RITEC Multiple EMAT Driver and Receiver System (MEDARS)

EMAT Phased Arrays Are Now Possible.

This instrument has been specifically designed to drive an array of up to 4 EMATs with very high power (up to 8 KW) RF bursts of energy at frequencies from 250 kHz to 5 MHz. Provisions have been made to adjust the phase delay of each driver so that the ultrasonic waves from all the EMATs will add constructively in the desired direction. This is valuable not only for focusing or beam direction control but, as in the case of inherently low efficiency devices such as EMATs, to improve the signal-to-noise ratio. This improvement in signal-to-noise ratio may be critical to the successful examination of a material.

Each pulser has its own associated receiver so that four different locations on a part being examined may be monitored simultaneously.

Each receiver is set up for either pulse echo or through transmission operation.

Each pulser/receiver unit is set up for either differential or single ended operation.

All Parameters Are Under Computer Control.

A block diagram showing the computer control functions and the elements of one pulser-receiver is shown in Fig. 1. Note: the shaded blocks are part of the MEDARS and the other items are provided by the user.

Bipolar Square Waves Provide The Highest Current Amplitudes In EMATs.

In order to produce high current pulses in the EMATs two design considerations become important:
1) The transmitter must be efficient to avoid producing large amounts of heat in the electronics and unnecessary loading of the power supply.
2) The output impedance must be low to facilitate matching (usually required) to the typical low impedances of the EMATs.

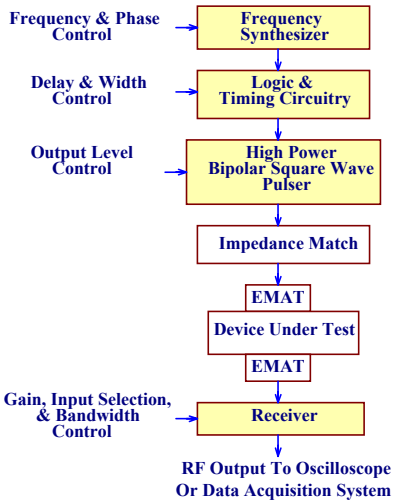

Fig. 1
Block diagram of one of the four pulser-receivers of the MEDARS unit.

A bipolar square wave transmitter is particularly suited to the above requirements. The general features of the bipolar output are shown in Fig. 2.

Phase Control Of The Synthesizers Provides Extremely Fine Control Of The Pulse Delays.

Delays are produced by counting cycles of synthesizer output and also adjusting the phases of the other synthesizers relative to the first. The 12 bit phase control allows sub nanosecond resolution in setting the delays. Note: there is no requirement that all the transmitters operate at the same frequency. However, when they operate at different frequencies, the phase coherence required for the fine delay adjustments is not present and the delay resolution becomes one cycle of RF with an inherent jitter of one cycle of the operating frequency.

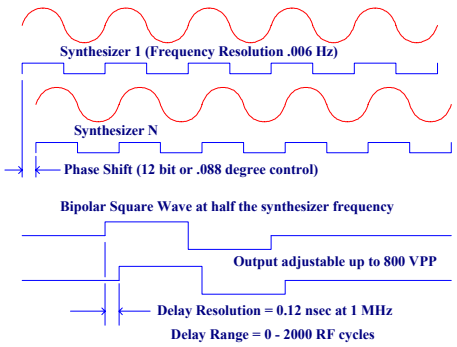

Fig. 2
Timing showing one cycle bipolar square wave bursts from two pulsers.

The 4-channel MEDARS consists of six modules. Each pulser/receiver unit is in a separate, fully shielded case. The master control unit with all the synthesizers, the interface to an external computer, and the delay generators are in the fifth case, and the power supplies are in the sixth case.

SPECIFICATIONS

General Specifications for the Pulsers are as follows:

Type: Square wave, bipolar, operating with high efficiency. The squarewave output is produced by combining in a transformer outputs of two unipolar squarewave generators which are 180 degrees out of phase.

Frequency Range: 100 kHz to 5 MHz.

Output Impedance: Approximately 5 Ohms

Output Amplitude: 800 Volts peak-to-peak into 50 Ohms; 400 Volts peak-to-peak into a 5 Ohm load.

Connectors for Pulser Outputs: Two switch selectable outputs are provided at the front panel: 1. Twin BNC differential connector for double ended output;
2. Standard BNC connector for single ended output. All other connectors are standard BNC.

Amplitude Adjustment: Each pulser has its own DC power supply (rated at 25.5 Watts) used to control its output level and is adjustable from zero to +425 Volts by means of a 12 bit D/A converter.

Duty Cycle: Each pulser has a maximum duty cycle of ~0.7% when operating into 50 Ohms and ~0.08% when operating into 6 Ohms. (Excess duty cycle will cause the high voltage supply to limit its output current which produces an unstable output voltage.)

Burst Width: Adjustable in 1 cycle steps of RF from 1 to 80. The width is also limited in software to 50 microseconds. The maximum width at any given frequency will be determined by the lesser of the two limiting functions

Synchronization: The unit may be triggered either from an internal source from the microprocessor or from an external trigger source. Maximum trigger rate in either case is 5000 pps.

Delay for each transmitter: The trigger to each pulser may be delayed up to 2000 cycles of the RF operating frequency. The 12 bit control of each synthesizer's phase provides the fine control needed for phased arrays. Triggers coherent with the start of each pulser are brought to the front panel of the control module.

Frequency Source: Each pulser has its own independently controlled synthesizer (DDS) which operates from a common 25 Mhz clock. A clock output is provided on the front panel of the control module in order to utilize this signal with an external data acquisition system. This will, in many cases, reduce greatly the inherent jitter in the digitization process because the MEDARS triggers and synthesizer start functions are coherent with the clock.

General Specifications for the Receivers:

Amplifier Type: High gain, broadband.

Frequency Range: 100 kHz to 5 MHz.

Total Gain: 95 dB including pre-amplifiers.

Gain Control: 80 dB in 0.4 dB steps.

High Pass Filters: 90 kHz, 200 kHz, 600 kHz, and 800 kHz.

Low Pass Filters: 2.5 MHz and 6 MHz.

Input Impedance: Nominally 50 Ohms.

Input connector: Twin BNC differential connector for double ended operation and a standard BNC connector for single ended operation.

Maximum Linear Output: 2 Volts pk-to-pk into 50 Ohms, single ended and limited to 3 VPP.

Output Impedance: 50 Ohms.

General Specifications for the Control System:

RS-232 Interface

Control Software: Written in Visual Basic and requires IBM compatible PC system. Source code is provided so that the user can customize the program to fit his specific needs.

Power Requirements: 85-240 Volts, 50-60 Hz, approximately 350 Watts.

Cabinet Dimensions: 53.34 cm (21") wide by 61 cm (24") high by 41.9 cm (16.5") deep.