Butler Matrix with cost-effective Components

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1 Abstract:

Conventional Butler martrices are constructed from packaged Quadrature hybrids and analog phase-shifters. Some of the commercially available phase shifters incorporate the hybrids and reactive elements to give the desired phase-shift.
Deviating from this practice, we had constructed a 16-beam Butler Matrix for the MEXART project of Instituto de Geofisica, UNAM,Mexico.The primary aim is to constuct one at minimal cost with no compromising of any of the performance functions.
The choice of design selected was:
(i). Wire-line Quadrature hybrids of Sage Laboratories
(ii). Tee-network of chip inductors and trimmers for the phase-shifter

Since the operational bandwidth of the Antenna Array at Mexico (intended for IPS studies) is 4 MHz.,the choice of discrete components-based-phase shifter was acceptable. Typical phase variations were within $\pm 2^\circ$.
Each hybrid was wired to a glass-epoxy PCB and the corresponding phase-shifter at the next level was also included on the same board.A chassis housing the hybrid + phase shifter has SMA connector ports; equal length of UT-85 semi-rigid cables were the interconnecting, constant phase path between the hybrids.

The cost advantage when compared to a design incorporating COTS components would be a factor of ~ 3 .The scalability to a higher order of the Matrix is a simple step of adding hybrids and tuned- phase shifters.

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