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Wireless Standards

Communication and Connectivity

NATIONAL INSTRUMENTS

Digital Cellular

	LTE/LTE-Advanced	W-CDMA/HSPA/HSPA+	TD-SCDMA / TD-HSPA / TD-HSPA+	GSM/GPRS/EDGE/EDGE Evolution/VAMOS	CDMA2000 EV-DO	CDMA2000 1xRTT
Modulation type	QPSK, 16QAM, 64QAM	QPSK (DL) 16QAM (DL, HSDPA) 64QAM (DL, HSPA+) Dual-BPSK (UL) 16QAM (UL, HSPA+)	QPSK, 8PSK 16QAM (HSPA) 64QAM (HSPA+)	GMSK 8PSK (EDGE) QPSK, 16QAM, 32QAM (EDGE Evo) AQPSK (VAMOS)	QPSK, 8PSK, 16QAM (DL, Rel. 0/Rev. A) 8PSK, QPSK, 8PSK (UL, Rel. 0/Rev. A) QPSK, 8PSK, 16QAM (DL, Rev. B) 8PSK, QPSK, 8PSK (UL, Rev. B)	QPSK (FL) HPSK, OQPSK (RL)
Transmission method/ multiple access	OFDMA (DL); localized SC-FDMA (UL, LTE Rel-8); Clustered SC-FDMA		TD-SCDMA, FDMA, TD-HSDPA	TDMA, FDMA	TDMA (DL) CDMA (UL)	CDMA
Duplex	FDD, TDD	FDD	TDD	FDD	FDD	FDD
Channel bandwidth	1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, and 20 MHz LTE-Advanced: up to 100 MHz with carrier aggregation (max. 5 carrier x 20 MHz)	5 MHz (W-CDMA/HSPA) 10 MHz (HSPA+ (DC-HSDPA, DC-HSUPA)) 20 MHz (HSPA+ (four-carrier HSDPA))	1.6 MHz	200 kHz (GSM/EDGE) 400 kHz (EDGE Evo)	1.25 MHz x N (N = number of channels, max. 15)	1.25 MHz
Peak data rate	LTE Rel-8: 300 Mbit/s (DL, 20 MHz, 64 QAM, 4x4 MIMO) 75 Mbit/s (UL, 20 MHz, 64QAM) LTE-Advanced: DL: 1 Gbit/s UL: 500 Mbit/s	384 kbit/s (DL, UL) 14.4 Mbit/s (DL, HSDPA) 5.76 Mbit/s (UL, HSUPA) 28 Mbit/s (DL, HSPA+, 16QAM, MIMO) 42.2 Mbit/s (DL, HSPA+, 64QAM, MIMO) 42.2 Mbit/s (DL, HSPA+, 64QAM, DC) 84.4 Mbit/s (DL, HSPA+, 64QAM, MIMO, DC) 168 Mbit/s (DL, HSPA+, 64QAM, MIMO, 4C) 11.5 Mbit/s (UL, HSPA+, 16QAM) 23 Mbit/s (UL, HSPA+, 16QAM, DC)	2.8 Mbit/s (DL, HSDPA) 2.2 Mbit/s (UL, HSUPA) 8.4 Mbit/s (DL, HSPA+) 2.2 Mbit/s (UL, HSPA+)	14.4 kbit/s (GSM) 171.2 kbit/s (DL, 8 slots, GPRS) 128.4 kbit/s (UL, 6 slots, GPRS) 473.6 kbit/s (DL, 8 slots, EDGE) 355.2 kbit/s (UL, 6 slots, EDGE) 1.89 Mbit/s (DL, 8 slots, EGPRS2-B, DL DC) 710 kbit/s (UL, 6 slots, EGPRS2-B)	2.4 Mbit/s (DL, Rel. 0) 153 kbit/s (UL, Rel. 0) 3.1 Mbit/s (DL, Rev. A) 1.8 Mbit/s (UL, Rev. A) 4.9 Mbit/s x N (UL, 64QAM, Rev. B) 1.8 Mbit/s x N (UL, Rev. B) (N = number of channels, max. 15)	153.6 kbit/s (Rel. 0) 307.7 kbit/s (Rev. E)
Standardization forums	3gpp.org globalcertificationforum.org ptcrb.com			3gpp.org globalcertificationforum.org ptcrb.com	3gpp2.org globalccf.org	
Frequency range	iE-IUTRA FDD Bands (in MHz) 1 UL: 1920 to 1980 DL: 2110 to 2170 2 UL: 1850 to 1910 DL: 1930 to 1990 3 UL: 1710 to 1785 DL: 1805 to 1880 4 UL: 1710 to 1755 DL: 2110 to 2155 5 UL: 824 to 849 DL: 869 to 894 6 UL: 830 to 840 DL: 875 to 885 7 UL: 2500 to 2570 DL: 2620 to 2690 8 UL: 880 to 915 DL: 925 to 960 9 UL: 1749.9 to 1784.9 DL: 1844.9 to 1879.9 10 UL: 1710 to 1770 DL: 2110 to 2170 11 UL: 1427.9 to 1447.9 DL: 1475.9 to 1495.9 12 UL: 699 to 716 DL: 729 to 746 13 UL: 777 to 787 DL: 746 to 756 14 UL: 788 to 798 DL: 758 to 768 15 UL: 1900 to 1920 DL: 2600 to 2620 (Europe only) 16 UL: 2010 to 2025 DL: 2585 to 2600 (Europe only) 17 UL: 704 to 716 DL: 734 to 746 (LTE only) 18 UL: 815 to 830 DL: 860 to 875 (LTE only) 19 UL: 830 to 845 DL: 875 to 890 20 UL: 832 to 862 DL: 791 to 821 21 UL: 1447.9 to 1462.9 DL: 1495.9 to 1510.9 22 UL: 3410 to 3490 DL: 3510 to 3590 23 UL: 2000 to 2020 DL: 2180 to 2200 (LTE only) 24 UL: 1626.5 to 1660.5 DL: 1525 to 1559 (LTE only) 25 UL: 1850 to 1915 DL: 1930 to 1995 TDD Bands (in MHz) 33 1900 to 1920 34 2010 to 2025 35 1850 to 1910 36 1930 to 1990 37 1910 to 1930 38 2570 to 2620 39 1880 to 1920 40 2300 to 2400 41 2496 to 2690 (LTE only) 42 3400 to 3600 (LTE only) 43 3600 to 3800 (LTE only)	FDD Bands (in MHz) T-GSM 380 UL: 380.2 to 389.8 DL: 390.2 to 399.8 T-GSM 410 UL: 410.2 to 419.8 DL: 420.2 to 429.8 GSM 450 UL: 450.4 to 457.6 DL: 460.4 to 467.6 GSM 480 UL: 478.8 to 486 DL: 488.8 to 496 GSM 710 UL: 698 to 716 DL: 728 to 746 GSM 750 UL: 777 to 793 DL: 747 to 763 T-GSM 810 UL: 806 to 821 DL: 851 to 866 GSM 850 UL: 824 to 849 DL: 869 to 894 P-GSM 900 UL: 890 to 915 DL: 935 to 960 E-GSM 900 UL: 880 to 915 DL: 925 to 960 R-GSM 900 UL: 876 to 915 DL: 921 to 960 DCS 1800 UL: 1710 to 1785 DL: 1805 to 1880 PCS 1900 UL: 1850 to 1910 DL: 1930 to 1990	BC or Band Classes (in MHz) 800 MHz Band 1900 MHz Band TACS Band JTACS Band Korean PCS Band 450 MHz Band 2 GHz Band 700 MHz Band 1800 MHz Band 900 MHz Band Secondary 800 MHz Band 400 MHz European PAMR Band 800 MHz PAMR Band 2.5 GHz IMT-2000 Extension Band US PCS 1.9 GHz Band AWS Band US 2.5 GHz Band US 2.3 GHz Forward Link Only Band 700 MHz Public Safety Band Lower 700 MHz Band L-Band S-Band *not specified for 1xRTT	BC0 RL: 815 to 849 FL: 860 to 894 BC1 RL: 1850 to 1910 FL: 1930 to 1990 BC2 RL: 872 to 915 FL: 917 to 960 BC3 RL: 887 to 925 FL: 832 to 870 BC4 RL:1750 to 1780 FL: 1840 to 1870 BC5 RL: 410 to 483 FL: 420 to 493 BC6 RL: 1920 to 1980 FL: 2110 to 2170 BC7 RL: 776 to 788 FL: 746 to 758 BC8 RL: 1710 to 1785 FL: 1805 to 1880 BC9 RL: 880 to 915 FL: 925 to 960 BC10 RL: 806 to 901 FL: 851 to 940 BC11 RL: 410 to 483 FL: 420 to 493 BC12 RL: 870 to 876 FL: 915 to 921 BC13 RL: 2500 to 2570 FL: 2620 to 2690 BC14 RL: 1850 to 1915 FL: 1930 to 1995 BC15 RL: 1710 to 1755 FL: 2110 to 2155 BC16 RL: 2502 to 2568 FL: 2624 to 2690 BC17 FL: 2624 to 2690* BC18 RL: 787 to 799 FL: 757 to 769 BC19 RL: 698 to 716 FL: 728 to 746 BC20 RL: 1626 to 1660 FL: 1525 to 1559 BC21 RL: 2000 to 2020 FL: 2180 to 2200 (UL/RL): Uplink/Reverse Link (DL/FL): Downlink/Forward Link (BS): Base Station (MS): Mobile Station	

Wireless Connectivity

	WiMAX / WiMAX Advanced	Wireless Gigabit	WLAN/WiFi	WLAN/WiFi	Bluetooth	ZigBee	RFID	NFC	UWB
	IEEE 802.16-2009 / 802.11m	IEEE 802.11ad	IEEE 802.11ac	IEEE 802.11a, b, g, n	IEEE 802.15.1	IEEE 802.15.4	ISO/IEC 18000	NFC Analog Specification	
Modulation type	BPSK, QPSK, 16QAM, 64QAM	SQPSK, QPSK, 16QAM, 64QAM (OFDM) π/2-BPSK, π/2-QPSK, π/2-16QAM (SC)	BPSK, QPSK, 16QAM, 64QAM, 256QAM	BPSK, DQPSK, QPSK, 16QAM, 64QAM (a, g, af) CCK, PBCC (b) BPSK, QPSK, 16QAM, 64QAM (n)	GFSK (Basic rate, LE) π/4-DQPSK, 8DPSK (EDR)	BPSK (868/915 MHz) OQPSK (2.4 GHz)	FSK, ASK, PSK, PJM, BPSK	ASK, BPSK	
Transmission method/ multiple access	SOFDMA (128, 256, 512, 1024, 2048) OFDM (256)	OFDM	OFDM	OFDM, CSMA/CA	FHSS, FDMA, TDMA (LE)	DSSS, CSMA/CA	TDMA, FDMA	TDMA, FDMA	
Duplex	TDD, FDD/HFDD	TDD	TDD	TDD	TDD	TDD	TDD	TDD	
Channel bandwidth	5 MHz, 7 MHz, 8.75 MHz,10 MHz WiMAX Advanced 5 MHz to 20 MHz, optionally 40 MHz	2.16 GHz	20 MHz, 40 MHz, 80 MHz, 160 MHz	20 MHz (a, b, g) 20 MHz, 40 MHz (n)	Channel spacing: 1 MHz (basic rate, EDR) 2 MHz (LE)	5 MHz	typ. 200 kHz/500 kHz	typ. 200 kHz/500 kHz	
Peak data rate	128 Mbit/s (DL, 20 MHz, 2x2 MIMO) 56 Mbit/s (UL, 20 MHz, 2x2 MIMO) WiMAX Advanced 300 Mbit/s (DL, 20 MHz, 4x4 MIMO) 135 Mbit/s (UL, 20 MHz, 2x4 MIMO)	6.757 Gbit/s (OFDM) 4.62 Gbit/s (SC)	6933.3 Mbit/s (8 spatial streams, 160 MHz or 80+80 MHz, short guard interval, 256AMS/6	54 Mbit/s (a, b, g) <600 Mbit/s (n)	1 Mbit/s (Basic rate, LE) 3 Mbit/s (EDR)	20 kbit/s (868 MHz) 40 kbit/s (915 MHz) 250 kbit/s (2.4 GHz)	106 kbit/s 212 kbit/s 424 kbit/s 848 kbit/s	106 kbit/s 212 kbit/s 424 kbit/s	50 bit/s
Standardization forums	ieee802.16 wimaxforum.org	ieee802.org/11	ieee802.org/11	ieee802.org/11	bluetooth.org	ieee802.org/15 zigbee.org	iso.org	iso.org nfc-forum.org	gps.gov
Frequency range	Profiles for WiMAX (in MHz) M2300T-01/02: 2300 to 2400 M2500T-01: 2496 to 2690 M3500T-02/03/05: 3400 to 3600 Targeted for WiMAX Advanced: UTRA/TDD Bands	Band (in GHz) 56.16 to 64.80	Bands (in MHz) 5170 to 5330 5490 to 5710 5735 to 5835	Bands (in MHz) 156 to 166 (af) 450 to 490 (af) 650 to 690 (af) 2400 to 2497 (b, g, n) 5150 to 5350 (a, n) 5725 to 5825 (a, n)	Band (in MHz) 2400 to 2483.5	Bands (in MHz) Worldwide: 2400 to 2483.5 North America: 902 to 928 Europe: 868.3	125 kHz to 134 kHz 6.7 MHz 7.4 MHz to 8.8 MHz 27 MHz 433 MHz 865 MHz to 868 MHz 902 MHz to 928 MHz 2.45 GHz 5.8 GHz 24.125 GHz	13.56 MHz	L1: 1575.42 MHz L2: 1227.60 MHz L5: 1176.45 MHz

GNSS

	GPS	GLONASS	Galileo	COMPASS
				BeiDou-2
Modulation type	BPSK	BPSK	CBOC (6,1,1/11) BPSK (E6)	BPSK, QPSK
Transmission method/ multiple access	CDMA	FDD-CDMA	CDMA	CDMA
Duplex				
Channel bandwidth	20.46 MHz (P-Code) 2.046 MHz (C/A Code)	562.5 kHz (L1) 473.5 kHz (L2) per satellite	24 MHz (E5a) 24 MHz (E5b) 40 MHz (E6) 32.736 MHz (E1)	16 MHz (E2)
Peak data rate	50 bit/s	50 bit/s	50 sps (E5a) 250 sps (E5b) 1000 sps (E6) 250 sps (E1)	50 bit/s (E2)
Standardization forums	gps.gov	glonass-ianc.rsa.ru	gsa.europa.eu	beidou.gov.cn
Frequency range	L1: 1575.42 MHz L2: 1227.60 MHz L5: 1176.45 MHz	L1: 1602 MHz L2: 1246 MHz	E5a: 1176.45 MHz E5b: 1207.14 MHz E6: 1278.75 MHz E1: 1575.42 MHz	E1: 1589.74 MHz E2: 1561.10 MHz E6: 1268.52 MHz E5b: 1207.14 MHz

Frequency Allocation

Longwave Radio · AM Radio · Shortwave Radio

T-GSM 380, GSM 450, GSM 480, GSM 710, GSM 750, T-GSM 810, GSM 850, P-GSM 900, E-GSM 900, R-GSM 900, DCS 1800, PCS 1900, iE-IUTRA Band 12, iE-IUTRA Band 17, iE-IUTRA Band 14, iE-IUTRA Band 13, iE-IUTRA Band 20, iE-IUTRA Band 5, iE-IUTRA Band 8, iE-IUTRA Band 6, iE-IUTRA Band 19, iE-IUTRA Band 18, iE-IUTRA Band 24, iE-IUTRA Band 11, iE-IUTRA Band 21, iE-IUTRA Band 9, iE-IUTRA Band 3, iE-IUTRA Band 4, iE-IUTRA Band 25, iE-IUTRA Band 1, iE-IUTRA Band 2, iE-IUTRA Band 10, iE-IUTRA Band 23, iE-IUTRA Band 40, iE-IUTRA Band 41, iE-IUTRA Band 38, iE-IUTRA Band 7, iE-IUTRA Band 42, iE-IUTRA Band 22, iE-IUTRA Band 43, iE-IUTRA Band 36, iE-IUTRA Band 33, iE-IUTRA Band 34, iE-IUTRA Band 37, iE-IUTRA Band 39, ZigBee, RFID, Bluetooth, WiMAX (M2500T-01), WiMAX (M3500T-02/03/05), WLAN (IEEE 802.11b, g, n), BC0, BC1, BC2, BC3, BC4, BC5, BC6, BC7, BC8, BC9, BC10, BC11, BC12, BC13, BC14, BC15, BC16, BC17, BC18, BC19, BC20, BC21, BCT, GPS L1, GPS L2, GPS L5, Galileo E5a, Galileo E5b, Galileo E6, Galileo E1, GLONASS L1, GLONASS L2, COMPASS E5b, COMPASS E6, COMPASS E1, COMPASS E2, ISM Band 2.4 GHz, ISM Band 5 GHz, WLAN (IEEE 802.11a, n), WLAN (IEEE 802.11ac), WLAN (IEEE 802.11a), WLAN (IEEE 802.11ac), Visible, Microwaves, Infrared, Ultraviolet, X-rays, Gamma Rays

Band Allocation: Reverse Link or Uplink · Forward Link or Downlink

10^{-2} 10^{-1} 10 10^{1} (MHz) 300 450 600 750 900 1050 1200 1350 1500 1650 1800 1950 2100 2250 2400 2550 2700 2850 3400 3550 3700 3850 5150 5300 5450 5600 5750 5900 10^{4} 10^{5} 10^{6} 10^{7} 10^{8} 10^{9} 10^{10} 10^{11} 10^{12} 10^{13} (MHz)

Wireless Communications Reference Section

Formulas

RF and Microwave Equations

Frequency and Wavelength

$\lambda = \frac{1}{f\sqrt{\varepsilon}}$

Where ε is the dielectric constant of the transmission medium

$\lambda = c/f$ (in free space or vacuum)

Free Space Path Loss

FSPL [dB] = $20\log_{10}\left(\frac{4\pi d}{\lambda}\right)$

(where d = distance from the transmitter in meters)

Power Conversion

Power [W] = 10(Power [dBW]-30)/ 10)

Power [dBm] = 10log(Power [W]+30)

Power [W] = 10(Power [dBW])/10)

Power [dBW] = 10log(Power [W])

Power [dBm] = Power [dBW]+30

Power [dBW] = Power [dBm]-30

Power Ratio [dB] = $10\log_{10}\frac{P_1}{P_2}$

(where P_1 is the measured power and P_2 is the reference power)

Noise

$P_{\text{Background noise}}[W] = kTB$ NF [dB] = $10\log_{10}\frac{SNR_{in}}{SNR_{out}}$

Noise Floor [dBm] = -174 dBm/Hz+NF+$10\log_{10}$B+Gain [dB]

Crest Factor

Crest Factor [dB] = $10\log_{10}\left(\frac{P_{peak}[W]}{P_{average}[W]}\right) = P_{peak}[dBm] - P_{average}[dBm]$

Reflection Coefficient, Impedance, VSWR, Return and Mismatch Loss

$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0}$ $Z = Z_0\frac{1+\Gamma}{1-\Gamma}$ $\rho = |\Gamma|$ $VSWR = \frac{1+\rho}{1-\rho}$

Return Loss [dB] = $-20\log_{10}\rho$

Mismatch Loss [dB] = $-10\log_{10}(1-\rho^2)$

Constants and Term Definition

c=Speed of Light=299792,458 m/s

f =Frequency

k=Boltzmann's Constant=1.38×10^{-23} J/K

T=Absolute Temperature,
K (0°C=273.15 K)

B = 3 dB Bandwidth, Hz

SNR or S/N = Signal to Noise Ratio

NF = Noise Figure in dB

Z = Impedance

Z_0 = Characteristic Impedance, Typically 50 Ω

Γ = Reflection Coefficient

VSWR = Voltage Standing Wave Ratio

Digital Modulation and Constellation Plots

BPSK, QPSK, 8 PSK, 16 QAM, 32 QAM, 64 QAM, 256 QAM

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NI LabVIEW

GRAPHICAL SYSTEM DESIGN

PXI

MODULAR INSTUMENTATION

Power Ratio, dBm to Milliwatt Conversion, Smith Chart, Geostationary, Orbital Period, Orbital Height, GPS, GLONASS, Galileo, National Instruments Corporate Headquarters, NI Global Offices, Error Vector Magnitude

Wireless Communications Reference Section

Acronyms

Common Industry Terms

1xEV-DO = Single Carrier Evolution – Data Optimized; 1xRTT = Single Carrier Radio Transmission Technology; 4C = Four Carrier;

ACLR = Adjacent Channel Leakage Ratio; ACPR = Adjacent Channel Power Ratio; AMSL = Above Mean Sea Level; AQPSK = Adaptive QPSK;

ASK = Amplitude Shift Keying; AWS = Advanced Wireless Services; BPSK = Binary PSK; C4FM = Continuous 4 Level FM;

CBOC = Composite Binary Offset Carrier; CCK = Complementary Code Keying; CDMA = Code Division Multiple Access; CQPSK = Compatible QPSK;

CSMA/CA = Carrier Sense Multiple Access with Collision Avoidance; DBPSK = Differential BPSK; DBPSK = Differential BPSK; DC = Dual Carrier;

DCM = Dual Code Modulation; DCS = Digital Cellular System; DECT = Digital Enhanced Cordless Telecommunication; DL = Downlink;

DPSK = Differential PSK; DQPSK = Differential QPSK; DSSS = Direct Sequence Spread Spectrum; E-GSM = Extended GSM; E-UTRA = Evolved UTRA;

ECMA = European Computer Manufacturers Association; EDGE = Enhanced Data Rates for GSM Evolution; EDR = Enhanced Data Rate;

EPC = Electronic Product Code; EVM = Error Vector Magnitude; FDD = Frequency Division Duplex; FDMA = Frequency Division Multiple Access;

FFI-OFDM = Fixed-Frequency Interleaving OFDM; FHSS = Frequency Hopping Spread Spectrum; FL = Forward Link; FSK = Frequency Shift Keying;

GFSK = Gaussian FSK; GLONASS = Global Navigation Satellite System; GMSK = Gaussian Minimum Shift Keying;

GNSS = Global Navigation Satellite System; GPRS = General Packet Radio Service; GPS = Global Positioning System;

GSM = Global System for Mobile Communications; HD = High Definition; HFDD = Hybrid FDD; HPSK = Hybrid PSK; HRP = High Rate Physical Layer;

HSDI/LIPA = High Speed (Downlink/Uplink) Packet Access; IEEE = Institute of Electrical and Electronics Engineers; IIP3 = Input Third-Order Intercept Point;

IMT = International Mobile Telecommunications; ISM Band = Industrial, Scientific and Medical Band; ISO = International Organization for Standardization;

ITU = International Telecommunications Union; JTACS = Japan TACS; LCR = Low Chip Rate; LE = Low Energy; LRP = Low Rate Physical Layer;

LTE = Long Term Evolution; MB-OFDM = Multiband OFDM; MER = Modulation Error Ratio; MIMO = Multiple Input Multiple Output;

MRP = Medium Rate Physical Layer; NF = Noise Figure; NFC = Near Field Communication; NI = The Leader in PXI;

OFDM = Orthogonal Frequency Division Multiplexing; OFDMA = Orthogonal Frequency Division Multiple Access; OIP3 = Output Third-Order Intercept Point;

OOK = On-Off Keying; OQPSK = Offset QPSK; P-GSM = Standard or Primary GSM; PAMR = Public Access Mobile Radio;

PBCC = Packet Binary Convolutional Coding; PCS = Personal Communications System; PHY = Physical Layer; PJM = Phase Jitter Modulation;

PSK = Phase Shift Keying; QAM = Quadrature Amplitude Modulation; QPSK = Quadrature PSK; RFID = Radio Frequency Identification;

R-GSM = Railway GSM; RL = Reverse Link; SC = Single Carrier; SNR (S/N) = Signal to Noise Ratio; SOFDMA = Scalable OFDMA;

SPS = Samples per Symbol; SQPSK = Spread QPSK; T-GSM = Trunking GSM; TACS = Total Access Communications Systems;

TD-SCDMA = Time Division Synchronous CDMA; TDD = Time Division Duplex; TDMA = Time Division Multiple Access;

TEDS = TETRA Enhanced Data Service; TETRA = Terrestrial Trunked Radio; TFI-OFDM = Time Frequency Interleaving OFDM; TOI = Third Order Intercept;

UL = Uplink; UTRA = Universal Terrestrial Radio Access; UWB = Ultra Wideband; VAMOS = Voice Services Over Adaptive Multiuser Channels on One Slot;

VST = Vector Signal Transceiver; VSWR = Voltage Standing Wave Ratio; W-CDMA = Wideband CDMA; WHDI = Wireless Home Digital Interface;

WiFi = Wireless Fidelity; WiGig = Wireless Gigabit; WiMAX = Worldwide Interoperability for Microwave Access; WLAN = Wireless Local Area Network

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