Microwave and Millimeter Wave Applications

Outline

Amplifier characteristics
Basics of amplifier design.
Low noise amplifiers. Power amplifiers.
Power combining.
MMICs and Millimeter-Wave Monolithic ICs.
Optical control of microwave devices.
Review of state-of-the art.
Si and Si-Ge competition.
Applications in systems.

Applications of 5 - 100 GHz Analog Technology

Application	Frequency Range (GHz)
LAN	5.2
Short distance communications	5.8
Direct Broadcast satellite	10.5-11.5
Point-to-Point communications	13 - 60
Video distribution Systems	28 (US - Local Multipoint Distribution System, LMDS) 42 (Europe Microwave Video Distribution system, WVDS)
Optical Links	Up to 60 GHz
Satellite Networks	12 - 40
Automotive radars	76

Adopted from M. Meyer, Compound Semiconductor, Dec. 1998, p. 17

Power Added Efficiency

$PAE = (P_{sat}/P_{dc})\ (1 - 1/G)$

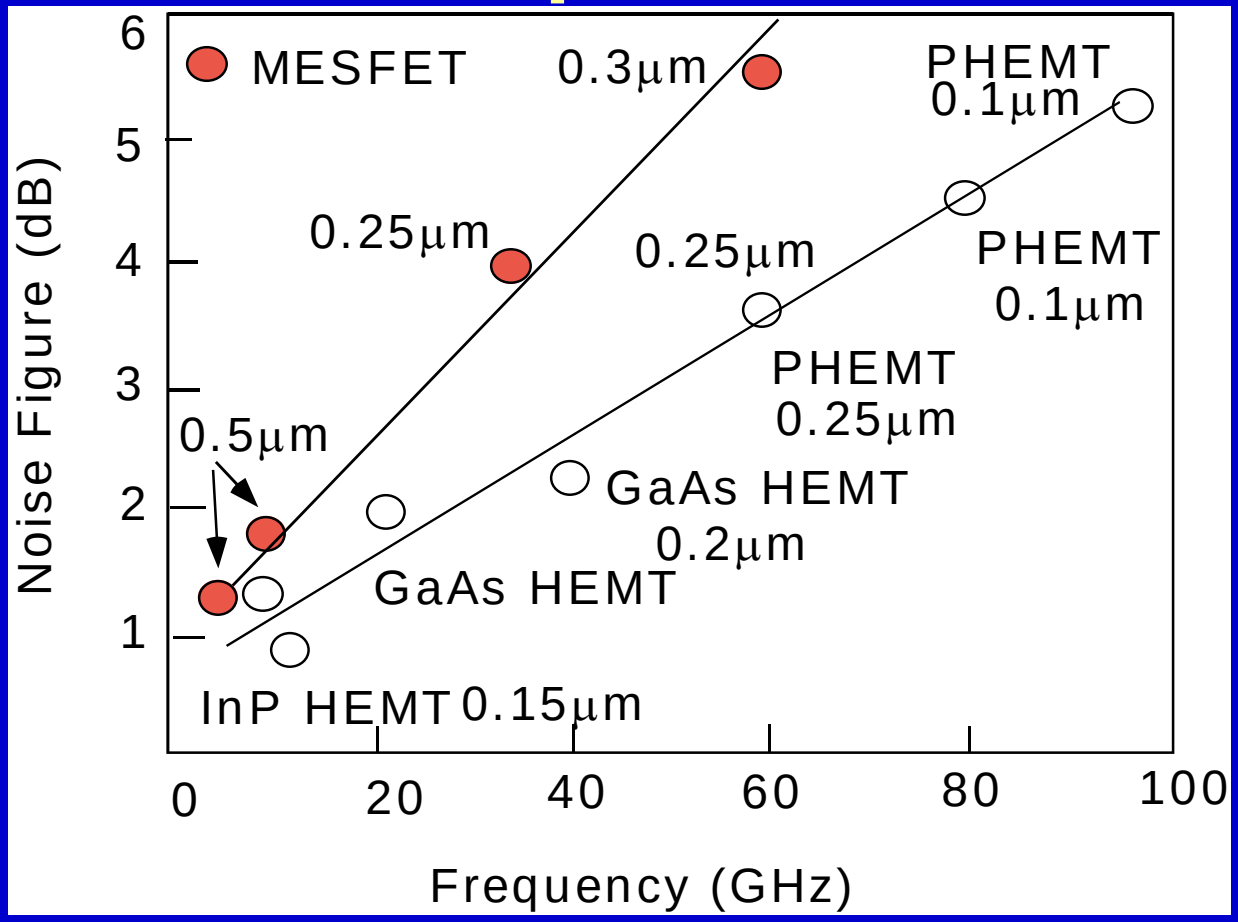
or

$PAE = (1/2)(1 - Vk/Vdc)\ 1.288\ (1 - 1/Ga)$

see L. J. Kushner, Microwave J., pp. 103-106, Oct. (1989)

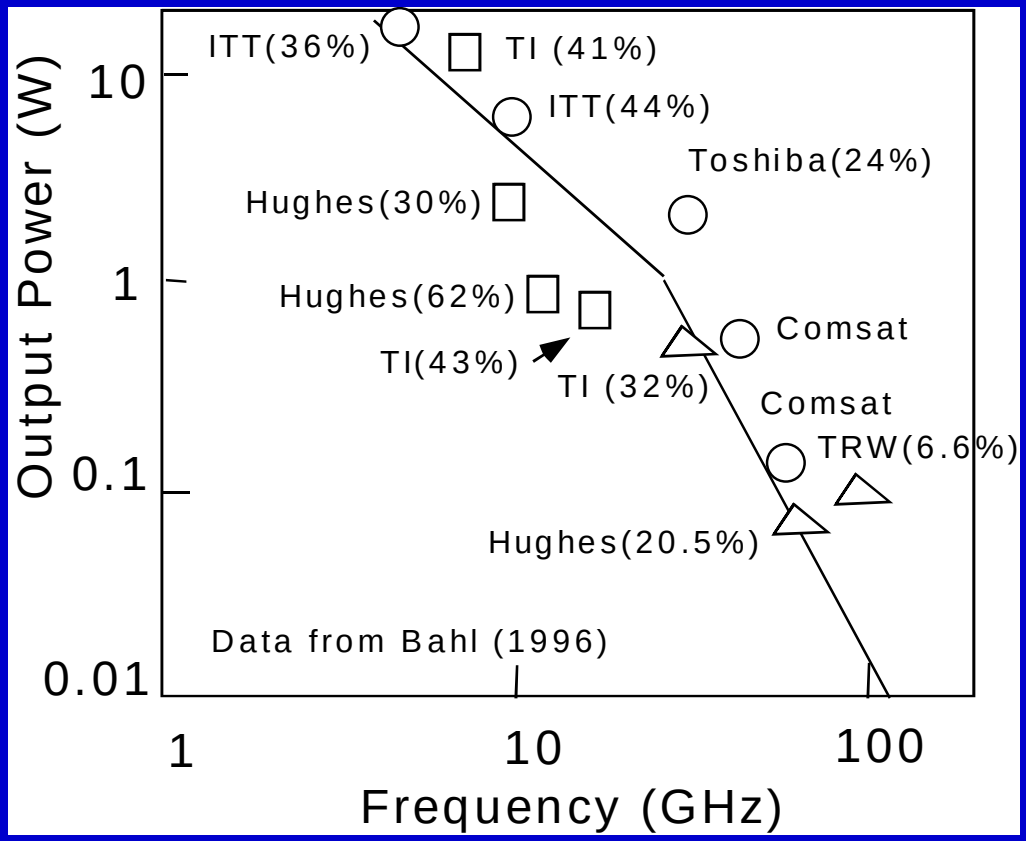
Here Vk is the knee voltage
Ga is the associated gain under the saturated power conditions

Low Noise Multi Stage Amplifiers



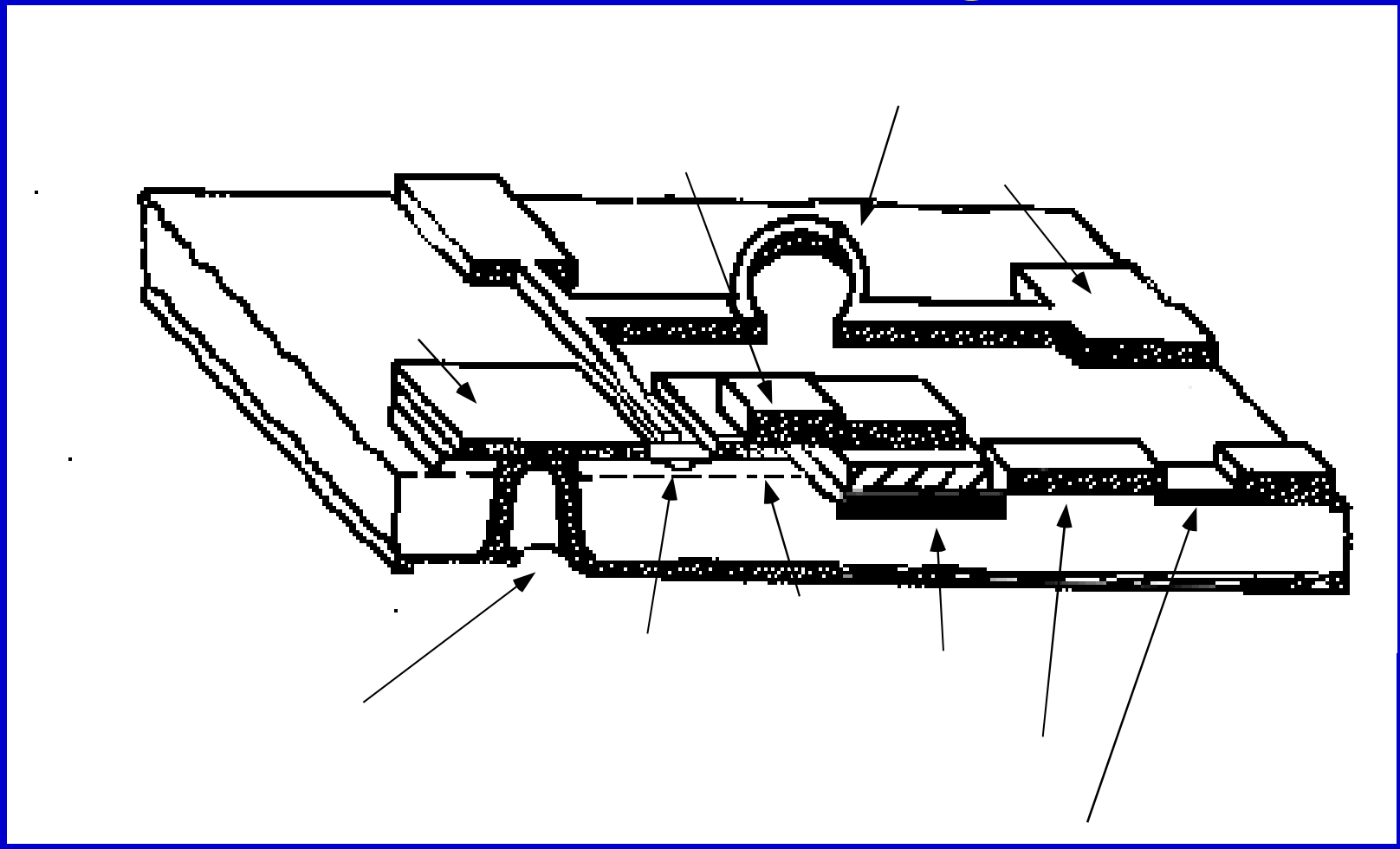
(Data from I.J. Bahl, in Compound Semiconductor Electronics, The Age of maturity, WS, Inc., 1996, Ed. M. S. Shur, pp. 175-208)

Single Chip power MMIC amplifiers



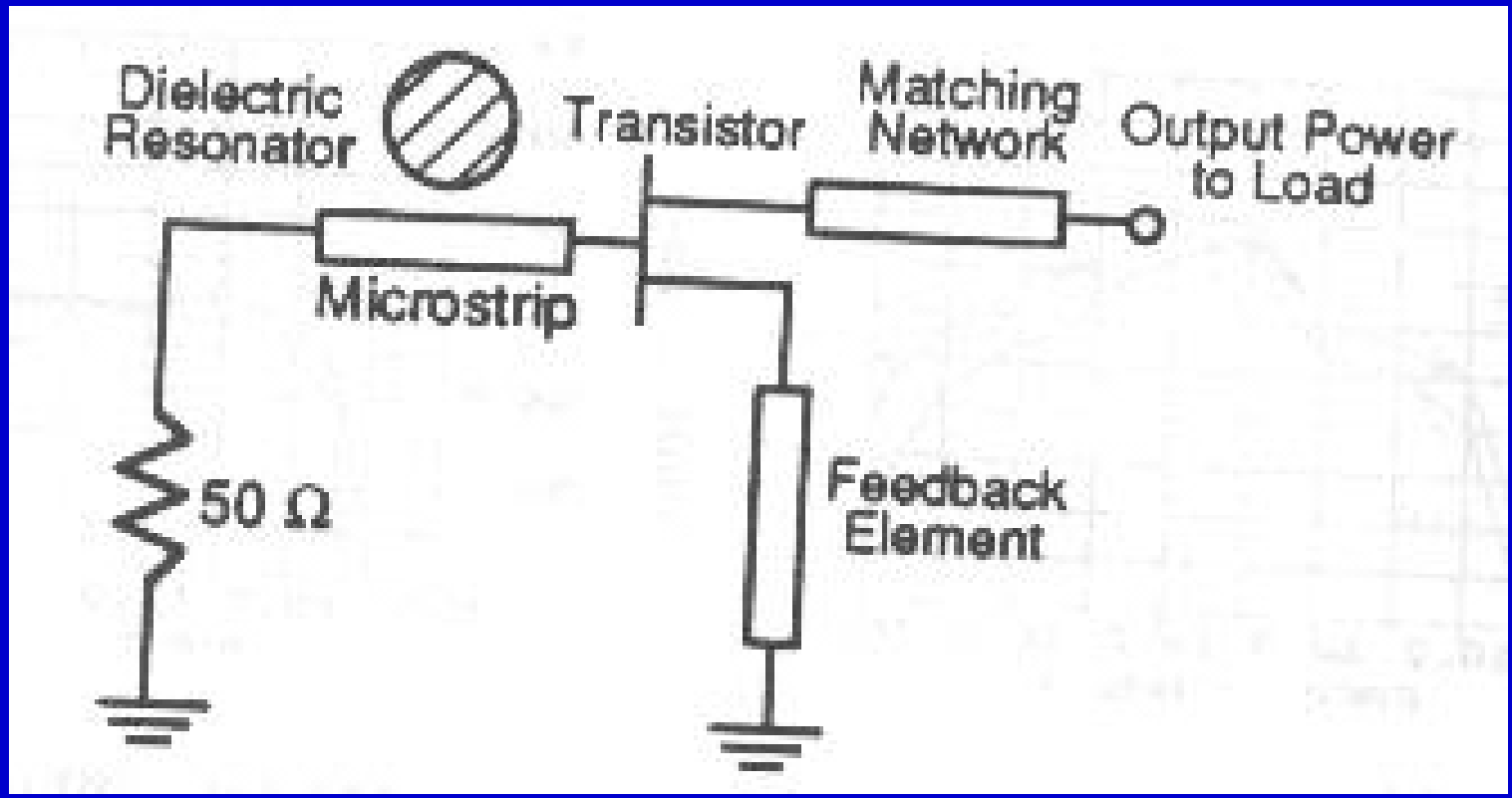
(Data from I.J. Bahl, in Compound Semiconductor Electronics, The Age of maturity, WS, Inc., 1996, Ed. M. S. Shur, pp. 175-208)

MMIC



After I.J. Bahl, in Compound Semiconductor Electronics,
The Age of maturity, WS, Inc., 1996, Ed. M. S. Shur, pp. 175-208

Oscillators



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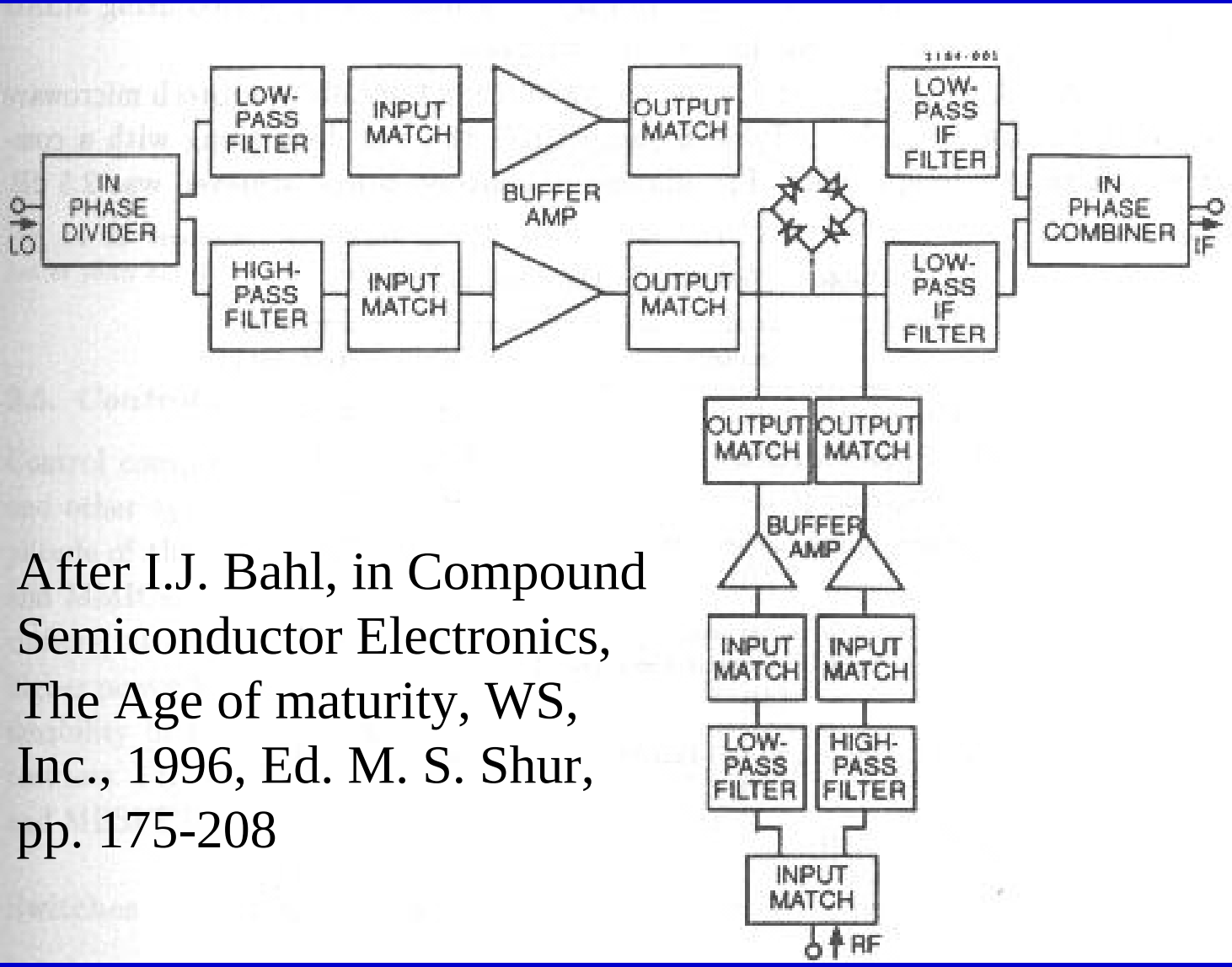
Mixers



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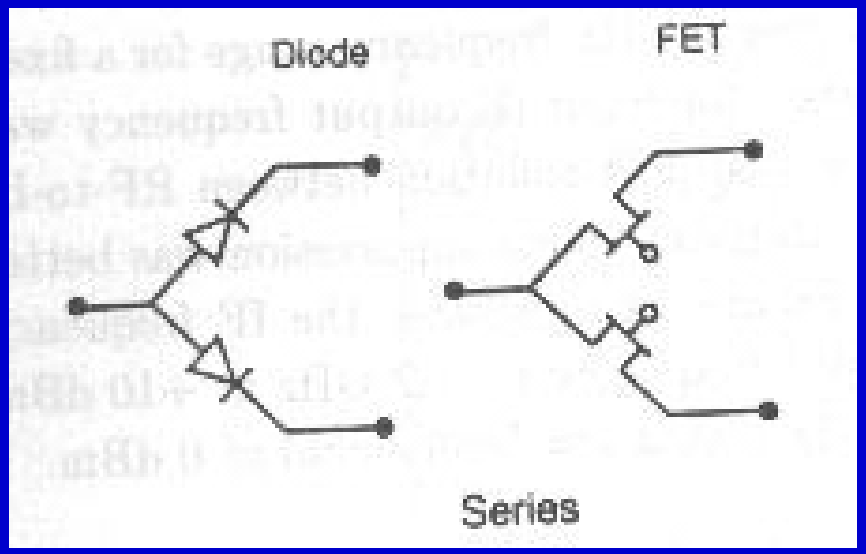
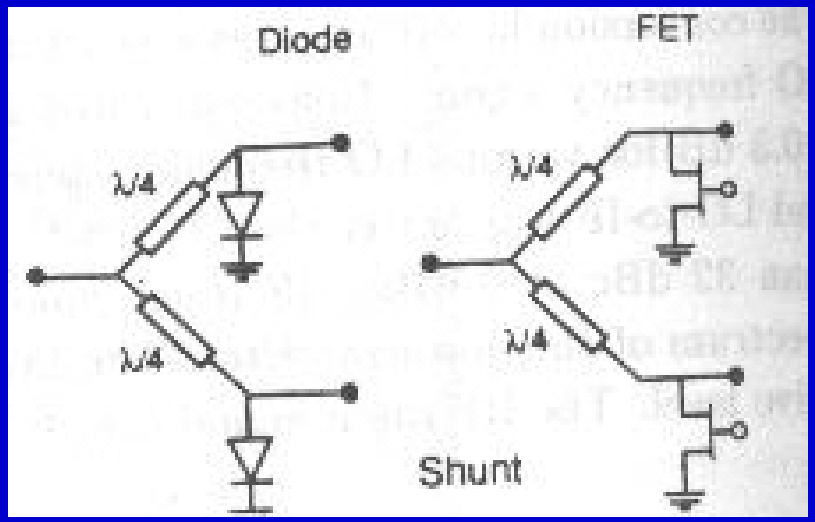
Switches

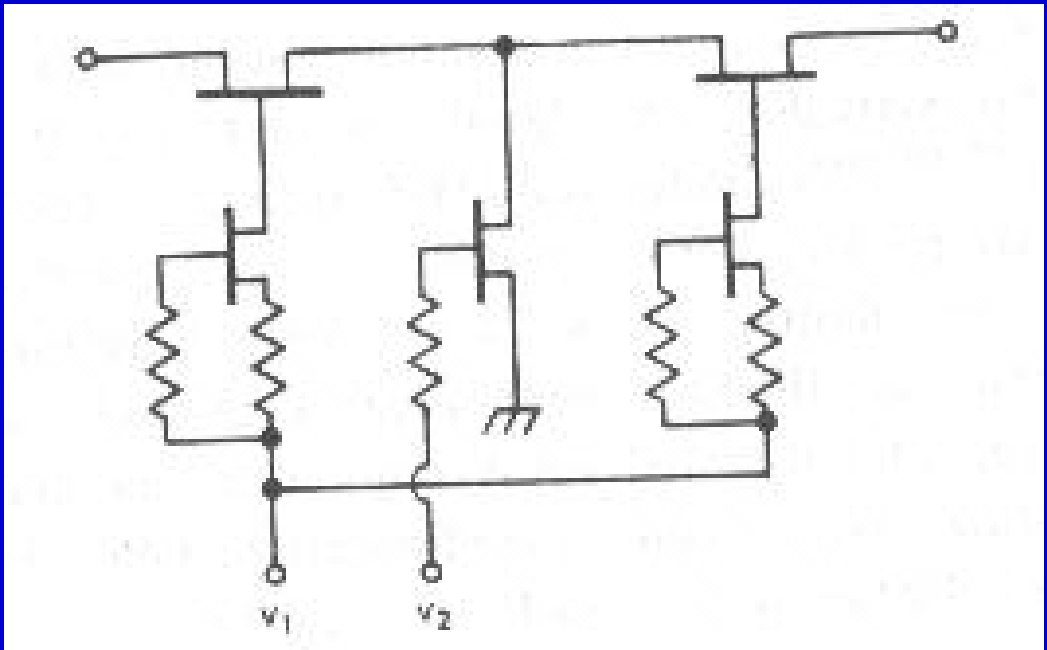




SPDT switch: Single Pole Double Throw

After I.J. Bahl, in Compound Semiconductor Electronics, The Age of maturity, WS, Inc., 1996, Ed. M. S. Shur, pp. 175-208

Attenuators



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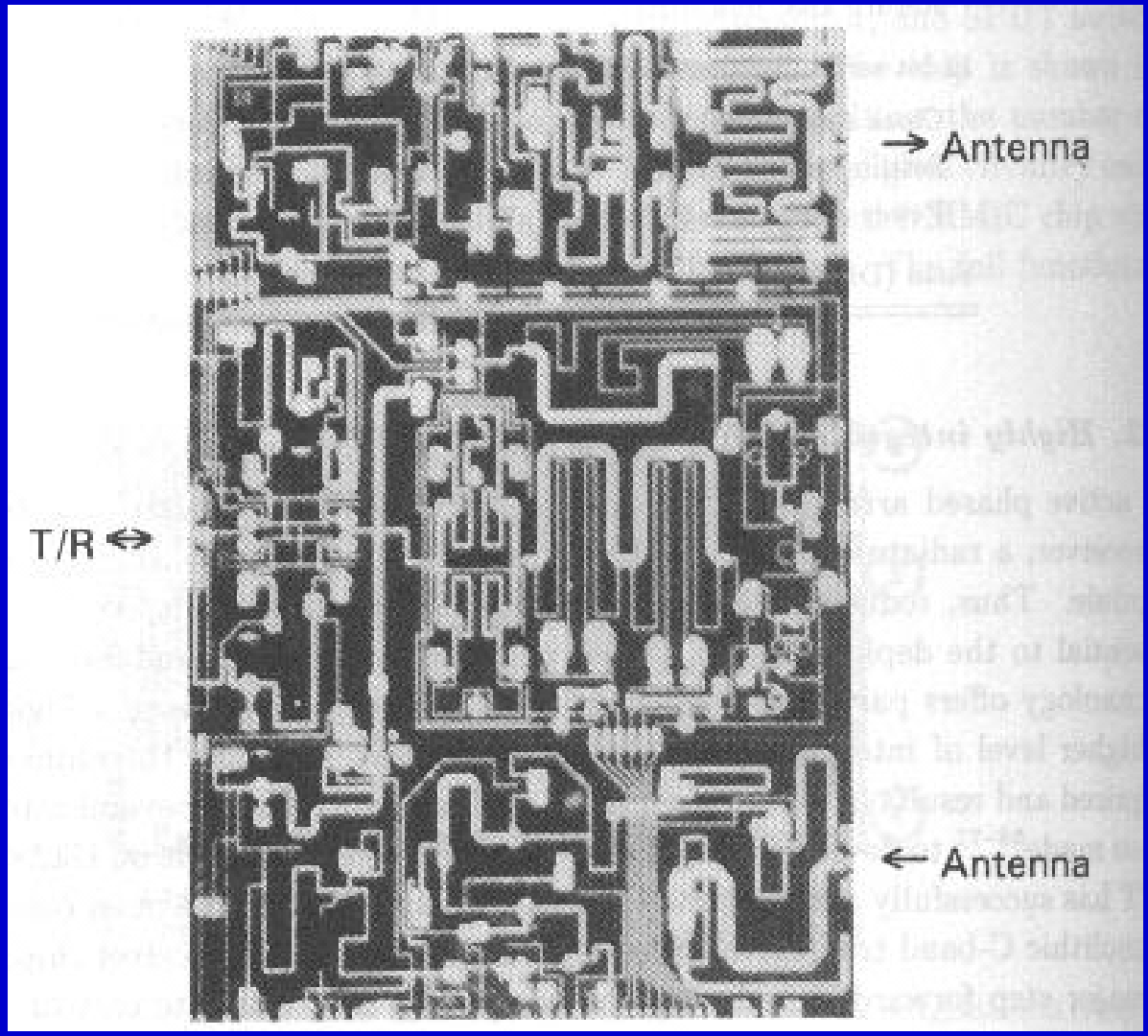
System Application Example



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