Outline:

1. Analog beamformer for a high frequency linear array.
   - Part of a Test system of up to 128 elements.
2. Three stages
   1. Delay unit
   2. Delay switches
   3. Summing unit
3. Capabilities:
   - 4-zone Dynamic Focusing
   - Dynamic Aperture Switching
   - Very Wide Bandwidth.

Introduction

An analog beamformer is described that is used to process the data from a high frequency linear array. This unit is a part of a test system, which has the capability to characterize ultrasound transducer arrays up to 128 elements. This beamformer consists of three stages: delay unit, delay switches and summing unit. They have the following characteristics: the delay and summing units are realized in the analog domain, utilizing 4-zone dynamic focusing, and dynamic aperture switching with very wide bandwidth. Each delay is composed of a fixed and a variable delay line. A set of 4:1 buffered analog-multiplexers is used to switch the different delays for different focusing zones. In our system, the focal range is divided into 4 zones consisting of a near, middle, far and fourth zone with a different set of delays for each zone. Dynamic aperture switching is accomplished by sequential selection of the multiplexer network. The aperture is set according to the focusing zone. For near zone, middle zone, far zone and fourth zone focusing, apertures are set to 8, 12, 16 and 16 elements respectively. In the last stage, very wide band summing amplifiers are used with surface mount resistor to decrease phase errors.
[1-4]

TGC-Beamformer Crosspoint Switch

- To Minimize the Total Number of components in the system.
  - Multiplex 48 Transducers onto 16-Channels.
  - A crosspoint switch is required to sort the output of the TGC prior to input into the Hardware Beamformer.
**Delay Unit**

- Composition
- Delay Unit
- Fixed Delay - either 5ns or 15ns
- Four 40-step adjustable delay lines varying from 0 to 20 ns.
- Delay Switch
- 4:1 Buffered-Multiplexer.
- Adjustable Gain Current Feedback Amplifier.
- Implementation the Dynamic Focus & Aperture Switching
- Switch the Focusing Zones and associated Apertures.
- Focal range is divided into 4 zones, ranging from 3 to 11 mm
- Near, Middle, Far and Fourth Zone
- Aperture is set according to the focusing zone 8, 12, 16 and 16 elements respectively.
Timing Control for Focal Zone Selection

- Gage only supplies device drivers for Windows 98.
  - Windows 98 is not a real-time operating system.
  - Implemented Hardware Controller
- Trigger Signal Supplied by SRI Delay Generator used to trigger A/D, TGC Ramp Generator and Timing Module simultaneously.
**Summing Module**

- Two stages – For Maximum BW –3dB 440-MHz
  - AD8009 Current Feedback Amplifiers
    - Very Wide Band Summing Amplifiers
    - Surface Mount Resistor to decrease phase errors.

**Conclusion**

- Successfully Implemented the 16-Channel Analog Beamformer in Two Modules
  - Delay Module
    - 4-Zone Dynamic Focus and Dynamic Aperture
    - -3dB Bandwidth - 130MHz
  - Summer Module
    - Two-Stages of Summing Amplifiers to Maximize the Bandwidth (–3dB BW 440MHz).

**Wire Phantom Target**

![Wire Phantom Target Diagram](image-url)
References