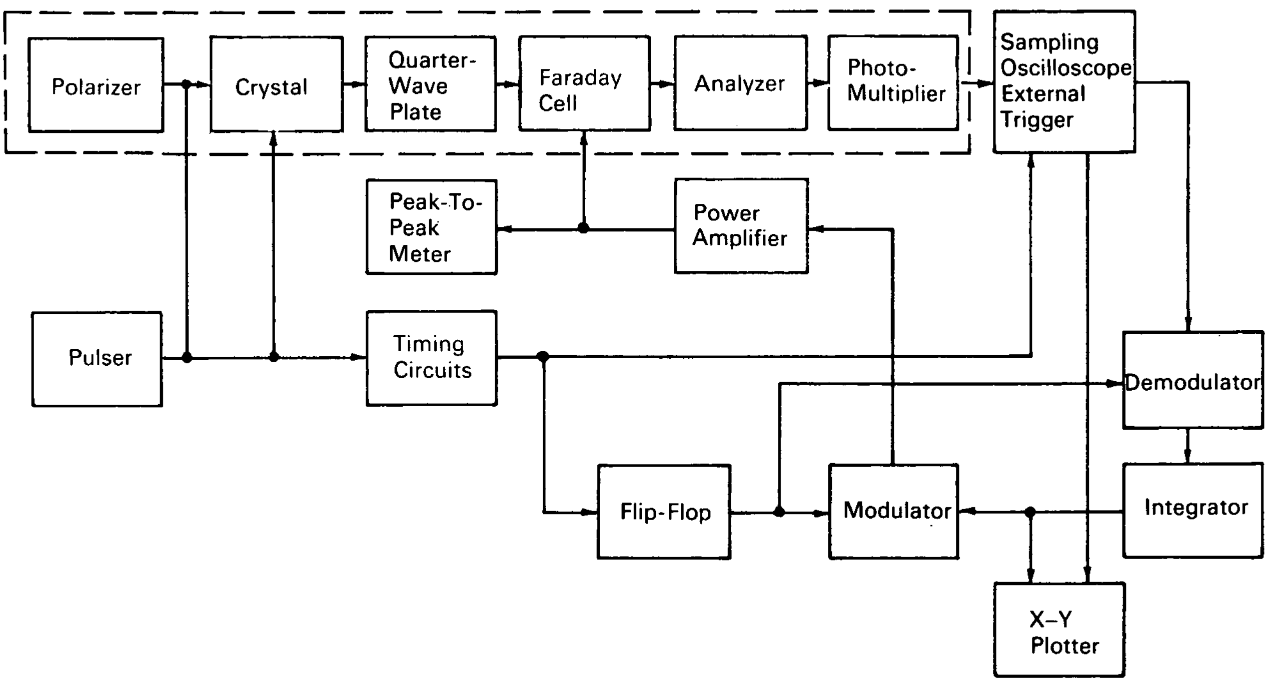
NASA TECH BRIEF

Polarimeter Provides Transient Response in Nanosecond Range



The problem:

Polarimeters used in the prior art have been relatively slow, the shift in polarization angle being detected by a manually operated analyzer or by a photomultiplier used in conjunction with a servo system to adjust the analyzer. These methods have proven nonresponsive to transients or rapidly changing polarization shifts. What is desired is a polarimeter that will greatly improve transient response and at the same time operate automatically to eliminate the undesirable feature of manual manipulation.

The solution:

A system in which the photomultiplier output of a conventional polarimeter with a Senarmont compensator is sampled electronically in phase with a periodically varied retardation by means of a feedback loop technique. The sampled output is fed to a low pass filter, resulting in a dc or low frequency signal representing the optical state existing at the instant of sampling.

How it's done:

In the diagram shown, the items within the dotted line comprise the conventional polarimeter that is used for the initial transient measurement. The balance form the feedback loop that comprises the innovation involved.

The pulser is a mercury switch type that delivers pulses up to 500 volts in amplitude, which induce a

(continued overleaf)

change in retardation in a crystal specimen, to be measured and provide a timing reference to the crystal. The actual voltage is selected to produce a convenient rotation, typically 1° to 3°. The timing circuits provide two identical pulses used to trigger the sampling oscilloscope. The first trigger pulse occurs as soon as possible after the start of the high voltage from the pulser. The second trigger pulse occurs so that it lies midway between consecutive high voltage pulses at a time when no voltage is being applied to the crystal. The flip-flop, used for driving the demodulator and modulator is also driven by the pulses from the timing circuits. The oscilloscope is manually adjusted while the timing of the trigger pulses is fixed. The oscilloscope thus samples the voltage at the output of the photomultiplier near the time of the first trigger pulse and then "holds", or provides this fixed voltage as its y-output until the arrival of the second trigger pulse. The y-output then changes and "holds" a voltage proportional to the photomultiplier output at that sampling time. The oscilloscope output is a noisy audio signal, in phase with the pulser, whose average amplitude is a measure of the difference between the light level at the time immediately following the voltage step and at an intermediate time when voltage is not present on the crystal. The analyzer is offset at a small arbitrary angle from null in order to provide an output from the photomultiplier proportional to the orientation of the plane-polarized light incident on it.

Conventional demodulation, with the integrator rejecting the noise and providing a large dc loop gain, and remodulation, provide the current to drive the Faraday cell. Maximum deflection of the plane of polarization by the Faraday cell occurs with alternating sign at each sampling time. Magnitude of ac current in the Faraday cell is automatically adjusted in response to the large total gain in the feedback loop to yield the same light level at the time during a pulse as at a time when the crystal is undisturbed, which implies the same angular orientation of the plane of polarization incident on the analyzer.

Notes:

1. With this technique, an unknown transient-induced retardation can be measured with time resolution of a few nanoseconds to an approximate angular accuracy of one arc minute.
2. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Jet Propulsion Laboratory
   4800 Oak Grove Drive
   Pasadena, California 91103
   Reference: B67-10021

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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