北京联华行科技有限公司

- 总部位于新加坡
- 北京成立于2002年
- 韩国TESCOM指定中国大陆代理商
- 为中国客户提供技术支持与服务
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韩国TESCOM

- 成立于１９９３年
- 位于韩国首都首尔
- 提供无线通讯测试仪器设备
- 蓝牙测试仪
- DAB/DMB测试仪
- RFID 测试仪
- TEM Cell
- 屏蔽箱及偶合器等

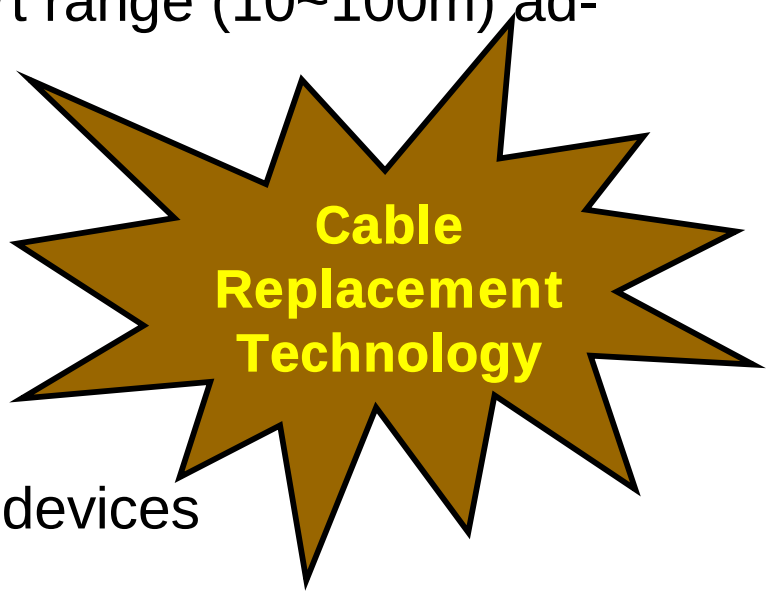
内容提要

- *蓝牙基本概念*
- *蓝牙测试内容*
- ***TC-3000C功能简介***

蓝牙基本概念

What Is Bluetooth?

- **Bluetooth** is…
  - a universal radio interface in the 2.4GHz frequency band that enables electronic devices to connect and communicate wirelessly via short range (10~100m) ad-hoc network.
- Key features:
  - Low power consumption
  - Low cost modules
  - Voice/data transmission
  - Applications mainly for portable devices

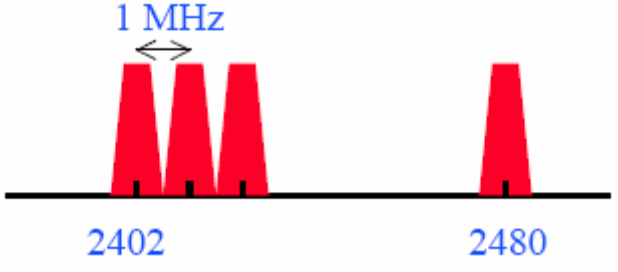


Spread Spectrum

- Frequency Hopping
  - The Bluetooth system operates in the 2.4 GHz ISM band.

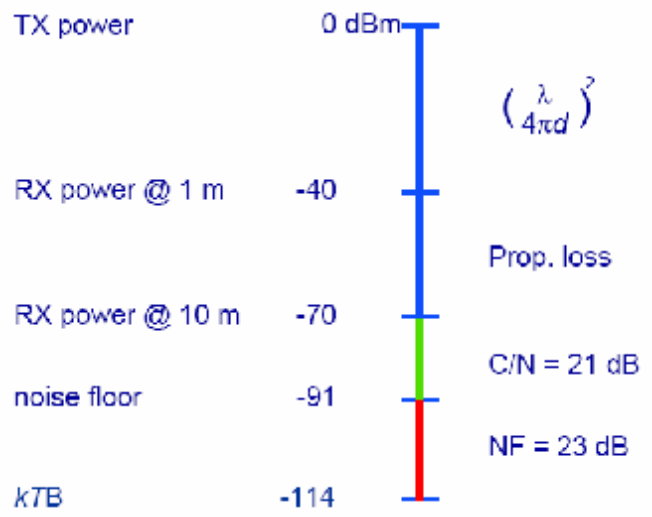
Regulatory Range	RF Channels
2.400-2.4835 GHz	f=2402+k MHz, k=0,…,78

  - 79 carriers, spaced at 1 MHz
  - Lower guard space: 1.5 MHz
  - Upper guard space: 3 MHz
  - Nominal hop rate: 1,600 hops/s



Device Power Classes

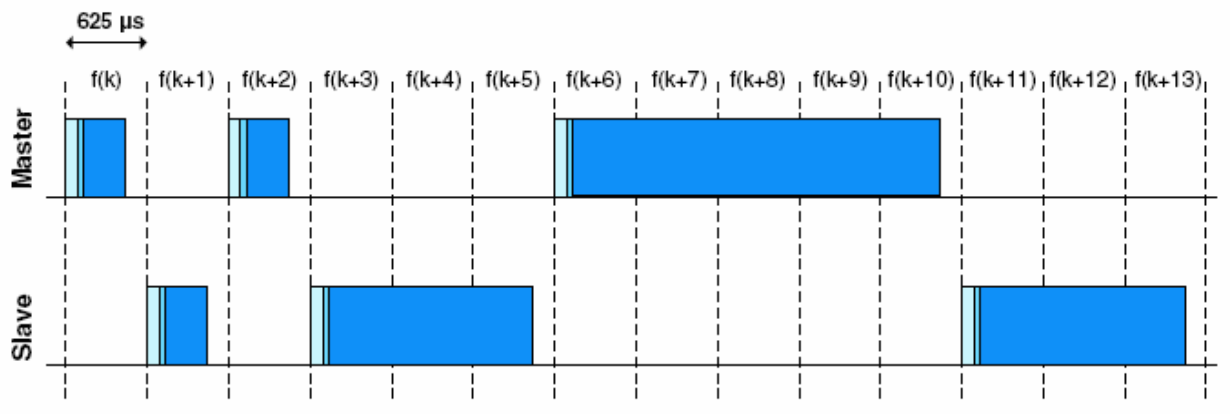
- Link Budget



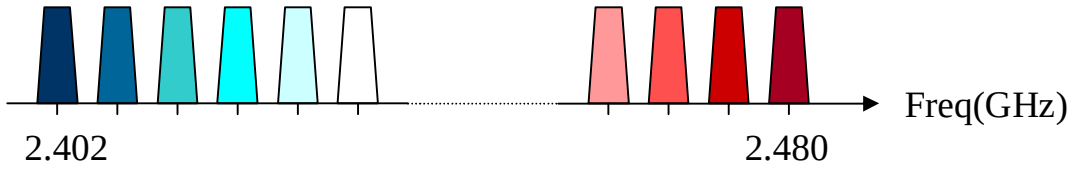
Power Class	Maximum Output Power (Pmax)	Nominal Output Power	Minimum Output Power[1]	Power Control
1	100 mW (20 dBm)	N/A	1 mW (0 dBm)	Pmin<+4 dBm to Pmax Optional: Pmin[2] to Pmax
2	2.5 mW (4 dBm)	1 mW (0 dBm)	0.25 mW (-6 dBm)	Optional: Pmin[2)] to Pmax
3	1 mW (0 dBm)	N/A	N/A	Optional: Pmin[2)] to Pmax

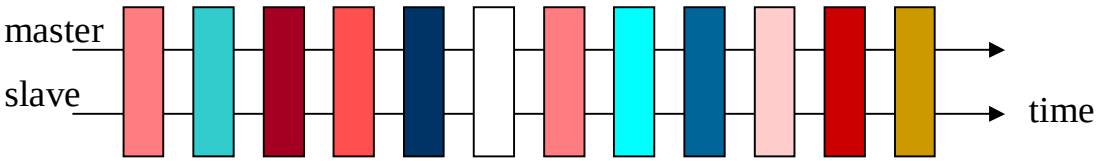
FH/TDD Channel

- Time Division Duplex (TDD)



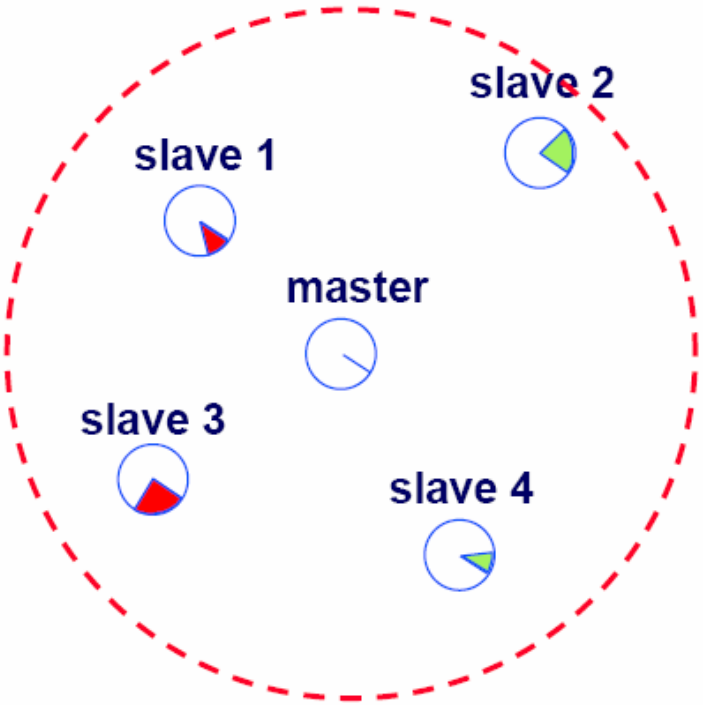
- FH

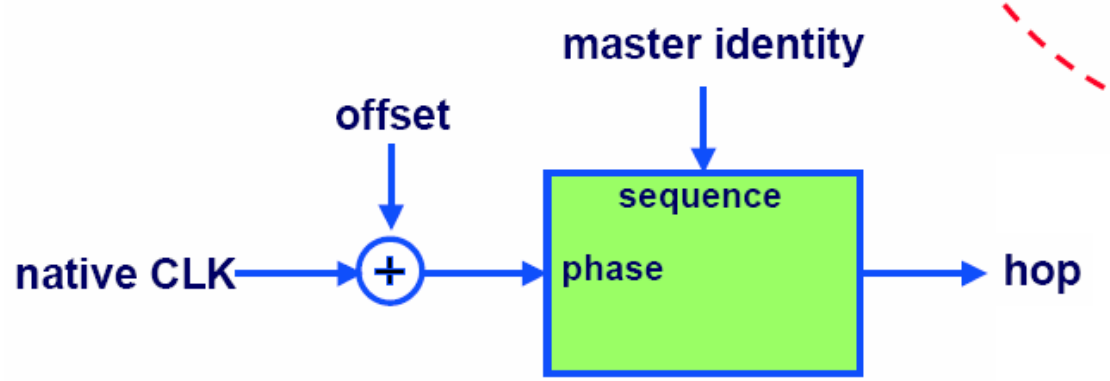




FH Synchronization

- Master identity **à** sequence
- Master clock **à** phase
- Free-running clocks





Modulation Characteristics

- Gaussian FSK
  - Modulation index (h): $0.28 < h < 0.35$
  - Gaussian shaping:
    BT (Bandwidth-bit period product) = 0.5
  - Symbol rate (R_s): R_s = 1 Ms/s
  - 20dB spectral bandwidth: 1 MHz
  - Symbol timing < ±20ppm
  - Max. frequency deviation: 140 ~ 175kHz
  - Min. frequency deviation: 115kHz

Packet Format

- Packet Format

- Access Code
  - Preamble (4-bit)
  - Sync Word (64-bit)
  - Trailer (4-bit)

Packet Types

Segment	TYPE code $b_3b_2b_1b_0$	Slot occupancy	SCO link	ACL link	SCO logical transport	eSCO logical transport	ACL logical transport
1	0000	1	NULL	NULL	NULL	NULL	NULL
	0001	1	POLL	POLL	POLL	POLL	POLL
	0010	1	FHS	FHS	FHS	reserved	FHS
	0011	1	DM1	DM1	DM1	reserved	DM1
2	0100	1	undefined	DH1	undefined	undefined	DH1
	0101	1	HV1	undefined	HV1	undefined	undefined
	0110	1	HV2	undefined	HV2	undefined	undefined
	0111	1	HV3	undefined	HV3	EV3	undefined
	1000	1	DV	undefined	DV	undefined	undefined
	1001	1	undefined	AUX1	undefined	undefined	AUX1
3	1010	3	undefined	DM3	undefined	undefined	DM3
	1011	3	undefined	DH3	undefined	undefined	DH3
	1100	3	undefined	undefined	undefined	EV4	undefined
	1101	3	undefined	undefined	undefined	EV5	undefined
4	1110	5	undefined	DM5	undefined	undefined	DM5
	1111	5	undefined	DH5	undefined	undefined	DH5

Control

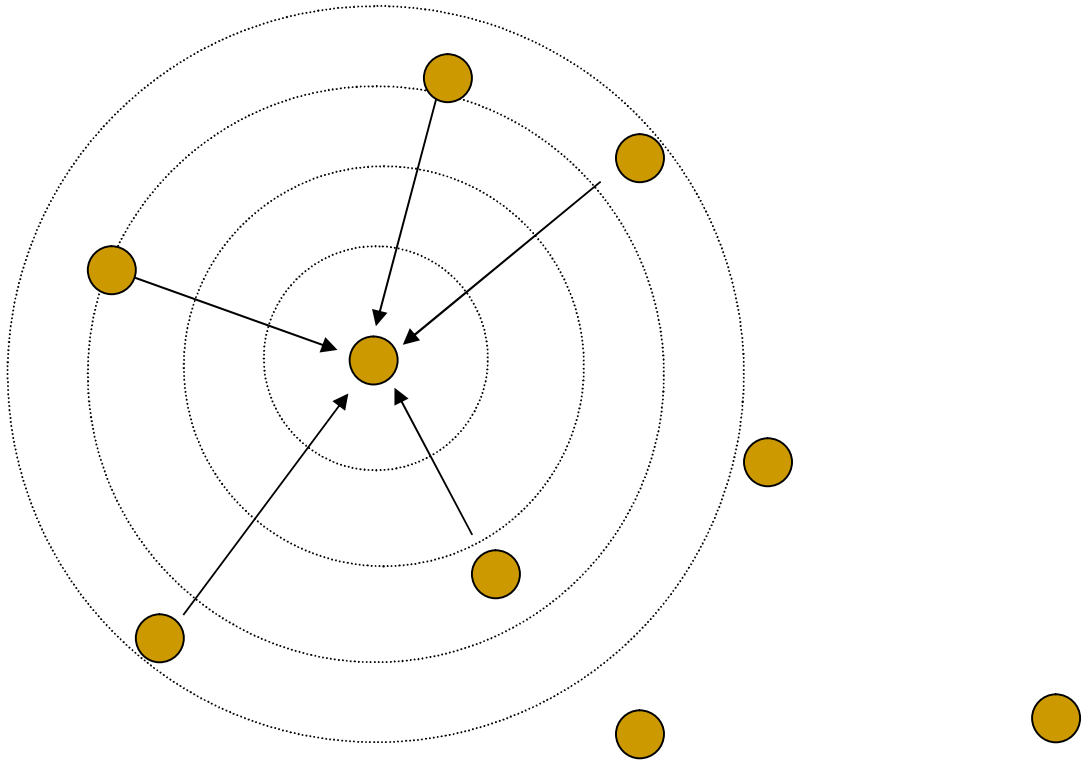
1-slot

3-slot

5-slot

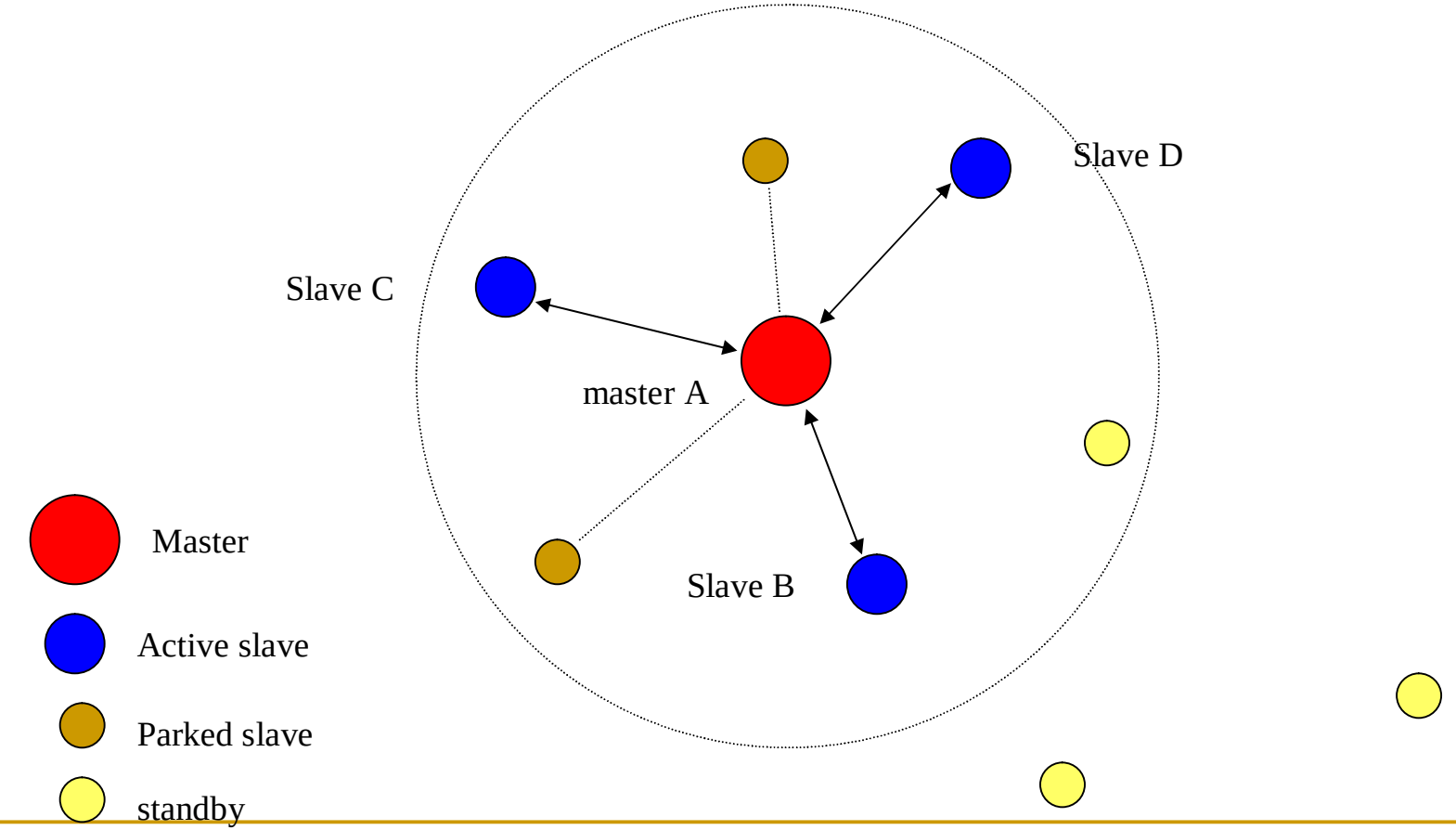
Discovery

- Inquiry



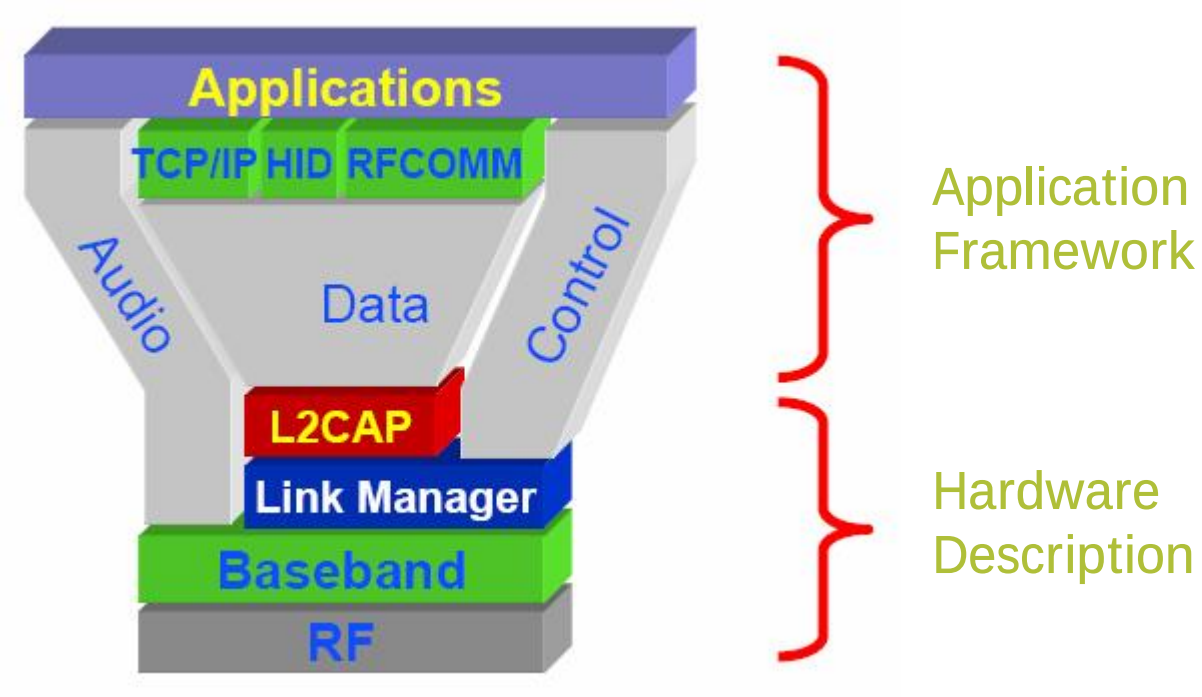
Link Setup

- Page: Creating a Piconet



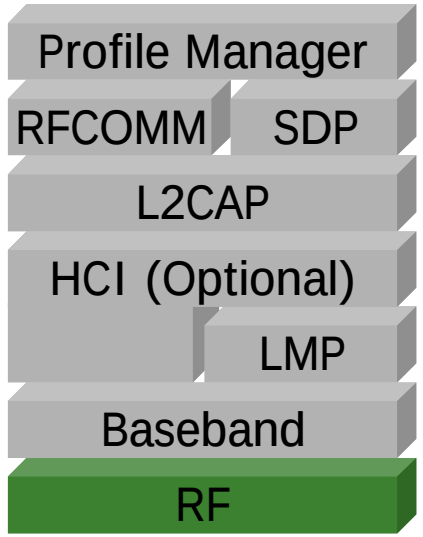
Protocol Stack

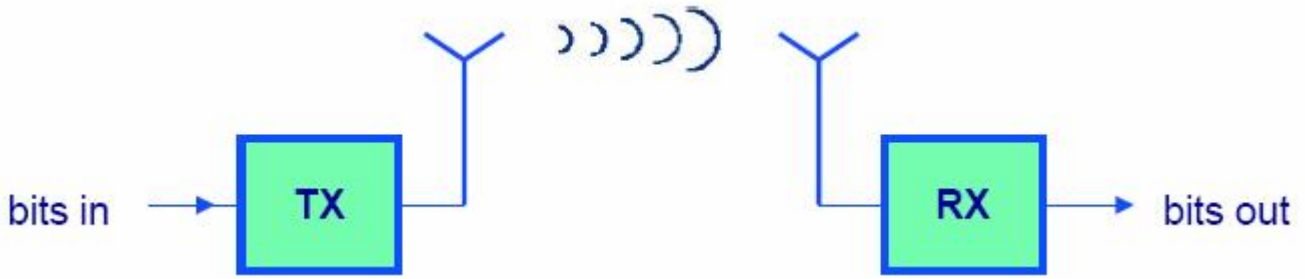
- Basics



RF Layer

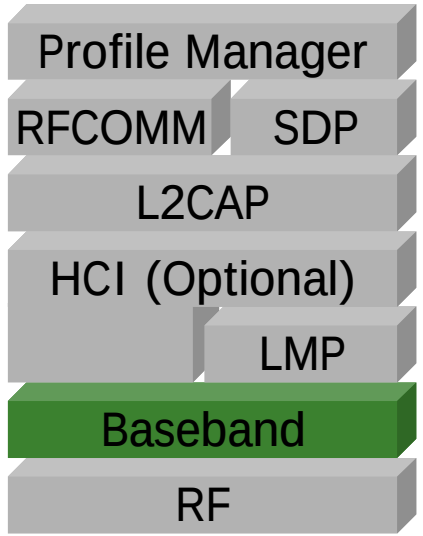
- Basic Radio Functions
  - Signal amplification
  - Frequency synthesis
  - Frequency up & down conversion
  - Modulation & demodulation
  - Conversion bits into symbols
  - Filtering & shaping





Baseband Layer

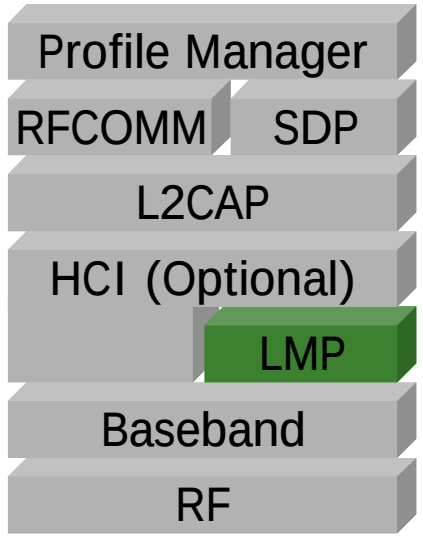
- Real-time Operations
  - Time slotting
  - Frequency hopping
  - Synchronization
  - Packet handling
  - Error correction
  - Basic connection establishment



LMP Layer

LMP: Link Manager Protocol

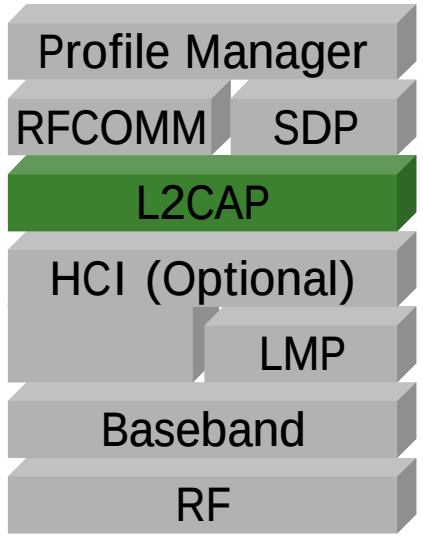
- Non Real-time Operations
  - Piconet Management
    - Attach/detach slaves
    - Master/slave switch
  - Link Configuration
    - Link handling and supervision
    - Quality of Service (QoS)
    - Low-power modes
    - Packet type selection
  - Security operations



L2CAP Layer

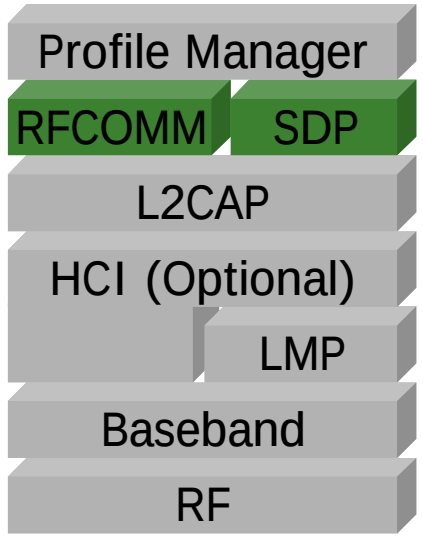
L2CAP: Logical Link Control & Adaptation Protocol

- Adaptation Layer
  - Only for ACL links
  - Protocol multiplexing
  - Segmentation & reassembly
  - QoS
  - Signalling channel for connection request



Other Layers

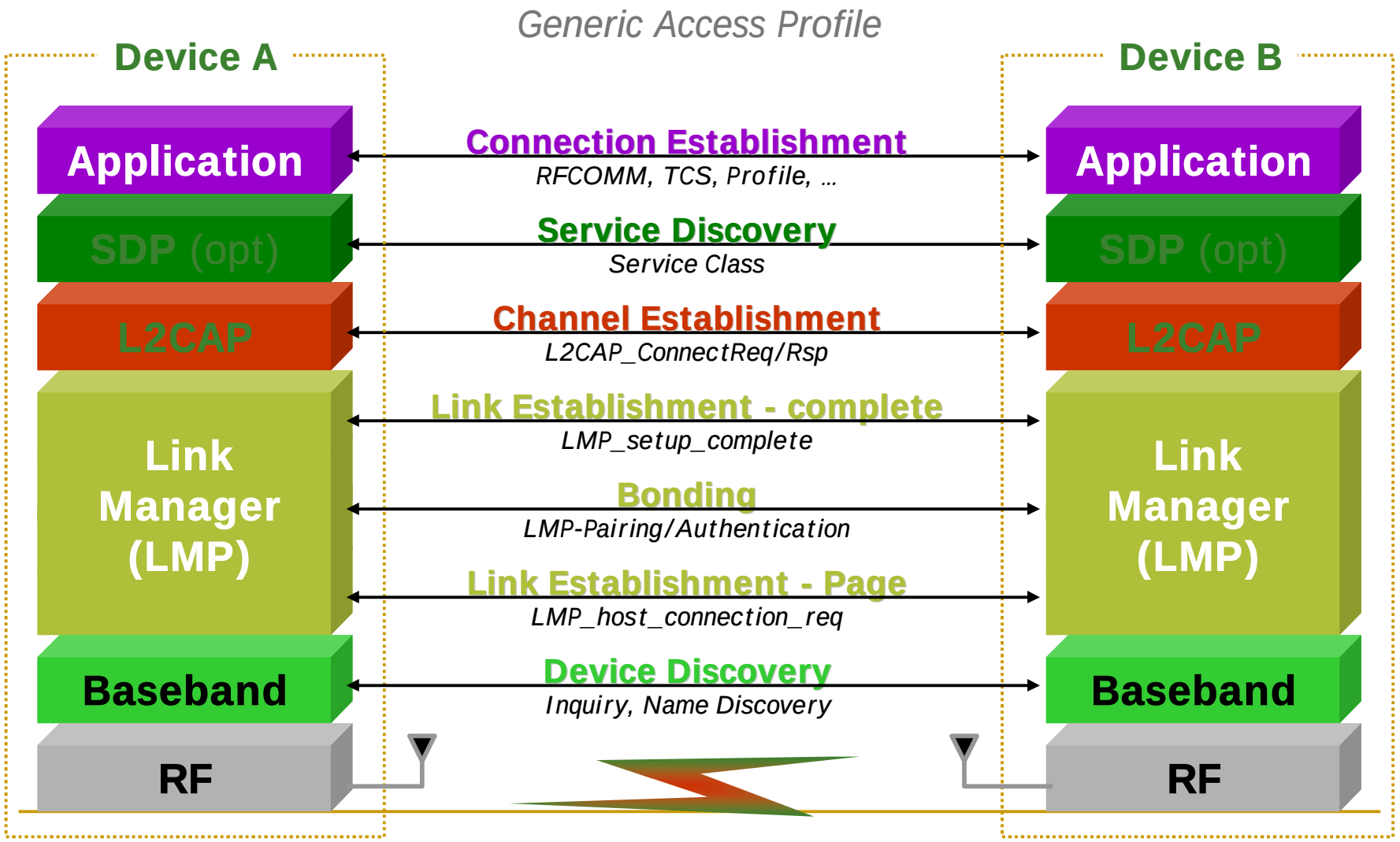
- RFCOMM
  - Transport protocol providing serial data transfer
- SDP
  - Service Discovery Protocol
  - Runs on a client server model



Generic Access Profile

- (Step1) Bluetooth Device Discovery
  - Bluetooth Device Inquiry
  - Bluetooth Device Name Discovery
- (Step2) Bluetooth Bonding
  - LMP-Pairing
  - LMP-Authentication
- (Step3) Establishment Procedure
  - Bluetooth Link Establishment – LMP level
  - Bluetooth Channel Establishment – L2CAP level
  - Bluetooth Connect Establishment – Application level
  - Service Discovery

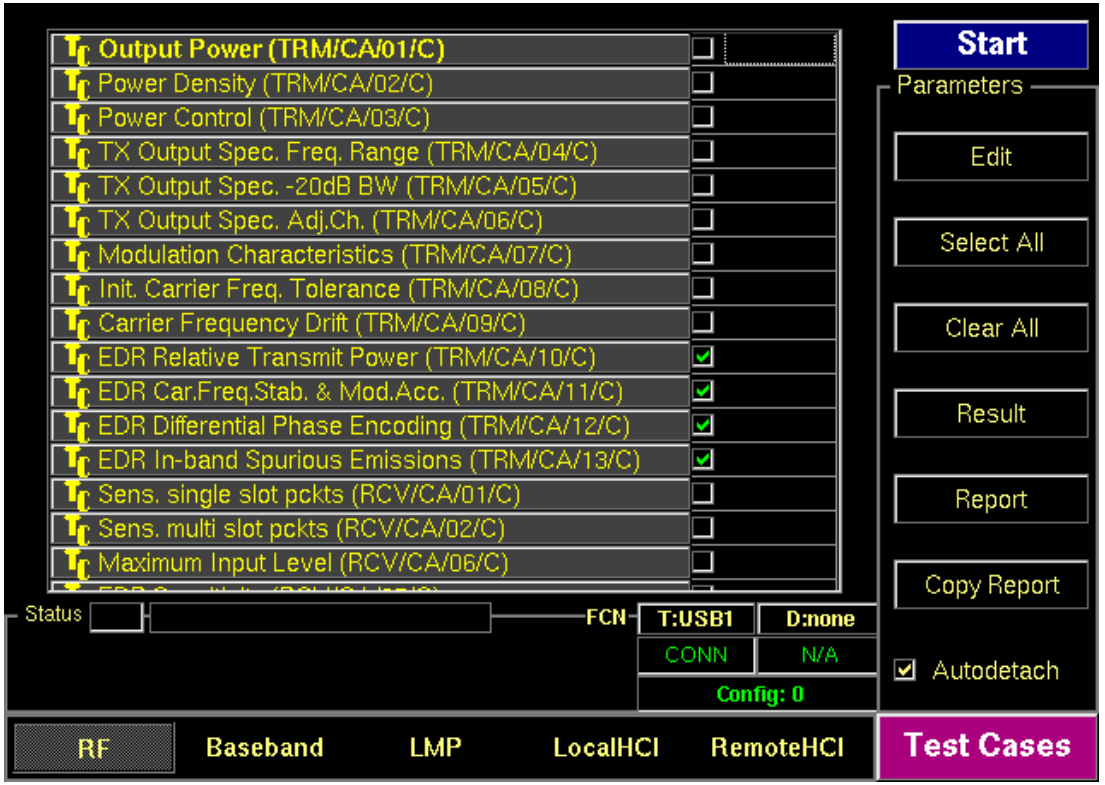
GAP Profile


Generic Access Profile
Device A
Device B
Application
SDP (opt)
L2CAP
Link Manager (LMP)
Baseband
RF
Connection Establishment
RFCOMM, TCS, Profile, ...
Service Discovery
Service Class
Channel Establishment
L2CAP_ConnectReq/Rsp
Link Establishment - complete
LMP_setup_complete
Bonding
LMP-Pairing/Authentication
Link Establishment - Page
LMP_host_connection_req
Device Discovery
Inquiry, Name Discovery
Application
SDP (opt)
L2CAP
Link Manager (LMP)
Baseband
RF

RF Test Cases

Test Cases - RF

- **TX Tests**
  - Output Power
  - Power Density
  - Power Control
  - Spectrum–Frequency Range
  - Spectrum–20dB Bandwidth
  - Adjacent Channel Power
  - Modulation Characteristics
  - Initial Carrier Freq. Tolerance
  - Carrier Frequency Drift
- **RX Tests**
  - Sensitivity – Single slot packets
  - Sensitivity – Multi-slot packets
  - Maximum Input Level



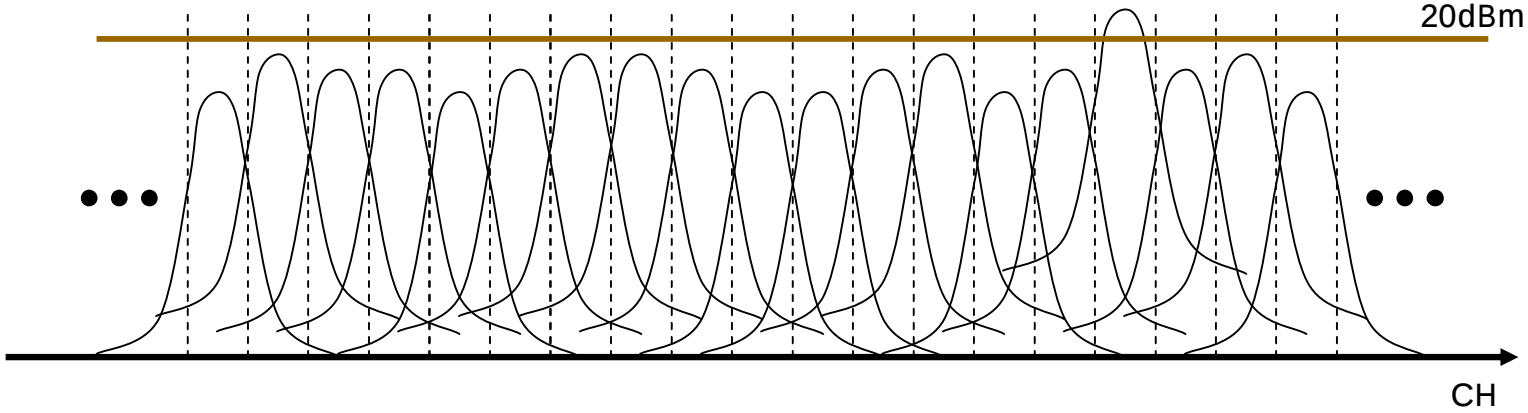
- ***Quick Testing for 4 TX Tests – OP/MOD/ICFT/CFD***

Output Power

- Verification of the maximum peak and average RF-output power
- Sets the EUT's output power as maximum
- Expected Outcome
  - P_{AV} < 100mW(20dBm)
  - P_{PK} < 200mW(23dBm)
  - class 1: P_{AV} > 1mW(0dBm)
  - class 2: 0.25mW(-6dBm) < P_{AV} < 2.5mW(4dBm)
  - class 3: P_{AV} < 1mW(0dBm)

Power Density

- Verification of the maximum RF-output power density
- Hopping on
- Expected Outcome
  - Power Density < 100mW(20dBm) per 100kHz



Power Control

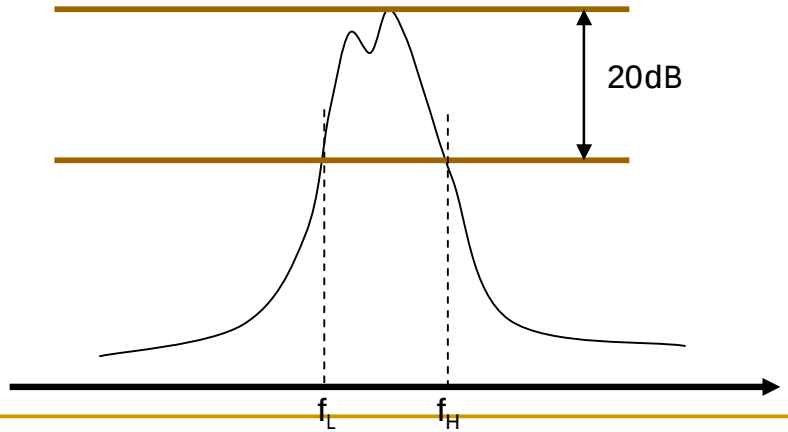
- Verification of the TX power control
- If the EUT does not support power control, this test case is not applicable
- Expected Outcome
  - Step size of the power control: 2dB ⩽ step size ⩽ 8dB
  - class 1: At minimum power step: P_{AV} < 4dBm

TX Output Spectrum-Frequency rage

- Verification of the emission inside the operating frequency range are within the limits
- Expected Outcome
  - f_L, f_H within the allowed frequency band
  - 2.4 GHz ~ 2.4835 GHz

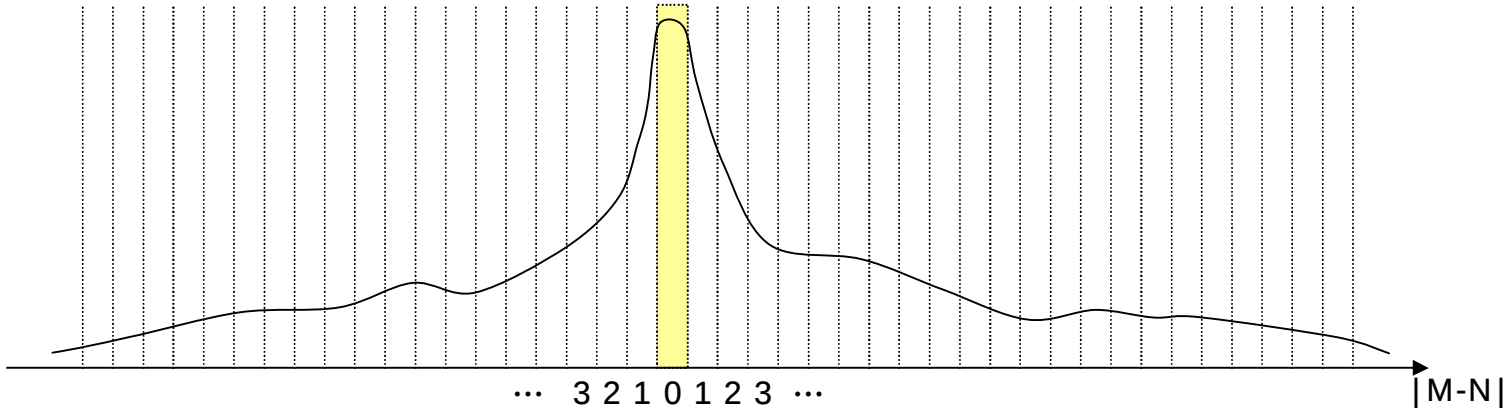
TX Output Spectrum-20dB Bandwidth

- Verification if the emissions inside the operating frequency range are within the limits
- Expected Outcome
  - The Transmit spectrum shall fulfill the following mask
  - $\Delta f = | f_H - f_L | \leqslant 1.0MHz$



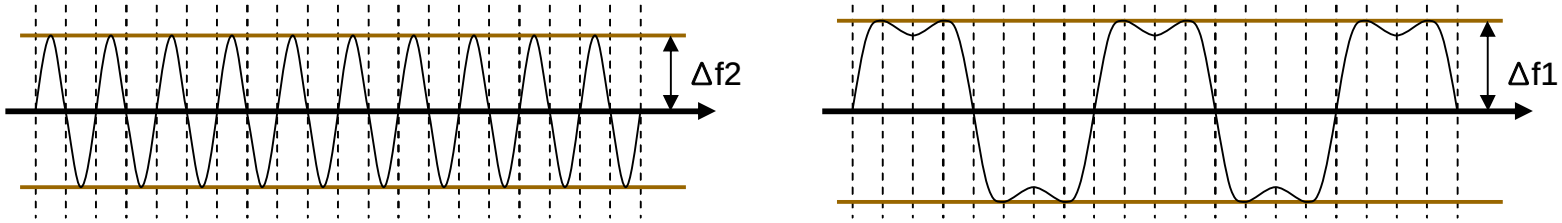
TX Output Spectrum-Adjacent channel power

- Verification if the emissions inside the operating frequency range are within the limits.
- Expected Outcome
  - $P_{TX}(f) \leqslant -20dBm$ for $|M-N|=2$
  - $P_{TX}(f) \leqslant -40dBm$ for $|M-N| \geqslant 3$



Modulation Characteristics

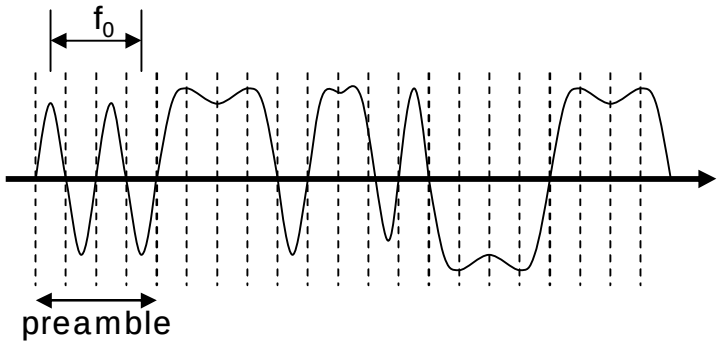
- Verification of the modulation index
- Expected Outcome
  - $140kHz \leqslant \Delta f1_{avg} \leqslant 175kHz$
  - $\Delta f2_{max} \leqslant 115kHz$ for at least 99.9% of all $\Delta f2_{max}$
  - $\Delta f2_{avg} / \Delta f1_{avg} \geqslant 0.8$



Initial Carrier Frequency Tolerance

- Verification of the transmitter carrier frequency accuracy

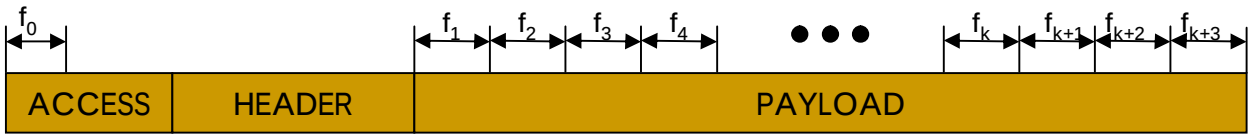
- Expected Outcome
  - $f_{TX} - 75kHz \leqslant f_0 \leqslant f_{TX} + 75kHz$



Carrier Frequency Drift

- Verification of the transmitter center frequency drift within a packet.

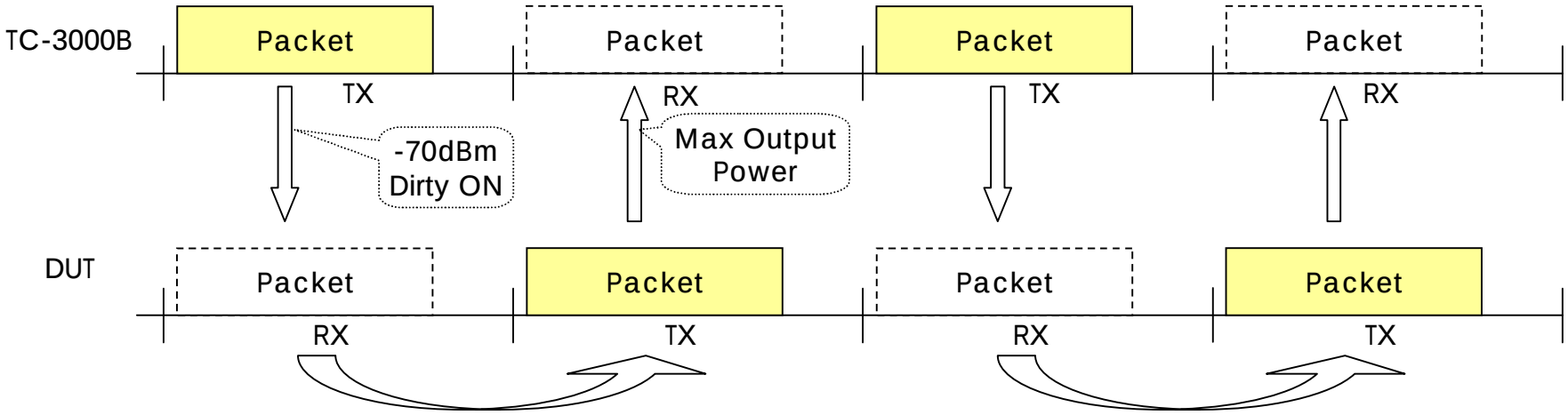
- Expected Outcome
  - Frequency Drift
    - One Slot packet: ±25kHz
    - Three Slot packet: ±40kHz
    - Five Slot packet: ±40kHz
  - Maximum drift rate is 20000Hz/50us
    - $|f_{k+5} - f_k| \leqslant 20000Hz$, k=0…max



Sensitivity (single-slot, multi-slot)

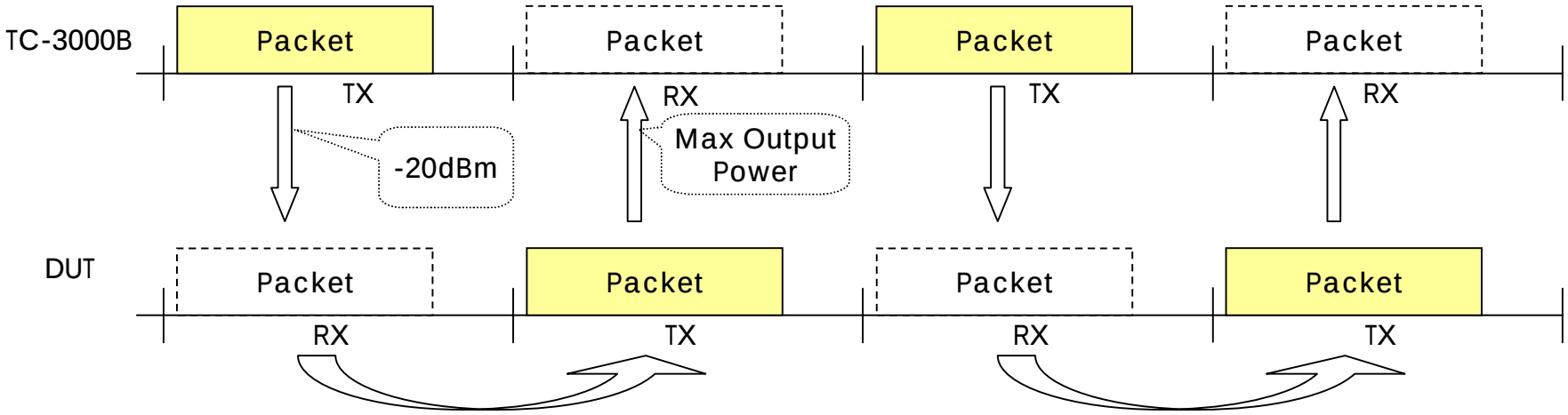
- The sensitivity is tested using a non-ideal transmitter. This test case defines the signal sent to the EUT in detail. The EUT must meet the required sensitivity for this non-ideal signal

- Expected Outcome
  - BER ⩽ 0.1% (minimum 1,600,000 bits)



Maximum Input Level

- Verification of the receiver performance.
- Expected Outcome
  - BER ⩽ 0.1% (minimum 1,600,000 bits)



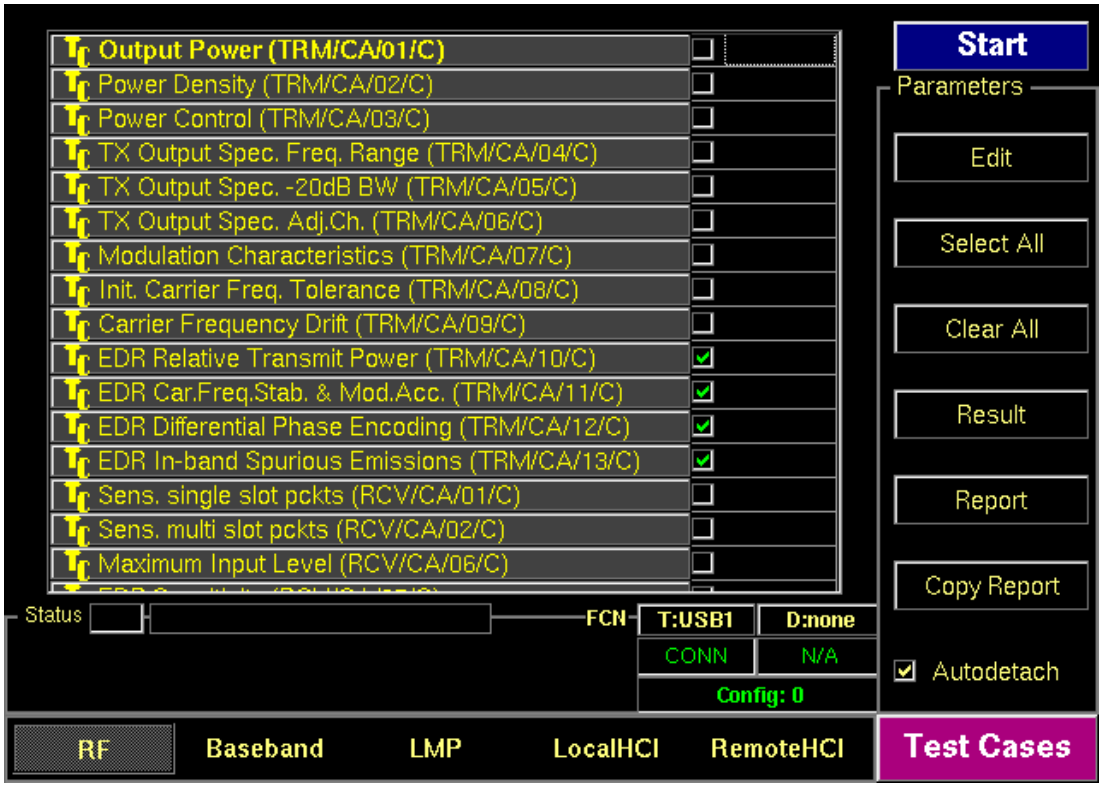
Packet Types (EDR)

Segment	TYPE code $b_3b_2b_1b_0$	Slot occupancy	SCO logical transport (1 Mbps)	eSCO logical transport (1 Mbps)	eSCO logical transport (2-3 Mbps)	ACL logical transport (1 Mbps) ptt=0	ACL logical transport (2-3 Mbps) ptt=1
1	0000	1	NULL	NULL	NULL	NULL	NULL
	0001	1	POLL	POLL	POLL	POLL	POLL
	0010	1	FHS	reserved	reserved	FHS	FHS
	0011	1	DM1	reserved	reserved	DM1	DM1
2	0100	1	undefined	undefined	undefined	DH1	2-DH1
	0101	1	HV1	undefined	undefined	undefined	undefined
	0110	1	HV2	undefined	2-EV3	undefined	undefined
	0111	1	HV3	EV3	3-EV3	undefined	undefined
	1000	1	DV	undefined	undefined	undefined	3-DH1
	1001	1	undefined	undefined	undefined	AUX1	AUX1
3	1010	3	undefined	undefined	undefined	DM3	2-DH3
	1011	3	undefined	undefined	undefined	DH3	3-DH3
	1100	3	undefined	EV4	2-EV5	undefined	undefined
	1101	3	undefined	EV5	3-EV5	undefined	undefined
4	1110	5	undefined	undefined	undefined	DM5	2-DH5
	1111	5	undefined	undefined	undefined	DH5	3-DH5

RF Test Cases (cont.)

Test Cases – EDR RF

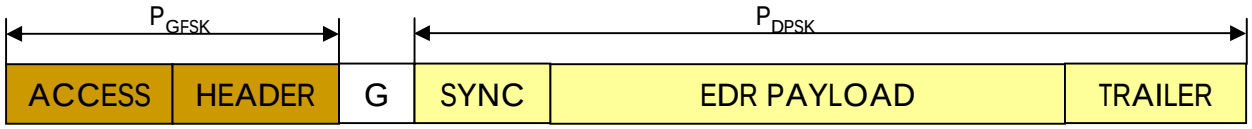
- **TX Tests**
  - EDR Relative Transmit Power
  - EDR Carrier Frequency Stability and Modulation Accuracy
  - EDR Differential Phase Encoding
  - EDR In-band Spurious Emissions
- **RX Tests**
  - EDR Sensitivity
  - EDR BER Floor Performance
  - EDR Maximum Input Level



EDR Relative Transmit Power

- This test ensures the difference in average transmit power during frequency modulated [GFSK] and phase modulated [DPSK] portions of a packet is within an acceptable range.

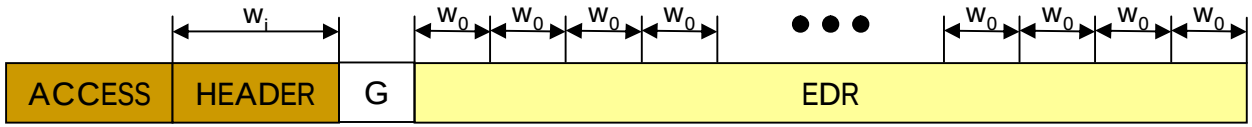
- Expected Outcome
  - $(P_{GFSK} – 4dB) < P_{DPSK} < (P_{GFSK} + 1dB)$



EDR Carrier Frequency Stability

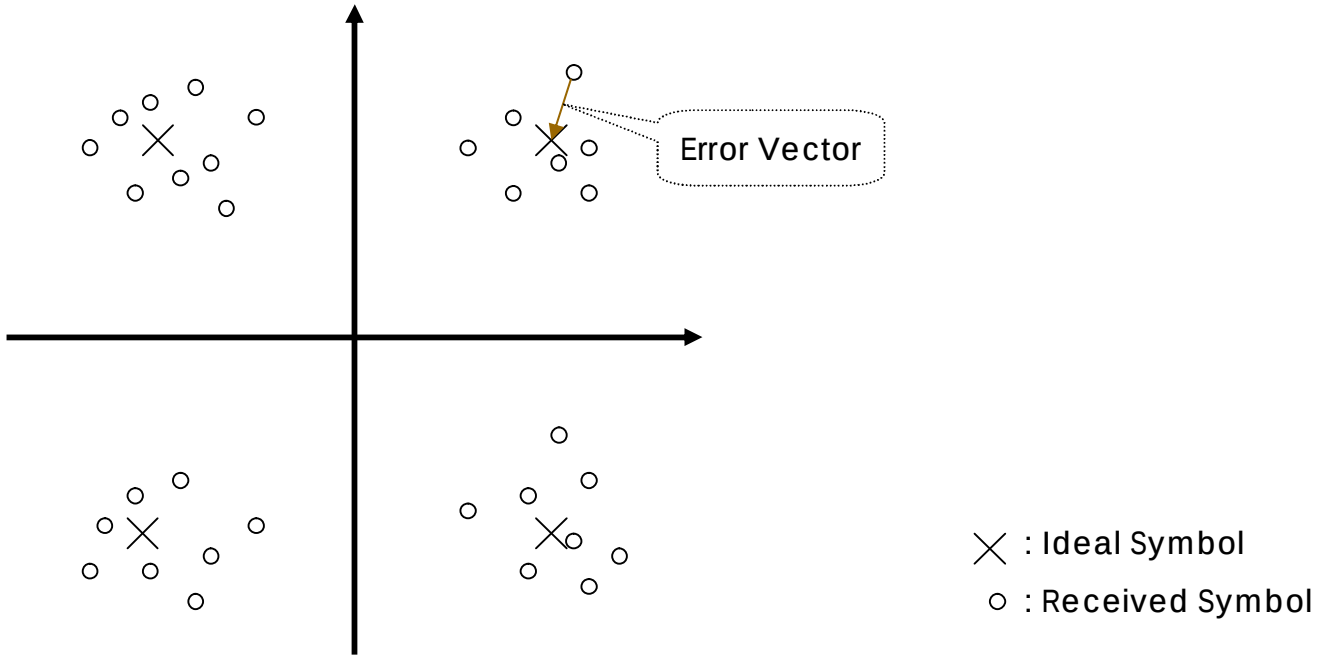
- This test verifies the transmitter carrier frequency stability
- Initial center frequency error (w_i) is measured from HEADER of packet
- EDR part is divided into non-overlapping blocks of 50 usecs and w_0 is measured for each block.

- Expected Outcome
  - $-75kHz \leqslant w_i \leqslant +75kHz$, for all packets
  - $-75kHz \leqslant (w_i + w_0) \leqslant +75kHz$, for all packets
  - $-10kHz \leqslant w_0 \leqslant +10kHz$, for all packets



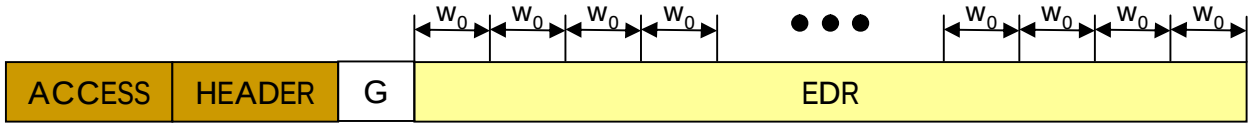
EDR Modulation Accuracy

- EVM: RMS value of Error Vector magnitude
- DEVM: EVM value of Differential modulation



EDR Modulation Accuracy

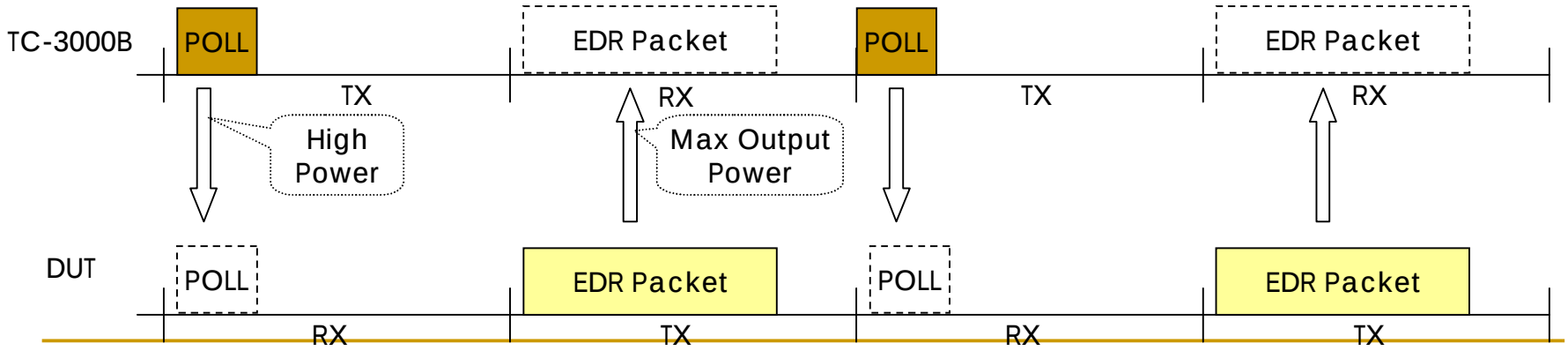
- This test verifies the modulation accuracy
- Frequency error is removed before calculating DEVM
- Expected Outcome
  - RMS DEVM
    - RMS DEVM ≤ 0.20, for all π/4-DQPSK blocks
    - RMS DEVM ≤ 0.13, for all 8DPSK blocks
  - Peak DEVM
    - DEVM ≤ 0.35, for all π/4-DQPSK symbols
    - DEVM ≤ 0.25, for all 8DPSK symbols
  - 99% DEVM
    - DEVM ≤ 0.30, for 99% of π/4-DQPSK symbols
    - DEVM ≤ 0.20, for 99% of 8DPSK symbols



EDR Differential Phase Encoding

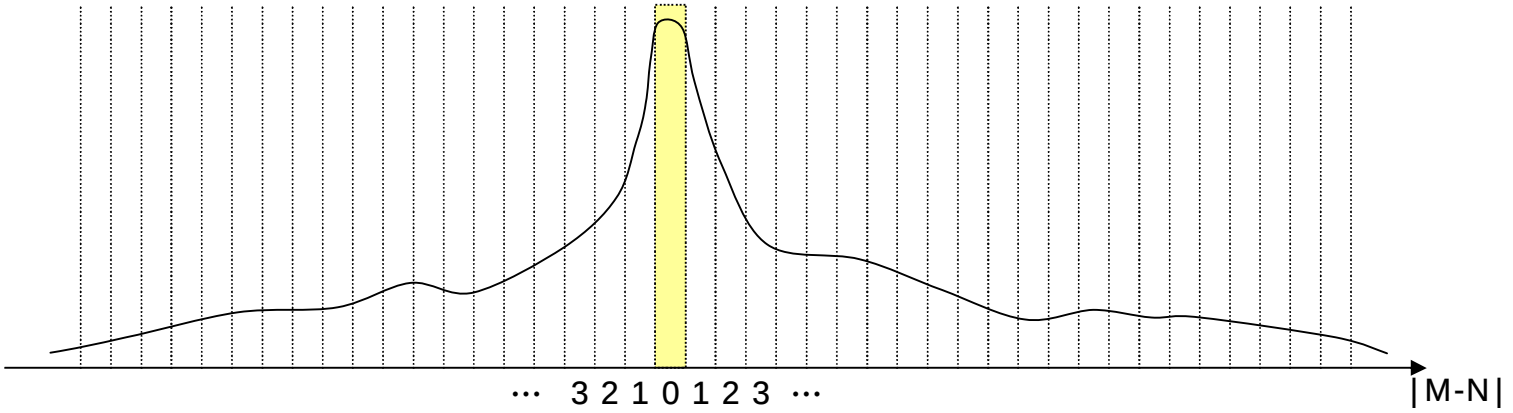
- Verification that the modulator correctly differential phase encodes the data.
- TX Mode Only
- Suppose that there is no error due to noise. Only DUT's PSK encoder could generate error.

- Expected Outcomes
  - Zero errors detected by the tester in 99% of the packets.



EDR In-band Spurious Emissions

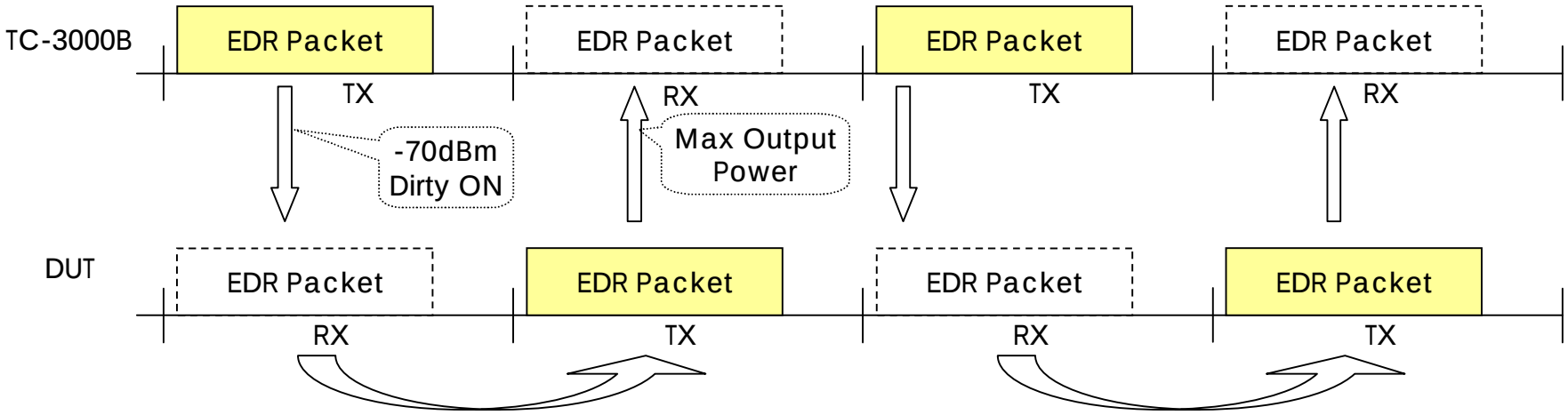
- Verification that the level of unwanted signals from the DPSK transmitter, within the frequency range used by the device, is below the required level.
- Expected Outcome
  - $P_{TX\text{-}26dB}(f) \leqslant P_{TXref} - 26dB$ for |M-N|=1
  - $P_{TX}(f) \leqslant -20dBm$ for |M-N|=2
  - $P_{TX}(f) \leqslant -40dBm$ for |M-N|$\geqslant$3



EDR Sensitivity

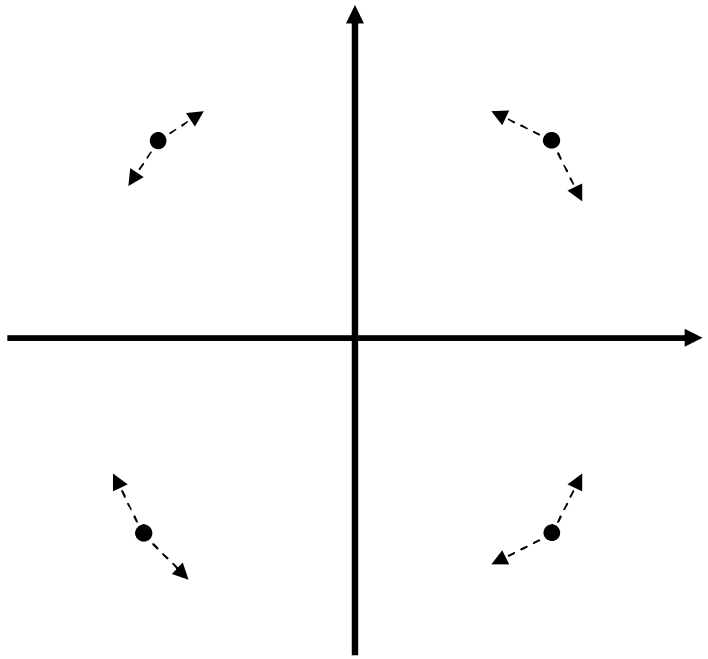
- Verification of the receiver sensitivity for the 10^{-4} bit error rate using a non-ideal transmitter.
- Loopback Mode Only

- Expected Outcome
  - BER $\leqslant 7*10^{-5}$ after 1,600,000 bits
  - BER $\leqslant 10^{-4}$ after 16,000,000 bits



EDR Dirty Mode

- The Tester transmits the first 20 packets using first parameter set of Table. The second 20 packets are transmitted with parameter set 2 and so forth.
- Additionally, a frequency modulation with a deviation of ±10kHz and a synchronized sine wave modulation period of 100us.

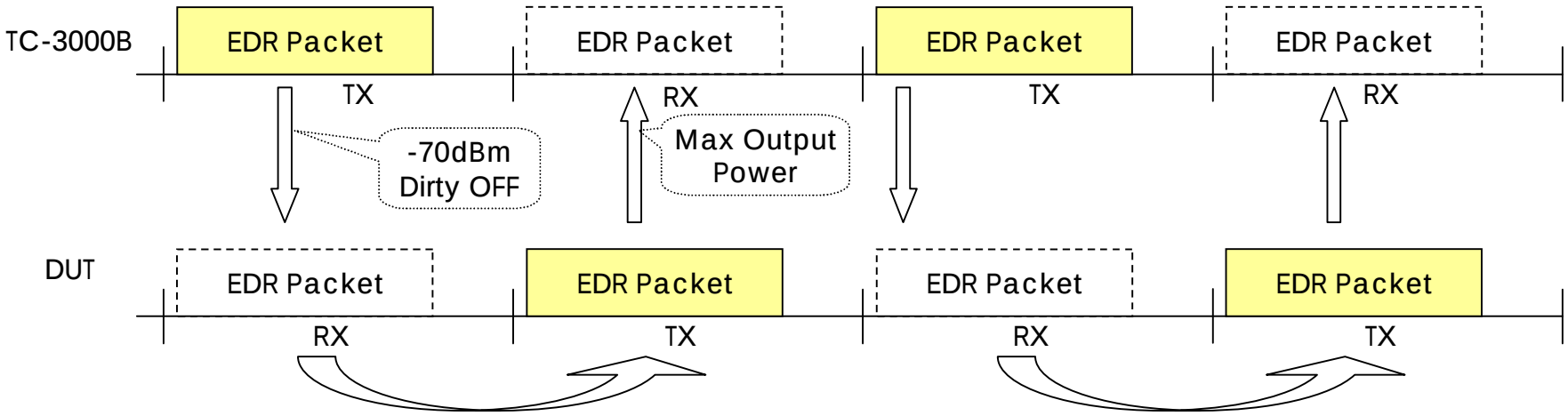


Set of Parameters	Carrier Offset Frequency	Symbol Timing Error
1	0 kHz	0 ppm
2	+65 kHz	+20 ppm
3	-65 kHz	-20 ppm

EDR BER Floor Performance

- Verification of the receiver performance for the 10^{-5} bit error rate.
- Loopback Mode Only

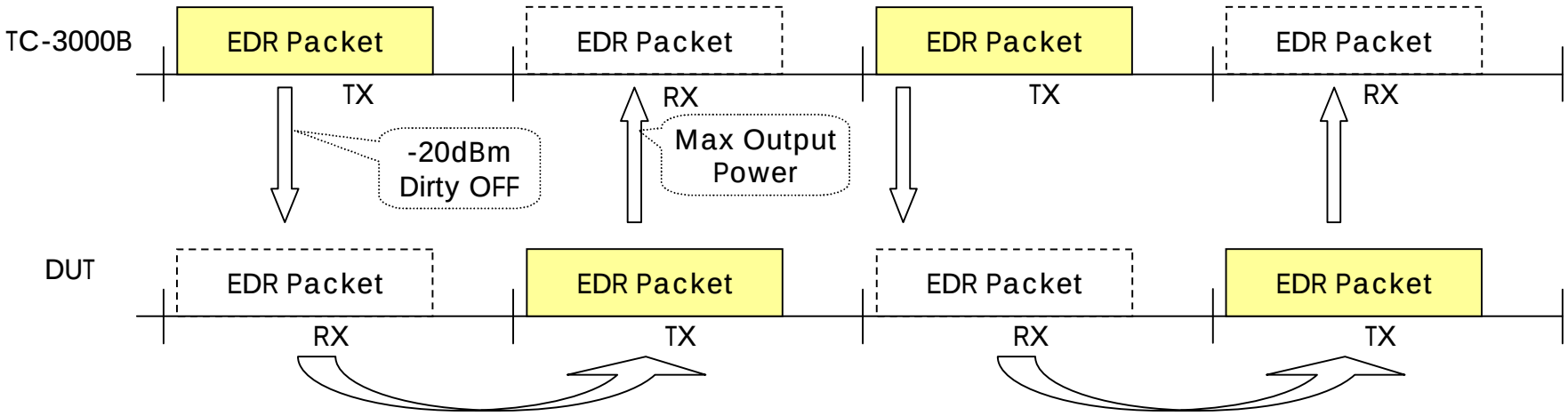
- Expected Outcome
  - BER $\leqslant 7*10^{-6}$ after 8,000,000 bits
  - BER $\leqslant 10^{-5}$ after 160,000,000 bits



EDR Maximum Input Level

- Verification of the receiver performance at the maximum specified input signal level.
- Loopback Mode Only

- Expected Outcome
  - BER ⩽ 10^{-3}



V3.0 High Speed

- 蓝牙3.0 的核心是 “Generic Alternate MAC/PHY” (AMP)，这是一种全新的交替射频技术，允许蓝牙协议栈针对任一任务动态地选择正确射频。
- 蓝牙3.0 的数据传输率提高到了大约24Mbps，是蓝牙2.0 的八倍。
- 功耗方面，通过蓝牙3.0 高速传送大量数据自然会消耗更多能量，但由于引入了增强电源控制(EPC)机制，再辅以802.11，实际空闲功耗会明显降低。
- EPC (Enhanced Power Control)

V4.0+BTLE

- 蓝牙 4.0 的标志性特色是低功耗蓝牙无线技术规范。用一粒纽扣电池可连续工作数年之久。
- 100 米以上超长距离、AES-128 加密等诸多特色。
- 可以用于计步器、心律监视器、智能仪表、传感器物联网等众多领域，大大扩展蓝牙技术的应用范围。
- BTLE (Low Energy RF Test Case) option 3000-50 需要单独订购。

蓝牙测试内容

- 射频一致性
- 协议一致性
- 音频参数

射频一致性

- SIG规范要求15项
- TC-3000C可测15项(其中3项需外界设备)
- EDR 共7项
- EPC
- BTLE
- Quick Test快速测试可用于工厂简单测试

协议一致性

- OSI协议分为7层
- TC-3000C可实时捕捉通讯命令
- 用于调试驱动程序
- 分析故障原因，保证通讯正常

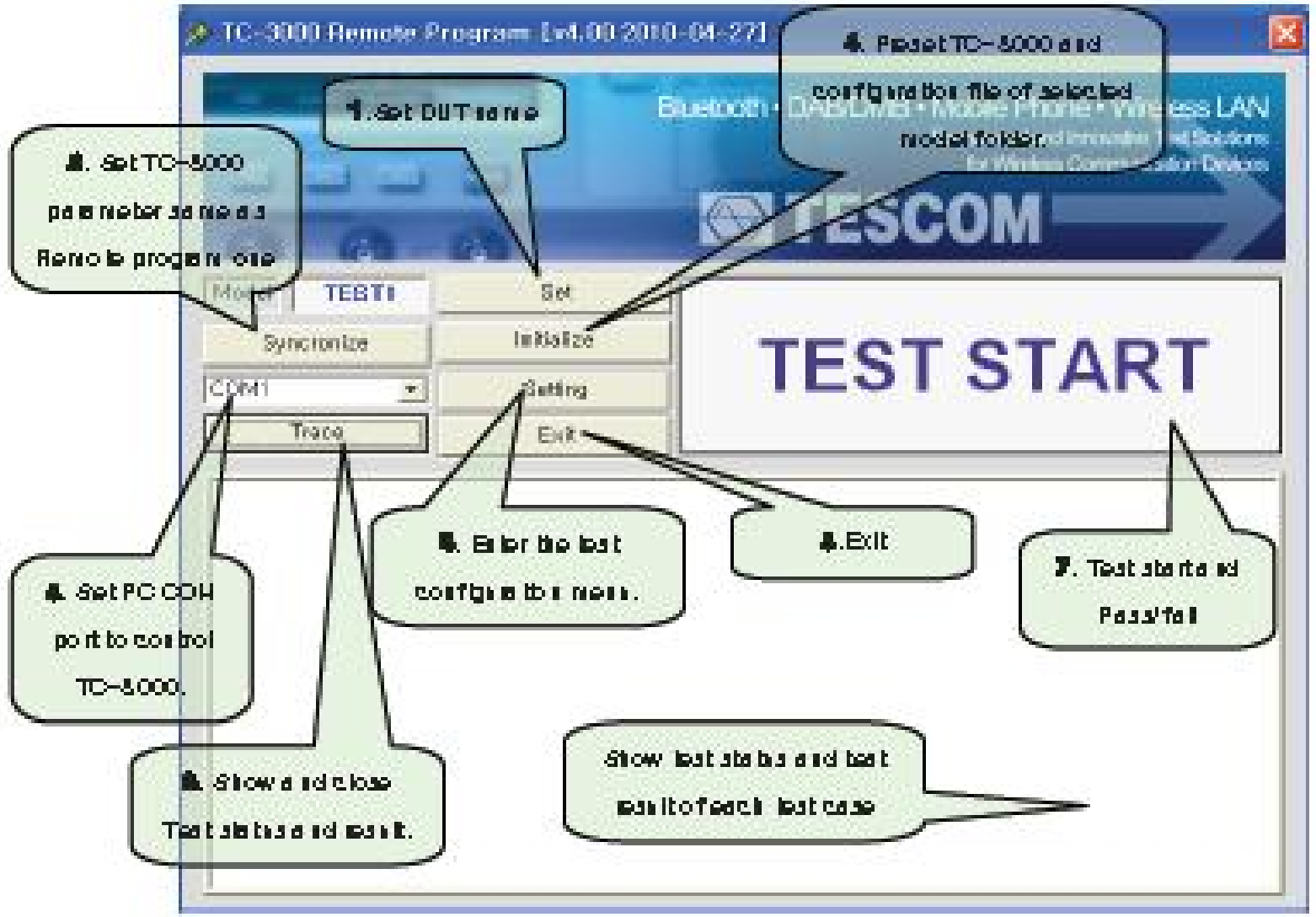
音频参数

- 音频是蓝牙的重要应用之一
- SINAD信噪失真比
- DISTN失真度

蓝牙测试环境

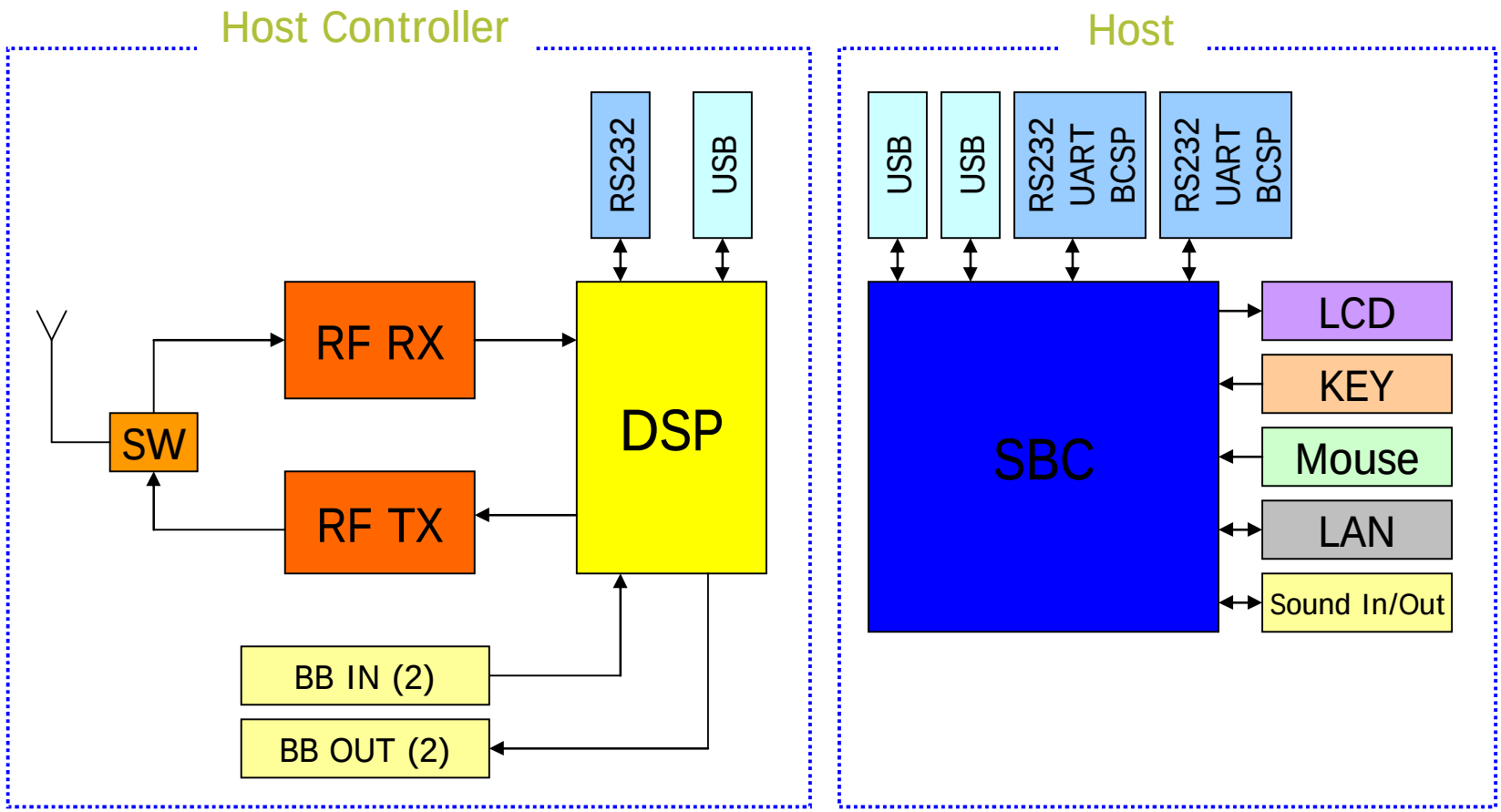
- 蓝牙测试仪
- 屏蔽箱（TEM Cell）
- 耦合器
- 由于蓝牙设备较小（无射频接口），需要耦合方式连接。
- 没有干扰的屏蔽环境才能保证测试参数的准确可靠。


BLUETOOTH TEST 3000B 蓝牙测試系统 v4.2 北京联华行科技有限公司(demo)
系统 操作 配置 查询 帮助
测试时间： 7 秒
DUT序列号：
被测机型：
testplanfull
系统信息：
系统登录成功!
系统设置保存成功!
开始定制测试!
Call TestStart End!
仪器初始化，请等待...
仪器控制出错：Error: Tester i
Timer set 0!
ResultShow!
GetPanelMenuBar!
ATTR_DIMMED!
SetActiveCtrl!
TestThread Callback !
TestThread release !
系统设置保存成功!
开始定制测试!
仪器初始化，请等待...
Call TestStart End!
DUT Name:13801236318
测试项目名称 测试结果 测试信息 发射信道 跳频模
1 输出功率 PASS PK Power:2.21; AV Power:1.72 0 OFF
2 调制特性 PASS df1_avg:159.20; df2_avg:147.80 0 OFF
3 初始载波频率容限 PASS df_min:-16.90; df_max:-16.90 0 OFF
4 载波频率漂移 PASS df_max:15.90; df_rate:-13.40 0 OFF
5 输出功率 PASS PK Power:0.06; AV Power:-0.45 39 OFF
6 调制特性 PASS df1_avg:159.50; df2_avg:147.20 39 OFF
7 初始载波频率容限 PASS df_min:-9.90; df_max:-9.90 39 OFF
8 载波频率漂移 PASS df_max:-6.60; df_rate:-8.60 39 OFF
9 输出功率 PASS PK Power:-3.39; AV Power:-3.91 78 OFF
10 调制特性 PASS df1_avg:159.80; df2_avg:144.60 78 OFF
11 初始载波频率容限 PASS df_min:-12.80; df_max:-12.80 78 OFF
12 载波频率漂移 PASS df_max:9.30; df_rate:-9.60 78 OFF
PASS!
100 %
测试情况： 6次测试 4次成功 2次失败 测试人： owner


TC-3000 Remote Program [v4.00 2010-04-27]
TESCOM
TEST START
Set
Initialize
Setting
Exit
Synchronize
Trace
COM1
1. Set DUT name
2. Set TC-3000 parameter same as Remote program value
3. Preset TC-3000 and configuration file of selected model folder.
4. Set PC COM port to control TC-3000.
5. Show and close Test status and result.
6. Enter the test configuration menu.
7. Exit
8. Test start and Pass/fail
9. Show test status and test result of each test case

TC-3000C功能简介

TC-3000C Structure

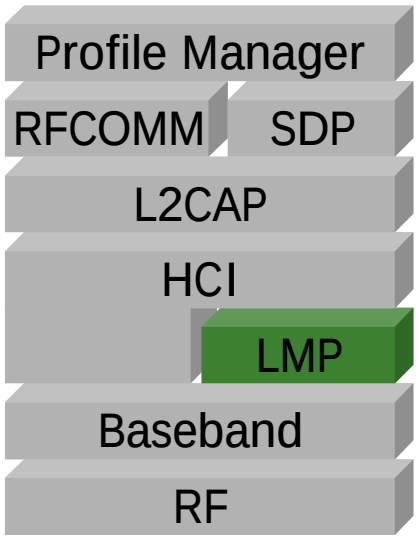


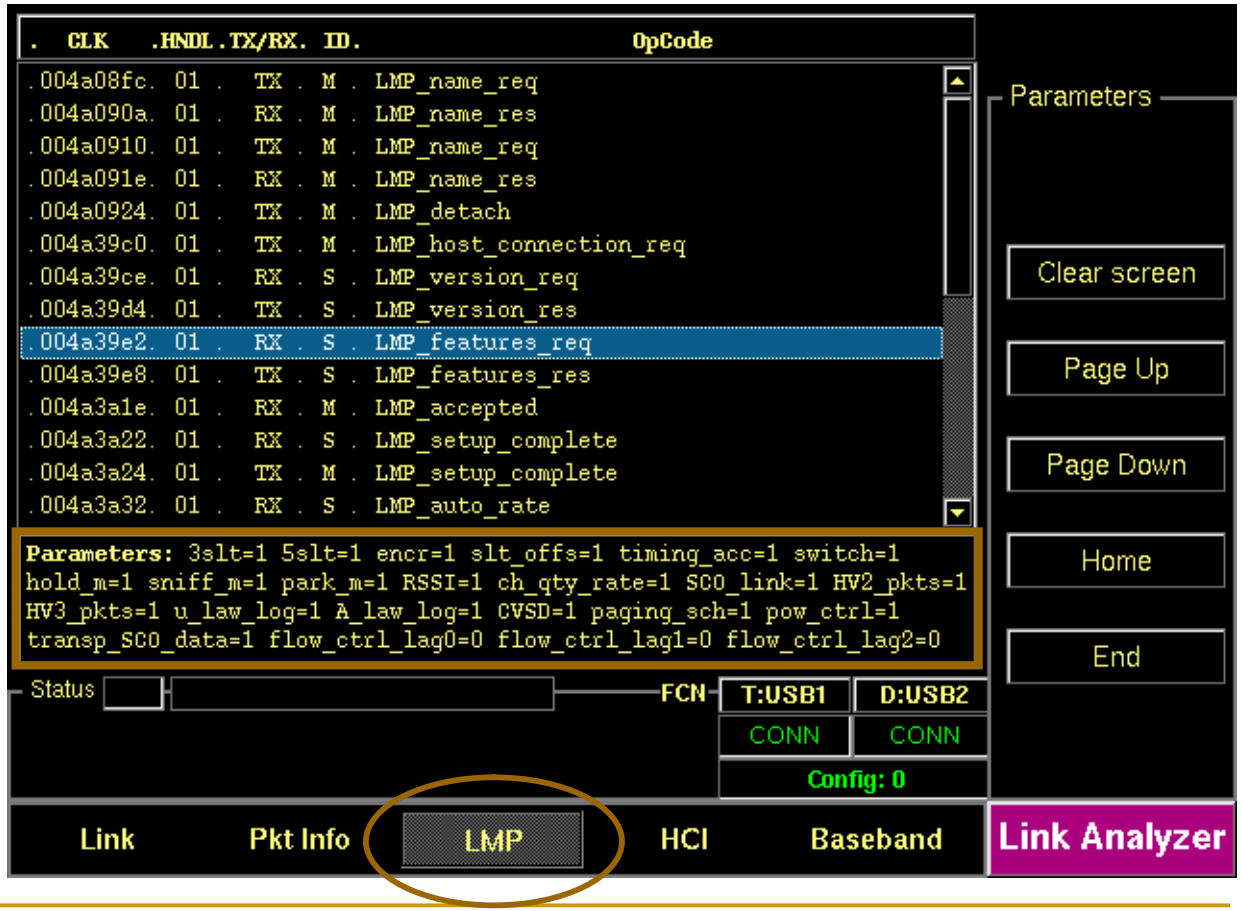
Functions

- **Link Analyzer**
  - Lower Layer Protocol Analyzer
- **Host Analyzer**
  - Upper Layer Protocol Analyzer
- **Measurements**
  - Graphical RF and Baseband Measurements
  - Bluetooth or General mode
- **Test Cases**
  - RF/Baseband Conformance Test Spec.
- **Audio**
  - Audio Quality Tests and Measurements
- **SigGen**
  - General Signal Generator @2.4GHz

LMP Messages

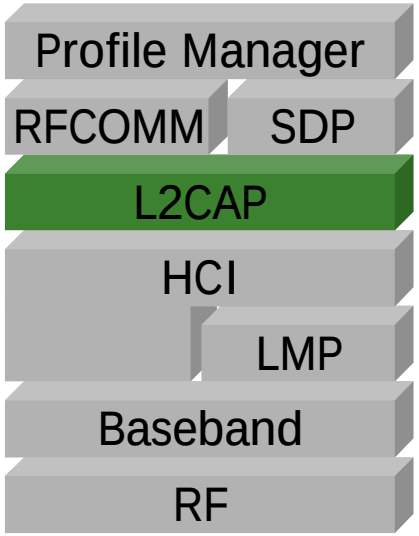
Link Analyzer - LMP





L2CAP Messages

Host Analyzer - L2CAP



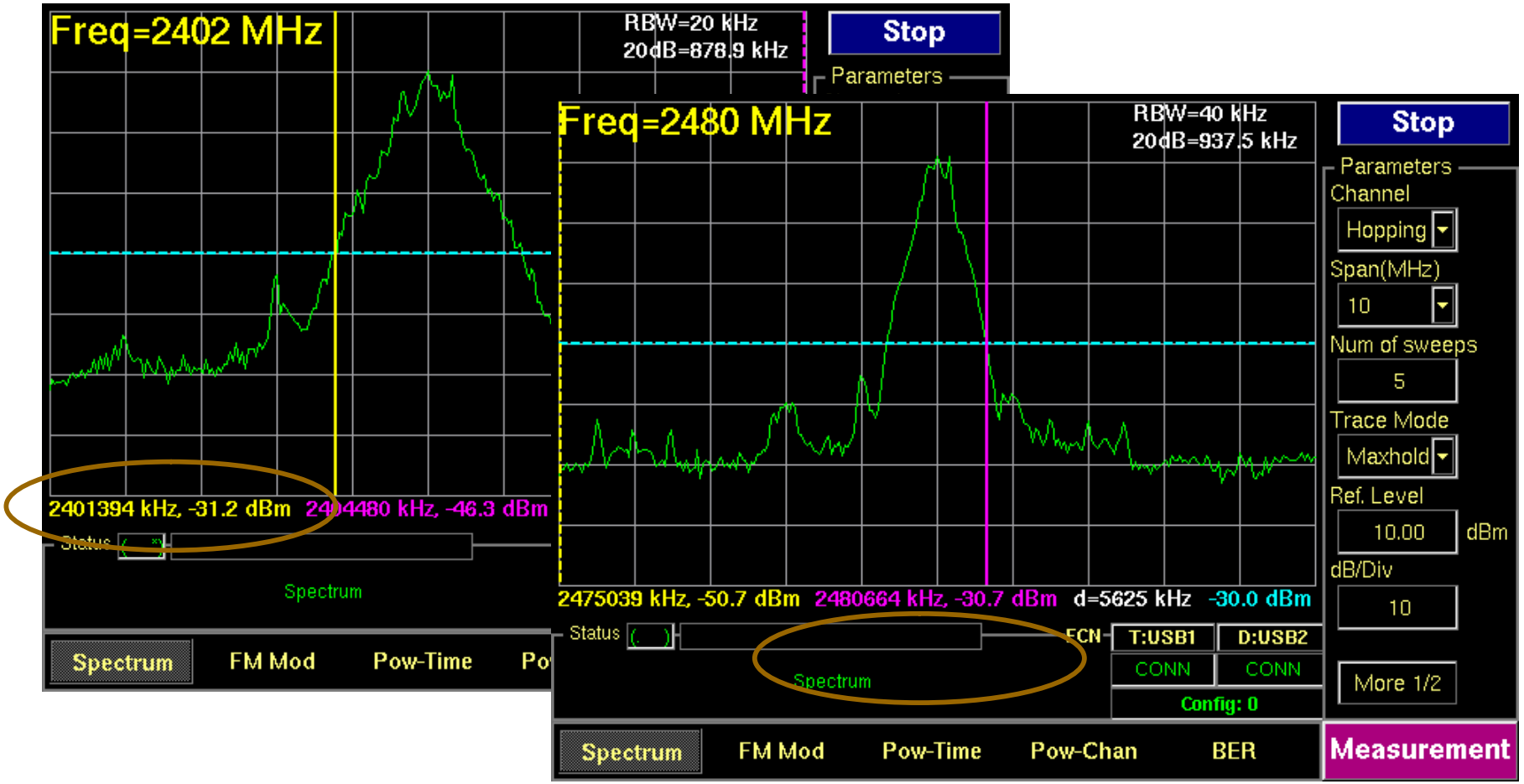
Measurement

Bluetooth RF Measurements

- **Supports 5 different measurements**
  - Spectrum, FM modulation, Power vs. Time, Power vs. Channel, Bit Error Rate (BER)
- **Provides to users the flexibility of controlling "Test Mode" parameters**
  - Transmitter/Loopback, hopping, whitening, packet type, length, bit pattern
- **Each measurement is closely related to Bluetooth Conformance Tests – *RF Test Cases***
  - If any Test Case fails, the corresponding measurement will help users to troubleshoot.

Frequency Range

Measurement - Spectrum



Test Cases

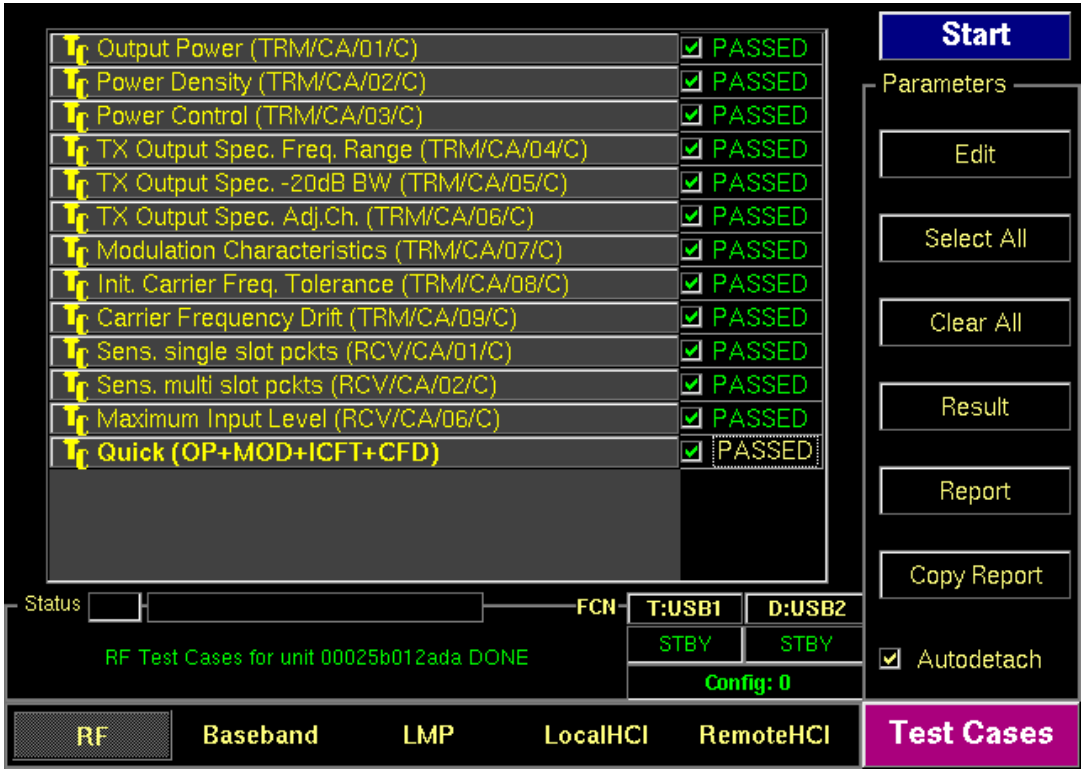
Bluetooth Conformance Test

- **Supports Bluetooth Conformance Test**
  - 12 RF Test Cases +7 EDR + Quick Test
  - 13 Baseband Test Cases
- **Provides to users the flexibility of controlling "Test Conditions" and "Test Limits"**
  - Setting 'Use Default" will follow exactly the Bluetooth Test Specification.
- **Provides HCI Loopback Test as defined in Specification: Local/Remote**
  - Remote Loopback Test will give an opportunity to test normal ACL and SCO links. (TBD)

RF Test Cases

Test Cases - RF

- **TX Tests**
  - Output Power
  - Power Density
  - Power Control
  - Spectrum–Frequency Range
  - Spectrum–20dB Bandwidth
  - Adjacent Channel Power
  - Modulation Characteristics
  - Initial Carrier Freq. Tolerance
  - Carrier Frequency Drift
- **RX Tests**
  - Sensitivity – Single slot packets
  - Sensitivity – Multi-slot packets
  - Maximum Input Level
- ***Quick Testing for 4 TX Tests – OP/MOD/ICFT/CFD***



Audio

Talk Test and Audio Measurement

- **Supports Audio Features completely**
  - Up to 3 SCO links
  - Supported Packet Type: HV1 / HV2 / HV3
  - Supported Air Coding: CVSD / u-law / A-law
- **Provides 2 different Audio Test Schemes**
  - SCO Loopback Test
  - Tone Test (Audio Measurement for 1KHz or 400Hz)
  - Audio Spectrum and Audio Sweep Test
  - For both, one-touch automatic test; no additional operation required to create connection or do something else.
- **Provides the powerful solution to test TX power and RX performance as well as Audio feature simultaneously**

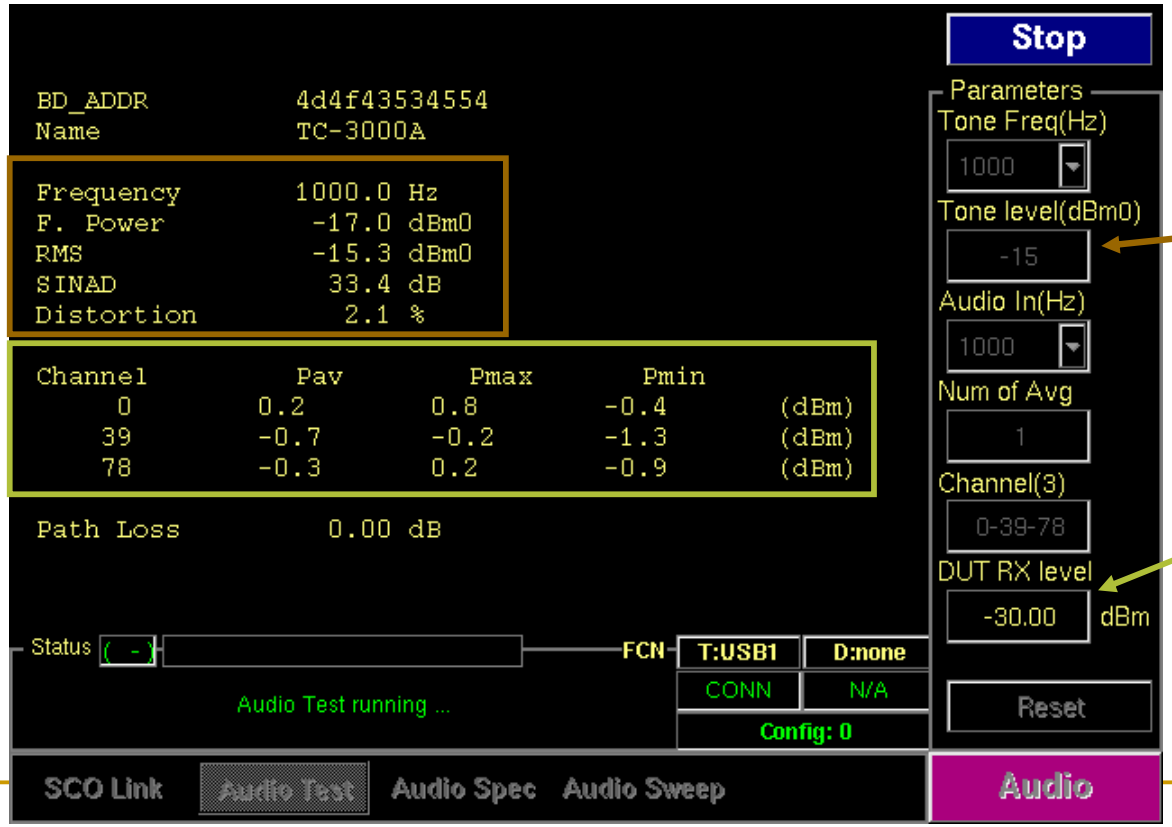
Audio Measurement (1)

Audio - Audio Test

- One-touch Automatic Test (with CVSD coded HV3 packet)

Audio Measurement results

DUT TX Power measured on three channels



User-definable tone level

DUT RX level is controllable to test DUT RX performance

总 结

- TC-3000C蓝牙综侧仪
  - 1 全部射频测试项（EDR，EPC，LE）
  - 2 频谱分析
  - 3 协议分析
  - 4 音频测试
  - 5 信号发射器
  - 6 快速测试功能（适合生产测试）
- 提供全套的测试环境
  - 1 蓝牙测试仪
  - 2 屏蔽箱，耦合器，TEM Cell
  - 3 自动测试软件

更快地分析解决调试中遇到的软硬件各种问题

典型用户

- LG
- 三星
- 大显
- 现代汽车电子
- 法国电信
- RDA芯片
- 多普达
- 龙旗研发
- 零点研发
- 歌尔电子
- 津亚电子
- 中星微

The End

中国代理商：北京联华行科技有限公司
北京朝阳区西坝河西里16号明宫A座1518
电话：010-64290135-605
手机：13801236318
Email: info@lwhtech.com
www.lwhtech.com

Thank you… J

射 频 和 天 线 设 计 培 训 课 程 推 荐

易迪拓培训(www.edatop.com)由数名来自于研发第一线的资深工程师发起成立，致力并专注于微波、射频、天线设计研发人才的培养；我们于 2006 年整合合并微波 EDA 网(www.mweda.com)，现已发展成为国内最大的微波射频和天线设计人才培养基地，成功推出多套微波射频以及天线设计经典培训课程和 ADS、HFSS 等专业软件使用培训课程，广受客户好评；并先后与人民邮电出版社、电子工业出版社合作出版了多本专业图书，帮助数万名工程师提升了专业技术能力。客户遍布中兴通讯、研通高频、埃威航电、国人通信等多家国内知名公司，以及台湾工业技术研究院、永业科技、全一电子等多家台湾地区企业。

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射频工程师养成培训课程套装

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手机天线设计培训视频课程

该套课程全面讲授了当前手机天线相关设计技术，内容涵盖了早期的外置螺旋手机天线设计，最常用的几种手机内置天线类型——如 monopole 天线、PIFA 天线、Loop 天线和 FICA 天线的设计，以及当前高端智能手机中较常用的金属边框和全金属外壳手机天线的设计；通过该套课程的学习，可以帮助您快速、全面、系统地学习、了解和掌握各种类型的手机天线设计，以及天线及其匹配电路的设计和调试...

课程网址： http://www.edatop.com/peixun/antenna/133.html

WiFi 和蓝牙天线设计培训课程

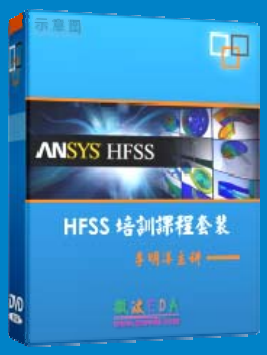
该套课程是李明洋老师应邀给惠普 (HP)公司工程师讲授的 3 天员工内训课程录像，课程内容是李明洋老师十多年工作经验积累和总结，主要讲解了 WiFi 天线设计、HFSS 天线设计软件的使用，匹配电路设计调试、矢量网络分析仪的使用操作、WiFi 射频电路和 PCB Layout 知识，以及 EMC 问题的分析解决思路等内容。对于正在从事射频设计和天线设计领域工作的您，绝对值得拥有和学习！…

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

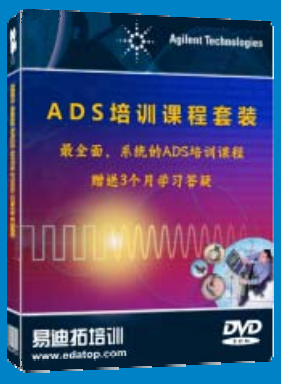


HFSS 学习培训课程套装

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

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