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Agenda

- Intro to UWB radios
- WUSB MAC-PHY Interface
- Integration/prototype development and testing
- Hardware design guidelines
- Antennas
- Summary



Intro to UWB Radios

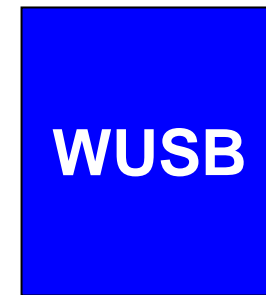
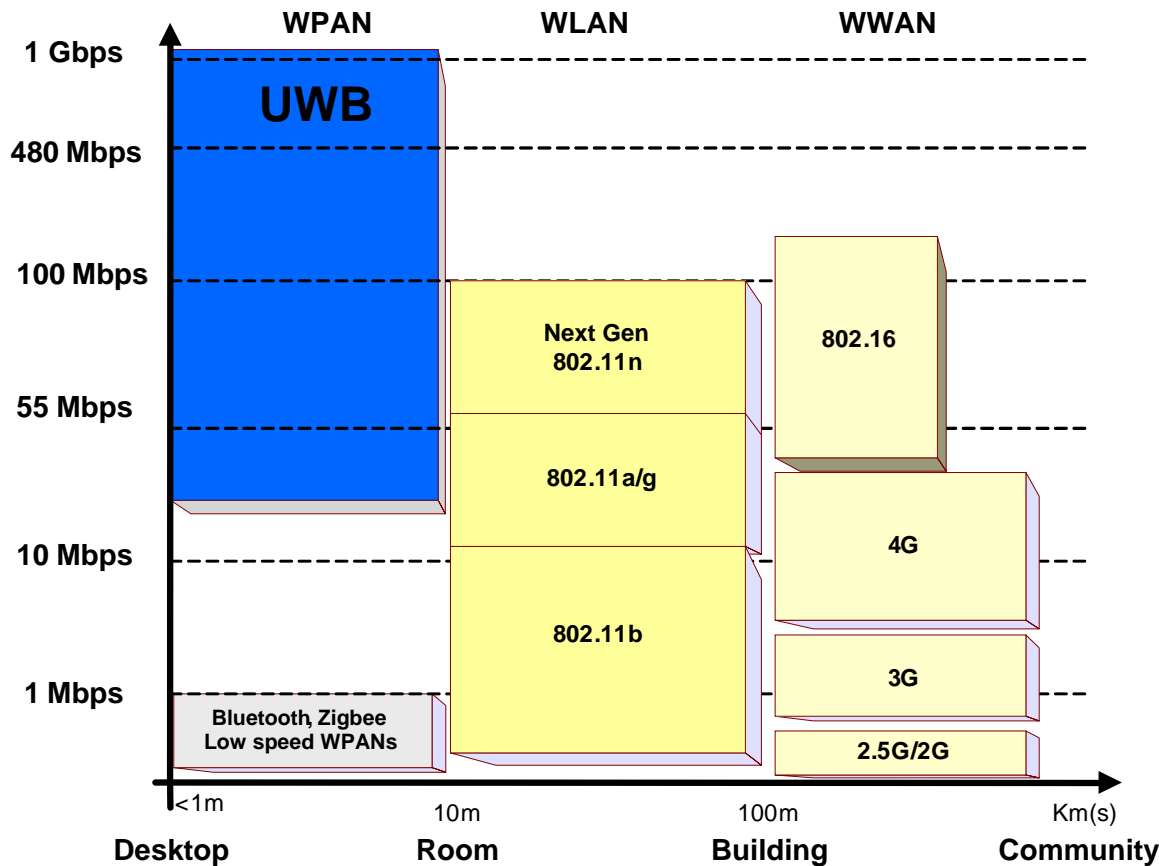
- What is UWB
- Frequency of wireless technologies
- Relative power of various wireless technologies
- Band Group 1
 - Sub-bands for initial implementation of WUSB
- UWB scope demonstration



What is UWB

- UWB, Ultra-Wideband (Signal with 528 MHz of BW)
- Underlay, Transmission that looks like noise to most narrow band transmitters and receivers
- OFDM Radio, Orthogonal Frequency Division Multiplexing

Where Does UWB Fit In



- Up to 480Mbps
- WPAN range

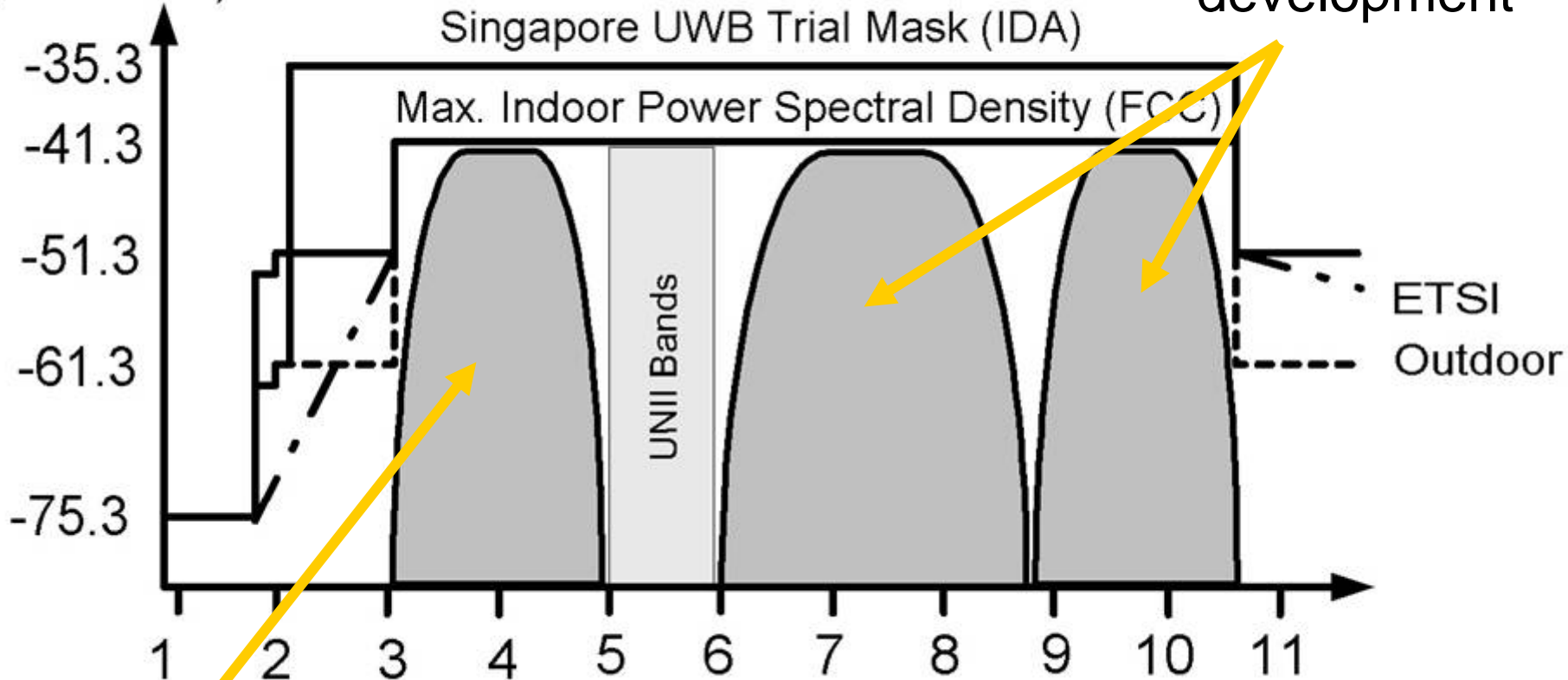
UWB Fills the Gap in the Bandwidth vs. Distance Plane

Frequency Range of UWB



Power Spectral Density

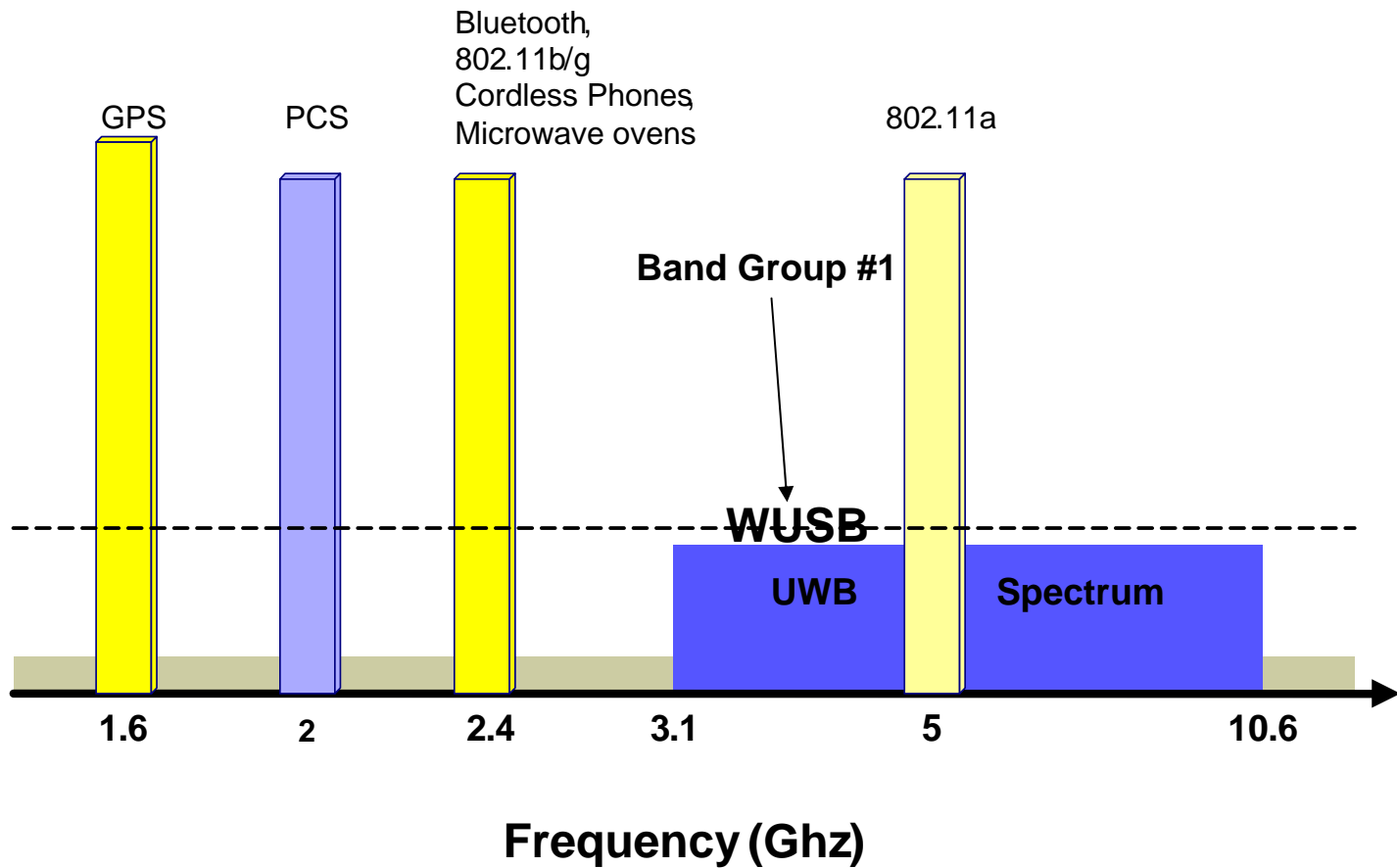
(dBm / MHz)



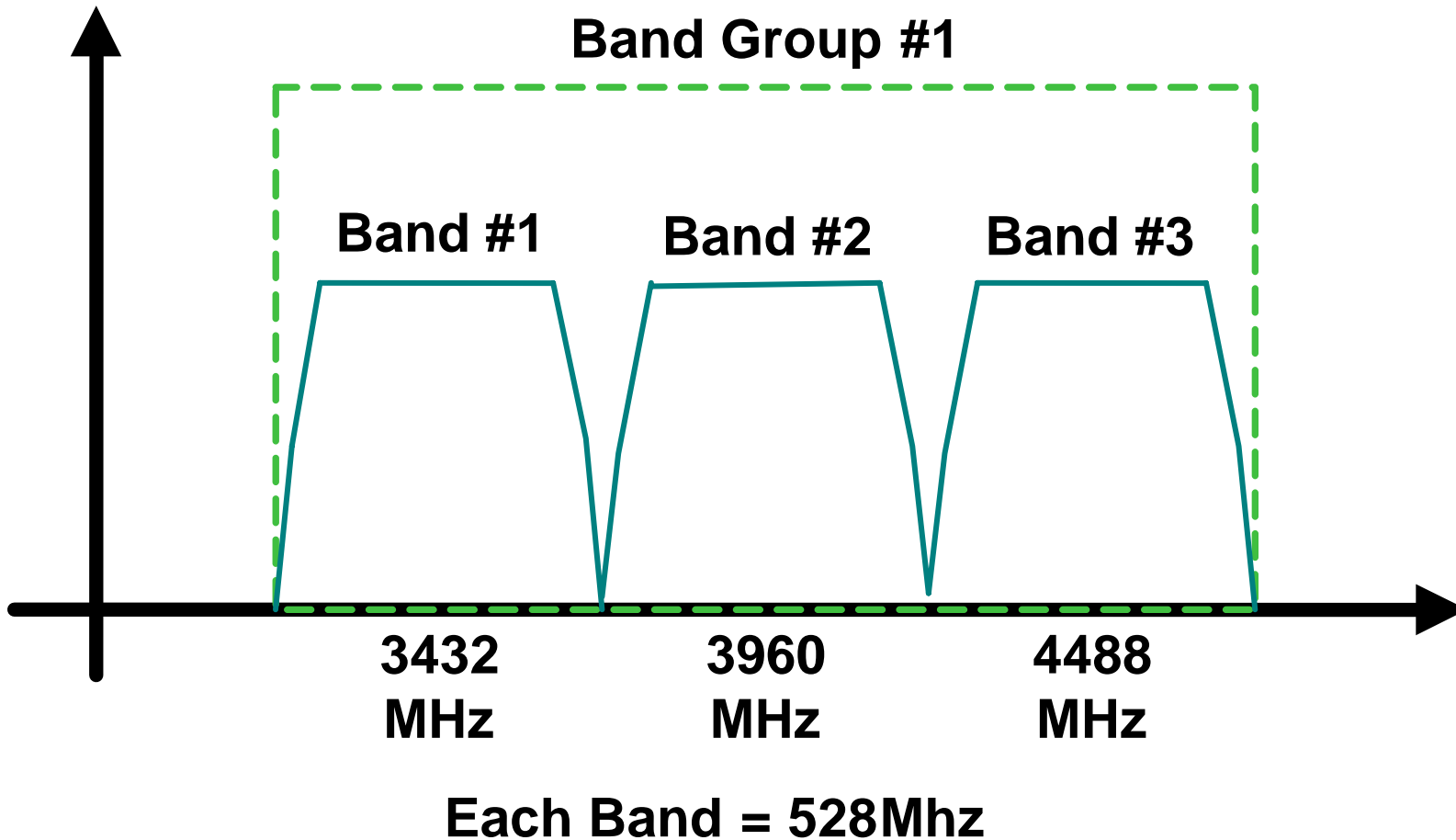
Ongoing development

Band Group #1, WUSB Frequency (GHz)

Relative Transmit Power



Band Group #1

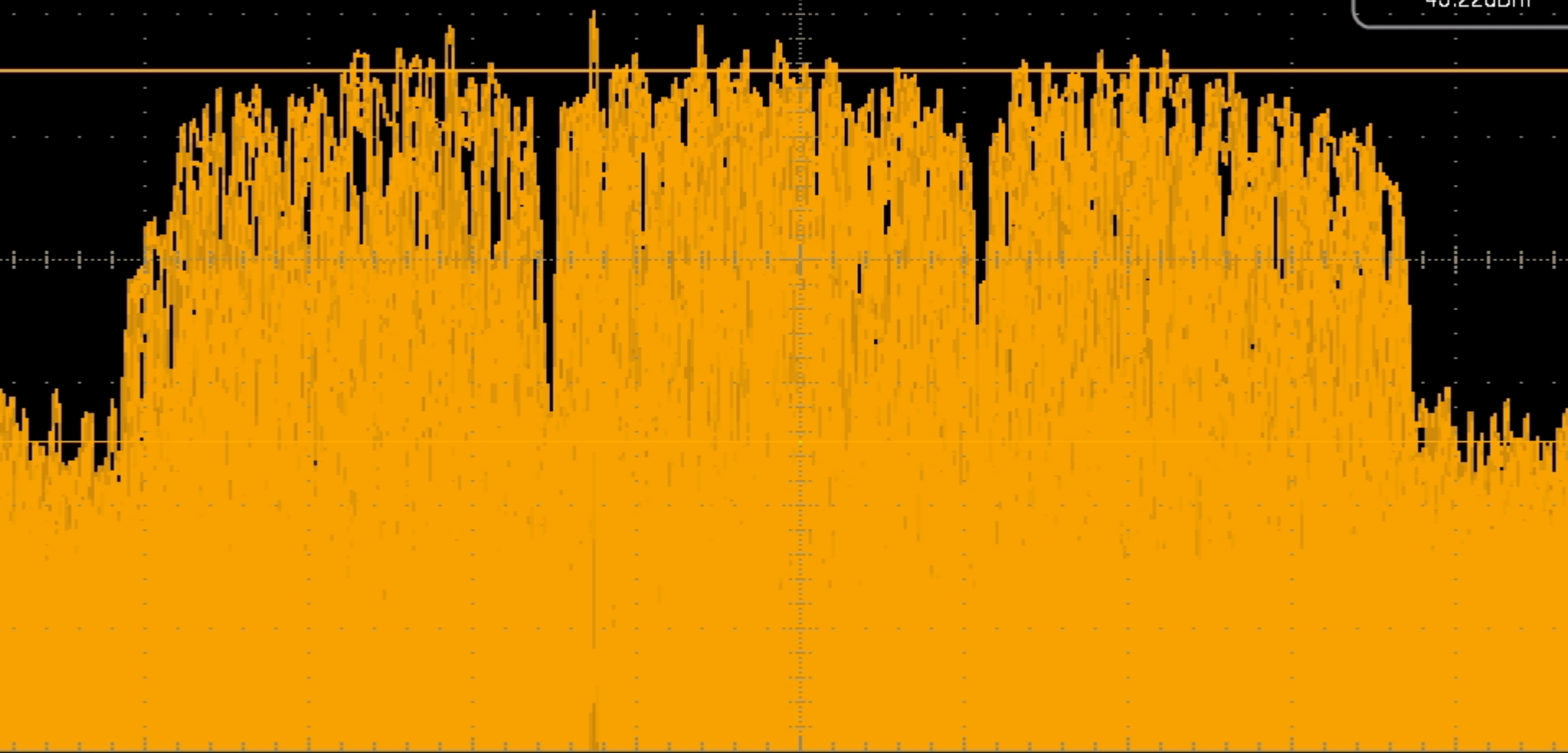


Curs1 Pos
-28.12dBm
Curs2 Pos
-43.22dBm

Band #1

Band #2

Band #3



M1 5.0dBm200MHz

M1 y1 : -28.12dBm
y2 : -43.22dBm
Δy : -15.1dBm

80.0ns/div
20.0GS/s 50.0ps/p
AC1 Runt

WUSB Scope Demonstration



Demo

WUSB MAC-PHY Interface



- **MAC-PHY interface**
 - WiMedia (MBOA) MAC-PHY Interface specification
 - Current revision at 0.95
 - Defines logical and timing interface
- **MAC-PHY Mechanical Interface specification for prototyping and integration/testing needed**
 - Should provide power to PHY
 - Need readily available connector
 - Should support cabling option
 - Needs to make strong physical connection

Prototyping MAC-PHY Connector Proposal



- Use a standard 2x20 stake pin (IDE style) connector
 - PHY uses standard IDE male connector
 - MAC uses 2x20 receptacle connector
- Can use 80-conductor Ultra ATA cable for cabled solutions
 - Cables readily available
 - Convenient LA probing
- Connectors readily available
- Minimal layout and routing constraints
- ***Multiple MAC and PHY vendors implementing this interface for early prototype development***



Refer to the *WUSB MAC-PHY prototype interface specification* for details.

40 Pin PDK Connector Pin-Out

Pin	Function	Pin	function
1	Reset	2	Ground
3	Data 0	4	NC
5	Data 1	6	PWR (3.3VDC)
7	Data 2	8	PWR (3.3VDC)
9	Data 3	10	PWR (3.3VDC)
11	Data 4	12	PWR (3.3VDC)
13	Data 5	14	PWR (3.3VDC)
15	Data 6	16	PWR (3.3VDC)
17	Data 7	18	NC
19	Ground	20	Key
21	PCLK	22	Ground
23	TXEN	24	Ground
25	RXEN	26	Ground
27	PHYACT	28	NC
29	DATAEN	30	Ground
31	CCA ST	32	Ground
33	SER DAT	34	Ground
35	STOPC	36	Ground
37	RSVD1	38	Ground
39	RSVD2	40	Ground



2x20 MAC-PHY PDK Connector Pin-out

MAC Connector



PHY Connector



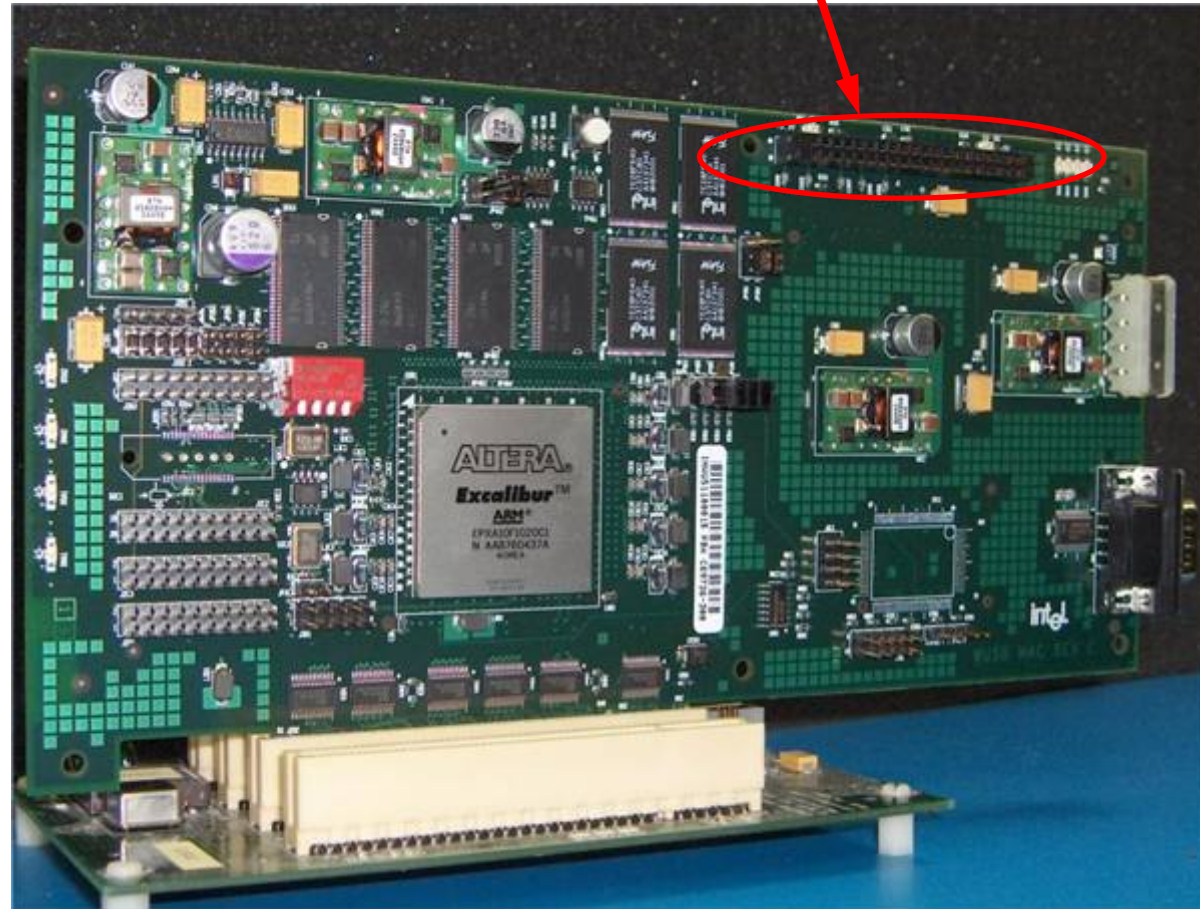
WUSB PDK



PDK Top View

- 33 MHz PCI Interface
- Altera Excalibur FPGA
 - ARM CPU
- 128MB SDRAM
- 32MB Flash
- UART

40 pin 2x20 connector



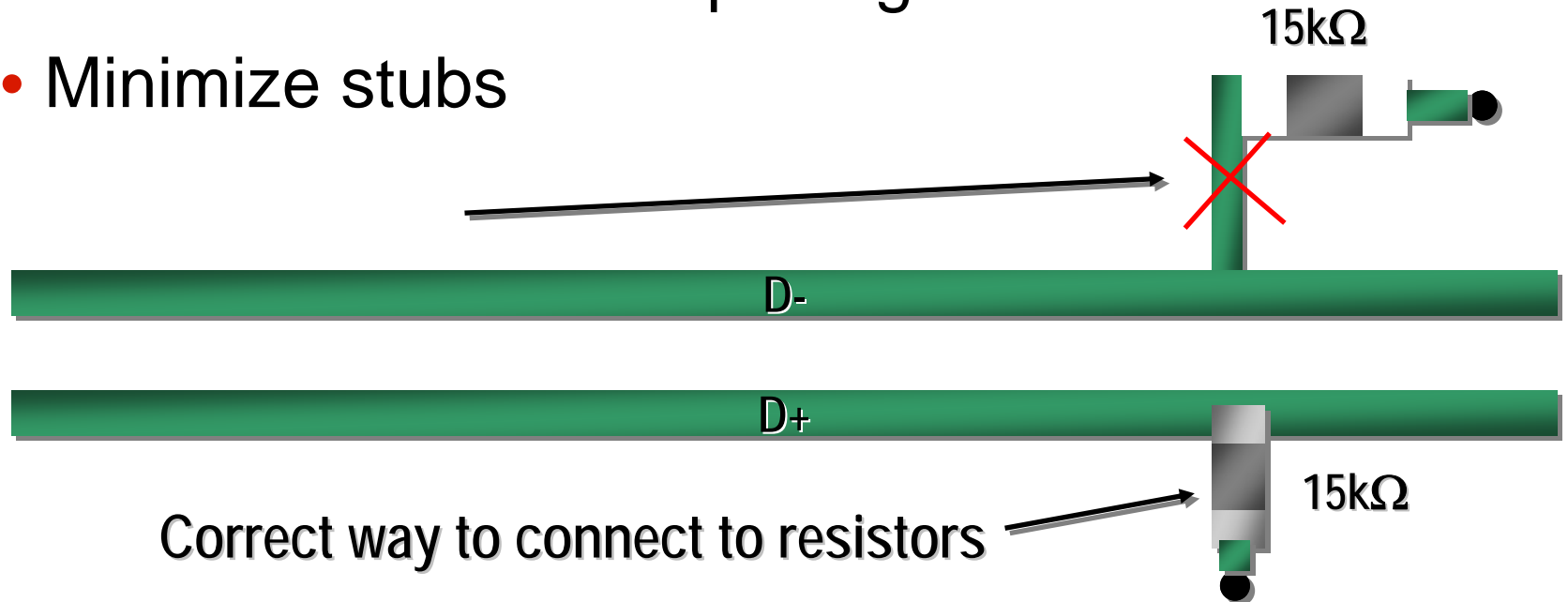
Hardware Design Considerations



- WUSB presents new challenges
 - Board routing, placement
 - EMI/EMC requirements
 - MAC-PHY interface testing/compatibility
 - RF testing
 - RF isolation
 - Antenna placement/connection considerations
- USB-IF Will Provide Design Guides In Such Areas

General Routing Guidelines

- Control trace widths to obtain target impedance
 - Ask your board vendor what they can achieve
 - As always, cost is a consideration
- Maintain strict trace spacing control
- Minimize stubs

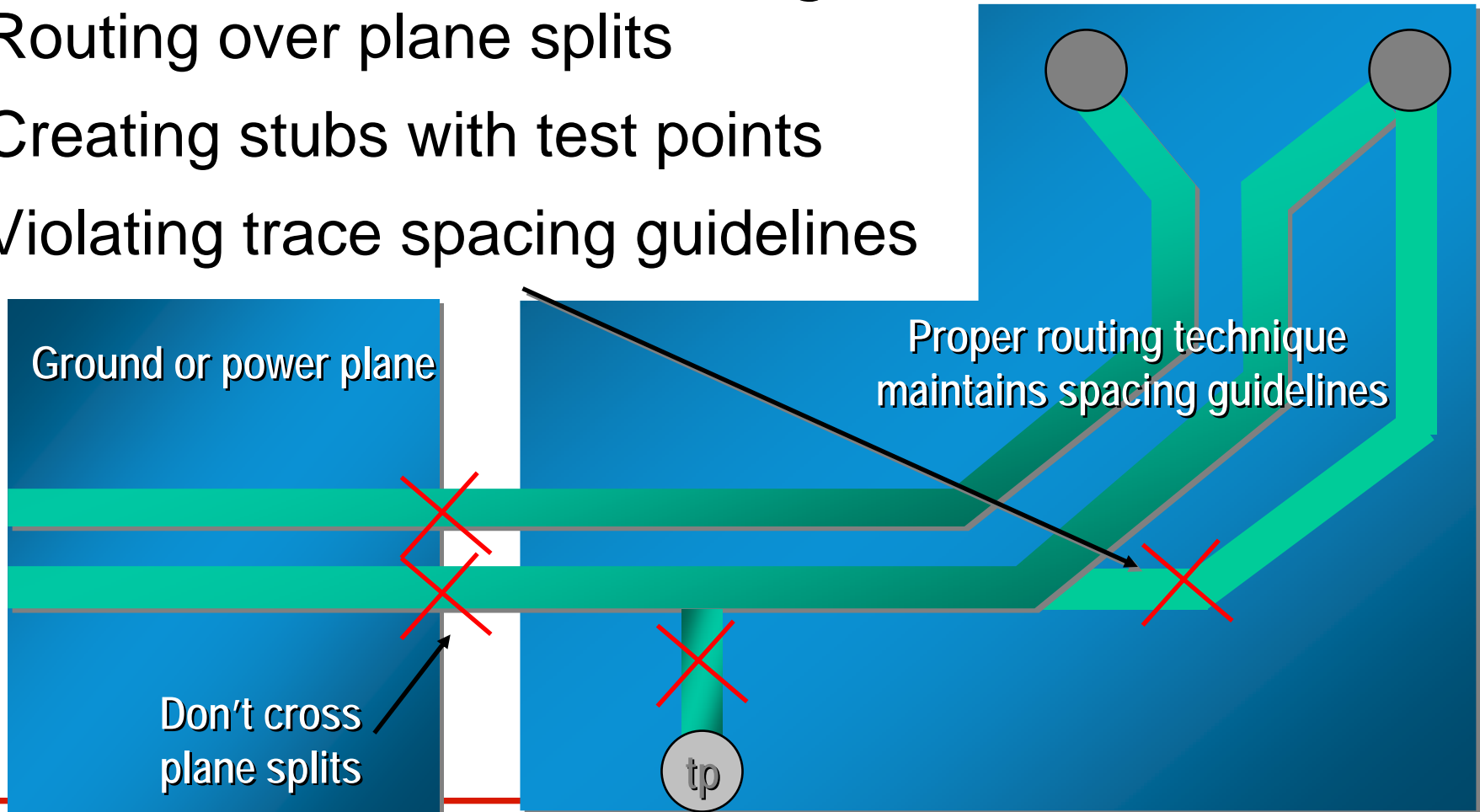


Routing Guidelines

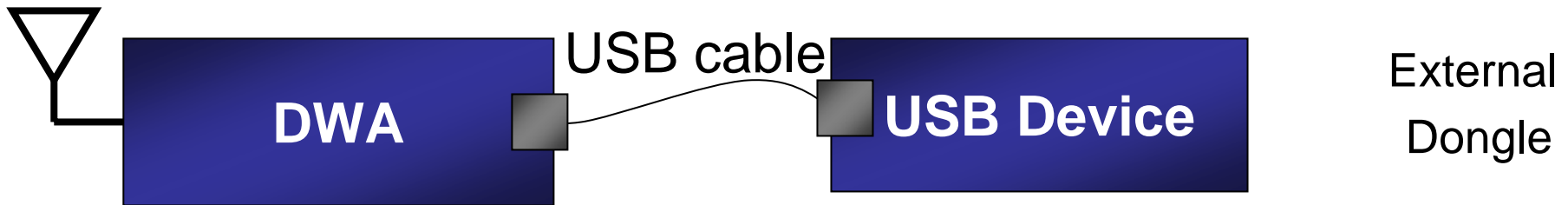


Common Routing Mistakes

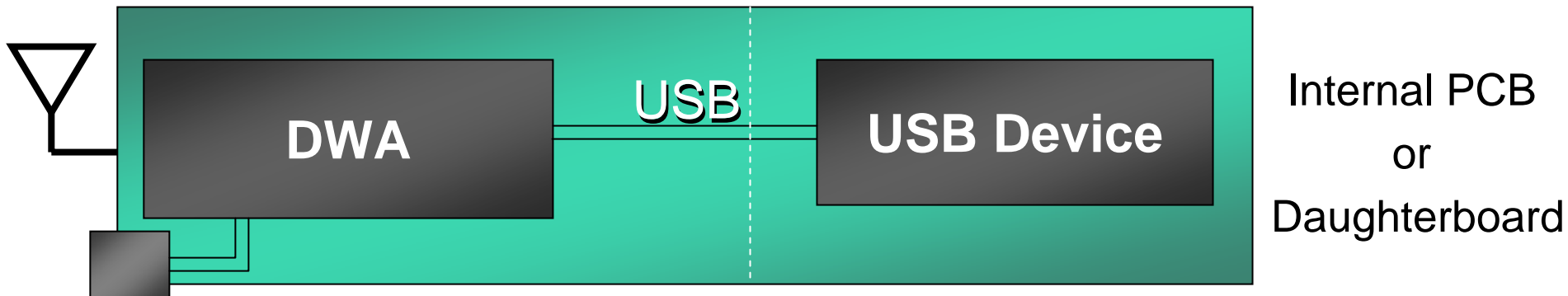
- Routing over plane splits
- Creating stubs with test points
- Violating trace spacing guidelines



DWA Design Considerations



Compelling choice for existing USB products



Association model used will effect HW design choices

RF Testing



- Transmitter test challenges
- What do I need to test?
 - Transmitter power
 - Power mask
 - Pulse shape
 - Error Vector Magnitude (EVM)
 - MBOA PHY specification compliance (PHY interoperability)
 - Others?

Antenna Placement Considerations



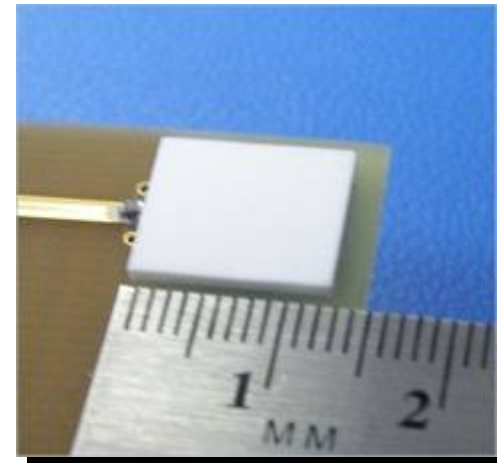
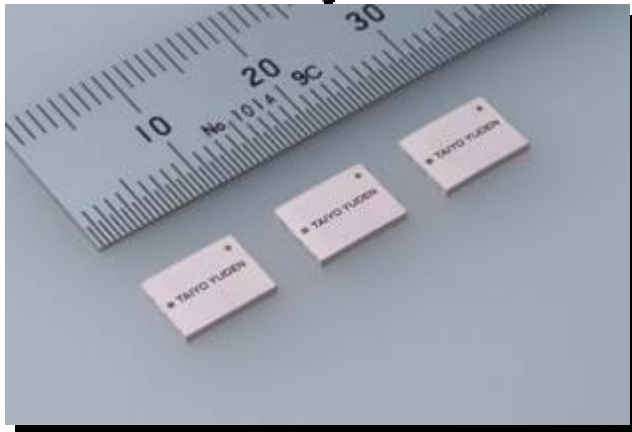
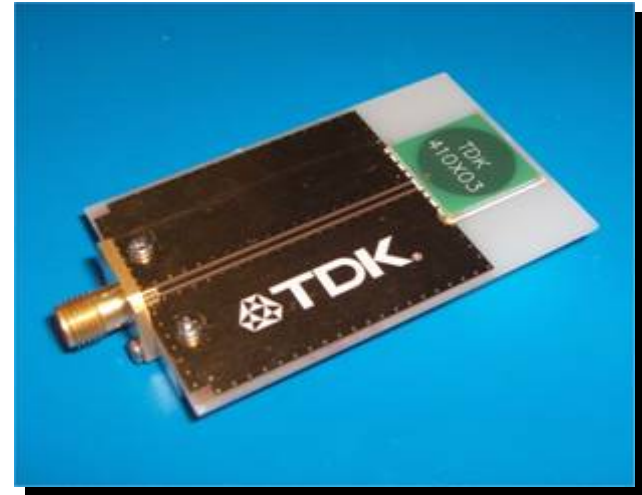
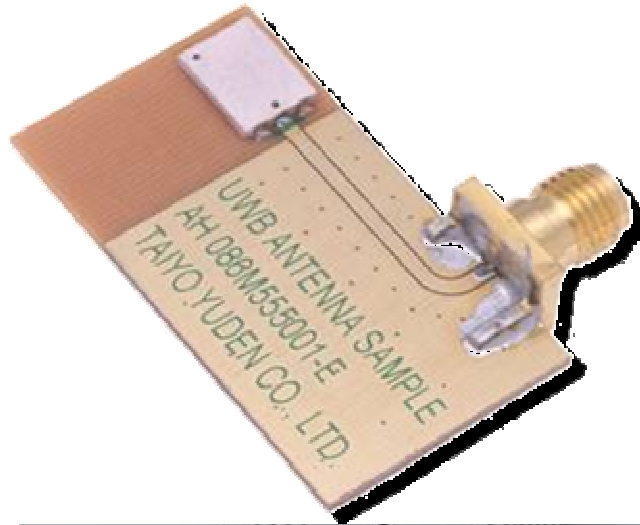
- Product type will effect Antenna placement options
 - Example: desktop PC vs Mobile PC
- Antenna distance and interconnect type to AFE is critical
- Proximity to noise sources and other RF sources is key consideration

UWB Antennas



How Big IS a UWB Antenna?

UWB Antennas

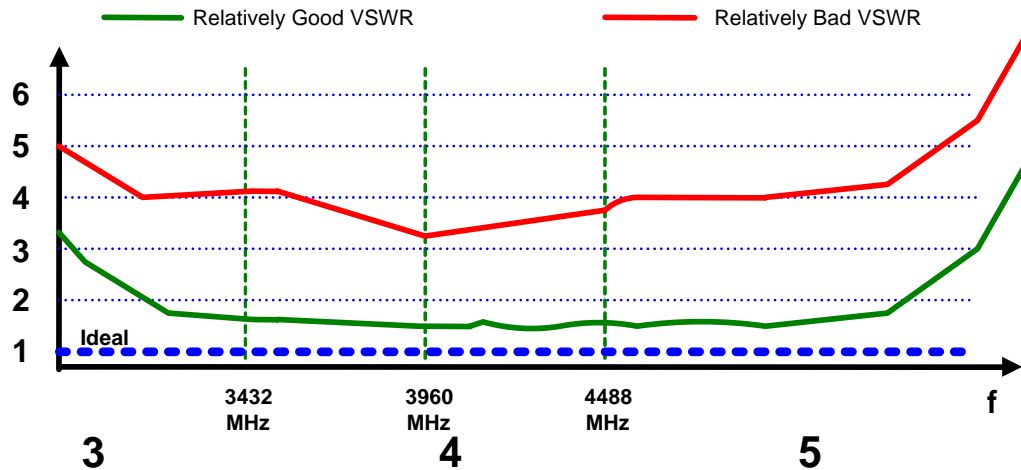




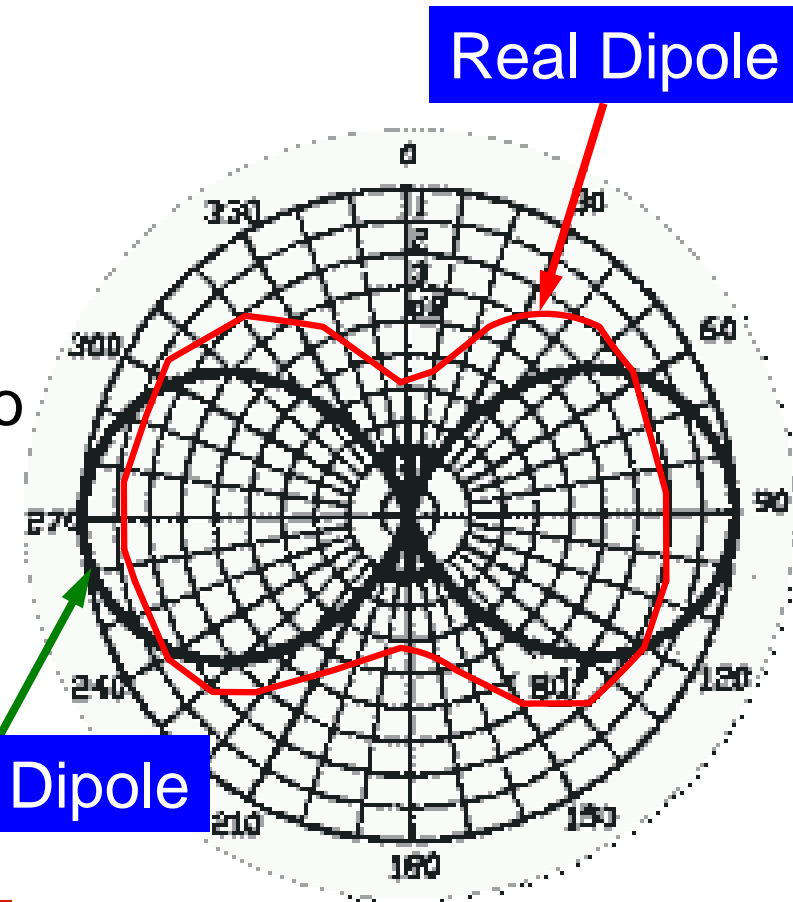
Antenna Design Considerations

- Common terms used in antenna specs
 - VSWR
 - Radiation Pattern
 - Antenna Gain
 - Frequency Range
 - Polarization
 - Impedance
 - Filters

Antenna Terminology

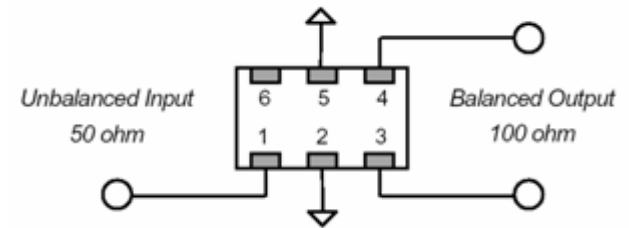


- VSWR – Voltage standing wave ratio
- Antenna Gain
 - Decibels (dB) = $10 \cdot \log(P_{out}/P_{in})$
 - dBi (relative to isotropic)
 - dBD (relative to Dipole)



Antenna Terminology

- Operating frequency (3.1-5.2GHz)
- Polarization
 - Linear (vertical and horizontal)
- Impedance
 - Typically 50 ohms
 - Requires BALUN (BALanced – Unbalanced)
- Filters
 - Band pass
 - Notch filter (for example 802.11a)



Summary



- WUSB uses UWB radios (3.1 – 10.6 GHz)
 - Band Group #1
- WUSB HW design presents new challenges
 - Understanding UWB technology advantages and limitations
 - Board Layout and Routing
 - Antenna Selection
 - Antenna Placement
 - RF Testing
 - MAC and PHY Interoperability
- The USB-IF will provide Design Guides In Such Areas