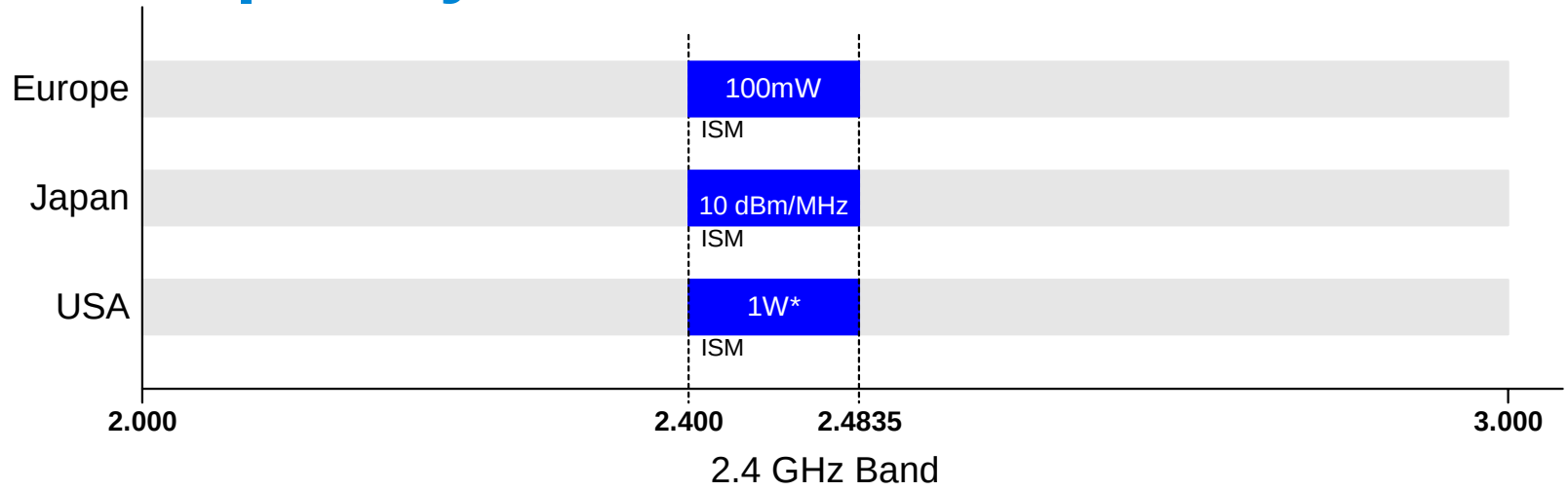
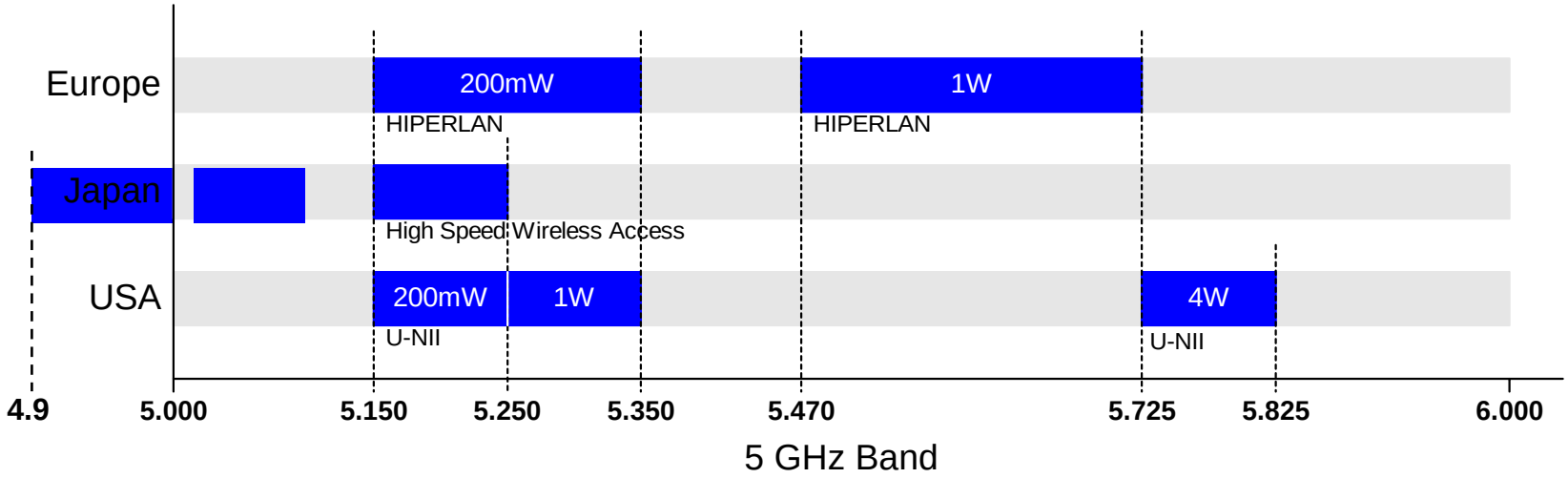
WLAN 802.11b Product base on standard Testing

Agilent Technologies

The Frequency Allocations...



*Per FCC 00-312, CFR 47 part 15 amended to allow 1W divided by BW in MHz (e.g. 5 MHz = 200mW)



ISM = Industrial, Scientific and Medical
HIPERLAN = HIgh PERformance LAN
U-NII = Unlicensed National Information Infrastructure

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A Bit More Detail on the 2.4 GHz Band

- The 2.4 GHz band is a license exempt frequency allocation of 2.400 to 2.4835 GHz for Industrial, Scientific and Medical (ISM) use. It is available Worldwide.
- The ISM band is unlicensed / license exempt, but it is not unregulated. In the USA, the bands are covered by FCC CFR 47 part 15. In Europe, by ETS 300 328. In Japan, by ARIB STD-T66
- The FCC and ETSI have historically had very specific guidelines for modulation used in the 2.4 GHz band. Hence many of the systems have similar physical layer specs. CCK modulation is unusual, it "bent the rules" to create a signal that can carry 11 Mbps rather than 2 Mbps.
- FCC have since relaxed rules further to allow OFDM at 2.4 GHz

IEEE802.11b Tx Specifications Overview

18.4.7.1 – Transmit power levels

18.4.7.2 – Transmit power level control

18.4.7.3 – Transmit spectrum mask

18.4.7.4 – Transmit center frequency tolerance

18.4.7.5 – Chip clock frequency tolerance

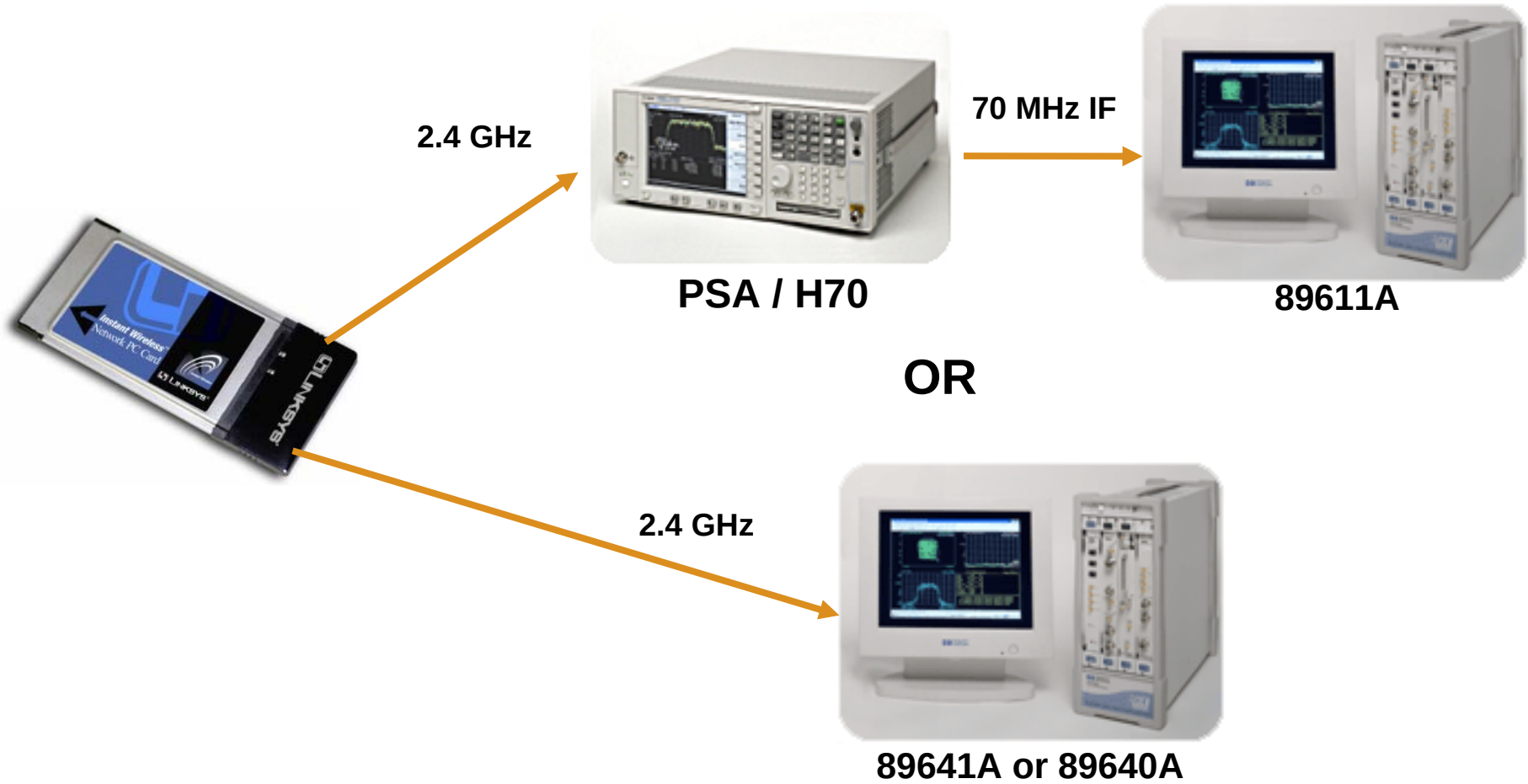
18.4.7.6 – Transmit power-on and power-down ramp

18.4.7.7 – RF carrier suppression

18.4.7.8 – Transmit modulation accuracy

18.4.6.8 Transmit and receive in-band and out-of-band spurious emissions

802.11b Tx Measurements Configuration



Transmitter Test:
18.4.7.1 Transmit power levels

- **Maximum Output Power:**

  USA:30dBm

  Europe:20dBm(EIRP)

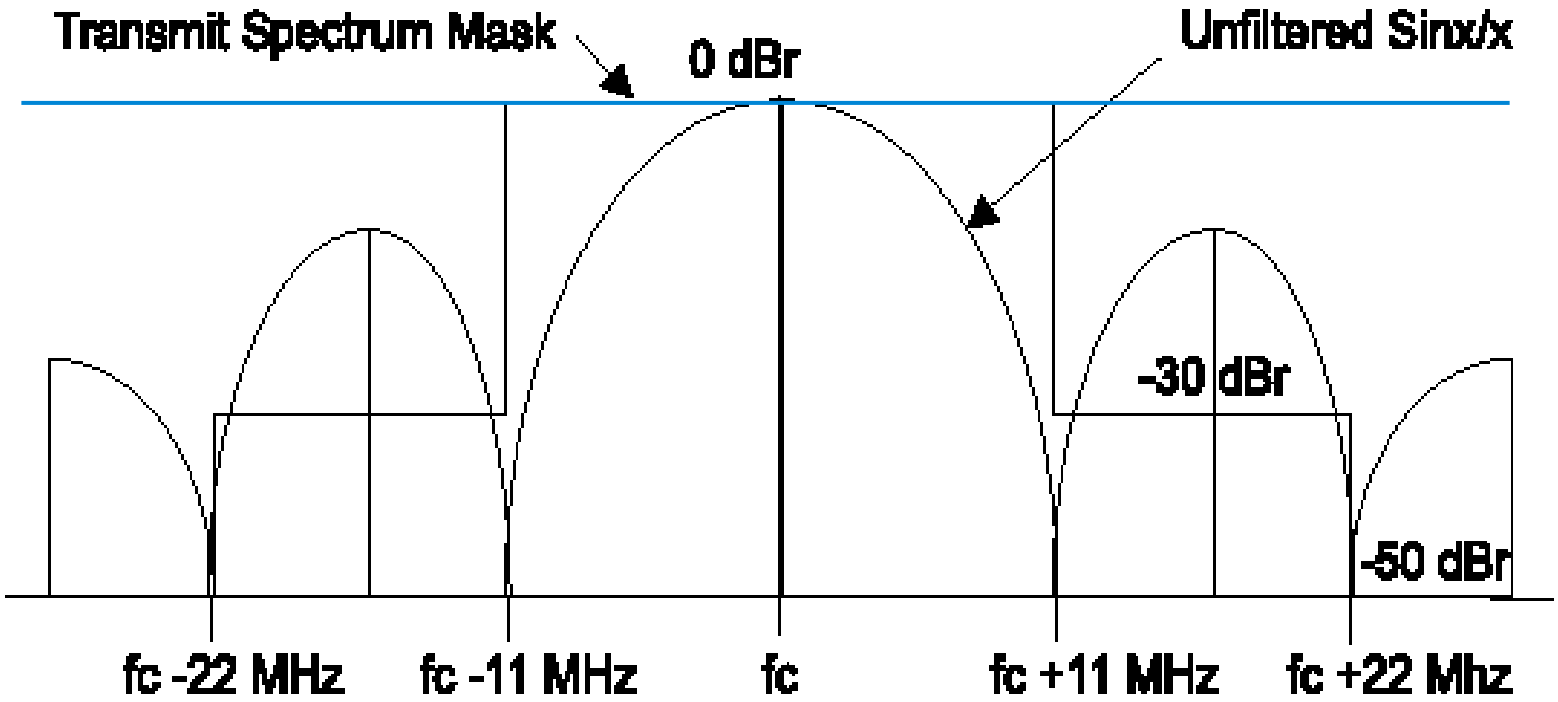
  Japan:10dBm/MHz

Transmitter Test:
18.4.7.2 Transmit power level control

- **Power control shall be provided for transmitted power greater than 100 mW.**
- **A maximum of four power levels may be provided.**
- **As a minimum, a radio capable of transmission greater than 100 mW shall be capable of switching power back to 100 mW or less.**

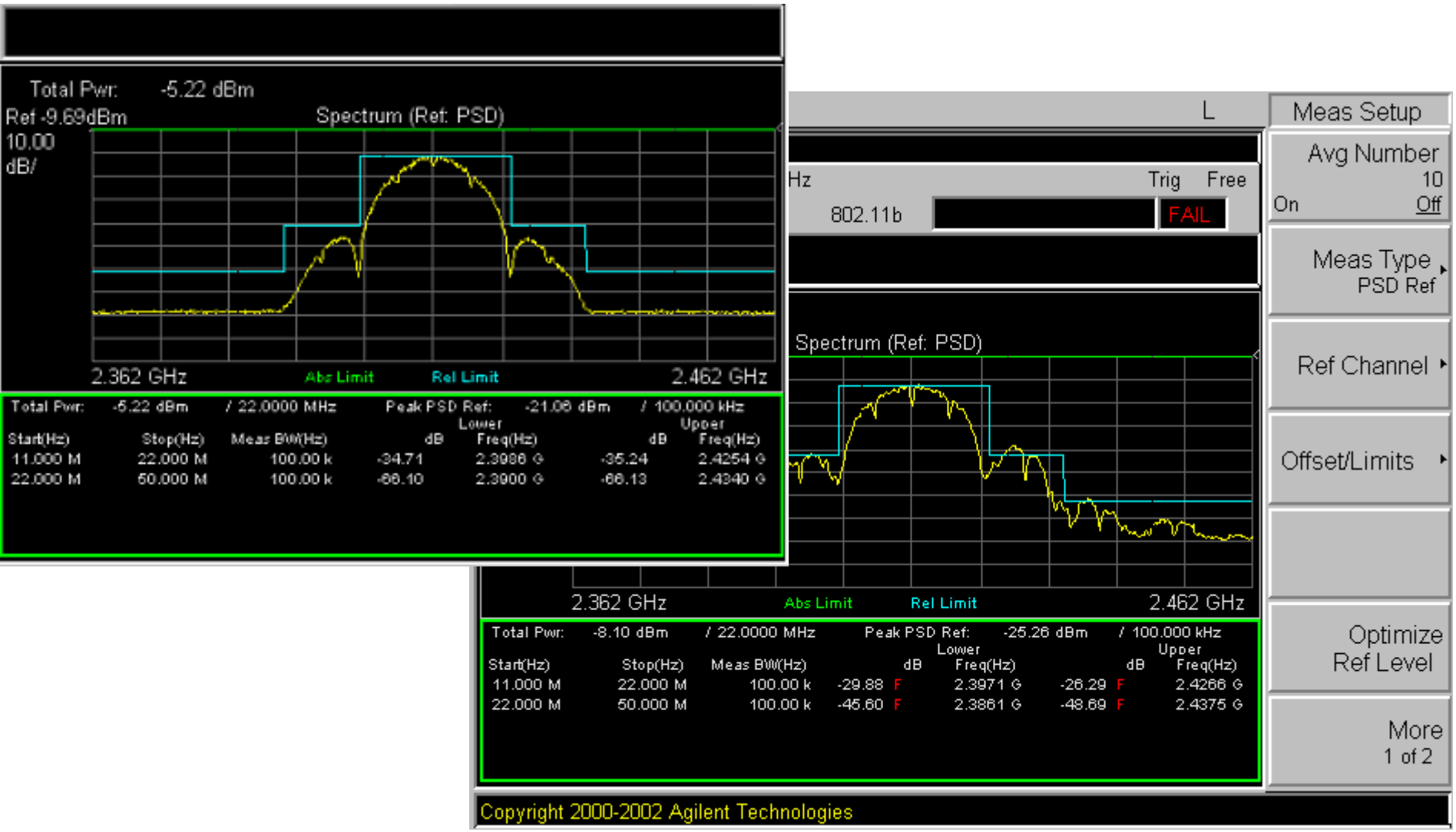
Transmitter Test:
18.4.7.3 Transmit spectrum mask

- **The measurements shall be made using a 100 kHz resolution bandwidth and a 100 kHz video bandwidth.**



dBr (dB relative to the SINx/x peak)
Fc:center frequency

802.11b Transmit spectrum mask

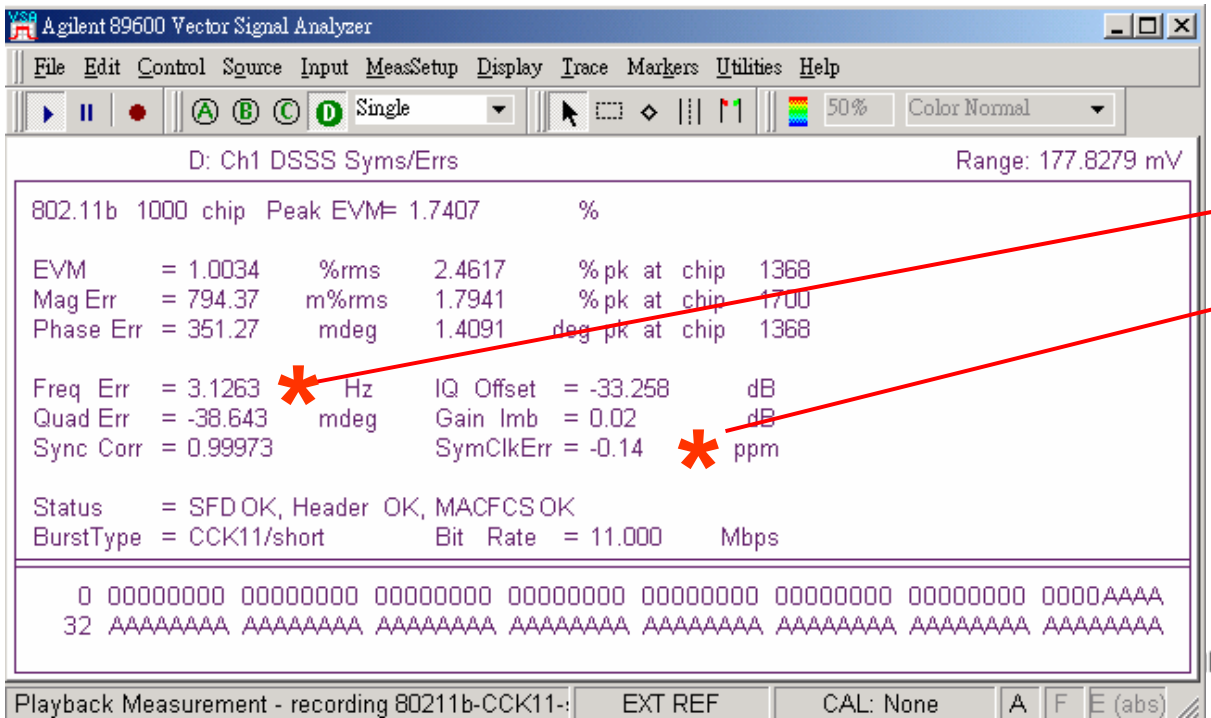


Transmitter Test:
18.4.7.4 Transmit center frequency tolerance

- **Center frequency tolerance shall be ±25 ppm maximum. (≈60kHz)**

Transmitter Test:
18.4.7.5 Chip clock frequency tolerance

- **Chip clock frequency tolerance ±25 ppm maximum.**

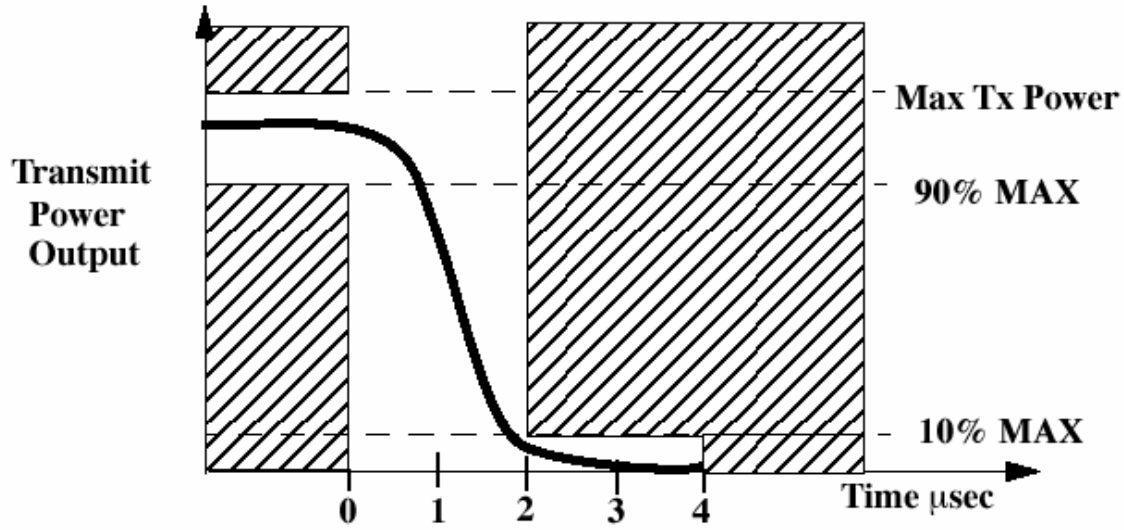


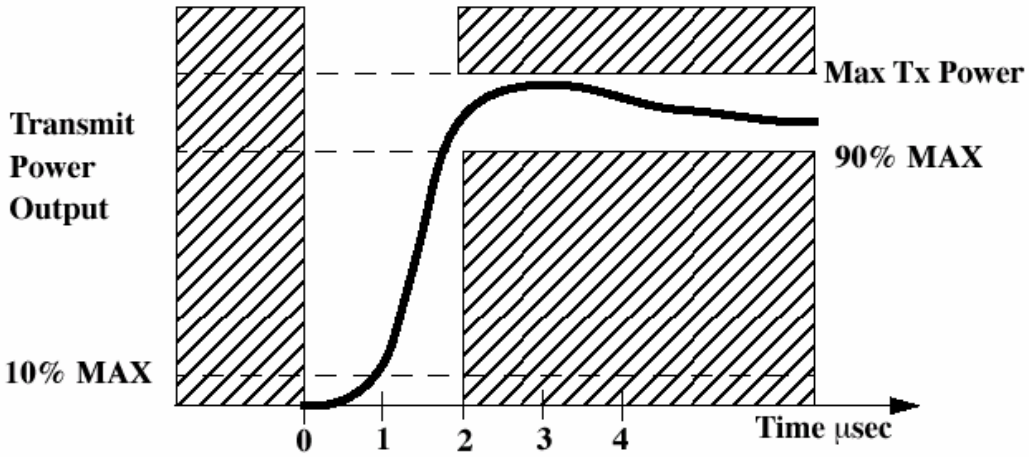
Center frequency tolerance

Chip clock frequency tolerance

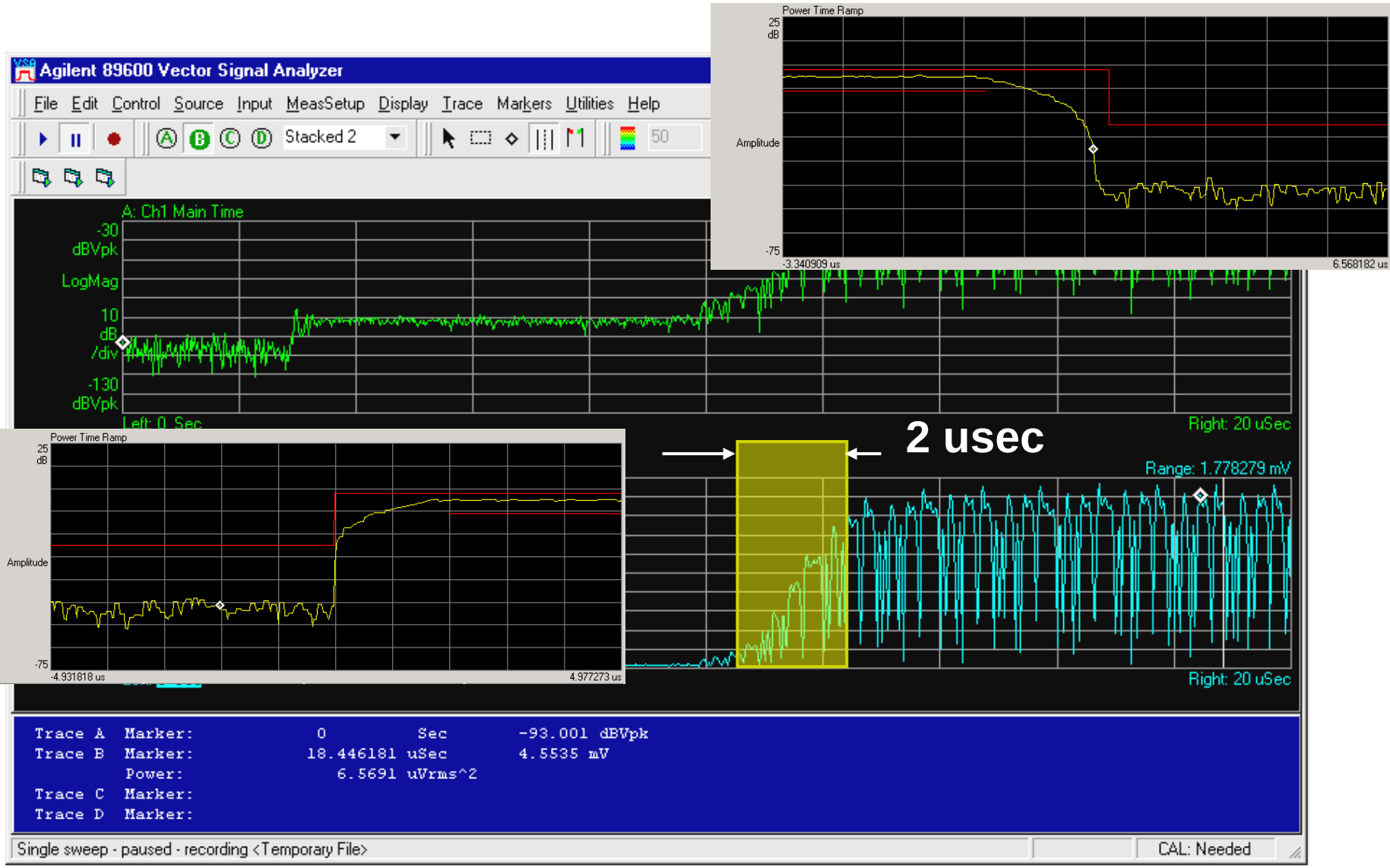
nologies

Transmitter Test:
18.4.7.6 Transmit power-on and power-down ramp





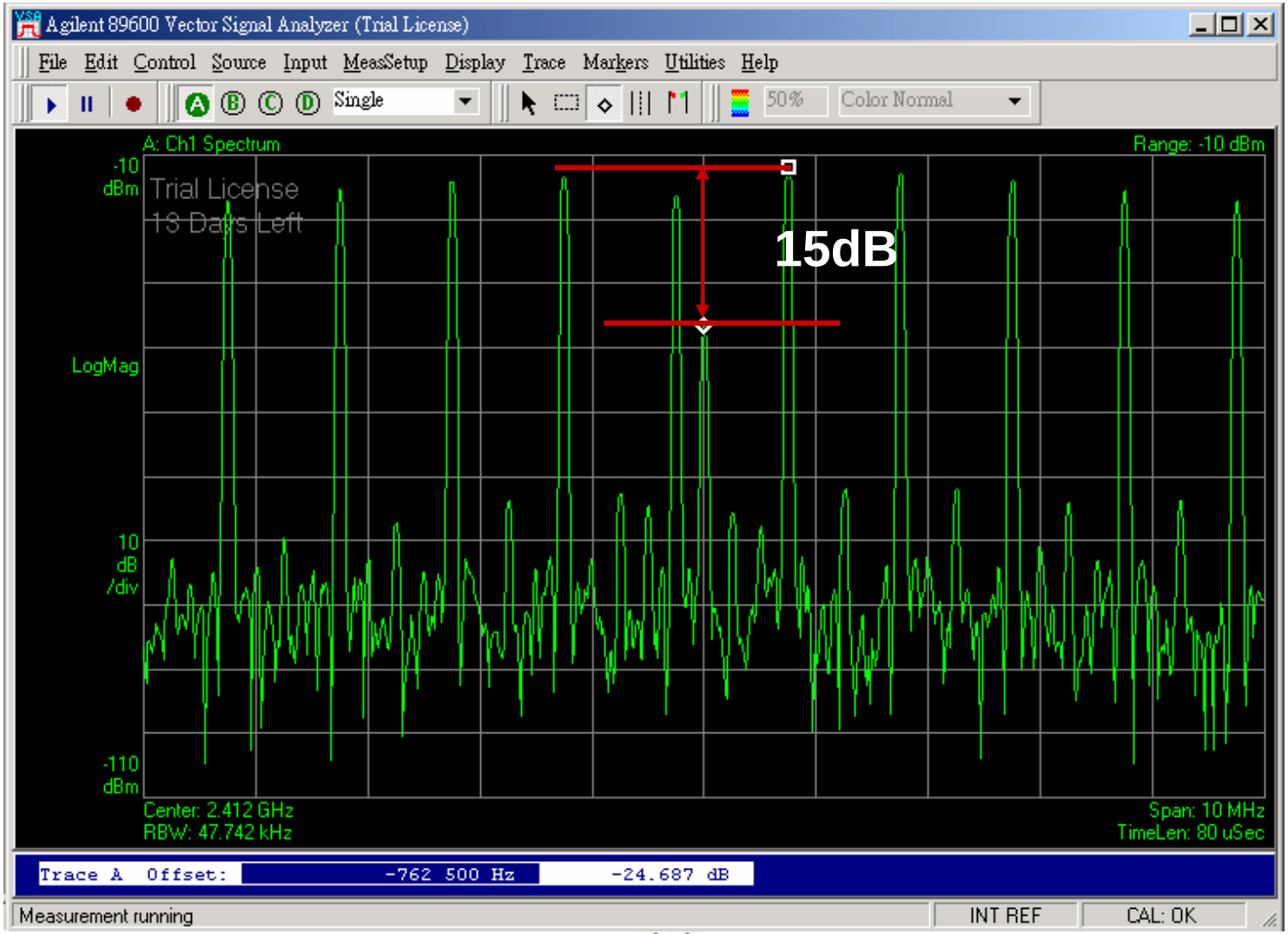
Power-Up Ramp 802.11b Spec's



Transmitter Test:
18.4.7.7 RF carrier suppression

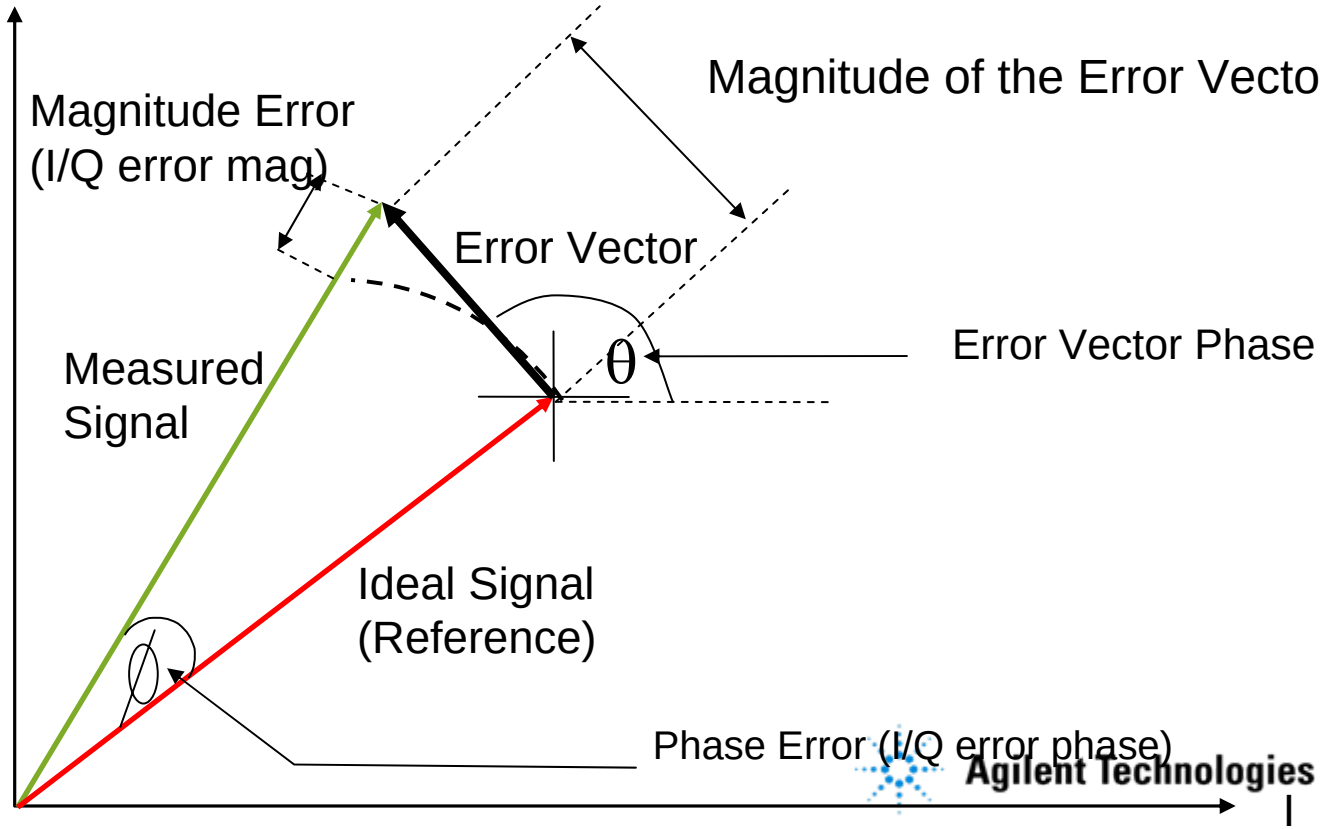
- **measured at the channel center frequency, shall be at least 15 dB below the peak SIN(x)/x power spectrum.**
- **transmitting a repetitive 01 data sequence with the scrambler disabled using DQPSK modulation.**
- **A 100 kHz resolution bandwidth shall be used to perform this measurement.**

Transmitter Test:
18.4.7.7 RF carrier suppression

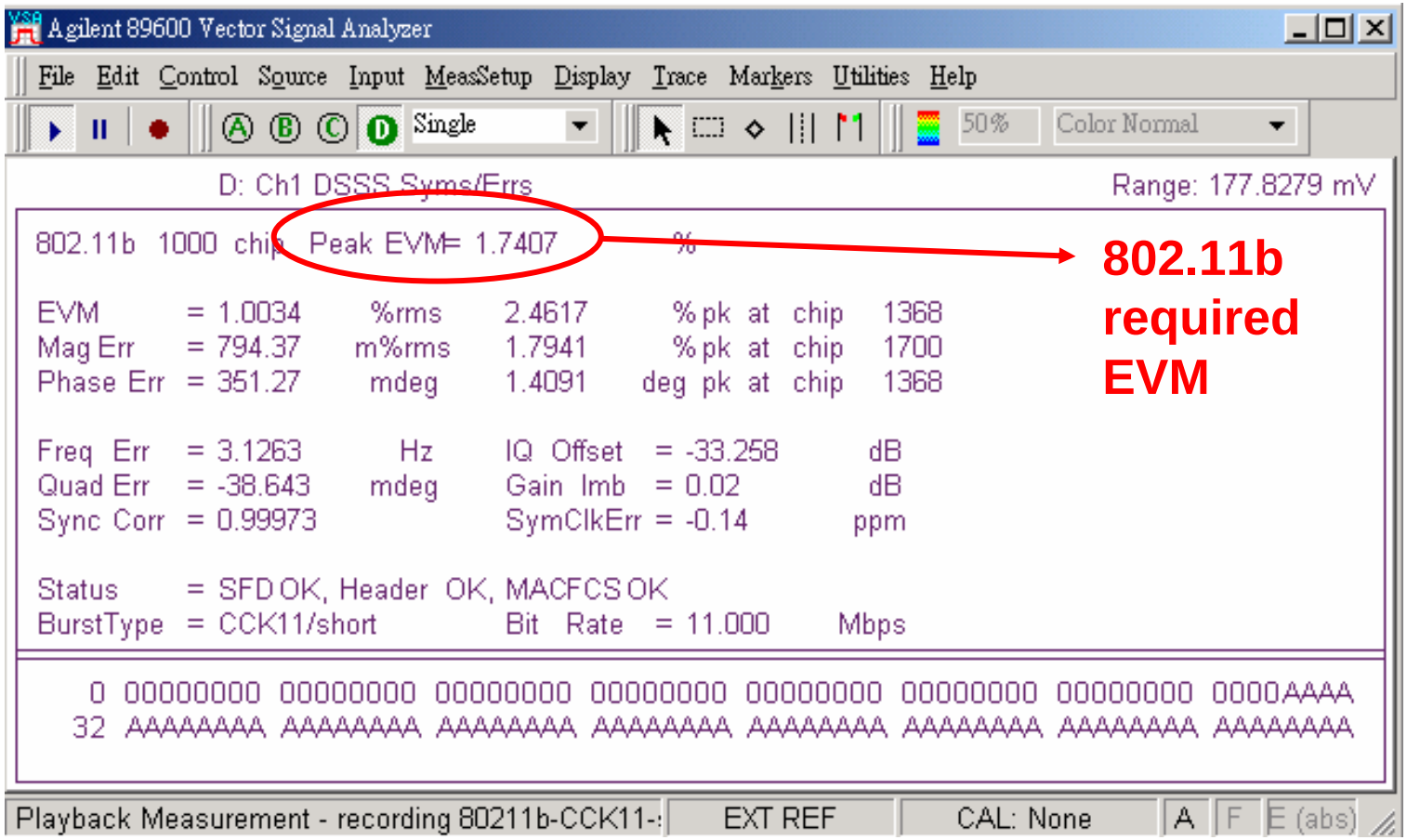


Transmitter Test:
18.4.7.8 Transmit modulation accuracy

- **Modulation accuracy shall be determined by measuring the peak vector error magnitude during each chip period.**
- **The measurement shall be made under the conditions of continuous DQPSK transmission using scrambled all one's.**
- **EVM not exceed 35% in 1000 samples**



EVM Time Display



Transmitter Test: 18.4.6.8 Transmit and receive in-band and out-of-band spurious emissions

- **Spurious transmissions from compliant devices shall conform to national regulations.**
  - **For the USA, refer to FCC 15.247, 15.205, and 15.209.**
  - **For Europe, refer to ETS 300–328.**
  - **For Japan, refer to the MPT ordinance for Regulating Radio Equipment, Article 49-20.**

IEEE802.11b Rx Specifications Overview

18.4.8.1 – Receiver Minimum input level sensitivity

18.4.8.2 – Receiver Maximum input level

18.4.8.3 – Receiver adjacent channel rejection

Rx Testing Configuration

Golden Sample

OR

E4438C VSG

Receiver Test:
18.4.8.1 Receiver Minimum input level sensitivity

- **Input signal: –76dBm,11Mbit/s CCK modulation**
- **Minimum requirement(FER,Frame Error Rate)**

  <=8*10^{-2},1024 octets PSDU*

***PSDU:PLCP service data units**

Receiver Test:
18.4.8.2 Receiver Maximum input level

- **Input signal: –10dBm ,11Mbit/s CCK modulation**
- **Minimum requirement (FER,Frame Error Rate)**

  <=8*10^{-2},1024 octets PSDU

Receiver Test:
18.4.8.3 Receiver adjacent channel rejection

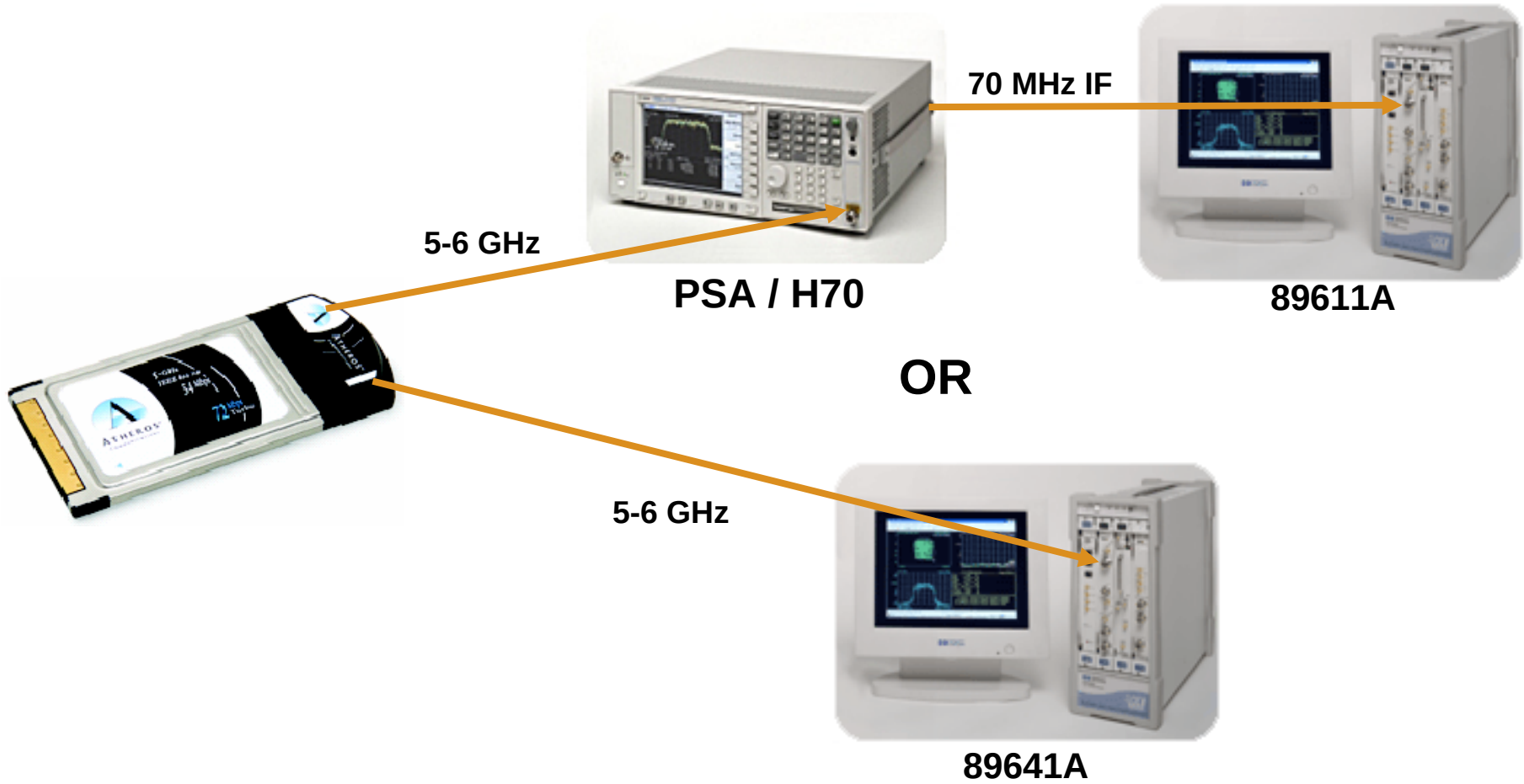
- **Adjacent Input signal: –35dBm,11Mbit/s CCK**
- **Input signal: –70dBm,11Mbit/s CCK**
- **Two channel>=25MHz**
- **Minimum requirement (FER,Frame Error Rate)**

  <=$8*10^{-2}$,1024 octets PSDU

WLAN 802.11a Product base on standard Testing

Agilent Technologies

802.11a Tx Measurements Configuration



IEEE802.11a Specifications Overview

17.3.9.1 – TX power level

17.3.9.2 – TX spectrum mask

17.3.9.3 – TX spurious

17.3.9.4 – TX center freq. tolerance

17.3.9.5 – Symbol clock freq. tolerance

17.3.9.6.1 – TX carrier leakage

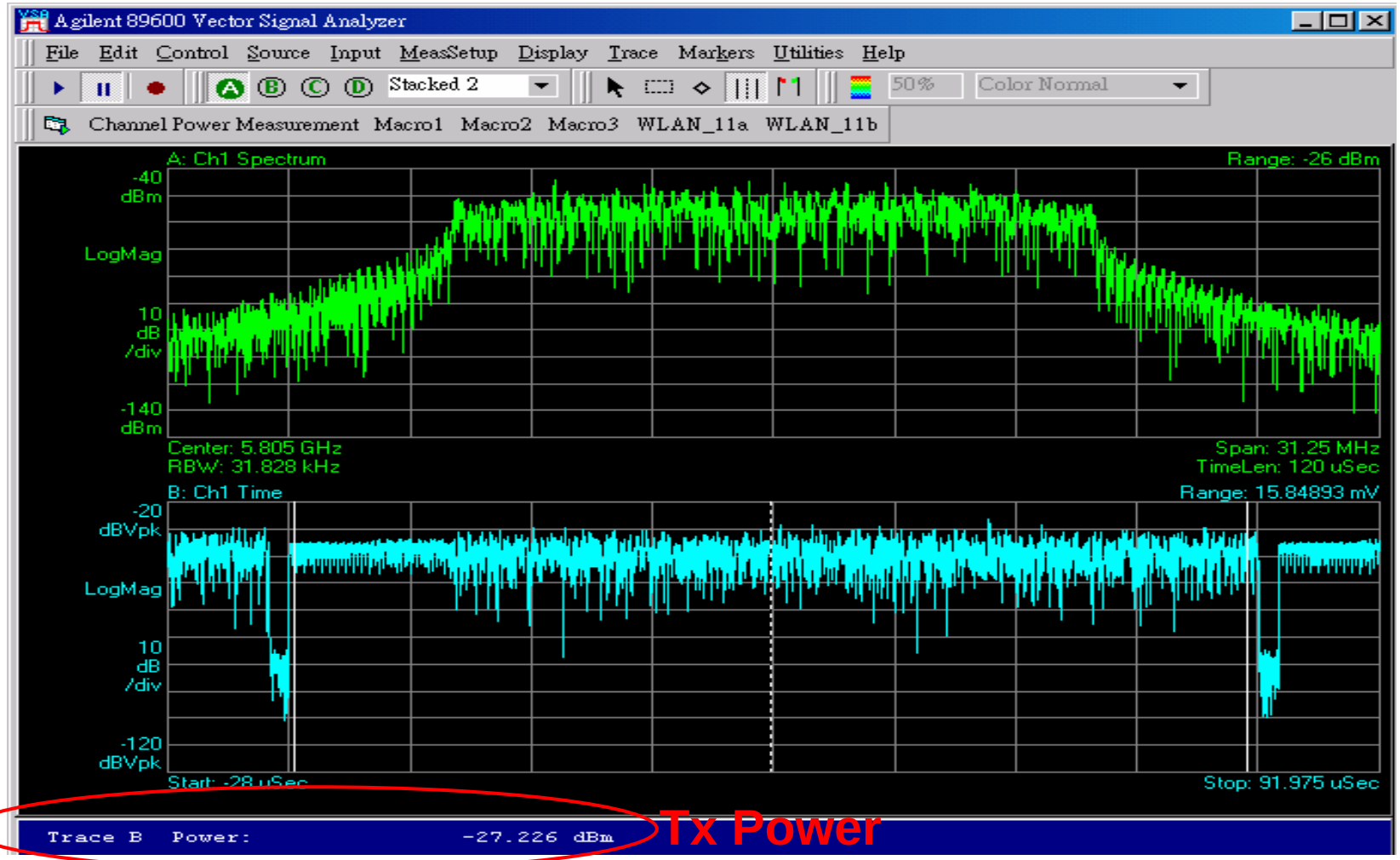
17.3.9.6.2 – TX spectral flatness

17.3.9.6.3 – TX constellation error

17.3.9.1 – TX power level

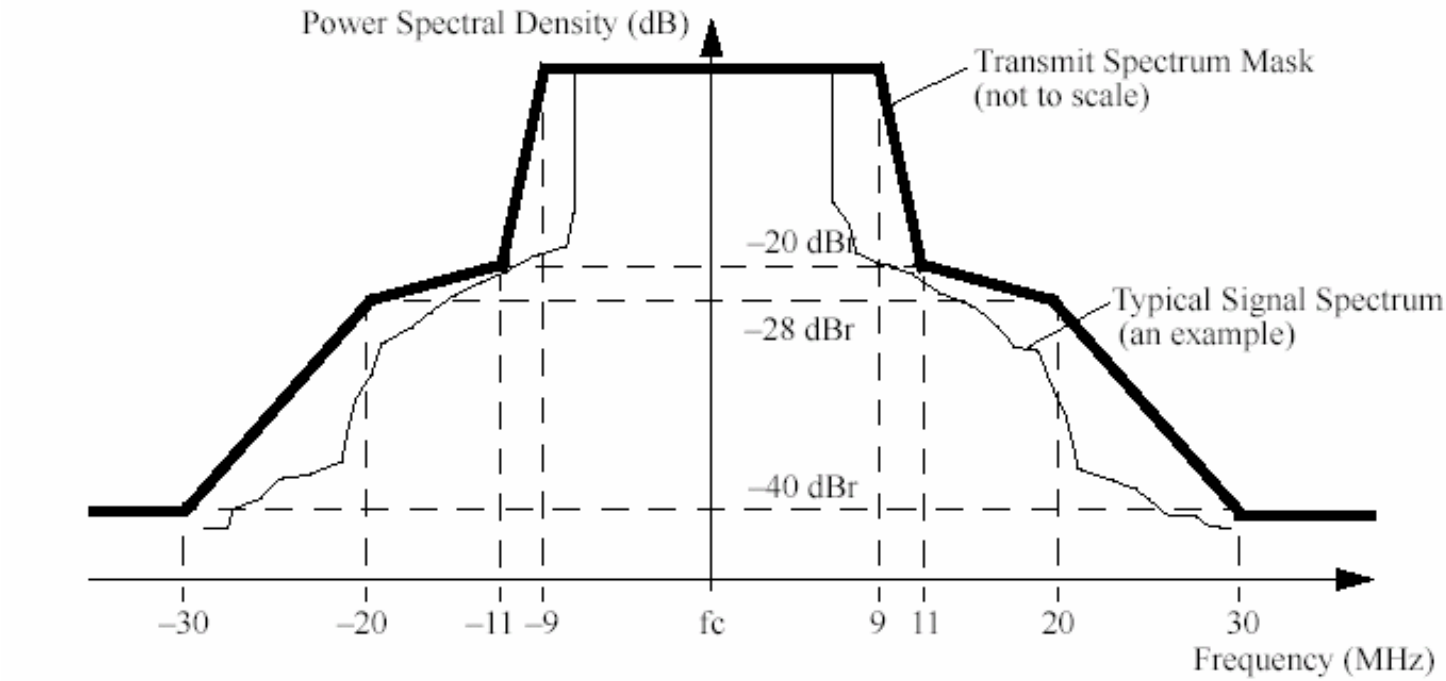
Frequency band (GHz)	Maximum output power with up to 6 dBi antenna gain(mW)
5.15–5.25	50mW(200mW EIRP with 6dBi antenna gain) or 2.5mW/MHz
5.25–5.35	250mW(1W EIRP with 6dBi antenna gain) or 12.5mW/MHz
5.725–5.825	1W(4W EIRP with 6dBi antenna gain) or 50mW/MHz

TX power level



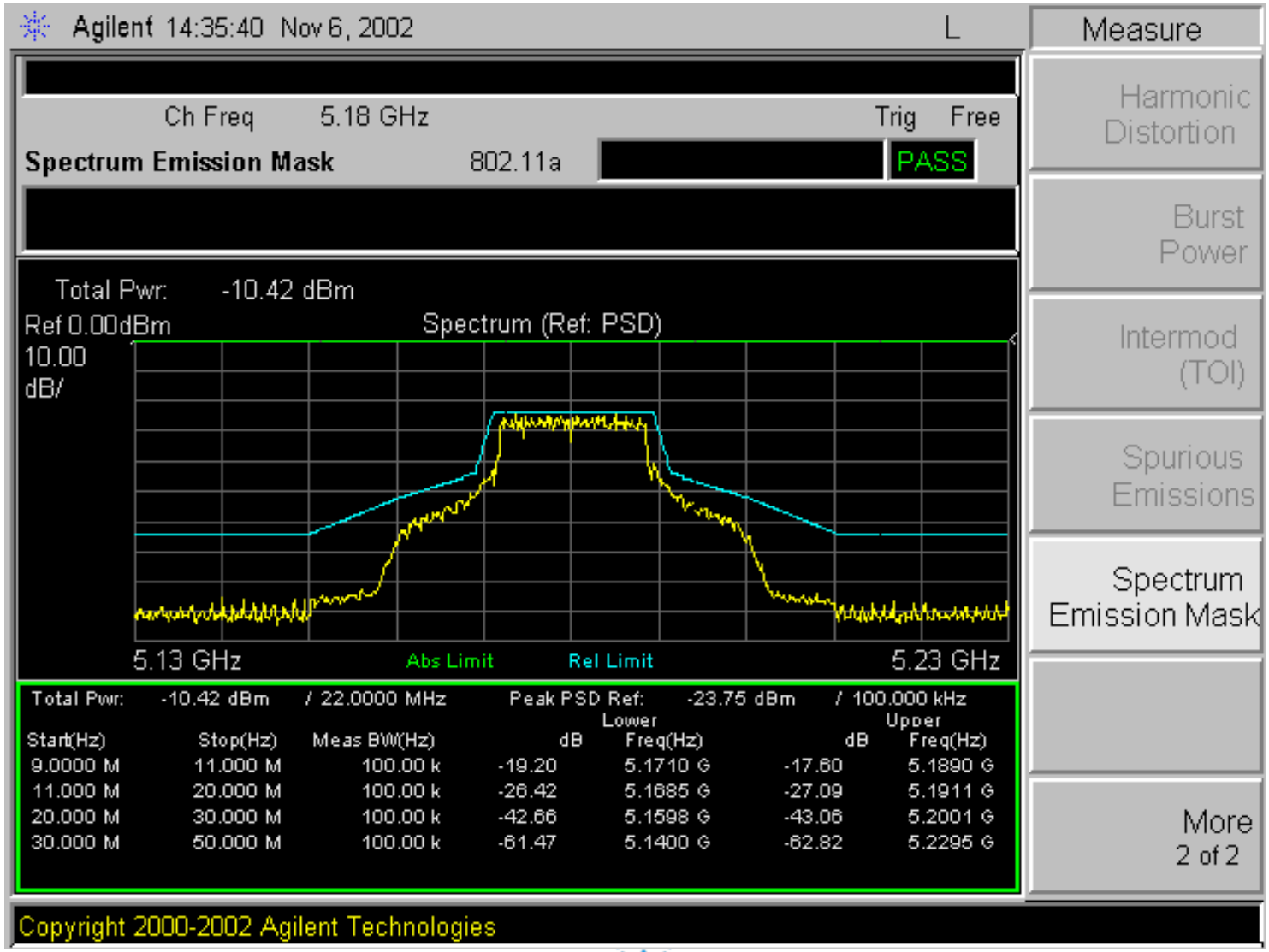
17.3.9.2 – TX spectrum mask

- **The transmitted spectrum shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18 MHz, –20 dBr at 11 MHz frequency offset, –28 dBr at 20 MHz frequency offset and –40 dBr at 30 MHz frequency offset and above.(RBW=100kHz,VBW=30kHz)**



FCC limits devices operating in U-NII band should be less than 20 MHz of emission bandwidth

802.11a Transmit spectrum mask



17.3.9.3 – TX spurious

- **Spurious transmissions from compliant devices shall conform to national regulations.**

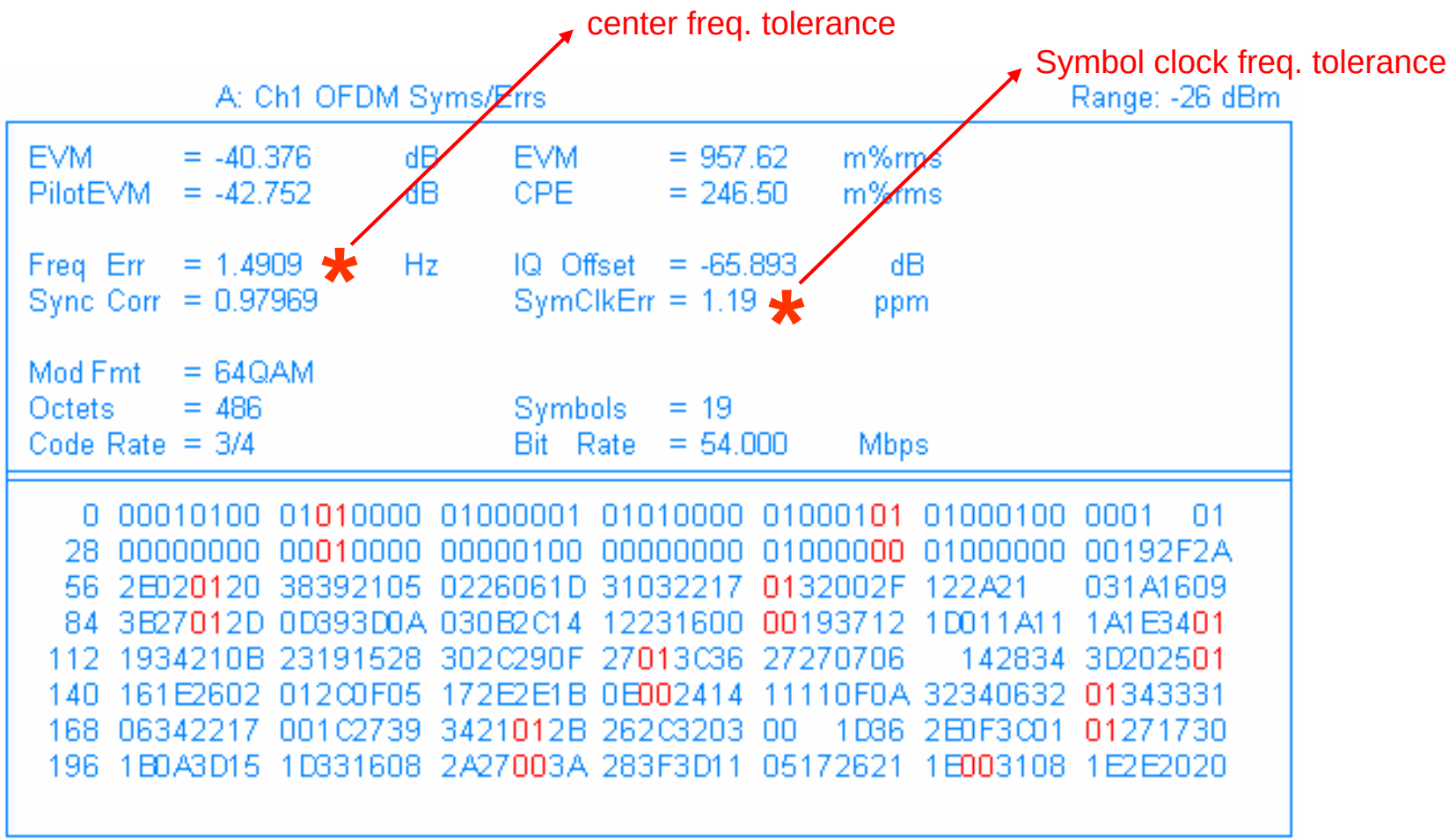
17.3.9.4 – TX center freq. tolerance

- **The transmitted center frequency tolerance shall be ± 20 ppm maximum. The transmit center frequency and the symbol clock frequency shall be derived from the same reference oscillator.**

17.3.9.5 – Symbol clock freq. tolerance

- **Symbol clock frequency tolerance shall be ± 20 ppm maximum.**

Measure TX center freq. and Symbol clock freq. tolerance

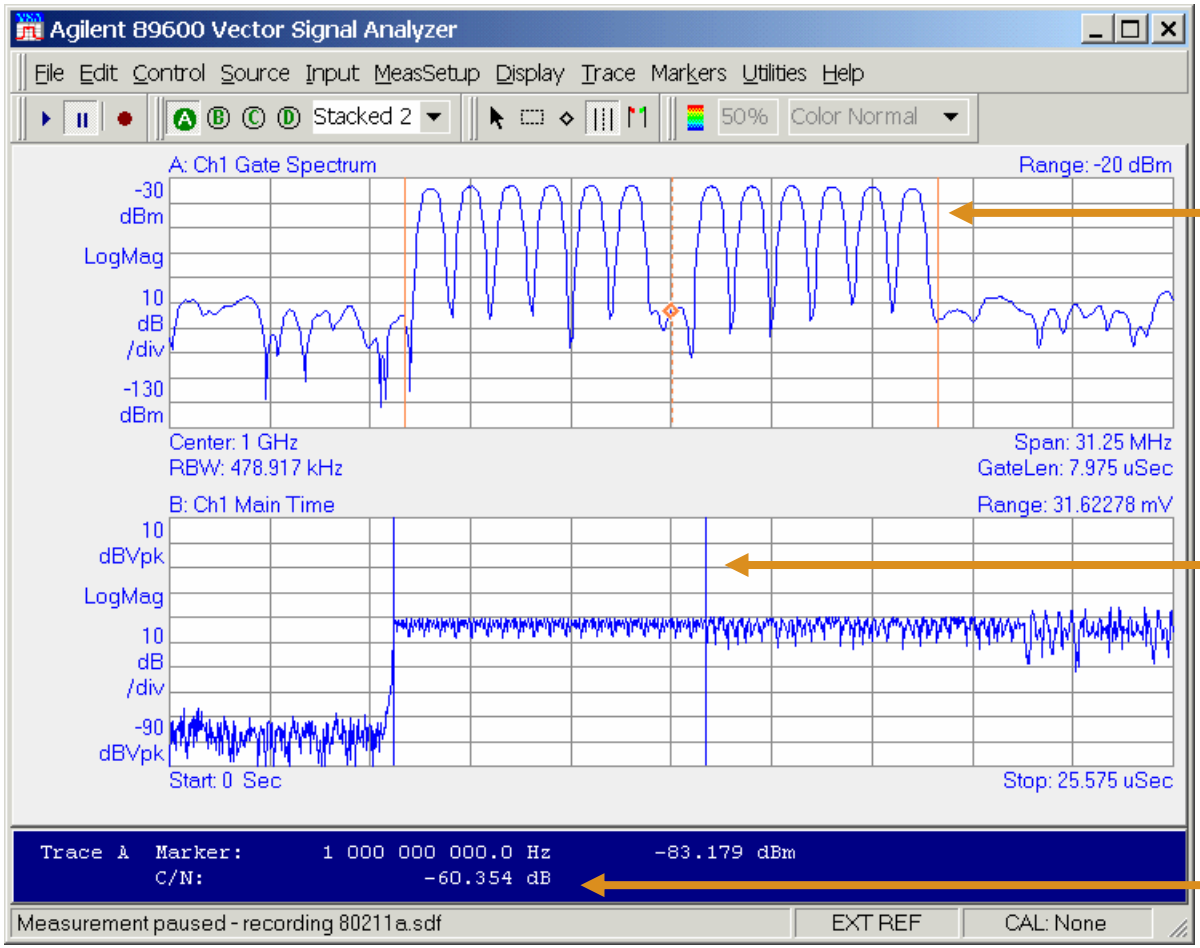


17.3.9.6.1 – TX carrier leakage

- **The data for this test shall be derived from the channel estimation phase(Long Training sequence).**
- **Such leakage shall not exceed -15 dB relative to overall transmitted power or, equivalently, +2 dB relative to the average energy of the rest of the subcarriers.**

Measuring Center Frequency Leakage

With std features: time gating, band power, C/N marker



Band Power measures power during the short sync.

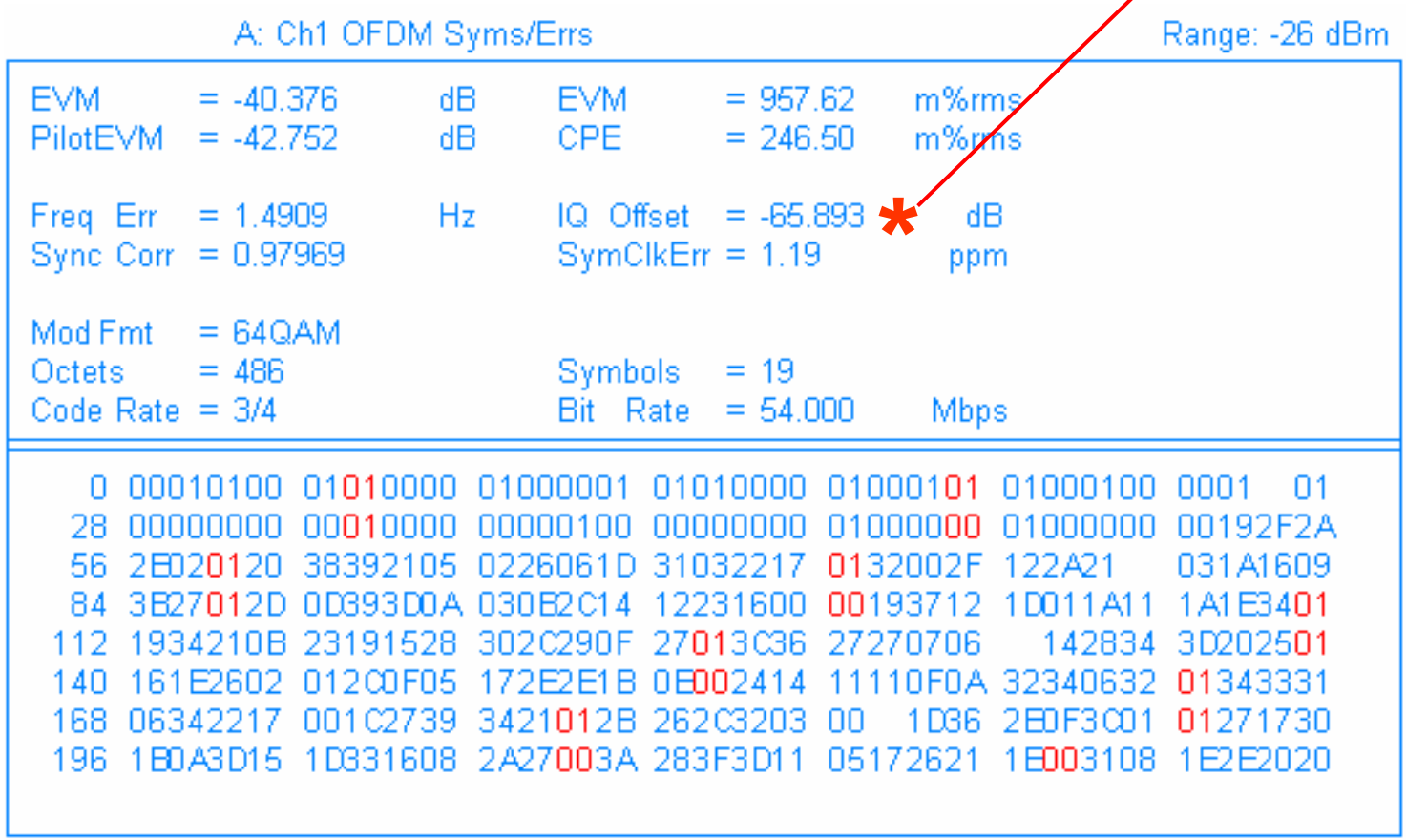
Time Gating selects just the short sync sequence.

C/N marker computes leakage at carrier #zero.

Measuring Center Frequency Leakage

Readout from Syms/Error Table

carrier leakage



A: Ch1 OFDM Syms/Errs — Range: -26 dBm

EVM	= -40.376	dB	EVM	= 957.62	m%rms
PilotEVM	= -42.752	dB	CPE	= 246.50	m%rms
Freq Err	= 1.4909	Hz	IQ Offset	= -65.893	dB
Sync Corr	= 0.97969		SymClkErr	= 1.19	ppm
Mod Fmt	= 64QAM				
Octets	= 486		Symbols	= 19	
Code Rate	= 3/4		Bit Rate	= 54.000	Mbps

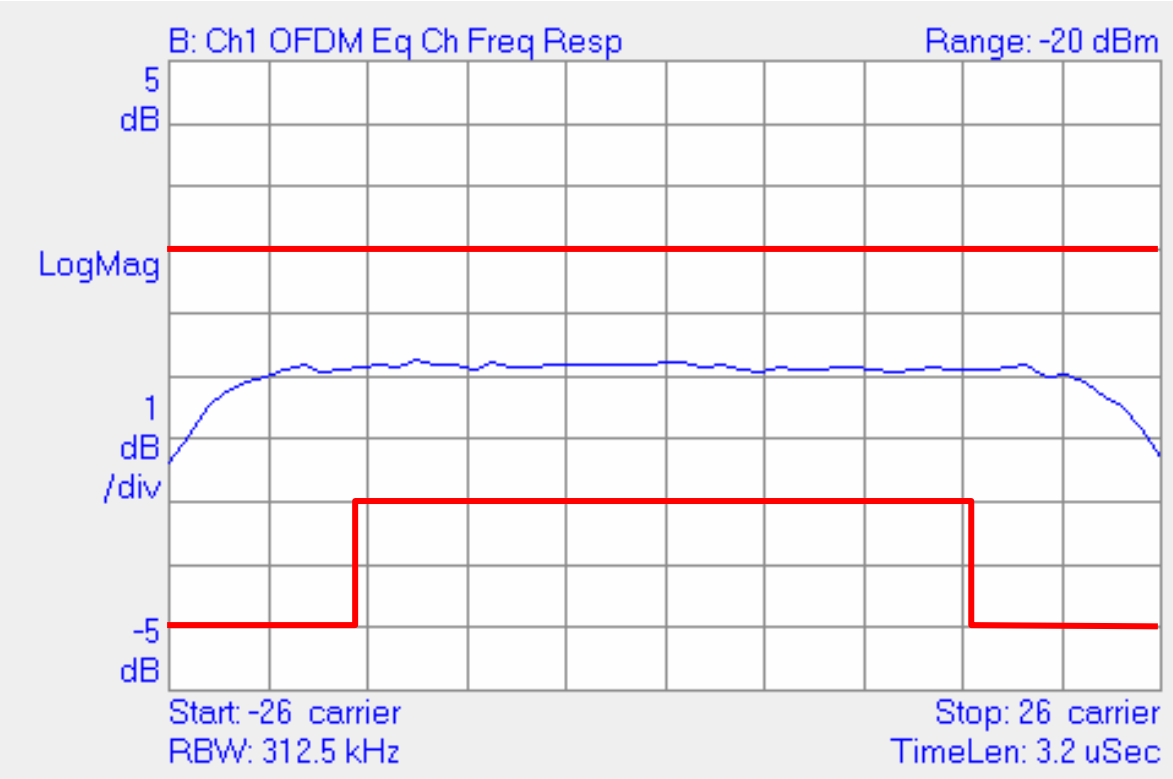
0	00010100	01010000	01000001	01010000	01000101	01000100	0001 01
28	00000000	00010000	00000100	00000000	01000000	01000000	00192F2A
56	2E020120	38392105	0226061D	31032217	0132002F	122A21	031A1609
84	3B27012D	0D393D0A	030B2C14	12231600	00193712	1D011A11	1A1E3401
112	1934210B	23191528	302C290F	27013C36	27270706	142834	3D202501
140	161E2602	012C0F05	172E2E1B	0E002414	11110F0A	32340632	01343331
168	06342217	001C2739	3421012B	262C3203	00 1D36	2E0F3C01	01271730
196	1B0A3D15	1D331608	2A27003A	283F3D11	05172621	1E003108	1E2E2020

17.3.9.6.2 – TX spectral flatness

- **The data for this test shall be derived from the channel estimation step (Long Training sequence).**
- **Spectral lines –16.. –1 and +1.. +16 will deviate no more than ± 2 dB**
- **Spectral lines –26.. –17 and +17.. +26 will deviate no more than +2/–4 dB**

Channel Freq Response

Equalizer-based



Display as Amplitude Response, Phase Response, Impulse Response, or Group Delay.

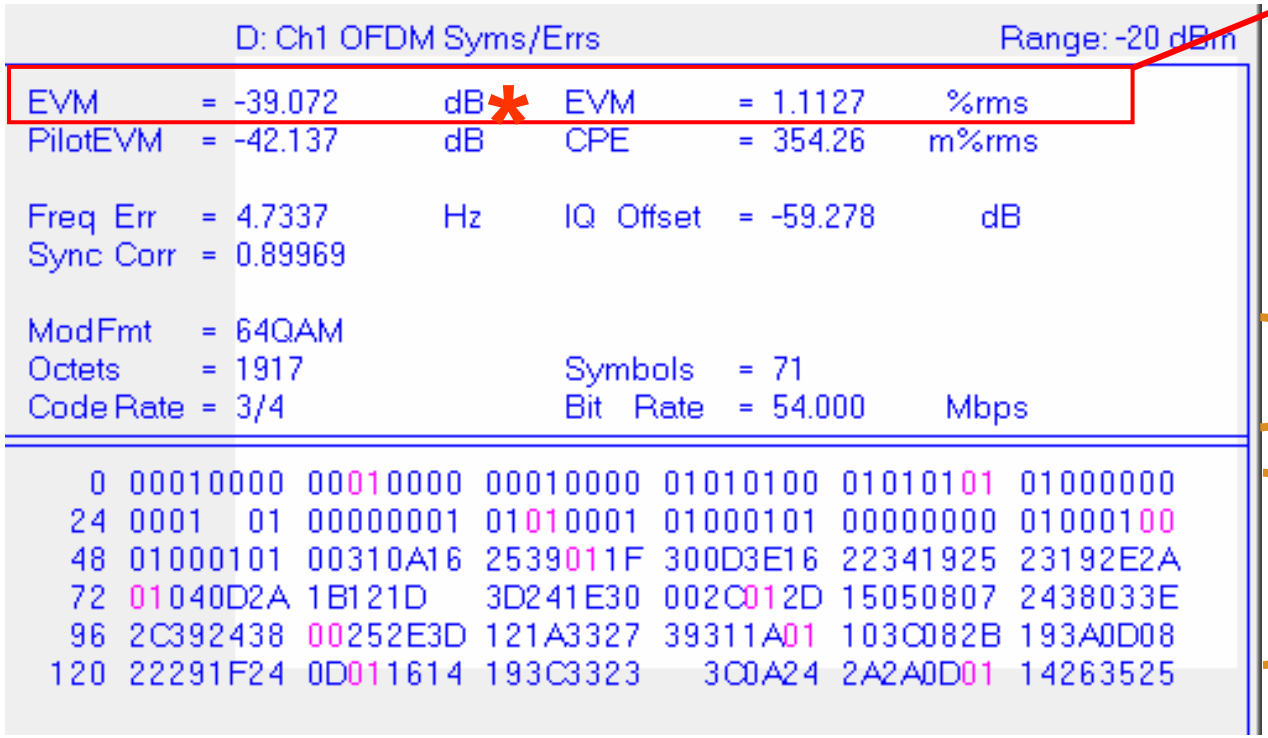
17.3.9.6.3 – TX constellation error

- **The test shall be performed over at least 20 frames (N_f), and the RMS average shall be taken. The packets under test shall be at least 16 OFDM symbols long. Random data shall be used for the symbols.**

Data Rate (Mbit/sec)	Relative Constellation Error (dB)	EVM (%RMS)
6	-5	56.2
9	-8	39.8
12	-10	31.6
18	-13	22.3
24	-16	15.8
36	-19	11.2
48	-22	7.9
54	-25	5.6

Modulation Quality Metrics

Symbols/Errors Display: "At-a-glance" summary of modulation quality.



EVM

As read from preamble. (n/a for HiperLAN/2)

Binary for B-QPSK (incl preamble and pilots), Hex for QAM's, blank for carrier zero.

Bits are coded and interleaved; you can't read them directly!

* Overall EVM in dB as required by 802.11a spec

IEEE802.11a Specifications Overview

17.3.10.1 – Receiver minimum input level sensitivity

17.3.10.2 – Adjacent channel rejection

17.3.10.3 – Non-adjacent channel rejection

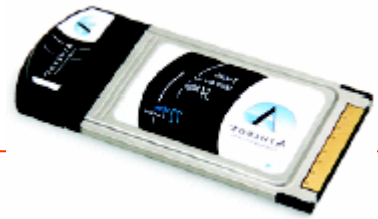
17.3.10.4 – Receiver maximum input level

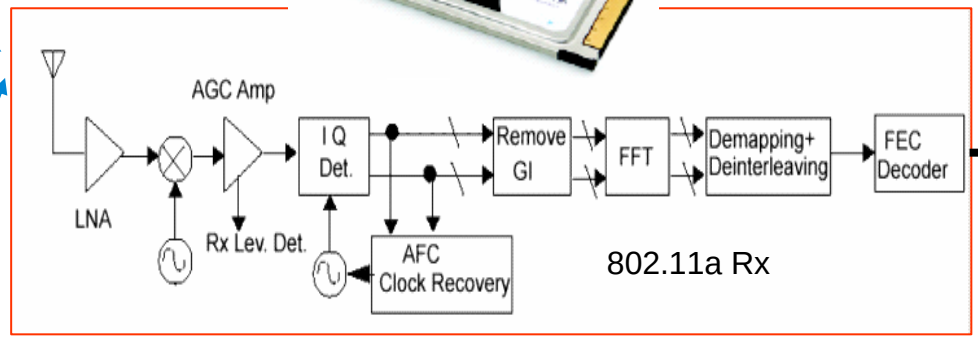
Receiver performance--Solutions

Golden Sample

OR

E4438C VSG





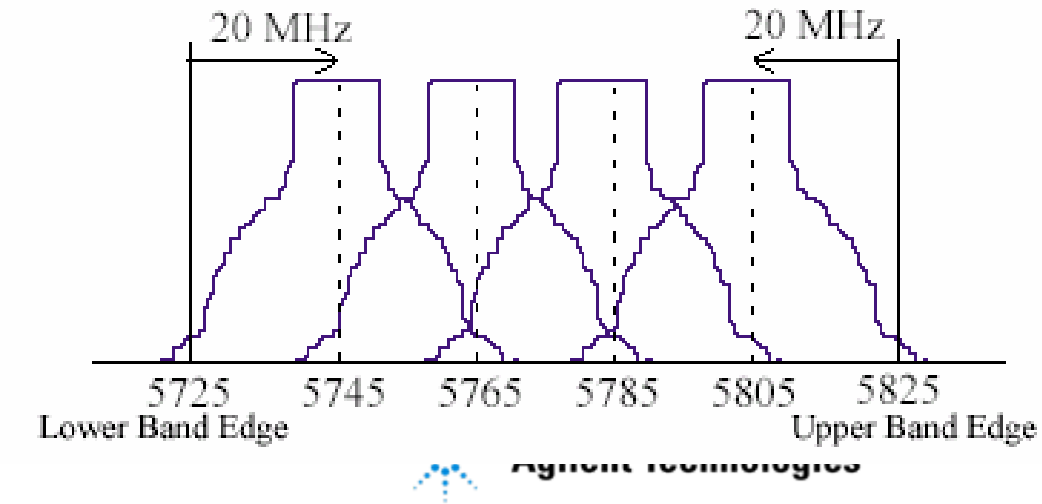
17.3.10.1 Receiver minimum input level sensitivity

- **PER(packet error rate):<=10% at a PSDU length of 1000 byte.**

Data rate (Mbits/s)	Minimum sensitivity (dBm)	Adjacent channel rejection (dB)	Alternate adjacent channel rejection (dB)
6	–82	16	32
9	–81	15	31
12	–79	13	29
18	–77	11	27
24	–74	8	24
36	–70	4	20
48	–66	0	16
54	–65	–1	15

17.3.10.2 Adjacent channel rejection

- **Step1: Desired signal's strength 3 dB above the rate dependent sensitivity**
- **Step2: Raising the power of the interfering signal(adjacent channel OFDM signal,20MHz spacing) until 10% PER is caused for a PSDU length of 1000 bytes.**
- **Step3: Power difference between the interfering and the desired channel is the corresponding adjacent channel rejection.**



17.3.10.3 Non-adjacent channel rejection

- **Step1: Desired signal's strength 3 dB above the rate dependent sensitivity**
- **Step2: Raising the power of the interfering signal(Non-adjacent channel OFDM signal,40MHz spacing) until 10% PER is caused for a PSDU length of 1000 bytes.**
- **Step3: Power difference between the interfering and the desired channel is the corresponding alternate adjacent channel rejection.**

17.3.10.4 Receiver maximum input level

- **Maximum input level of –30 dBm.**
- **PER<=10% at a PSDU length of 1000 bytes.**

IEEE802.11g Test Overview

- **The 802.11g PHY transmitter standard essentially consists of the full 802.11b specification, plus the 802.11a specification with 802.11b channel assignments.**
- **Use the 802.11b tests for measuring CCK mode transmissions.**
- **Use the 802.11a tests for measuring OFDM mode transmissions. But the specification limits for the Center Frequency Tolerance and Clock Frequency Tolerance can be relaxed to +/-25 ppm, less stringent than the 802.11a standard.**

射 频 和 天 线 设 计 培 训 课 程 推 荐

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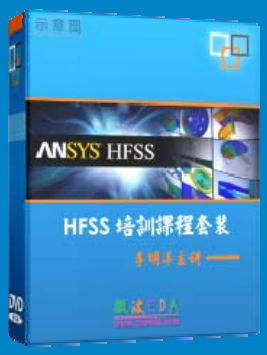
课程网址：http://www.edatop.com/peixun/antenna/134.html

CST 学习培训课程套装

该培训套装由易迪拓培训联合微波 EDA 网共同推出，是最全面、系统、专业的 CST 微波工作室培训课程套装，所有课程都由经验丰富的专家授课，视频教学，可以帮助您从零开始，全面系统地学习 CST 微波工作的各项功能及其在微波射频、天线设计等领域的设计应用。且购买该套装，还可超值赠送 3 个月免费学习答疑…

课程网址：http://www.edatop.com/peixun/cst/24.html

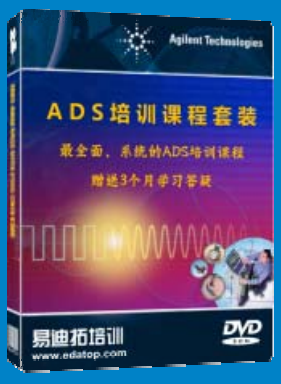


HFSS 学习培训课程套装

该套课程套装包含了本站全部 HFSS 培训课程，是迄今国内最全面、最专业的 HFSS 培训教程套装，可以帮助您从零开始，全面深入学习 HFSS 的各项功能和在多个方面的工程应用。购买套装，更可超值赠送 3 个月免费学习答疑，随时解答您学习过程中遇到的棘手问题，让您的 HFSS 学习更加轻松顺畅…

课程网址：http://www.edatop.com/peixun/hfss/11.html

ADS 学习培训课程套装



该套装是迄今国内最全面、最权威的 ADS 培训教程，共包含 10 门 ADS 学习培训课程。课程是由具有多年 ADS 使用经验的微波射频与通信系统设计领域资深专家讲解，并多结合设计实例，由浅入深、详细而又全面地讲解了 ADS 在微波射频电路设计、通信系统设计和电磁仿真设计方面的内容。能让您在最短的时间内学会使用 ADS，迅速提升个人技术能力，把 ADS 真正应用到实际研发工作中去，成为 ADS 设计专家...

课程网址： http://www.edatop.com/peixun/ads/13.html

我们的课程优势：

※ 成立于 2004 年，10 多年丰富的行业经验，

※ 一直致力并专注于微波射频和天线设计工程师的培养，更了解该行业对人才的要求

※ 经验丰富的一线资深工程师讲授，结合实际工程案例，直观、实用、易学

联系我们：

※ 易迪拓培训官网：http://www.edatop.com

※ 微波 EDA 网：http://www.mweda.com

※ 官方淘宝店：http://shop36920890.taobao.com