

eFire-TCP Firing System

A tubing-conveyed perforating firing head system with precise delay times, low-pressure initiation, and insensitivity to well conditions

AN EFFICIENT, ECONOMICAL ELECTRONIC FIRING HEAD

The eFire-TCP* electronic firing head system for tubing-conveyed perforating (TCP) deployment combines two field-proven technologies into a single firing head: the IRIS* Intelligent Remote Implementation System and the S.A.F.E.* Slapper-Actuated Firing Equipment. The combination of these technologies produces an efficient and economical method for a wide range of perforating operations. The eFire-TCP fast-pressure sampling rate is ideal for capturing the PURE* perforating system signature, making it perfect for use with TCP PURE perforating jobs.

For temporary or permanent completions, the eFire-TCP system enables perforating under less rigid conditions than with conventional methods. Designed to give the operator the flexibility to abort firing at any time during the operation, the system offers an enhanced safety margin with precise delay times, low-pressure initiation, and insensitivity to well conditions.

The eFire-TCP system is an excellent choice for permanent completion perforating where traditional hydraulic firing systems are limited due to permanent packer setting pressure. The system initiates when it receives the pressure key (signature), not the absolute pressure.

MULTIPLE SAFEGUARDS

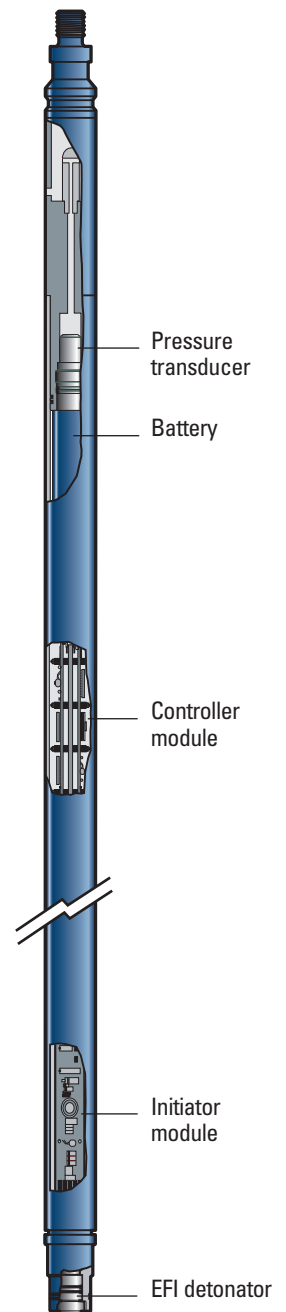
Depending on the application, the eFire-TCP electronic firing head system and TCP guns can be conveyed downhole by a workstring or completion string. The eFire-TCP firing head, which can be activated as the tool is run into a well, is set at the surface to arm 1 h after it reaches a predetermined hydrostatic pressure level. The system can also record the dynamic pressure transient during perforating operations. Approximately 1 s before initiation, the tool begins to record 1,000 samples/s and continues for 6 s.

Low-level, coded pressure pulses in liquid-filled or partially air-filled tubing are used to communicate with the firing head. This communications system eliminates problems associated with pressure testing the tubing, high applied pressure levels while setting packers, or pressure testing the casing. In partially air-filled tubing, the firing head is activated using nitrogen bottles, eliminating the need for an onsite nitrogen-pumping unit.

A pressure transducer in the electronics section detects the commands sent from the surface. Two separate processors in the controller module must independently verify the unique commands.

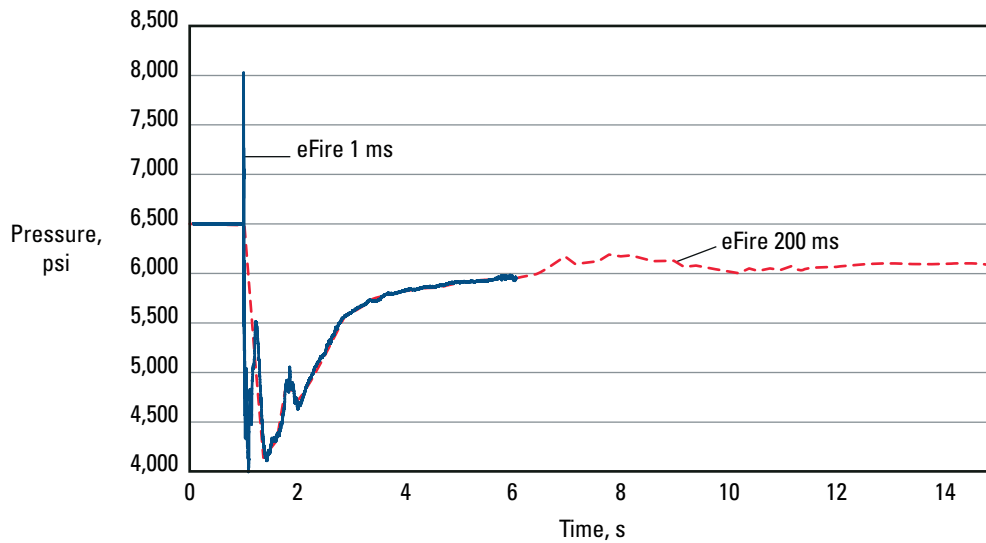
An initiator module then converts battery power to the high voltage level required to initiate the S.A.F.E. detonator, which uses an exploding foil initiator (EFI) to eliminate primary high voltages associated with conventional firing heads. This S.A.F.E. detonator makes the firing head insensitive to radio frequency radiation, stray voltages, welding operations, and cathodic protection systems.

The eFire-TCP firing head can also be used as a stand-alone tool inside a downhole fill sub equipped with a fluid isolation device, which reduces the chances of debris plugging the pressure path. If an application requires, the firing head can be used in combination with other Schlumberger TCP accessories such as the SXAR automatic gun release and the MAXR monobore anchor.



eFire-TCP firing head.

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Dynamic underbalance transient recorded by the eFire-TCP system during a PURE perforating job in the North Sea.

eFire-TCP Firing System Specifications

Model	eFire V1	eFire V3
OD, mm [in]	43.4 [1.71]	44.4 [1.75]
Makeup length, m [ft]	2.02 [7.95]	1.88 [7.40]
Temperature, [†] degC [degF]	160 [320]	177 [350]
Pressure, kPa [psi]	103,421 [15,000]	172,533 [25,000]
Shock test, g _n	500	500
Time delay, min	5 to 480	5 to 480
Transient pressure recorder rate, ms	1,000 [‡]	6,000 [§]
Battery autonomy, ^{††} h	240	240

[†] Limited to HMX time-temperature ratings

[‡] One pressure sample every 6 s (pre-eFire initiation) plus 200 pressure samples/s for 5 min plus one pressure sample every 6 s (post-eFire initiation).

[§] One pressure sample every 6 s (pre-eFire initiation) plus 1,000 pressure samples during 6 s, then 200 pressure samples/s for 5 min plus one pressure sample every 6 s (post-eFire initiation).

^{††} Battery autonomy of 1,000 h is an available option.

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