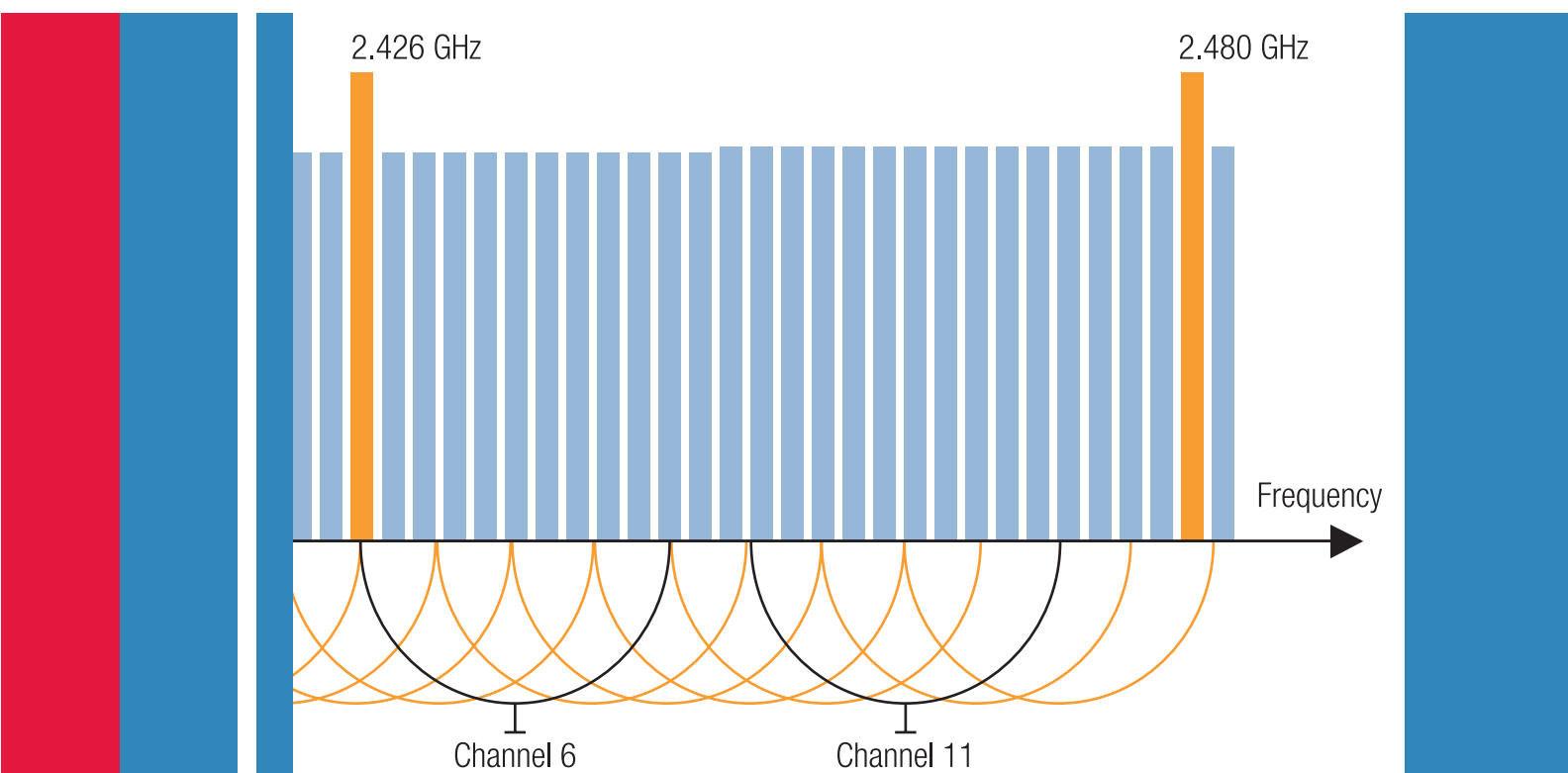


Bluetooth Physical Layer and Transmitter Measurements Poster



Bluetooth® Physical Layer and Transmitter Measurements

	Basic Data Rate		Enhanced Data Rate		Low Energy Data Rate	
	Modulation	Data Rate	Modulation	Data Rate	Modulation	Data Rate
	GFSK	1 Mb/s	$\pi/4$ -DQPSK	2 Mb/s	GFSK	1 Mb/s
			8DPSK	3 Mb/s		

Channel Allocation	Coexistence with WLAN Channels			Bluetooth Channels										Bluetooth Low Energy Channels			
	Frequency (MHz)	Channel	WLAN Channel	Frequency (MHz)	CH	Frequency (MHz)	CH	Frequency (MHz)	CH	Frequency (MHz)	CH	Frequency (MHz)	CH	Frequency (MHz)	CH		
	2402 GHz	0	802.11 Channel 1	2419 GHz	17	2436 GHz	34	2453 GHz	51	2470 GHz	68	2402 MHz	37	2430 MHz	12	2458 MHz	26
	2403 GHz	1		2420 GHz	18	2437 GHz	35	2454 GHz	52	2471 GHz	69	2404 MHz	0	2432 MHz	13	2460 MHz	27
	2404 GHz	2		2421 GHz	19	2438 GHz	36	2455 GHz	53	2472 GHz	70	2406 MHz	1	2434 MHz	14	2462 MHz	28
	2405 GHz	3		2422 GHz	20	2439 GHz	37	2456 GHz	54	2473 GHz	71	2408 MHz	2	2436 MHz	15	2464 MHz	29
	2406 GHz	4		2423 GHz	21	2440 GHz	38	2457 GHz	55	2474 GHz	72	2410 MHz	3	2438 MHz	16	2466 MHz	30
	2407 GHz	5		2424 GHz	22	2441 GHz	39	2458 GHz	56	2475 GHz	73	2412 MHz	4	2440 MHz	17	2468 MHz	31
	2408 GHz	6		2425 GHz	23	2442 GHz	40	2459 GHz	57	2476 GHz	74	2414 MHz	5	2442 MHz	18	2470 MHz	32
	2409 GHz	7		2426 GHz	24	2443 GHz	41	2460 GHz	58	2477 GHz	75	2416 MHz	6	2444 MHz	19	2472 MHz	33
	2410 GHz	8		2427 GHz	25	2444 GHz	42	2461 GHz	59	2478 GHz	76	2418 MHz	7	2446 MHz	20	2474 MHz	34
	2411 GHz	9		2428 GHz	26	2445 GHz	43	2462 GHz	60	2479 GHz	77	2420 MHz	8	2448 MHz	21	2476 MHz	35
	2412 GHz	10		2429 GHz	27	2446 GHz	44	2463 GHz	61	2480 GHz	78	2422 MHz	9	2450 MHz	22	2478 MHz	36
	2413 GHz	11		2430 GHz	28	2447 GHz	45	2464 GHz	62			2424 MHz	10	2452 MHz	23	2480 MHz	39
	2414 GHz	12		2431 GHz	29	2448 GHz	46	2465 GHz	63			2426 MHz	38	2454 MHz	24		
	2415 GHz	13		2432 GHz	30	2449 GHz	47	2466 GHz	64			2428 MHz	11	2456 MHz	25		
	2416 GHz	14		2433 GHz	31	2450 GHz	48	2467 GHz	65								
	2417 GHz	15		2434 GHz	32	2451 GHz	49	2468 GHz	66								
2418 GHz	16		2435 GHz	33	2452 GHz	50	2469 GHz	67									

Spectrum Mask and Power Spectrum	Basic Rate In-Band Emission and Adjacent Channel Power		EDR Transmitter Spectrum Mask		Low Energy In-Band Emission and Adjacent Channel Power	
		At ± 500 kHz, -20dBc		26 dB		At ± 2 MHz, -20dBm

Packet Information	Basic Rate Packet		Enhanced Data Rate Packet		Low Energy Test Packet		Low Energy Link Packet	
		72 Bit	54 Bit	72 Bit	54 Bit	8 Bit	48 Bit	8 Bit

Transmitter Measurements	Basic Data Rate			Enhanced Data Rate			Low Energy (TRM-LE)		
	Bluetooth Transmitter Test	Identifier	Bluetooth SIG Radio Frequency Test Specification Version 4.2.0	Bluetooth Transmitter Test	Identifier	Bluetooth SIG Radio Frequency Test Specification Version 4.2.0	Bluetooth Transmitter Test	Identifier	Bluetooth SIG Radio Frequency Test Specification Version 4.2.0
Output Power	TP/TRM/CA-01-C	$P_{AV} < 100$ mW (20 dBm) $P_{PK} < 200$ mW (23 dBm) Power Class 1: $P_{AV} > 1$ mW (0 dBm) Power Class 2: 0.25 mW (-6 dBm) < $P_{AV} < 2.5$ mW (4 dBm) Power Class 3: $P_{AV} < 1$ mW (0 dBm)	EDR Relative Transmit Power	TP/TRM/CA-10-C	$(P_{DPSK} - 4dB) < P_{DPSK} < (P_{DPSK} + 1dB)$; P_{DPSK} and P_{GFSK} are average power over 80% of the DPSK and GFSK portion of the packet	Output Power at NOC	TRM-LE/CA-01-C	$-20dBm \leq P_{AV} \leq +10dBm$ EIRP $P_{PK} \leq (P_{AV} + 3dBm)$	
Power Density	TP/TRM/CA-02-C	Power Density < 100 mW (20 dBm) per 100 kHz EIRP	EDR Carrier Frequency Stability and Modulation Accuracy	TP/TRM/CA-11-C	Carrier Frequency -75 kHz $\leq \omega_i \leq +75$ kHz, for all packets, ω_i is the initial packet frequency error -75 kHz $\leq (\omega_i + \omega_0) \leq +75$ kHz, for all blocks, ω_0 block frequency error -10 kHz $\leq \omega_0 \leq +10$ kHz, for all blocks	Output Power at EOC	TRM-LE/CA-02-C	$-20dBm \leq P_{AV} \leq +10dBm$ EIRP $P_{PK} \leq (P_{AV} + 3dBm)$	
Power Control	TP/TRM/CA-03-C	Step size of the power control: 2dB \geq step size \geq 8dB $P_{AV} < 4dBm$ (for Power Class 1 device)	RMS DEVM		RMS DEVM ≤ 0.20 , for all $\pi/4$ -DQPSK blocks RMS DEVM ≤ 0.13 , for all 8DPSK blocks	In-band Emissions at NOC	TRM-LE/CA-03-C	$P_{TX} \leq -20$ dBm for $(f_{TX} \pm [3 + n] \text{ MHz})$; where $n=0, 1, 2, \dots, 9$ For each operating frequency, up to three bands of 1 MHz width. Exceptions must comply with an absolute value of $P_{TX} \leq -20$ dBm.	
Tx Output Spectrum: Frequency Range	TP/TRM/CA-04-C	fL, fH: lowest and highest frequency below (or above) operating frequency at which power density drops -80dBm/Hz are within the allowed frequency band: 2.4 GHz to 2.4835 GHz	Peak DEVM		DEVM ≤ 0.35 for all $\pi/4$ -DQPSK symbols DEVM ≤ 0.25 , for all 8DPSK symbols	In-band Emissions at EOC	TRM-LE/CA-04-C	$P_{TX} \leq -20$ dBm for $(f_{TX} \pm [3 + n] \text{ MHz})$; where $n=0, 1, 2, \dots, 9$ For each operating frequency, up to three bands of 1 MHz width. Exceptions must comply with an absolute value of $P_{TX} \leq -20$ dBm.	
Tx Output Spectrum: -20 dB Bandwidth	TP/TRM/CA-05-C	fL, fH: lowest and highest frequency below (or above) operating frequency at which Tx power drops 20dB below emission peak - If the emission peak is ≥ 0 dBm: $f = fH - fL \leq 1.0$ MHz - If the emission peak is < 0 dBm: $f = fH - fL \leq 1.5$ MHz	99% DEVM		DEVM ≤ 0.30 for 99% $\pi/4$ -DQPSK symbols DEVM ≤ 0.20 , for 99% 8DPSK symbols	Modulation Characteristics	TRM-LE/CA-05-C	225 kHz $\leq \Delta f_{AVG} \leq 275$ kHz At least 99.9% of all Δf_{2MAX} frequency values recorded over 10 test packets must be greater than 185 kHz. $(\Delta f_{2MAX}) / (\Delta f_{1MAX}) \geq 0.8$	
Tx Output Spectrum Adjacent Channel Power	TP/TRM/CA-06-C	The EUT is transmitting on channel M and the adjacent channel power is measured on channel number N. - $P_{TX}(f) \leq -20$ dBm for IM-NI = 2 - $P_{TX}(f) \leq -40$ dBm for IM-NI ≥ 3 Exception: $P_{TX}(f) \leq -20$ dBm in up to three bands are allowed where IM-NI ≥ 3 .	EDR Differential Phase Encoding	TP/TRM/CA-12-C	Zero errors detected by the tester in 99% of the packets.	Carrier Frequency Offset and Drift at NOC	TRM-LE/CA-06-C	$f_{TX} - 150$ kHz $\leq f_n \leq f_{TX} + 150$ kHz where f_{TX} is the nominal transmit frequency and $n=0, 1, 2, 3, \dots, k$ $ f_0 - f_n \leq 50$ kHz where $n = 2, 3, 4, \dots, k$ $ f_0 - f_n \leq 20$ kHz and $ f_n - f_{n-1} \leq 20$ kHz, where $n = 6, 7, 8, \dots, k$ f_n is the last frequency measurement before the CRC field.	
Modulation Characteristics	TP/TRM/CA-07-C	For DM or DH packets with '00001111' 8 bit sequence, the average of all frequency deviations is: 140 kHz $\leq \Delta f_{1AVG} \leq 175$ kHz. For '01010101' 8 bit sequence, $\Delta f_{2MAX} \geq 115$ kHz for at least 99.9% of all Δf_{2MAX} . The ratio of all frequency deviations Δf_{2AVG} and Δf_{1AVG} is: $(\Delta f_{2AVG}) / (\Delta f_{1AVG}) \geq 0.8$	EDR In-band Spurious Emissions	TP/TRM/CA-13-C	PTX-26dB (f) \leq PTXref -26dB for IM-NI = 1 PTX (f) \leq -20dBm for IM-NI = 2 PTX (f) \leq -40dBm for IM-NI ≥ 3 Exception: Ptx(f) \leq -20 dBm in up to three bands are allowed where IM-NI ≥ 3 .	Carrier Frequency Offset and Drift at EOC	TRM-LE/CA-07-C	$f_{TX} - 150$ kHz $\leq f_n \leq f_{TX} + 150$ kHz where f_{TX} is the nominal transmit frequency and $n=0, 1, 2, 3, \dots, k$ $ f_0 - f_n \leq 50$ kHz where $n = 2, 3, 4, \dots, k$ $ f_0 - f_n \leq 20$ kHz and $ f_n - f_{n-1} \leq 20$ kHz, where $n = 6, 7, 8, \dots, k$ f_n is the last frequency measurement before the CRC field.	
Initial Carrier Frequency Tolerance	TP/TRM/CA-08-C	$f_0 =$ EUT's carrier frequency. $f_{TX} =$ ETU's chosen nominal carrier frequency $f_{TX} - 75$ kHz $\leq f_0 \leq f_{TX} + 75$ kHz	EDR Power Control	TP/TRM/CA-14-C	$\geq 2dB$ \leq step size $\leq 8dB$. ■ The power differences between GFSK headers of the supported modulations $\leq 10dB$. ■ For Power Class 1: $P_{AV} \leq 4dBm$ ■ The Maximum power level for each of the supported modulations measured at the start of the test is within $\pm 3dB$ of the power measured at the end of the test sequence.				
Carrier Frequency Drift	TP/TRM/CA-09-C	One Slot Packet: ± 25 kHz Three Slot Packet: ± 40 kHz Five Slot Packet: ± 40 kHz							

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