5 and 6).

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## MEETING TODAY'S TOUGHEST CHALLENGES

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As wells become more challenging and complex, the MaxFire systems' unmatched specifications, robustness and flexibility help manage exploration and production efforts cost effectively.

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## FLEXIBLE ENOUGH FOR VIRTUALLY ANY NEED

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These four different tools make the Halliburton MaxFire EFS family ideal for a variety of challenging applications and environments. This brochure will help you understand each tool, so that you can determine which one best fits your needs.

### Perforating

For TCP, the MaxFire tools' high load-bearing capacity enables them to perforate several kilometers per run, saving significant cost. The Command MaxFire Multi-Shoot SL system can be set up for select-fire perforating.

### Cutting Pipe/Pipe Recovery

The slickline version's speed makes it ideal for cutting pipe during interventions, which can also result in significant cost savings. MaxFire tools can initiate any type and size of cutter for severing pipe.

### Setting Plugs and Packers

The speed of the slickline version also makes it attractive for setting plugs and packers in situations where customers wish to use explosives for that purpose. The Command MaxFire Multi-Shoot system can be utilized for plug and perforation operations.



# RF-Safe Rig Environment Detonator (RED<sup>®</sup>)

Each variation of the MaxFire system utilizes the industry-leading Halliburton RED<sup>®</sup> tool for initiating perforating guns. This tool has proven its value in thousands of wells.

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## MULTIPLE LEVELS OF BUILT-IN SAFETY PROTECTION

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A top-fire design provides significantly improved safety compared to conventional resistor-based devices. And because the RED tool is radio-frequency (RF) safe, wellsite communication can continue during perforating without fear of accidental detonation from radio signals.

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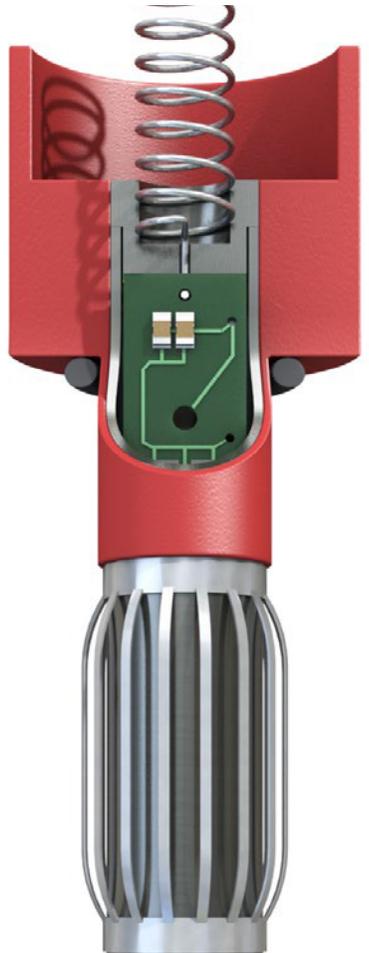
## BETTER THAN CONVENTIONAL DETONATORS

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The RED tool is a simple, economical and offshore-safe substitute for resistorized exploding bridge wire (EBW) and exploding foil initiator (EFI) detonators. When used with a scalloped gun where a fluid-disabled feature is not required, the RED tool is rated up to 375°F (191°C) for an hour. It can also be used with tubing and casing cutters – in essence, all pipe recovery operations. In addition to being RF safe, the RED tool allows many normal rig operations, including welding and cathodic protection, to continue uninterrupted while perforating. It does not require special firing panels or downhole firing units.

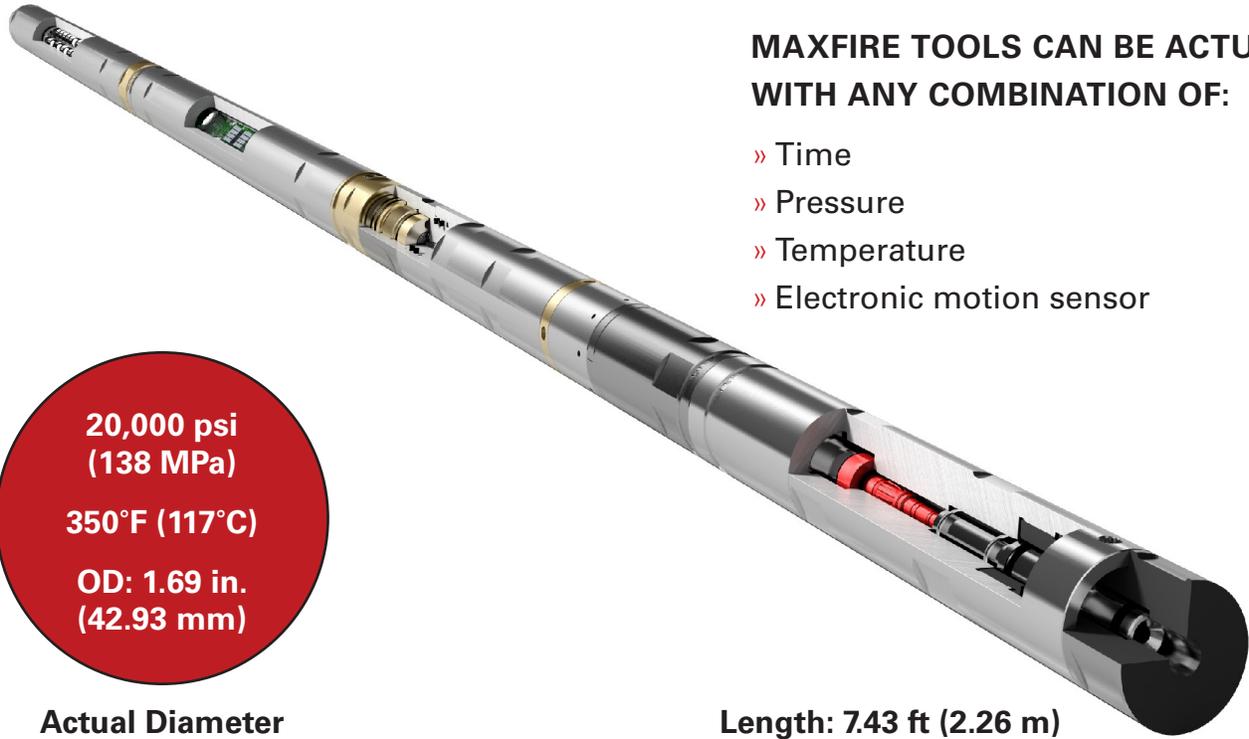
## Sensor/Trigger Options Improve Safety

To prevent accidental detonation, the MaxFire system uses multiple sequences to activate the trigger. The tool can monitor temperature, pressure, tool motion and time. In specific applications, an initial run in the hole can gather this data, so that the tool can be precisely set to each unique initiating environment. The MaxFire tool will only go into firing mode when conditions and preprogrammed sequences match the distinctive planned values or the specified combinations of these variables, thus ensuring a safe electronic firing system.



*Using controlled pressure cycles, operators can reset or halt the firing sequence at any time by bleeding down the pressure in the well or by moving the tool.*

# For Slickline or Coiled Tubing



## MAXFIRE TOOLS CAN BE ACTUATED WITH ANY COMBINATION OF:

- » Time
- » Pressure
- » Temperature
- » Electronic motion sensor

20,000 psi  
(138 MPa)

350°F (117°C)

OD: 1.69 in.  
(42.93 mm)

**Actual Diameter**

**Length: 7.43 ft (2.26 m)**

Improving worksite safety are the many ways to trigger the SL/CT version of the MaxFire electronic firing systems. These triggering options eliminate the need for electric line (e-line) to trigger explosives – thus creating a cost advantage over many competing systems.

## BENEFITS

The small MaxFire SL/CT tool can:

- » Record data before, during and after detonation
- » Record days longer than competing tools, at greater frequencies and higher resolutions

Such data provide valuable insights that can help lead to better decisions and higher production.

## KEY CAPABILITIES

- » Memory = 16 MB
- » Can record downhole for up to six days
- » Captures data before, during and after detonation
- » Sampling rates
  - Normal mode: 1 sample/second
  - Trigger mode: 10 samples/second for 2 minutes, and 1 sample/second after 2 minutes
- » Ideal for pipe recovery
- » Load capacity limited only by strength of conveyance
- » Tool must sit still to enter firing mode

# For Tubing-Conveyed Perforating

## MAXFIRE TOOLS CAN BE ACTUATED WITH:

- » Electrical sensors that respond to a combination of pressure and temperature
- » Mechanical sensors that respond to a combination of pressure and temperature
- » A specified pressure signature (variations over time, like Morse code)



40,000 psi  
(276 MPa)

350°F (117°C)

OD: 2.125 in.  
(53.98 mm)

**Actual Diameter**

**Length: 8.84 ft (2.69 m)**

The MaxFire electronic firing system for tubing-conveyed perforating differs from the slickline version. Optimized for different applications and environments, it boasts the highest pressure rating in the industry – 40,000 psi (276 MPa). This makes the MaxFire EFS the tool of choice in ultra-deepwater environments. The triggering pressure of other tools may exceed the pressure limit of the casing used at the bottom of ultra-deep wells. In such cases, the MaxFire system can be triggered after recognizing a specific sequence of very small pressure variations over time.

With the escalating costs of rig time and the safety concerns with running a perforating string, it is necessary to have the ability to run redundant firing heads. The TCP MaxFire EFS has mutable accessories that provide the ability to run redundant systems in tandem above or below any string design. The dual-firing-head carrier allows two TCP MaxFire systems to be run on top and/or bottom of the perforating string, thus providing the capability to run four independent firing heads at once.

## BENEFITS

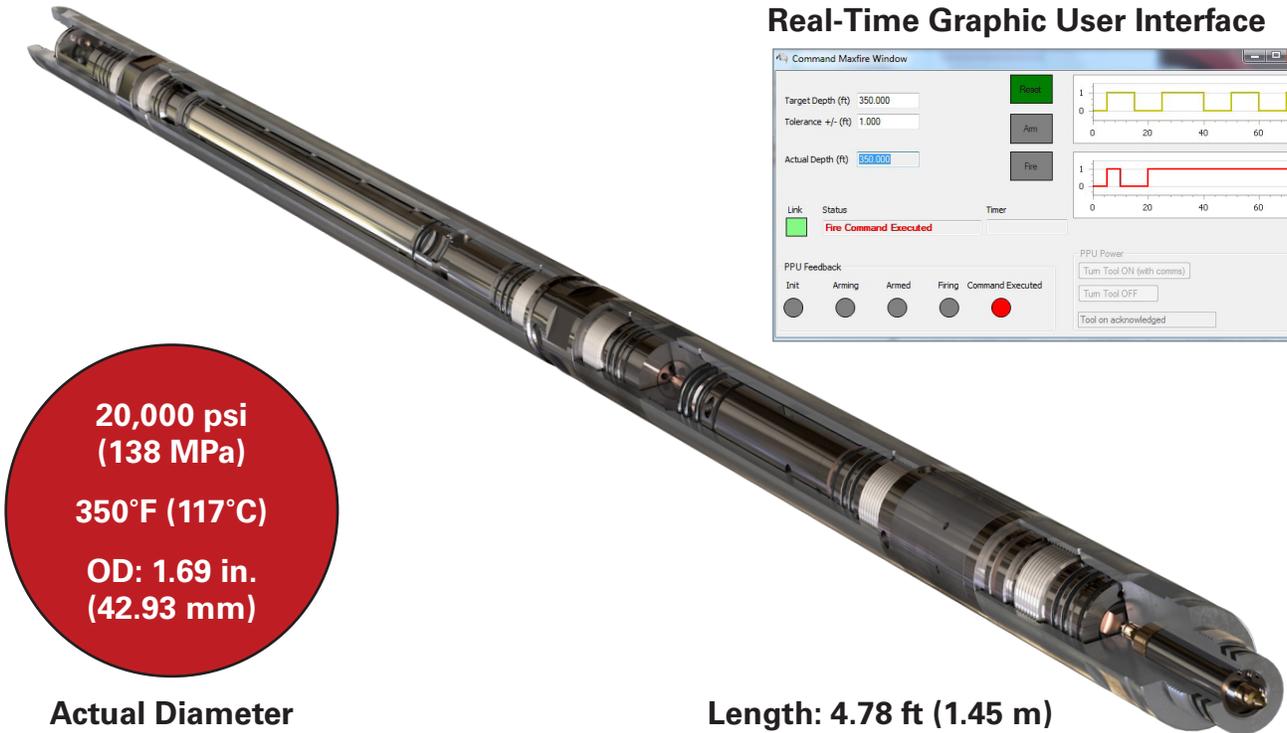
Compared to competitive solutions, the MaxFire system, designed for tubing-conveyed perforating, is rated to an industry-leading 40,000 psi and can:

- » Trigger after recognizing a specific pressure variation sequence
- » Record downhole data for up to 30 days (approximately five times longer than the next best competing tool)
- » Detonate strings of perforating guns several kilometers long
- » Act as a primary or secondary firing head

## KEY CAPABILITIES

- » Memory = 16 MB
- » Can record downhole for up to 30 days
- » Captures data before and during detonation
- » Sampling rates
  - 0.25 samples/second in normal mode
  - 10 samples/second in trigger mode, lasting for 2 minutes
- » Ideal for ultra-high-pressure wells
- » Load capacity limited only by strength of shroud
- » Able to perforate thousands of feet at a time

# RELAY™ DSL Explosive Trigger



**20,000 psi  
(138 MPa)**

**350°F (117°C)**

**OD: 1.69 in.  
(42.93 mm)**

**Actual Diameter**

**Length: 4.78 ft (1.45 m)**

The Command MaxFire and Command MaxFire Multi-Shoot systems are set up for RELAY DSL, with the same pressure and temperature safety switches used in the MaxFire SL system. However, these two systems can be triggered on command via a Graphic User Interface (GUI) on the engineer's laptop. This feature allows Halliburton to do any required explosive triggering runs without the need for a temperature/pressure parameter run, and the RDSL platform has real-time downhole sensors (including for axial and radial vibration, pressure, temperature, and downhole stress) for an in-situ confirmation of the explosive event. The Command MaxFire system is a single triggering event device outputting positive 325VDC to fire the RED tool, and the Command MaxFire Multi-Shoot system is set up to toggle between positive and negative 325VDC for select-triggering applications.

## BENEFITS

- » Surface readout (SRO) casing-collar locator (CCL) depth control
- » Triggers on command
- » Downhole SRO axial and radial vibration sensors confirm in-situ explosive events
- » Additional downhole sensors (including for temperature, pressure, CCL and downhole stress) corroborate vibration data and confirm that the explosives have fired as planned
- » Command MaxFire Multi-Shoot system can do select-fire perforating or multiple explosive trigger events, including plug and perforating operations

## KEY CAPABILITIES

- » No need for parameter runs to record pressure and temperature
- » Pressure and temperature safety switch that can be configured with two temperature switches for high-shock gas perforating or select-fire perforating
- » ISO 12100:2010 certified
- » Command MaxFire system's single triggering device sends positive 325V firing voltage for 2 minutes to the RED tool
- » Command MaxFire Multi-Shoot system's multiple triggering device toggles between positive and negative 325V firing voltage
- » Ideal for pipe recovery, and Command MaxFire Multi-Shoot system can be set up for perforation/jet cutter in a single run
- » Load capacity limited only by strength of conveyance cable

# MaxFire System Makes the Difference

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## WHY HALLIBURTON?

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### Flexibility

No other firing system on the market offers the flexibility of the MaxFire electronic firing system – which can be safely deployed in any situation that calls for perforating casing, cutting pipe or setting plugs – without the necessity for hiring multiple service providers to be on site.

### Safety

The RED tool, used in conjunction with the MaxFire system, provides triggering options suited to virtually any well. And because the RED tool is free from RF interference, rigsite communications can safely continue during perforation operations.

### Data and Pressure Ratings

Finally, no other firing system in the world offers the data recording capabilities and pressure ratings of the MaxFire electronic firing system.

**To learn more, call your Halliburton representative today.**





HAL-37698

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