

UWB system for sensor network

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UWB principles

- ▶ UWB stands for Ultra Wideband, however at present there is not consistent definition of that how ultra wideband system should be

- ▶ The most widespread seems to be US FCC definition that states:

$$2 \frac{f_u - f_l}{f_u + f_l} \geq 0.25$$

Where:

f_u = upper 10 dB down point

f_l = lower 10 dB down point

- ▶ ... or at least 500MHz as nice gesture to industry community

Sensor network

- ▶ Self organizing network (AD HOC)
- ▶ Distributed network
- ▶ Network with high density of deployment of nodes
 - ▶ 10s -1000s / square meter
- ▶ Low power consumption network
- ▶ Basically low data rate network
- ▶ Non intrusive, seamless
- ▶ Low cost

Sensor node requirements

- ▶ Long life time with limited power source
- ▶ Low cost in mass production
- ▶ Non intrusive – small size
- ▶ Fully scalable
- ▶ Ideally should have some processing features
 - ▶ Gain of the distributed processing
- ▶ Self organizing

Why UWB ???

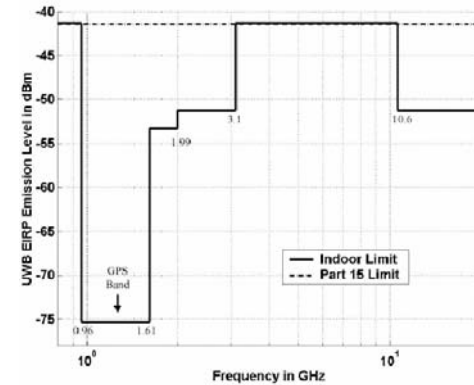


- ▶ UWB system is highly immune to multipath propagation phenomenon
- ▶ Able to provide 3D tracking capability with resolutions down to centimetres
- ▶ Power aware and efficient from power consumption point of view
- ▶ Extremely hard to eavesdrop
- ▶ Achievable high data rates (up to 500Mb/s) in short range communication with low power consumption (i.e. Bluetooth quality of service with 100 times less average power)
- ▶ Simpler transceiver's architecture (???)
- ▶ Able to see through obstacles (often used as ground penetrating radars)

UWB transceiver



- ▶ FCC ruling
 - ▶ Low radiated power EIRP -41.2dBm/MHz
 - ▶ Allowed band 3.1-10.6 GHz



UWB transceiver cont.

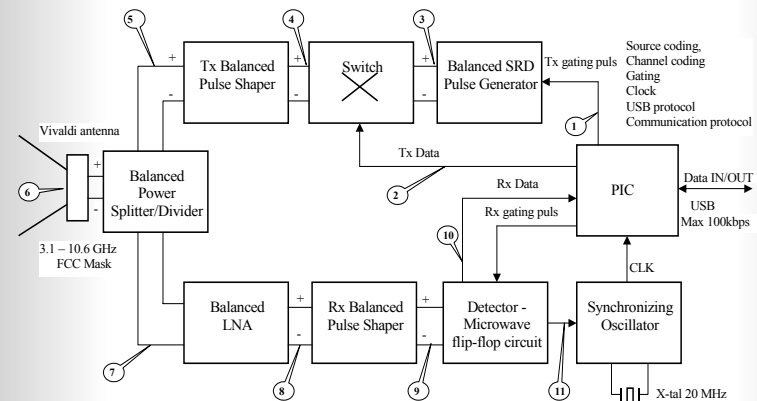


- ▶ Specification
 - ▶ OOK modulation
 - ▶ Matched filter concept
 - ▶ Omnidirectional Antenna
 - ▶ Distance 10 m
 - ▶ FCC mask
 - ▶ LNA NF=3 dB, G=30 dB
 - ▶ Data Rate 100 kbps
 - ▶ Low power supply 2.5-3.6 V

UWB transceiver cont.



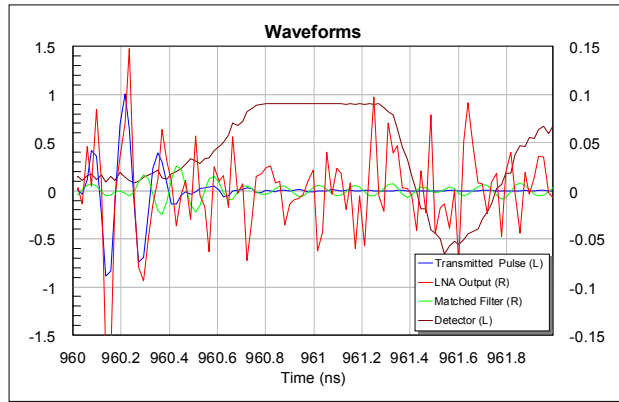
- ▶ Block diagram of the UWB transceiver



UWB transceiver



Waveforms

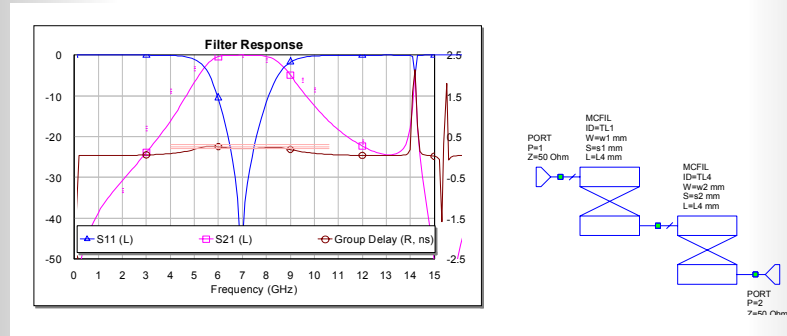


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Matched filter



Implementation in microstrip technology – simple 3rd order filter

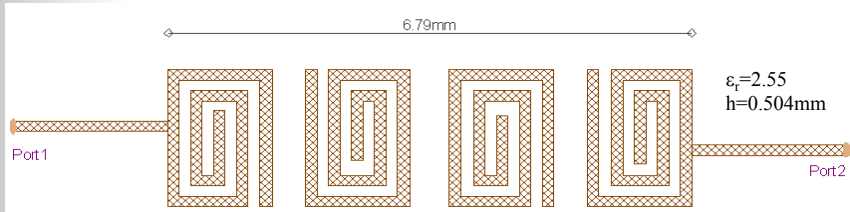
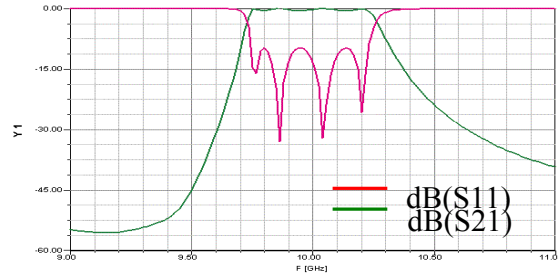


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Matched filter



Planar spiral filter

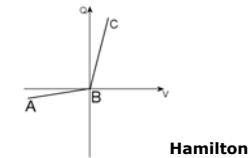
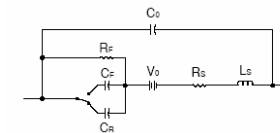


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Balanced pulse generator

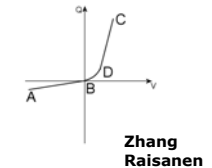


Active component step recovery diode



Improved model

$$Q = \begin{cases} \frac{C_f - C_r}{2\Phi} \left(V + \frac{C_r \Phi}{C_f - C_r} \right)^2 - \frac{C_r^2}{2(C_f - C_r)} \Phi & V \leq 0 \\ C_f V - \frac{C_f - C_r}{2} \Phi & 0 < V < \Phi \\ C_f V - \frac{C_f - C_r}{2} \Phi & V \geq \Phi \end{cases}$$

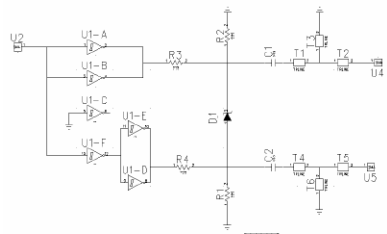


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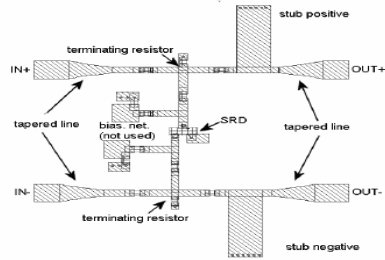
Balanced pulse generator



► Schematic



► Layout



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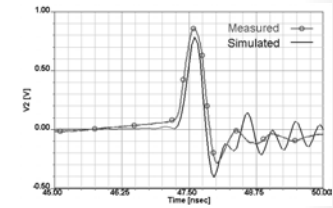
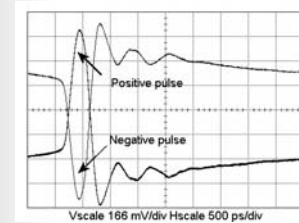
Balanced pulse generator



► Pulse parameters

Parameter	Distributed pulse forming network	Lumped pulse forming network
Rise/fall time (10-90%)	168 ps	rise 272ps fall 566ps
Pulse width (50-50%)	335ps	511ps
Pulse amplitude	±896 mV (11.9 dBm -peak power)	±1.6V (17dBm peak power)

► Pulse waveforms



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Future work



- Further improvement of the pulse generator
 - Higher peak power
 - Higher frequency content up to 7 GHz
- Investigation of the pulse generation with different shaping networks (NLTLs)
- Implementation of the pulse generator in UWB transceiver

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Thank
You



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