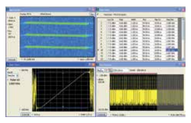
MDO4000B Series

The only oscilloscope with a built-in spectrum analyzer provides time-correlated analog, digital and RF signal debug and troubleshooting capabilities as well as the most affordable 802.11ac testing solution. SignalVu-PC Software Extends the MDO4000B Series RF measurement capability with WLAN signal analysis.

RSA5000A Series

Mid-range real-time spectrum analyzer for many applications such as WLAN testing and others. Combine the best-in-class RF performance up to 110 MHz bandwidth and 3rd Generation DPX® technology.



Real-Time Oscilloscopes

Versatile, makes it easy to solve your most difficult challenges. You can add SignalVu (option SVE and one of the WLAN options) to analyze WLAN signals.

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Contact List Updated June 2013

For Further Information
Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit **www.tektronix.com**

02/14 DM/ 37W-29687-0

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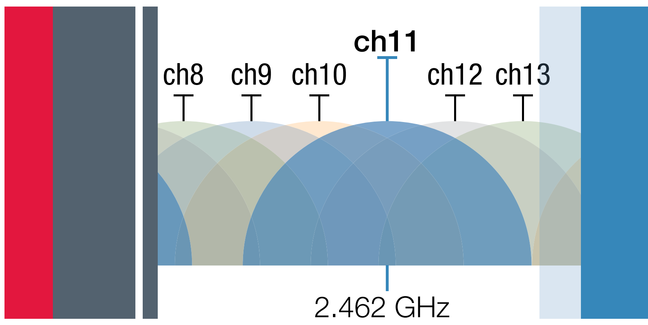
802.11 Wi-Fi Physical Layer and Transmitter Measurements Poster



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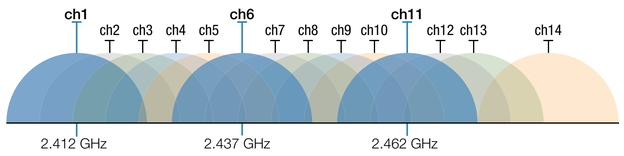
802.11 Wi-Fi Physical Layer and Transmitter Measurements

	802.11b (HR/DSSS)	802.11a and 802.11g (ERP)	802.11n (HT)	802.11ac (VHT)	Channel # / Center Frequency

Channel Allocation

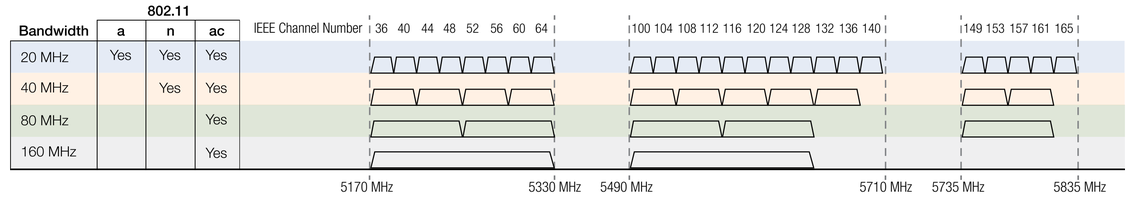
2.4 GHz



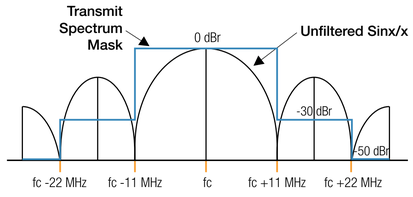
2.4 GHz									
Primary Channel	1	2	3	4	5	6	7	8	9
2nd Channel	5	6	7	8	9	10	11	12	13
Center Channel	3	4	5	6	7	8	9	10	11
Center Frequency	2422	2427	2432	2437	2442	2442	2452	2457	2462

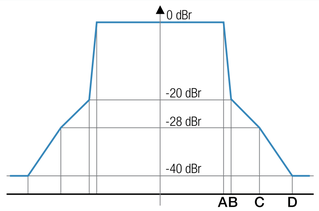
5 GHz

Bandwidth	802.11 a	n	ac
20 MHz	Yes	Yes	Yes
40 MHz		Yes	Yes
80 MHz			Yes
160 MHz			Yes



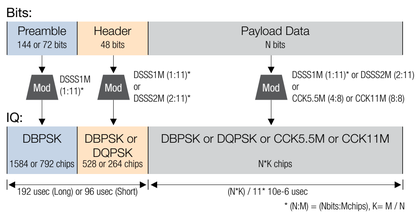
Spectral Shape and Emission Mask

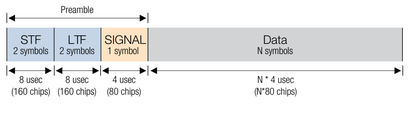


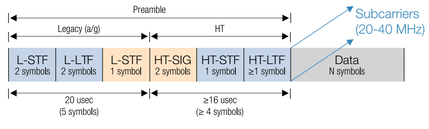


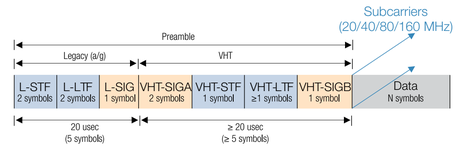
Spectral Mask for 20, 40, 80, and 160 MHz Channels				
Channel Size	A	B	C	D
20 MHz	9 MHz	11 MHz	20 MHz	30 MHz
40 MHz	19 MHz	21 MHz	40 MHz	60 MHz
80 MHz	39 MHz	41 MHz	80 MHz	120 MHz
160 MHz	79 MHz	61 MHz	160 MHz	240 MHz

Packet Information









Data Rates and Modulation Types

802.11b			
Signal Field HEX	Data Rate	Spreading/ Coding Scheme	Modulation
0A	1 Mbps	11 chip barker code	DBPSK
14	2 Mbps	11 chip barker code	DQPSK
37	5.5 Mbps	CCK	DQPSK
6E	11 Mbps	CCK	DQPSK

802.11a/g (20 MHz Bandwidth)			
Rate	Modulation	FEC Rate	Data Rate
1101 (13)	BPSK	1/2	6 Mbps
1111 (15)	BPSK	3/4	9 Mbps
0101 (5)	QPSK	1/2	12 Mbps
0111 (7)	QPSK	3/4	18 Mbps
1001 (9)	16QAM	1/2	24 Mbps
1011 (11)	16QAM	3/4	36 Mbps
0001 (1)	64QAM	2/3	48 Mbps
0011 (3)	64QAM	3/4	54 Mbps

802.11n			802.11ac					
MCS	Modulation	FEC Rate	Data Rate (SISO: 1 Stream, Short Guard Interval)					
			20 MHz	40 MHz	20 MHz	40 MHz	80 MHz	160 MHz
0	BPSK	3/4	7.2 Mbps	15.0 Mbps	7.2 Mbps	15.0 Mbps	32.5 Mbps	65 Mbps
1	QPSK	1/2	14.4 Mbps	30.0 Mbps	14.4 Mbps	30.0 Mbps	65 Mbps	130 Mbps
2	QPSK	3/4	21.7 Mbps	45.0 Mbps	21.7 Mbps	45.0 Mbps	97.5 Mbps	195 Mbps
3	16QAM	1/2	28.9 Mbps	60.0 Mbps	28.9 Mbps	60.0 Mbps	130 Mbps	250 Mbps
4	16QAM	3/4	43.3 Mbps	90.0 Mbps	43.3 Mbps	90.0 Mbps	195 Mbps	390 Mbps
5	64QAM	2/3	57.8 Mbps	120.0 Mbps	57.8 Mbps	120.0 Mbps	260 Mbps	525 Mbps
6	64QAM	3/4	65.0 Mbps	135.0 Mbps	65.0 Mbps	135.0 Mbps	292.5 Mbps	585 Mbps
7	64QAM	5/6	72.2 Mbps	150.0 Mbps	72.2 Mbps	150.0 Mbps	325 Mbps	650 Mbps
8	256QAM	3/4			86.7 Mbps	180.0 Mbps	390 Mbps	780 Mbps
9	256QAM	5/6				200.0 Mbps	433.3 Mbps	866.7 Mbps

Transmitter Measurements

Type of Measurement	Measurement	802.11 DSSS	b	a	g	n	ac	IEEE Standard Limit
Transmit Power	Transmit Power	Yes	Yes	Yes	Yes	Yes		Country Dependent
	Transmit Power On/Off Ramp	Yes	Yes					(10% - 90%) 2 us
Transmit Spectral	Transmit Spectrum Mask	Yes	Yes	Yes	Yes	Yes	Yes	Standard Mask
	RF Carrier Suppression	Yes	Yes					-15 dB
	Center Frequency Leakage			Yes		20 MHz		-15 dBc or +2 dB w.r.t. averages subcarrier power
						40 MHz		-20 dBc or +0 dB w.r.t. averages subcarrier power
	Transmit Spectral Flatness			Yes			Yes	± 4 dBc, + 4/-6 dB (various BWs, 20 - 160 MHz)
	Transmission Spurious			Yes				Country Dependent
	Out-of-band Spurious Emission	Yes	Yes	Yes	Yes			Country Dependent
Transmit Frequency	Transmit Center Frequency Tolerance	Yes	Yes		Yes			± 25 ppm (DSSS, b, g)
				Yes				± 20 ppm (20 MHz and 10 MHz), ± 10 ppm (5 MHz)
						Yes	Yes	± 20 ppm (5 GHz band), ± 25 ppm (2.4 GHz band)
	Symbol Clock Frequency Tolerance	Yes	Yes	Yes	Yes	Yes	Yes	same specifications as above

Type of Measurement	Measurement	802.11 DSSS	b	a	g	n	ac	IEEE Standard Limit
Transmit Modulation	Transmit Modulation Accuracy	Yes						Peak EVM<0.35%
			Yes					Peak EVM<0.36%
	Transmitter Constellation Error							
	Modulation Type / Coding Rate	Limits in dB						
	BPSK 1/2			-5		-5	-5	
	BPSK 3/4			-8				
	QPSK 1/2			-10		-10	-10	
	QPSK 3/4			-13		-13	-13	
	16-QAM 1/2			-16		-16	-16	
	16-QAM 3/4			-19		-19	-19	
	64-QAM 2/3			-22		-22	-22	
	64-QAM 3/4			-25		-25	-25	
	64-QAM 5/6					-27	-27	
	256-QAM 3/4						-30	
	256-QAM 5/6						-32	

2.4 GHz					
Channel Number	Center Frequency	North America (FCC)	Europe (ETSI)	Japan	ROW
1	2412	Yes	Yes	Yes	Yes
2	2417	Yes	Yes	Yes	Yes
3	2422	Yes	Yes	Yes	Yes
4	2427	Yes	Yes	Yes	Yes
5	2432	Yes	Yes	Yes	Yes
6	2437	Yes	Yes	Yes	Yes
7	2442	Yes	Yes	Yes	Yes
8	2447	Yes	Yes	Yes	Yes
9	2452	Yes	Yes	Yes	Yes
10	2457	Yes	Yes	Yes	Yes
11	2462	Yes	Yes	Yes	Yes
12	2467	No	Yes	Yes	Yes
13	2472	No	Yes	Yes	Yes
14	2484	No	No	802.11b only	No

5 GHz					
Channel Number	Center Frequency	U.S.	Europe	Japan	China
36	5180	Yes	Indoors	Yes	Yes
38	5190	No	No	Client Only	No
40	5200	Yes	Indoors	Yes	Yes
42	5210	No	No	Client Only	No
44	5220	Yes	Indoors	Yes	Yes
46	5230	No	No	Client Only	No
48	5240	Yes	Indoors	Yes	Yes
52	5260	DFS	Indoors/DFS/TPC	DFS/TPC	Yes
56	5280	DFS	Indoors/DFS/TPC	DFS/TPC	Yes
60	5300	DFS	Indoors/DFS/TPC	DFS/TPC	Yes
64	5320	DFS	DFS/TPC	DFS/TPC	Yes
100	5500	DFS	DFS/TPC	DFS/TPC	Yes
104	5520	DFS	DFS/TPC	DFS/TPC	Yes
108	5540	DFS	DFS/TPC	DFS/TPC	No
112	5560	DFS	DFS/TPC	DFS/TPC	No
116	5580	DFS	DFS/TPC	DFS/TPC	No
120	5600	No	DFS/TPC	DFS/TPC	No
124	5620	No	DFS/TPC	DFS/TPC	No
128	5640	No	DFS/TPC	DFS/TPC	No
132	5660	DFS	DFS/TPC	DFS/TPC	No
136	5680	DFS	DFS/TPC	DFS/TPC	No
140	5700	DFS	DFS/TPC	DFS/TPC	No
149	5745	Yes	SRD	No	Yes
153	5765	Yes	SRD	No	Yes
157	5785	Yes	SRD	No	Yes
161	5805	Yes	SRD	No	Yes
165	5825	Yes	SRD	No	Yes

5 GHz				
Channel Number	Center Frequency	Korea	Australia	Brazil
36	5180	Yes	Yes	Indoors
38	5190	Yes	No	Indoors
40	5200	Yes	Yes	Indoors
42	5210	Yes	No	Indoors
44	5220	Yes	Yes	Indoors
46	5230	Yes	No	Indoors
48	5240	Yes	Yes	Indoors
52	5260	Yes	DFS/TPC	Indoors
56	5280	Yes	DFS/TPC	Indoors
60	5300	Yes	DFS/TPC	Indoors
64	5320	Yes	DFS/TPC	Indoors
100	5500	Yes	DFS/TPC	DFS
104	5520	Yes	DFS/TPC	DFS
108	5540	Yes	DFS/TPC	DFS
112	5560	Yes	DFS/TPC	DFS
116	5580	Yes	DFS/TPC	DFS
120	5600	Yes	No	DFS
124	5620	Yes	No	DFS
128	5640	Yes	No	DFS
132	5660	No	DFS/TPC	DFS
136	5680	No	DFS/TPC	DFS
140	5700	No	DFS/TPC	DFS
149	5745	Yes	Yes	Yes
153	5765	Yes	Yes	Yes
157	5785	Yes	Yes	Yes
161	5805	Yes	Yes	Yes
165	5825	Yes	Yes	Yes

DFS = Dynamic Frequency Selection
TPC = Transmit Power Control
SRD = Short Range Devices 25 mW max power

Based on IEEE802.11-2012 standard.

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