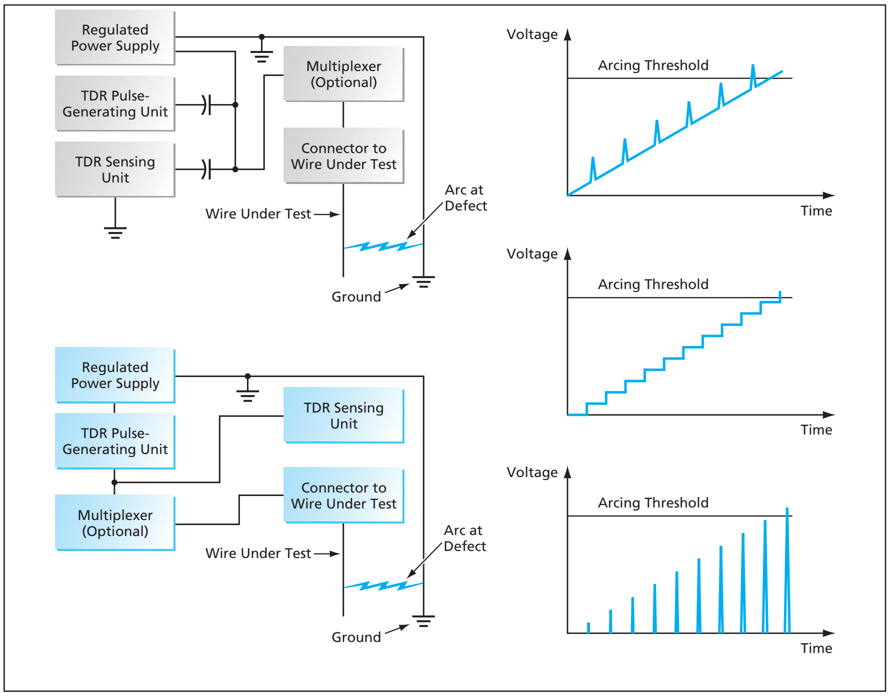


A **Wire Is Tested** by applying a suitable voltage waveform to produce arcing and measuring the time between (1) the pulse or staircase edge that immediately precedes the arcing and (2) the receipt of the arcing signal at the location of application of the waveform. The distance to the defect where the arcing occurs is calculated from the time thus measured.

wiring and ground. The DWV method does not provide an indication of the location of the defect (unless, in an exceptional case, the arc happens to be visible). In addition, if there is no electrically conductive component at ground potential within about 0.010 in. (≈ 0.254 mm) of the wire at the location of an insulation defect, then the DWV method does not provide an indication of the defect. Moreover, one does not have the option to raise the potential in an effort to increase the detectability of such a defect because doing so can harm previously undamaged insulation.

In the TDR method as practiced heretofore, one applies a pulse of electricity having an amplitude of <25 V to a wire and measures the round-trip travel time for the reflection of the pulse from a defect. The distance along the wire from the point of application of the pulse to the defect is then calculated as the product of half the round-trip travel time and the characteristic speed of a propagation of an electromagnetic signal in the wire. While the TDR method as practiced heretofore can be used to locate a short or open circuit, it does not ordinarily enable one to locate a small breach in insulation because the pulse voltage is too low to cause arcing and thus too low to induce an impedance discontinuity large enough to generate a measurable reflection.

The present improved method overcomes the weaknesses of both the prior DWV and the prior TDR method. One prepares the system to be tested by filling all or part of the system with a liquid or gas that does not harm the wiring and that is either electrically conductive or undergoes dielectric breakdown (and thereby becomes electrically conductive) at a relatively low applied electric field. For example, if the system to be tested is an aircraft, one can fill the interior of the aircraft with neon, through which arcs can readily develop between wires and metal grounds. This permits arcing to a ground as far as 1.0 in. (≈25.4 mm) from the conductor.

The figure depicts two typical alternative assemblies of equipment that could be used to implement the present method, along with three typical alternative voltage waveforms that could be used in the method. Once the system to be tested has been prepared as described in the preceding paragraph, one of these waveforms is applied to a wire under test. In the case of the first waveform, one superimposes a conventional TDR signal on a gradually increasing voltage until arcing occurs. To make the arcing occur at the identifiable time of one of the TDR pulses (preventing the somewhat random arcing that might otherwise occur) and thereby make it possible to measure the round-trip travel time, (1) the rate of the interval between the TDR pulses is made long enough to encompass any reflections that might occur and (2) the rate of gradual increase of voltage is made such that highest voltage yet reached occurs at the peak of each superimposed TDR pulse.

The second voltage waveform is a staircase function. In this case, the highest voltage yet reached (and thus arcing) always occurs at a rising edge. The third waveform consists solely of TDR pulses, but unlike in conventional TDR, these are high-voltage pulses. In this case, the amplitude of the pulses is increased gradually until they cause arcing.

This work was done by Owen R. Greulich of **Ames Research Center**. *Further information is contained in a TSP (see page 1).*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Ames Research Center, (650) 604-5104. Refer to ARC-14612.

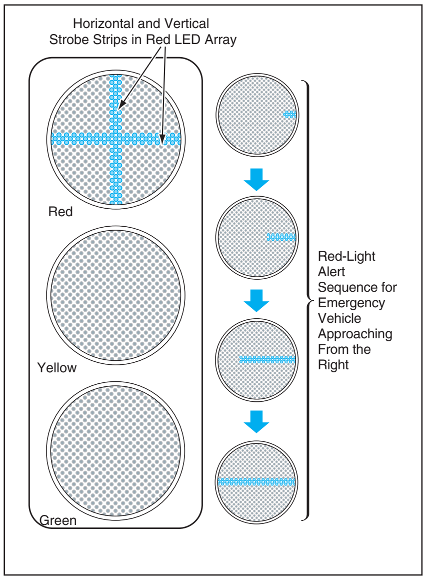
Strobe Traffic Lights Warn of Approaching Emergency Vehicles

Simple, intuitive displays indicate directions of approach.

NASA's Jet Propulsion Laboratory, Pasadena, California

Strobe-enhanced traffic signals have been developed to aid in the preemption of road intersections for emergency vehicles. The strobe-enhanced traffic signals can be incorporated into both new and pre-existing traffic-control systems in which the traffic-signal heads are of a relatively new type based on arrays of light-emitting diodes (LEDs). The strobe-enhanced traffic signals offer a less expensive, less complex alternative to a recently developed system of LED-based warning signs placed next to traffic signals. Because of its visual complexity, the combination of traffic signals and warning signs is potentially confusing to motorists. The strobe-enhanced traffic signals present less visual clutter.

In a given traffic-signal head, the strobe-enhanced traffic signal is em-



The **LEDs in the Horizontal Strobe Strip** are lit in sequence from right to left to indicate that an emergency vehicle is approaching from the right.

bedded in the red LED array of the "stop" signal. Two strobe LED strips — one horizontal and one vertical — are made capable of operating separately from the rest of the red LED matrix. When no emergency vehicle is approaching, the red LED array functions as a normal "stop" signal: all the red LEDs are turned on and off together. When the intersection is to be preempted for an approaching emergency vehicle, only the LEDs in one of the strobe strips are lit, and are turned on in a sequence that indicates the direction of approach. For example (see figure), if an emergency vehicle approaches from the right, the strobe LEDs are lit in a sequence moving from right to left.

Important to the success of strobe-enhanced traffic signals is conformance to city ordinances and close relation to pre-existing traffic standards. For instance, one key restriction is that new icons must not include arrows, so that motorists will not confuse new icons with conventional arrows that indicate allowed directions of movement. It is also critical that new displays like strobe-enhanced traffic signals be similar to displays used in traffic-control systems in large cities. For example, Charleston, South Carolina uses horizontal strobes on red traffic lights to alert motorists and thereby help motorists not to miss red lights. The one significant potential disadvantage of strobe-enhanced traffic lights is initial unfamiliarity on the part of motorists.

This work was done by Aaron Bachelder of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to NPO-30716, volume and number of this NASA Tech Briefs *issue, and the page number.*

Improved Timing Scheme for Spaceborne Precipitation Radar

This scheme enables automated targeting and prevents pulse collisions.

NASA's Jet Propulsion Laboratory, Pasadena, California

An improved timing scheme has been conceived for operation of a scanning satellite-borne rain-measuring radar system. The scheme allows a real-time-generated solution, which is required for auto targeting. The current timing scheme used in radar satellites involves pre-computing a solution that allows the instrument to catch all transmitted pulses without transmitting and receiving at the same time. Satellite altitude requires many pulses in flight at any time, and the timing solution to prevent transmit and receive operations from colliding is usually found iteratively. The proposed satellite has a large number of scanning beams each with a different range to target and few pulses per beam. Furthermore, the satellite will be self-targeting, so the selection of which beams are used will change from sweep to sweep. The proposed timing solution guarantees no echo collisions, can be generated using simple FPGA-based hardware in real time, and can be mathematically shown to deliver the maximum number of pulses per second, given the timing constraints.

The timing solution is computed every sweep, and consists of three phases: (1) a build-up phase, (2) a feedback phase, and (3) a build-down phase. Before the build-up phase can begin, the beams to be transmitted are sorted in numerical order. The numerical order of the beams is also the order from shortest range to longest range. Sorting the list guarantees no pulse collisions.

The build-up phase begins by transmitting the first pulse from the first beam on the list. Transmission of this pulse starts a delay counter, which stores the beam number and the time delay to the beginning of the receive window for that beam. The timing generator waits just long enough to complete the transmit pulse plus one receive window, then sends out the second pulse. The second pulse starts a second delay counter, which stores its beam number and time delay. This process continues until an output from the first timer indicates there is less than one transmit pulse width until the start of the next receive event. This blocks future transmit pulses in the build-up phase.

The feedback phase begins with the first timer paying off and starting the first receive window. When the first receive window is complete, the timing generator transmits the next beam from the list. When the second timer pays off, the second receive event is started. Following the second receive event, the timing generator will transmit the next beam on the list and start an additional timer. The timers work in a circular buffer fashion so there only need to be enough to cover the maximum number of echoes in flight.