TRANSIENT DETECTORS AND RECORDERS

Measuring Transients

The following paragraphs discusses time-domain, EMI-related instruments which are used to intercept and record transient spikes that may appear on power, control, or signal lines. Transient detectors may also be operated in a radiated mode using an antenna as a sensor. They are intended to measure a portion of the frequency spectrum over a wide amplitude dynamic range on either one or many channels of strip-chart recorders. Thus, the baseband peak of a fast transient is sensed, amplified, captured, and handed over to a slower-responding recorder.

For the purpose of this discussion, transients are arbitrarily defined as impulses whose time durations are less than 100 $u$sec, which establishes requirements for recording with devices having greater than a 10 kHz bandwidth. For reference purposes, it is noted that small single or multi-channel strip-chart recorders have responses ranging from one to about 100 Hz, and oscillographs using galvanometers respond up to 10kHz. Thus, direct recording of spikes having main-energy content below 10 kHz can be documented as an amplitude vs time readout on oscillographs.

Three disadvantages of the above conventional recording techniques are observed:

(1) An enormous amount of chart paper is consumed to faithfully record spikes continuously over more than a few minutes time. Data reduction is also time consuming.

(2) Spikes greater than a few kHz bandwidth are integrated for recording galvanometers; only uncalibrated glitches are indicated above 10 kHz.

(3) Cost of a multi-channel system to record transients faster than 100 usec is expensive.

Consequently, a different technique must be employed to capture fast transients in which a measuring system of known bandwidth locks on to the peak of a transient, stretches it, and hands the peak value over to a slower-moving meter or strip-chart recorder. Such recording peak detectors are available to process transients at full amplitude greater than 20 nsec duration (narrowband operation) for even faster transients.

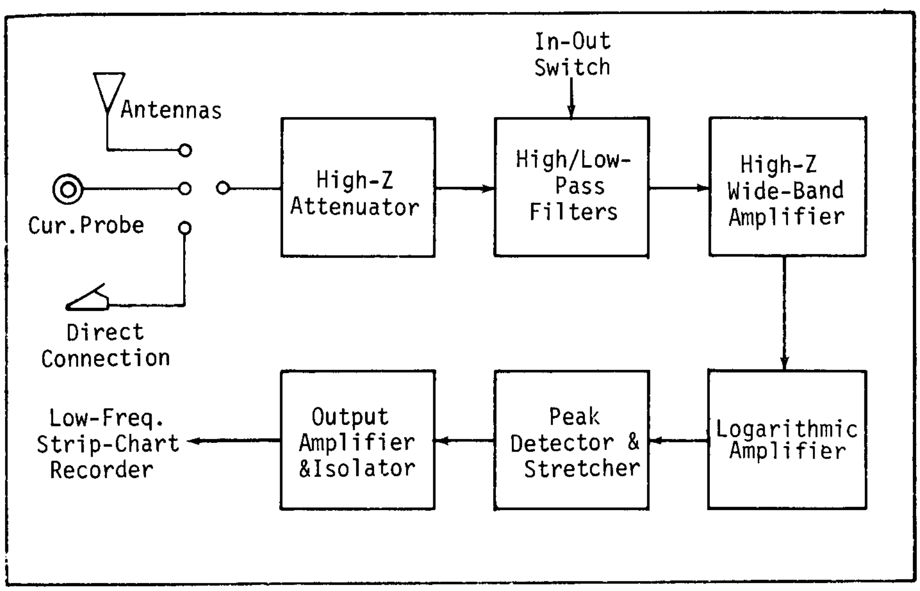

Figure 1 Block Diagram of Typical Transient Detector and Recorder

Applications

Transient detectors are frequently self-contained units within the probe which measures and holds the peak amplitude. Some units operate continuously, unattended, and provide hard copy data which is calibrated in dB above a particular reference. Current transients, appearing in one or more conductor cables, may be sensed by a current probe and fed to the transient detector. A high-impedance probe, operated as a two-terminal voltmeter, may be connected across a conductor to drive a transient detector. Typical applications include EMI cable wire transient identification, permanent recording of power-line transients; spacecraft and aerospace systems checkout; environmental shock, vibration and temperature peak recordings; DC bus transient measurements; maximum switching currents during actuation of control circuits; and related measurements requiring memory of signal conditioning for recording on low-frequency readout devices.

The transient detector and recorder may also be used to provide time-domain, radiated-field measurements. For example, a high-impedance probe may be directly connected to a monopole antenna for the purpose of sampling electric-field peak signals in a local area for EMI culprit identification or for lightning and high-voltage discharge measurements. For magnetic field measurements, a loop or a ferrite probe may be connected to the input of a transient detector to permit culprit source location and identification preparatory to performing EMI fixes. While not an EMI problem, acoustic transient data can be obtained by using a microphone as the sensor feeding a transient detector. This arrangement is useful in determining the peak amplitude of acoustical noise sources such as aircraft jet engines, sonic booms, missile skin noises, factory machinery noise levels, and other high-engery, broadband acoustical sources.

Functional Description

Fig. 1 shows a block diagram of one form of a transient detector. Any one of the three sensor types shown may be used as the pick-up device. For voltage-probe applications, the transient detector may be directly connected to the test circuit if its impedance does not load the line, In the figure, the sensor feeds a high-impedance attenuater, whose input resistance is typically $10M\Omega$ or higher and whose output impedance is about $1M\Omega$. An external attachment probe is used for high-voltage (>1kv) connections and a 50Ω shunt resistance is used for currect-probe couplings.

When it is desired to record transients as low as 1 mV, such as required for some EMI applications on signal circuits or power buses, a base-band logarithmic amplifier is driven from the wideband FET amplifier. It provides 20 dB gain to 1 volt signals when no RF attenuation is inserted, and 60 dB gain to 1mV signals. Outputs correspondingly swing from 1 to 10 volts to drive a peak detector. When the transient detector is designed to accommodate peak voltages of not less than about 0.5 volts, the logarithmic amplifier may then be a D-C type and follows the peak detector rather than precedes it. In either event, a log amplifier is important since it is generally desired to measure transients over a 60 dB range (e.g: 60 dBuV to 120 dBuV as in the above EMI example. or 1 uV to 1,000 uV for power-line applications).

The peak detector has a rise time faster than that of the preceding amplifiers, or typically from 10 to 1000 nsec. It stretches pulses to result in a decay time of about 1 sec so that handover, without amplitude integration loss, can be made to a very in-expensive strip-chart recorder having typically a 1 Hz response. To permit coupling to a wide variety of recorders, the peak detector and stretcher feeds a coupling amplifier having a high input and low output impedance.

The next element of the transient detector in Fig. 1 is a high/low pass filter combination which may be switched in or out. A blocking high-pass filter, provides 60 dB attenuation to 60 Hz power-line voltages and is transparent above 2 kHz for power-line transient monitoring. A low-pass filter may be switched-in to eliminate broadcast (and all other higher-frequency signals) when competing non-transient signals are concurrently present on power lines or other test buses. The output from the filter is coupled to a high-impedance, wide-band amplifier (typically having bandwidths from 1 to 30 MHz). FETS are generally used to provide a unity voltage gain at 50 ohm outputs.

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