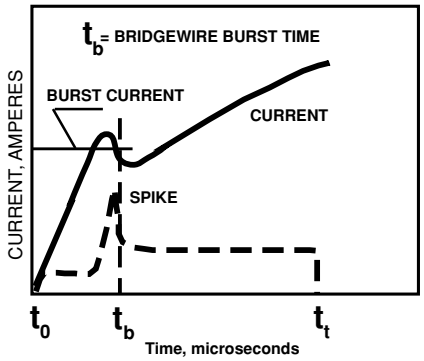
(continued)

As regards transmission and function time, a low energy detonator requires milliseconds to function because of the time required to heat the wire and the primary explosive so as to build up from a deflagration to a detonation. An EBW detonator requires only microseconds to function because the explosion of the bridgewire requires a fast rate energy pulse for proper function; therefore, the time is in the microsecond range. There is a buildup time in the secondary explosive next to the bridgewire as the shock wave from the wire moves into the explosive; however, this is very short.

It has been demonstrated that both low energy and EBW detonators can be built to high reliability if properly designed. Once properly designed, reliability becomes a quality control function during production. Low energy detonators are inherently more hazardous due to the presence of the more sensitive primary explosives, whereas EBW detonators are safer due to the presence of less sensitive secondary explosives.

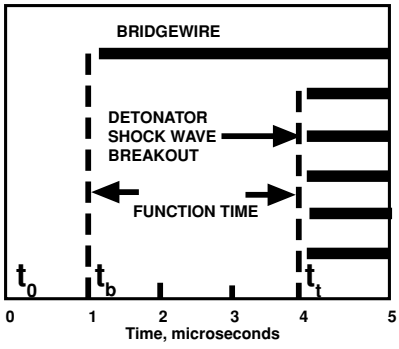
DEFINITIONS

- Time Zero(t_o)-This is the time at which the firing set switch is closed and current starts to flow in the circuit. It can be noted on Figure 6.
- Transit Time-The time from application of current to the circuit until shock wave breakout t_o - t_t on Figure 6.
- Bridgewire Burst Time (t_b)-This is the time at which the bridgewire explodes and the shock wave is initiated. This time can be observed in several ways. It is the time of the current dip inflection point as observed on a current versus time trace. It can be observed as a voltage spike by measuring the voltage across the bridgewire as it is exploded. The bridgewire burst time can also be observed on a streaking camera film as the first light seen as the wire is exploded.
- Detonator Shock Breakout Time (t_t)-This is the time at which the shock wave breaks out of the end of the detonator. It can be observed as a light output on a streaking camera film or also by the closure of an ionization switch placed at the end of the detonator with its impulse added to the streak of the voltage across the bridgewire.
- Function Time- The function time of the detonator is the time from bridgewire burst to shock wave breakout. This can be noted as t_b - t_t on Figure 6. Also called transmission time (t_m).
- Firing Voltage- This is the voltage to which the firing set capacitor is charged prior to firing.
- Threshold- Is defined as that input condition to the detonator bridgewire at which the probability of explosive initiation is 50%. It may be referred to in terms of voltage, current or power; i.e. I_{bth}, P_{bth}, etc.
- Bridgewire Burst-Occurs when the available energy is greater than that required for complete vaporization. This term is ordinarily used when the vaporization occurs with such rapidity that a violent reaction occurs giving rise to a shock wave in the surrounding H.E. medium. This term does not necessarily imply explosive detonation.
- Burst Current (I_b)-The current in the bridgewire at the time of peak voltage or resistance. Bridgewire resistance increases from a few milliohms to several ohms at burst through heating effects from the input current.
- Peak Power at Burst (P_b)-Is defined as the product of bridgewire burst current and peak voltage at burst.
- Melt-Bridgewire melt occurs when the energy applied is less than that necessary for complete vaporization, but great enough that the wire either liquifies into droplets or burns through. The performance is similar to a fuse wire.
- Detonation-A high order reaction of explosives usually propagating in the range of 5000 m/s in the low density initial pressing and 8000 m/s in the high density output pellet.
- Deflagration-A low order reaction in explosives usually propagating in the range of 500 to 2000 m/s. Generally considered not capable of initiating secondary explosives to full detonation.



CURRENT AND VOLTAGE TRACE

Figure 6
Operation Times For An EBW Detonator



SIMULATED STREAKING CAMERA PHOTOGRAPH