MediaTek Wireless RF Solutions

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Outline

- MTK GSM/GPRS RF HW Solution
- MT612X Functional Block and Feature
- Rx/Tx Architecture
- Hardware and Register Control
- L1 Driver Timing Control
- RF Application Schematic and Layout
- Rx/Tx Performance
- RF 2nd Source Component Qualification

- **MTK GSM/GPRS RF HW Solution**
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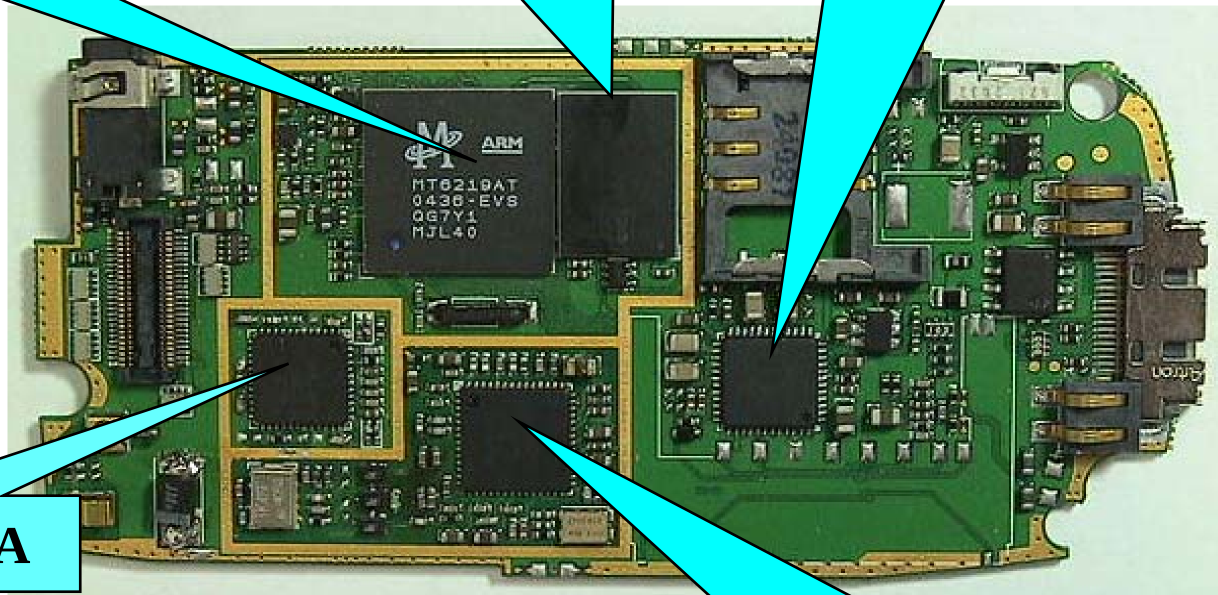
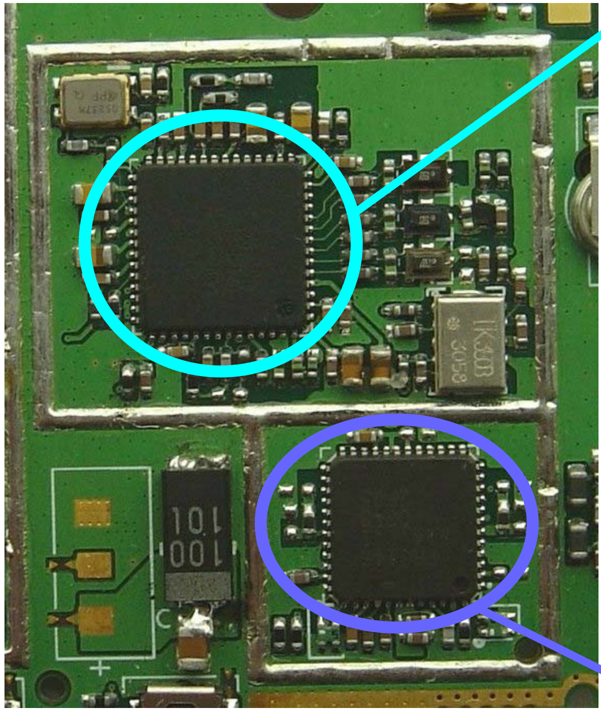
MTK GSM/GPRS RF HW Solution



MT612X GPRS Platform



MTK MT612X RF Transceiver

Low-IF Architecture
Integrated TXVCO, RF VCO
Integrated TXLPF, SXLPF(need one external capacitor)
Internal Regulators
Triple band LNAs(MT6120 Quad-band), Mixers, Frequency Synthesizer, etc
QFN56 with 8mm*8mm
Area: 425mm^2

PA Module
7mmx7mm Size
Quad-band PA & Controller
Area: 170mm^2

BOM:
R: 12, C: 33, L: 9, VCTCXO: 1, TRSW:1, SAW: 3, PA: 1, TRX: 1

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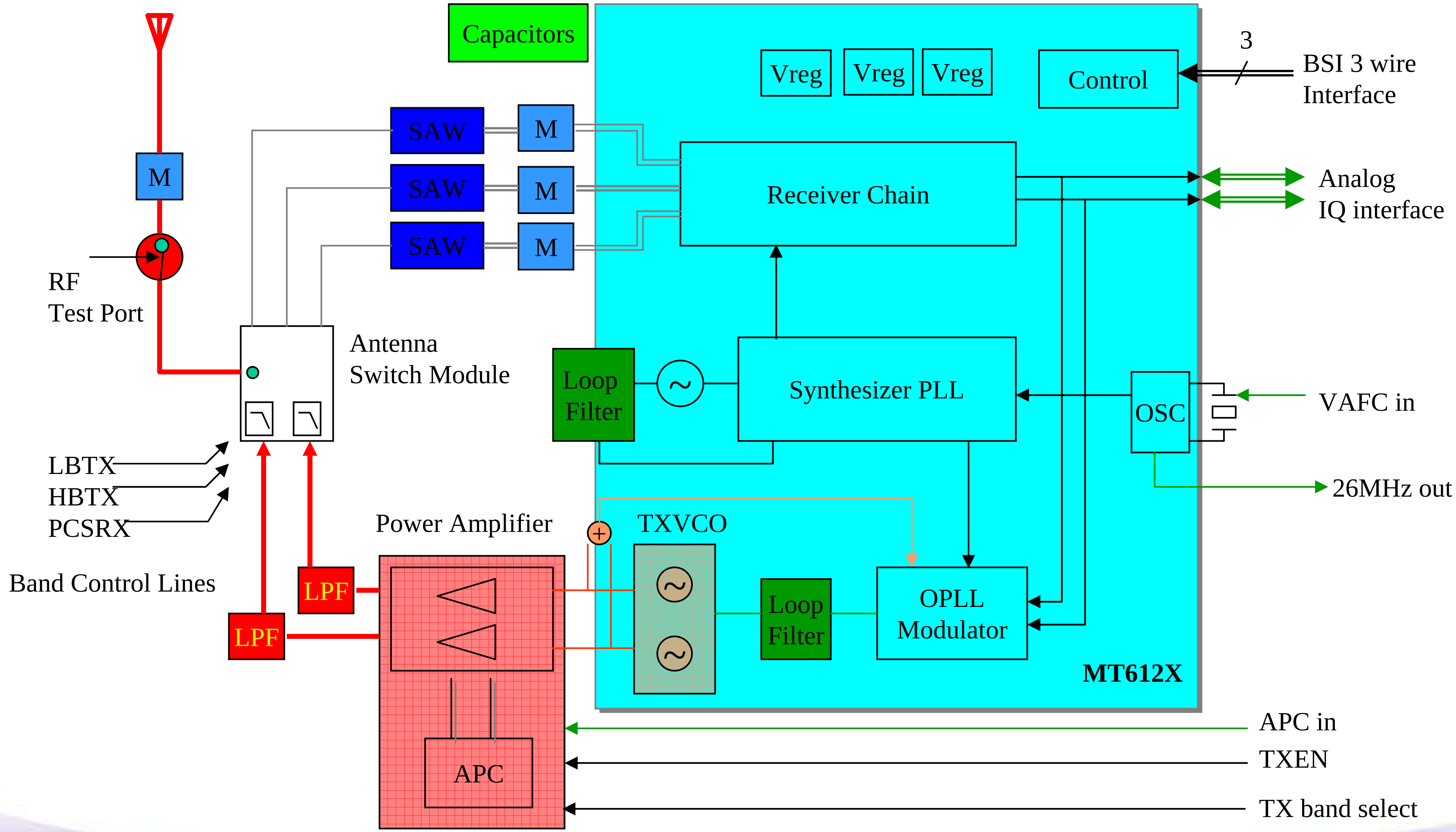
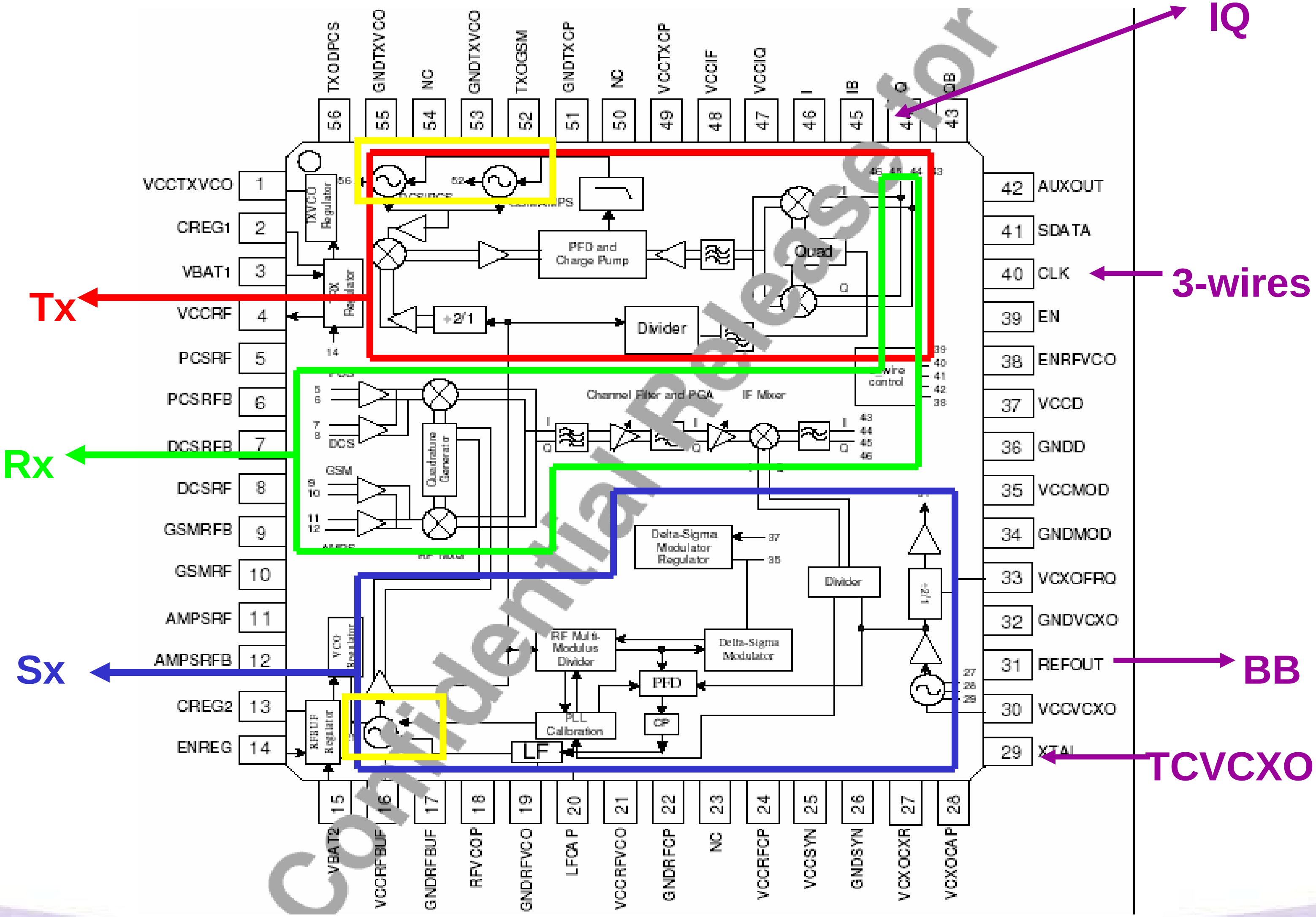
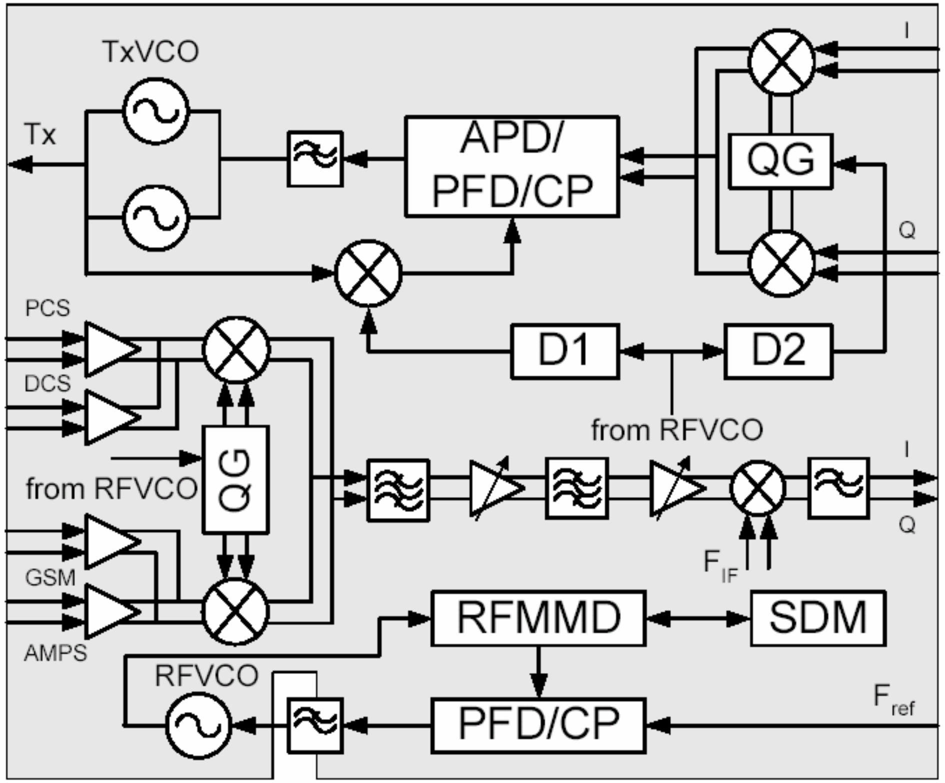
MT612X Radio Transceiver Block Diagram

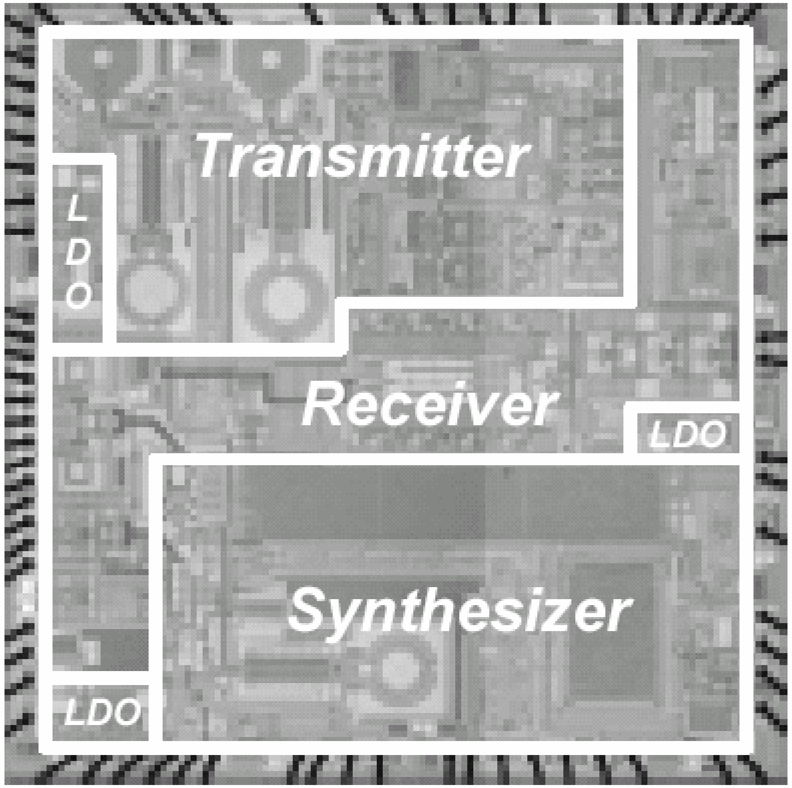


MT612X Functional Block – 1



MT612X Functional Block – 2





Feature Summary - Receiver

- Receiver
  - Very low IF architecture (No DC offset cancellation and calibration needed. Improves AM suppression and blocking rejection)
  - Quad band differential input LNA's for 850, 900, 1800, 1900MHz application (8 pins)
  - Fully integrated channel filter, no extra components required
  - Maximum more than 100dB gain with 78dB gain control range
  - Fast settling time of gain setting to support class12 (4Down/4Up/5sum)
  - Image-reject mixers and filters to eliminate interference
  - Analog IQ base-band output without external frequency conversion components

Feature Summary - Transmitter / Synthesizer

- **Transmitter**
  - Hi-precision IQ modulator
  - Translation Loop OPLL with SPURIOUS FREE Rx bands noise.
  - Fully integrated TXVCO (128 sub-band to cover process and temperature variation)
  - Fully integrated TXLPF
  - Support Quad-bands operation (850, 900, 1800, 1900)
- **Frequency synthesizer**
  - Single integrated, fully programmable fractional-N synthesizer
  - Fully integrated wideband RF VCO : 1.7(850Rx) ~ 2.15(PCSTx)GHz
  - Integrated 4 components of LPF (need one external cap. 1.5nF)
  - Fast settling time suitable for multi-slot GPRS application – Class 12. (4Rx or 4Tx)

Feature Summary - Aux. Part

- **Build in low noise 3 Low-DropOuts for RF. No external regulator needed for transceiver.**
- **Multiplexed IQ interface with baseband. – Reduced hardwire number**
- **Fully 3-wire control interface with simplified control registers, no try and error is needed.**
- **QFN (Quad-Flat Non-lead) package 56 pins**
- **Low Power consumption**
  - **RX mode : 68mA (29mA without Synthesizer and RFVCO)**
  - **TX mode : 120mA (77mA without TxVCO)**
  - **Sleep mode : 10uA**
- **Clock reference output : 26MHz / 13MHz**
- **0.35um BiCMOS process**

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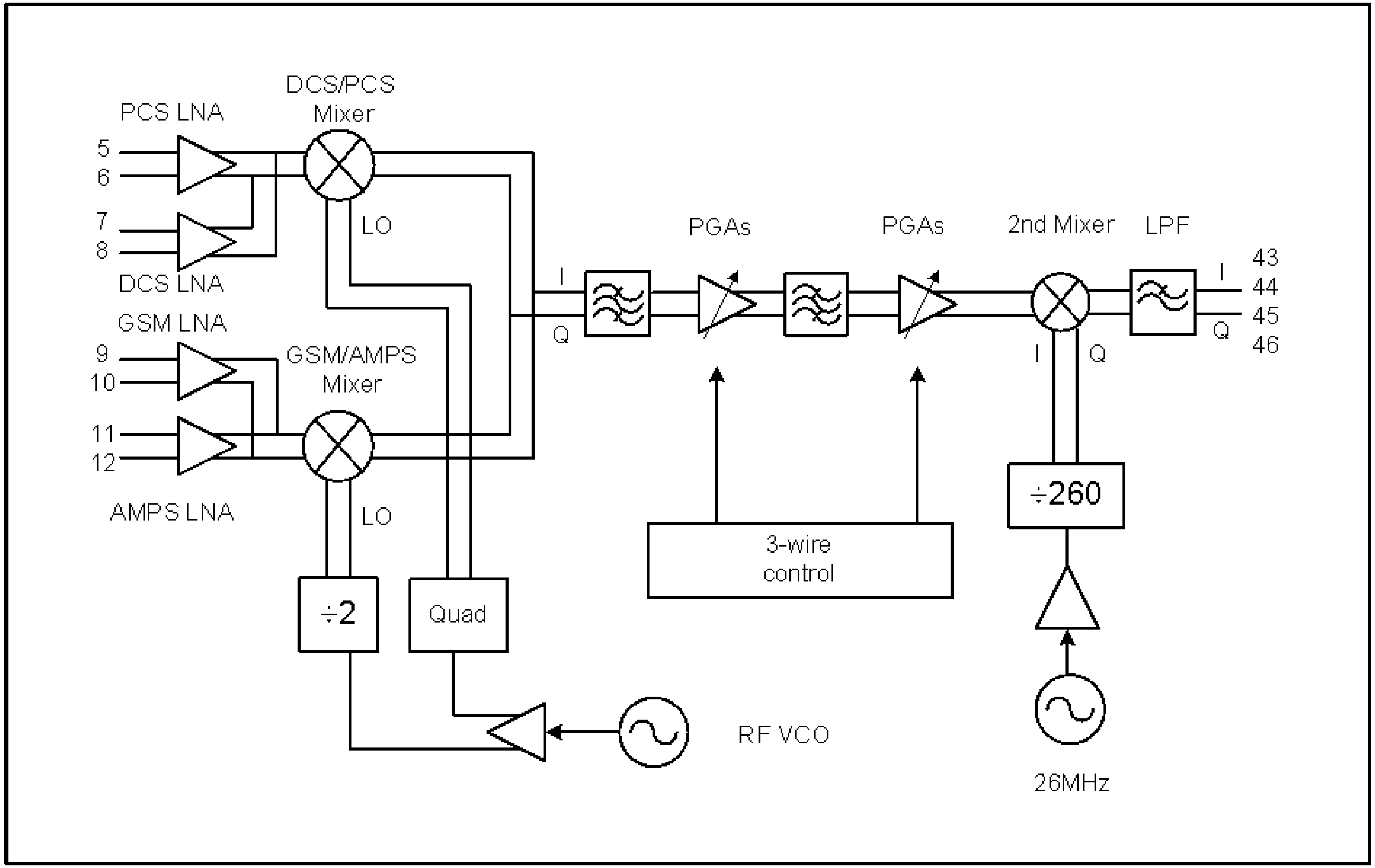
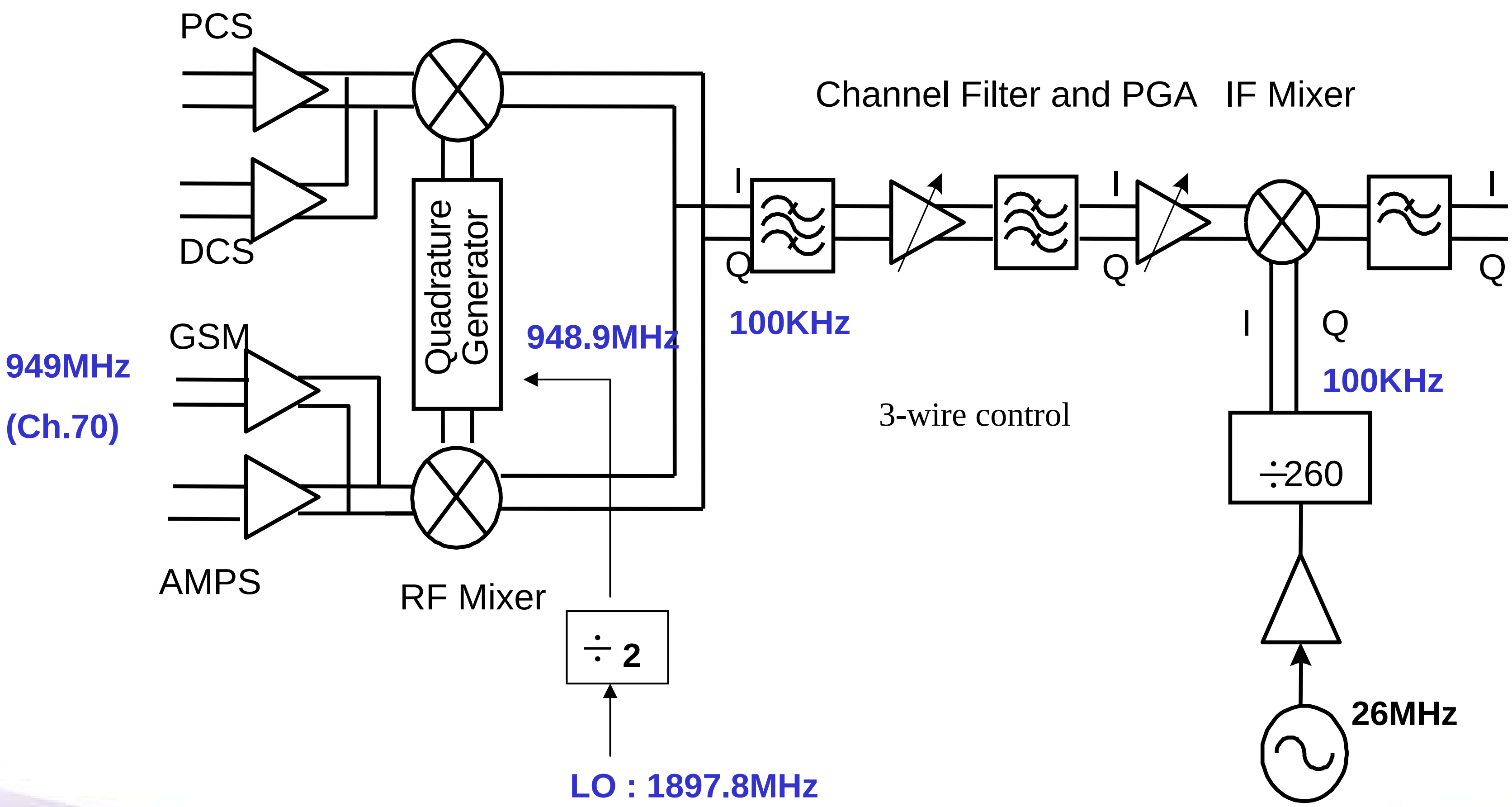
Receiver – Very Low IF Architecture

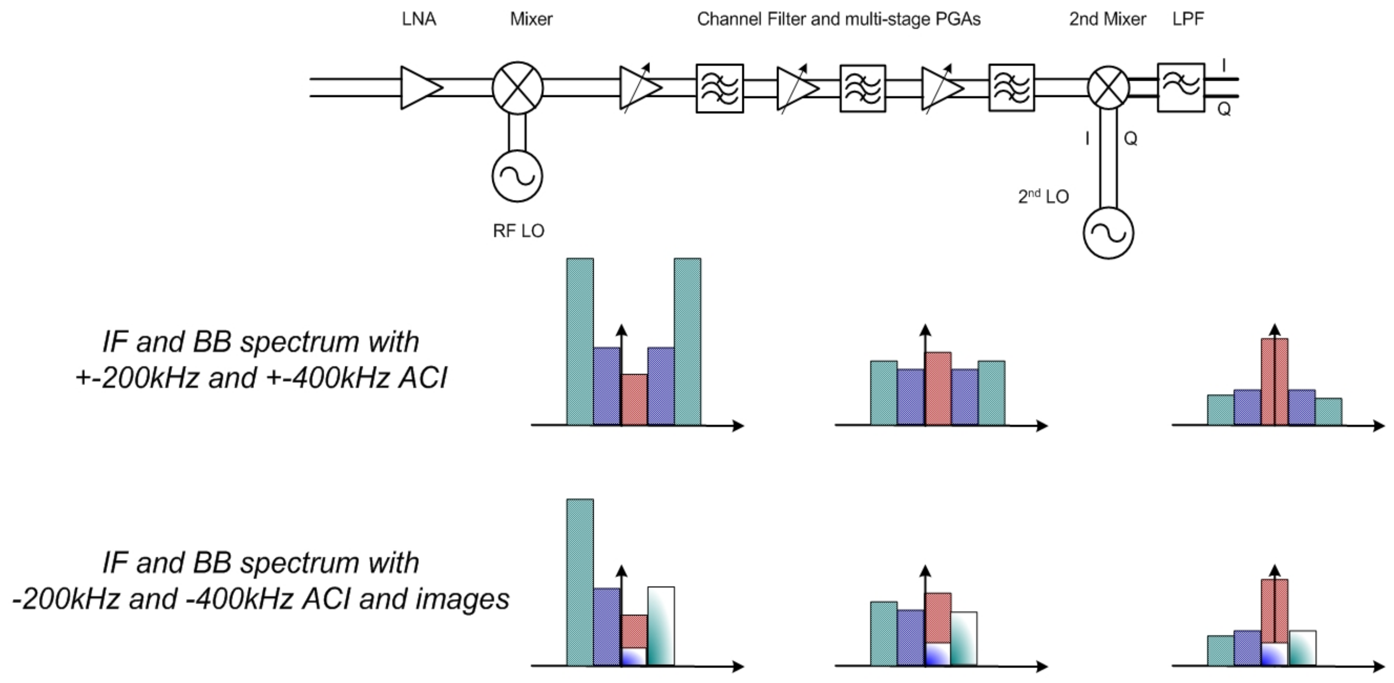


Receiver – GSM Band Example

MT612X Receiver Block Diagram



Low-IF Receiver vs. Image Rejection – 1



MT6119 Receiving spectrum with interferences and images

Low-IF Receiver vs. Image Rejection – 2

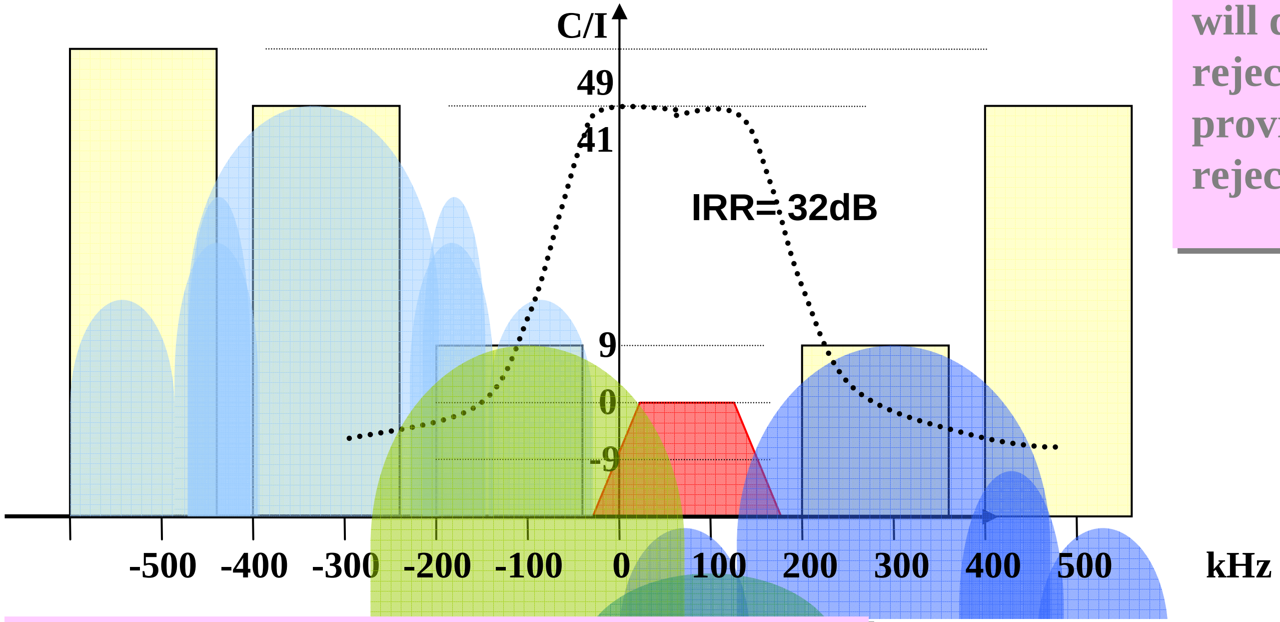


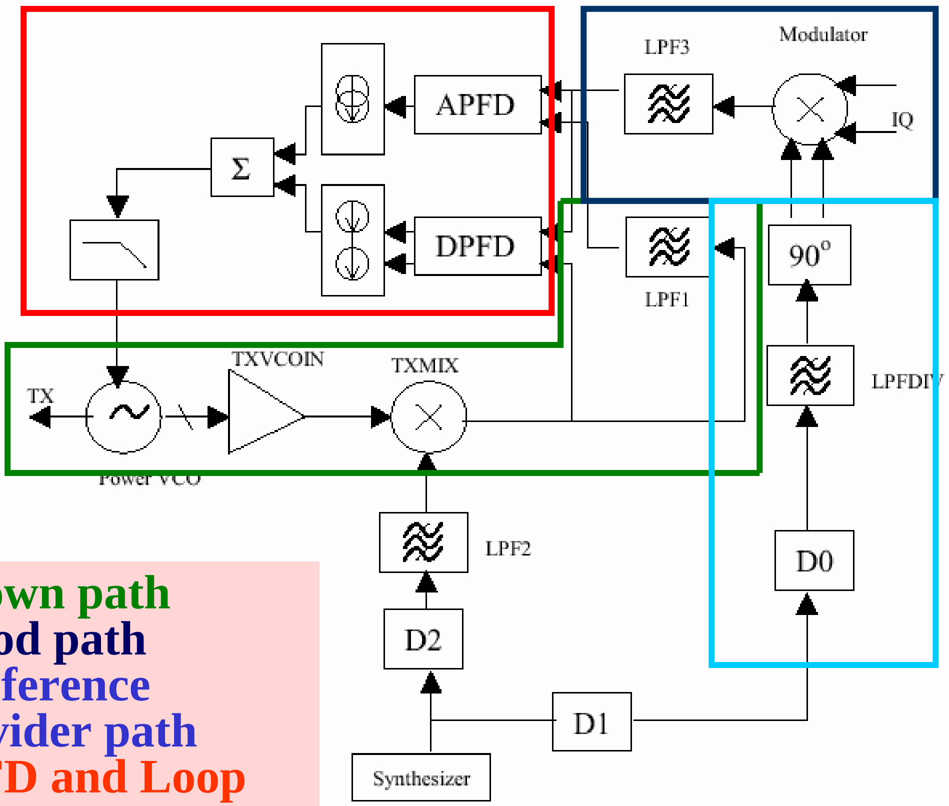
Image Rejection in low IF receiver will dominate the adjacent channel rejection performance. MT6129 provides good enough image rejection figure, IRR > 34dBc

Channel Filter Rejection

Offset	Rejection
+/- 200KHz	17dB
+/- 400KHz	40dB
+/-600KHz	62dB
+/-1.6MHz	80dB
+/- 3MHz	>100dB

High rejection channel filter design will prevent the saturation by interference Signal. DSP set point for analog baseband output can then be increased and down-fading margin is also increased.

Transmitter – OPLL Architecture



- Down path
- Mod path
- Reference divider path
- PFD and Loop filter

GSM/DCS/PCS Band

GSM: D0=÷2, D2=÷2

DCS/PCS: D0=÷1, D2=÷1

GSM/DCS/PCS D1 Selection

1. GSM

(1). D1=÷9 : Frequency Resolution=50kHz

$$\frac{LO}{2}-TX=\frac{1}{18}LO \Rightarrow TX=\frac{8}{18}LO \Rightarrow LO=\frac{9}{4}TX$$

(2). D1=÷11 : Frequency Resolution=40kHz

$$\frac{LO}{2}-TX=\frac{1}{22}LO \Rightarrow TX=\frac{10}{22}LO \Rightarrow LO=\frac{11}{5}TX$$

2. DCS/PCS

(1). D1=÷9 : Frequency Resolution=25kHz

$$LO-TX=\frac{1}{9}LO \Rightarrow TX=\frac{8}{9}LO \Rightarrow LO=\frac{9}{8}TX$$

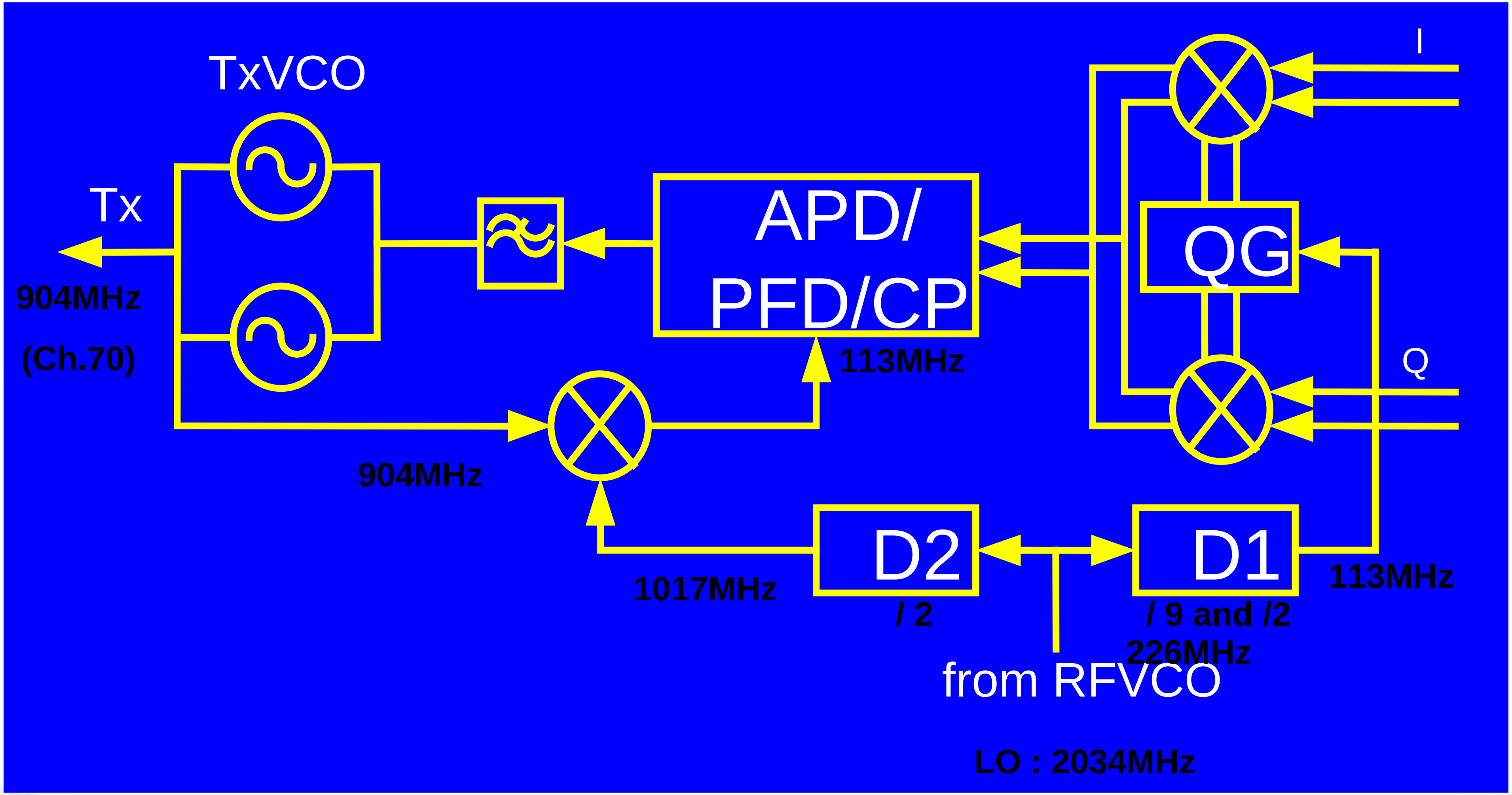
(2). D1=÷11 : Frequency Resolution=20kHz

$$LO-TX=\frac{1}{11}LO \Rightarrow TX=\frac{10}{11}LO \Rightarrow LO=\frac{11}{10}TX$$

=> All Frequency Resolution=5kHz

=> LO Change Frequency can shift 40~50MHz with D1=÷9 and D1=÷11 on the same TX

Transmitter – GSM Band Example



Tx Frequency Plan

- **Divider 11 is first priority**
- **IF fractional-N synthesizer fraction number < 400 (2MHz) , than it will change divider from divider 11 to divider 9**

	Divider Priority			Lo frequency range
	D0	D1	D2	MHz
GSM	2	11 or 9	2	1936.44 ~ 2012.56
DCS	1	11 or 9	1	1881.22 ~ 1963.28
PCS	1	11 or 9	1	2035.22 ~ 2100.78

Example: GSM band

ARFCN Range	TX Frequency (MHz)	TXDIV9_11	LO Formula	LO Frequency
LO Frequency = 2 x (TX Frequency) x TXDIV / (TXDIV – 1)				
975 ~ 1001	880.2 ~ 885.4	1 "/11"	2 x FTX x 11/10	
1002 ~ 1010	885.6 ~ 887.2	0 "/9"	2 x FTX x 9/8	
1011 ~ 1023	887.4 ~ 897.2	1 "/11"	2 x FTX x 11/10	
0 ~ 36	897.4 ~ 899	1 "/11"	2 x FTX x 11/10	
37 ~ 45	899.2 ~ 909	0 "/9"	2 x FTX x 9/8	
46 ~ 95	909.2 ~ 910.8	1 "/11"	2 x FTX x 11/10	
96 ~ 104	910 ~ 910.8	0 "/9"	2 x FTX x 9/8	
105 ~ 124	911~ 914.8	1 "/11"	2 x FTX x 11/10	

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Hardware Control Pin Description

Name	Setting	Description
ENREG	0	Power off Regulator1 and 2
	1	Power on Regulator 1 and 2
ENRFVCO	0	Power off RFVCO
	1	Power on RFVCO
VCXOCXR	0	Select internal VCXO
	1	Select external TCVCXO Note: Connect to VCCVCXO
VCXOFRQ	0	Reference output buffer 13 MHz
	1	Reference output buffer 26 MHz Note: Connect to VCCVCXO

3-Wire Control Word – CW0 & CW1

DATA BITS																	ADDRESS BITS			
D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	A3	A2	A1	A0
POR	TXOPG[1:0]		GPO	VCO SEL	REGT[1:0]		AFC[4:0]					FLT0	DIEN	SYN PW	SYNCP[1:0]		0	0	0	0

Name	Setting	Description
POR	0 (default)	No software Power-On-Reset
	1	Software Power-On-Reset action

DATA BITS																				ADDRESS BITS			
D19	D18	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	A3	A2	A1	A0
TRX	N_INT[5:0]						N_FRA[12:0]													0	0	0	1

Name	Setting	Description
TRX	0 (default)	Turn on receiver VCO buffers
	1	Turn on transmitter VCO buffers

Synthesizer Frequency Programming for Rx Mode

The frequency range of the RF synthesizer for Rx mode is

GSM900	1850 MHz ~ 1920 MHz
DCS1800	1805 MHz ~ 1880 MHz
PCS1900	1930 MHz ~ 1990 MHz.

The divider number N can be decided by the following procedure.

1. Calculate LO frequency f_{VCO} from Rx channel frequency f_{CH}
   $f_{VCO} = 2 * f_{CH} – 200k$ for GSM900
   $f_{VCO} = f_{CH} – 100k$ for DCS1800 and PCS1900
2. Calculate N_{int} and N_{frac}
   $N = 64 + N_{int} + N_{frac}/5200 = f_{VCO}/26M$ N_{int} and N_{frac} are integers
   $0 \le N_{frac} < 5200$
3. Use the binary equivalents of N_{int} and N_{frac} to program registers CW1-N_INT and CW1-N_FRA.

Example for Rx Mode

Example :

If the Rx channel frequency f_{CH} is 947.4 MHz, the divider number N can be decided by the following procedure.

1. Calculate LO frequency f_{VCO} from Rx channel frequency f_{CH} .

   This is a GSM900 Rx channel frequency. The calculation of LO frequency is as following.

   $f_{VCO} = 2 * f_{CH} – 200k$

   $= 2 * 947.4M – 200k$

   $= 1894.6M (Hz)$

2. Calculate N_{int} and N_{frac}

   $N = 64 + N_{int} + N_{frac}/5200 = f_{VCO}/26M$

   $64 + N_{int} + N_{frac}/5200 = 1894.6M/26M$

   Solving the upper equation, we can get the N_{int} is 8 and N_{frac} is 4520.

3. Use the binary equivalents of N_{int} and N_{frac} to program registers CW1-N_INT and CW1-N_FRA.

   The CW1-N_INT[5:0] = [001000] and CW1-N_FRA[12:0] = [1000110101000].

Synthesizer Frequency Programming for Tx Mode

The frequency range of the RF synthesizer for Tx mode is

GSM900	1936 MHz ~ 2059 MHz
DCS1800	1881 MHz ~ 2008 MHz
PCS1900	2035 MHz ~ 2149 MHz

And the divider number N can be decided by the following procedure.

1. Set the divider ratio D1 of Tx reference divider = 11
2. Calculate LO frequency f_{VCO} from Tx channel frequency f_{CH}

   $f_{VCO} = 2 * D1 * f_{CH} / (D1-1)$ for GSM900

   $f_{VCO} = D1 * f_{CH} / (D1-1)$ for DCS1800 and PCS1900
3. Calculate N_{int} and N_{frac}

   $N = 64 + N_{int} + N_{frac}/5200 = f_{VCO}/26M$ N_{int} and N_{frac} are integers

   $0 \le N_{frac} < 5200$
4. If $N_{fra} < 400$ or $N_{fra} > 4800$, re-set D1 = 9 and repeat Step 2 and 3 to get new N_{int} and N_{frac}.
5. Use the binary equivalents of N_{int} and N_{frac} to program registers CW1:N_INT and CW1:N_FRA.

Example for Tx Mode

Example :

If the Tx channel frequency f_{CH} is 891 MHz, the divider number N can be decided by the following procedure.

1. Set the divider ratio D1 of Tx reference divider = 11

2. Calculate LO frequency f_{VCO} from Tx channel frequency f_{CH}

   This is a GSM900 Tx channel frequency. The calculation of LO frequency is as following.

   $f_{VCO} = 2 * D1 * f_{CH} / (D1-1)$ for GSM900

   $= 2 * 11 * 891M / (11-1)$

   $= 1960.2M$ (Hz)

3. Calculate N_{int} and N_{frac}

   $N = 64 + N_{int} + N_{frac}/5200 = f_{VCO}/26M$

   $64 + N_{int} + N_{frac}/5200 = 1960.2M/26M$

   Solving the upper equation, we can get the N_{int} is 11 and N_{frac} is 2040.

4. If $N_{fra} < 400$ or $N_{fra} > 4800$, re-set D1 = 9 and repeat Step 2 and 3 to get new N_{int} and N_{frac}.

   The $N_{fra} = 2040$. So we don't need to calculate the new N_{int} and N_{frac}.

5. Use the binary equivalents of N_{int} and N_{frac} to program registers CW1-N_INT and CW1-N_FRA.
   The CW1-N_INT[5:0] = [001011] and CW1-N_FRA[12:0] = [0011111111000].

3-Wire Control Word – CW2

DATA BITS																			ADDRESS BITS			
D18	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	A3	A2	A1	A0
PGAI[1:0]		PGAT[3:2]		PGAT[1:0]		TXDIV9_11	MODE[2:0]			BAND[1:0]		PGA[5:0]						LNAGAIN	0	0	1	0

Name	Setting	Description
TXDIV9_11	0 (default)	Reference divider divide by 9
	1	Reference divider divide by 11

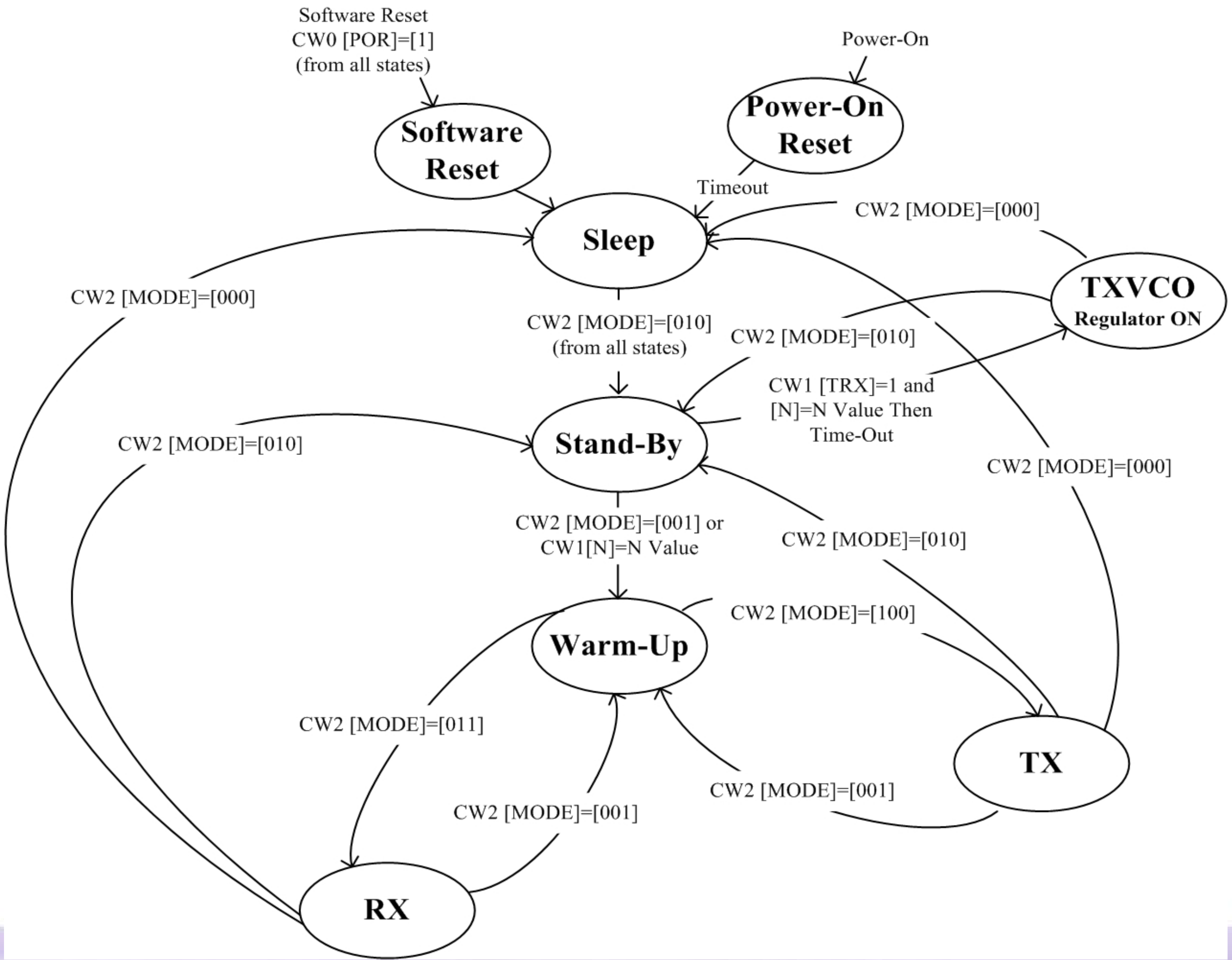
Name	Setting	Description
MODE[2:0]	[0 0 0](default)	Sleep mode
	[0 1 0]	Stand-by mode
	[0 0 1]	Warm-up mode
	[0 1 1]	Receive (Rx) mode
	[1 0 0]	Transmit (Tx) mode
	[1 0 1]	Reserved
	[1 1 0]	Reserved
	[1 1 1]	Reserved

Name	Setting	Description
BAND[1:0]	[0 0]	Reserved
	[0 1] (Default)	GSM band
	[1 0]	DCS band
	[1 1]	PCS band

Name	Setting	Description
LNAGAIN	0	Low gain
	1 (default)	High gain

GainPGA = (1-PGA[5 :5]_setting) * 18 + (PGA[4 :0]_setting) * 2 (dB)

Control State Diagram



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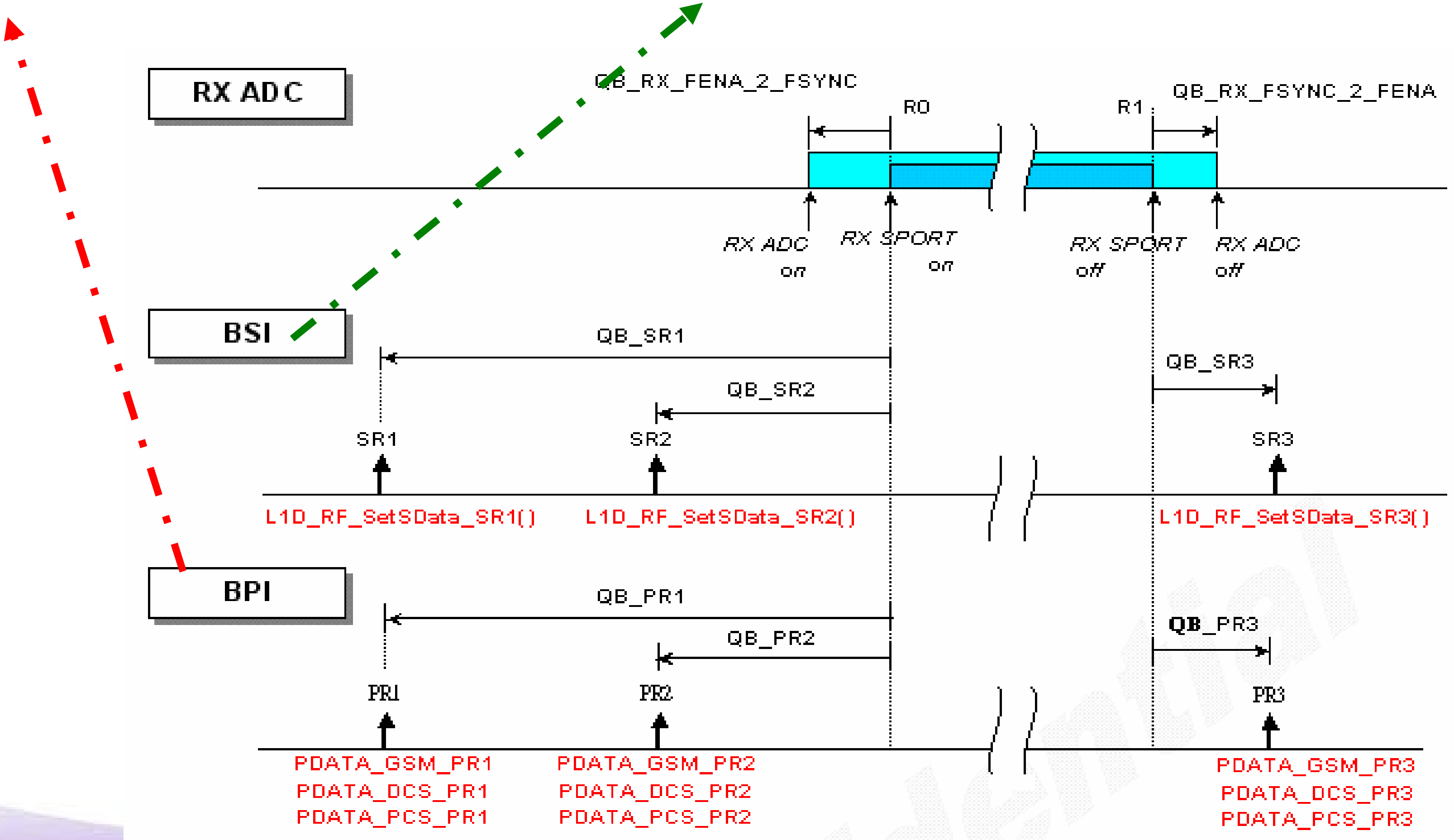
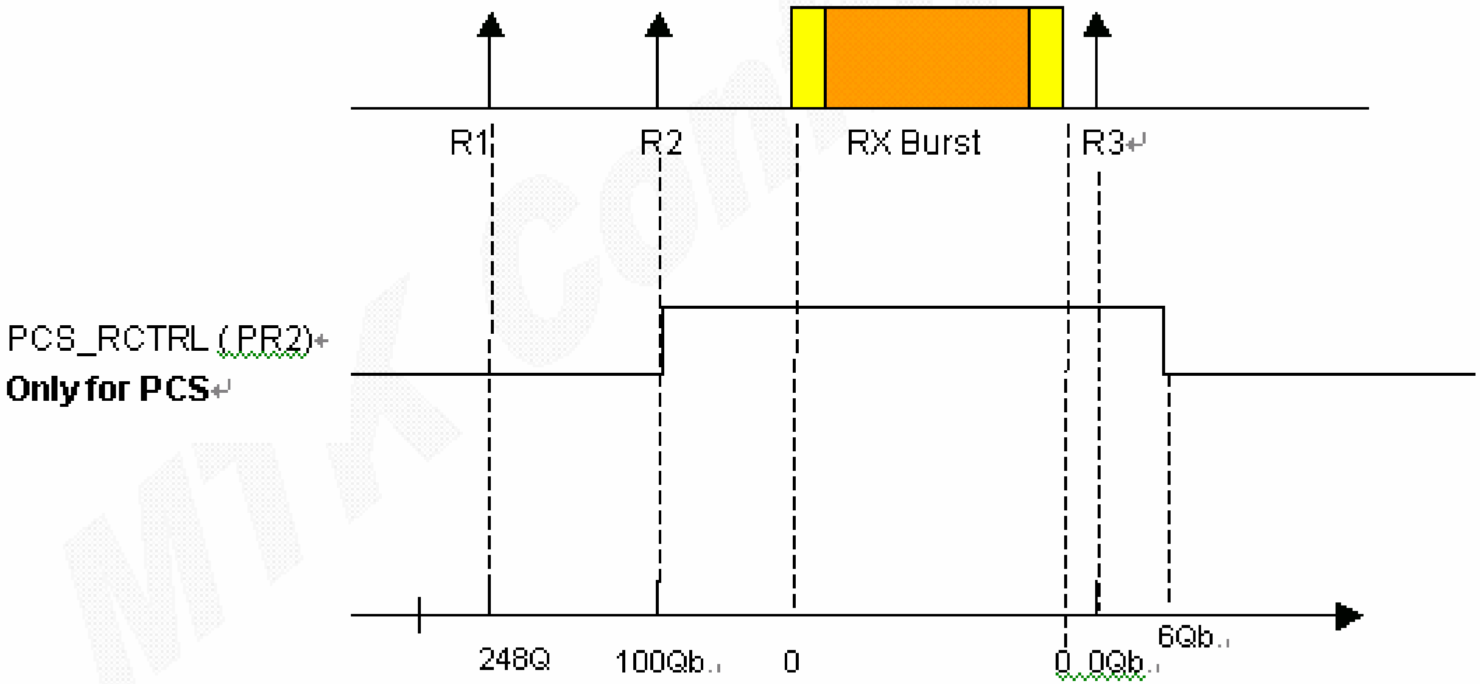
Timing Definition for Rx Window

PR1 : disable
PR2 : Set TRSW Mode (Rx mode)

SR1 : Set PLL frequency (TRx warm-up)
SR2 : Set TRx RX Mode, gain setting



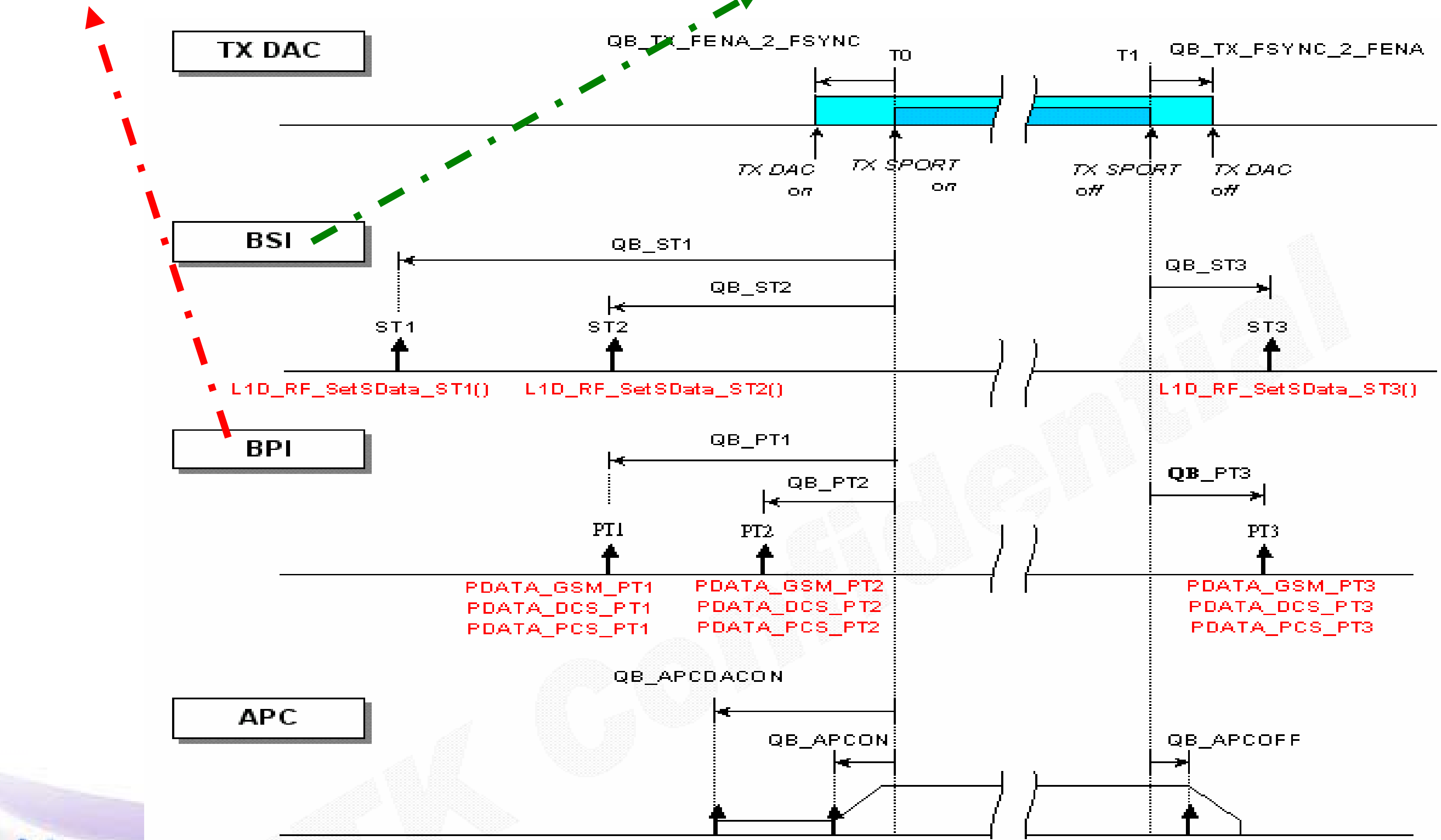
Rx Timing – GSM example (ASM)



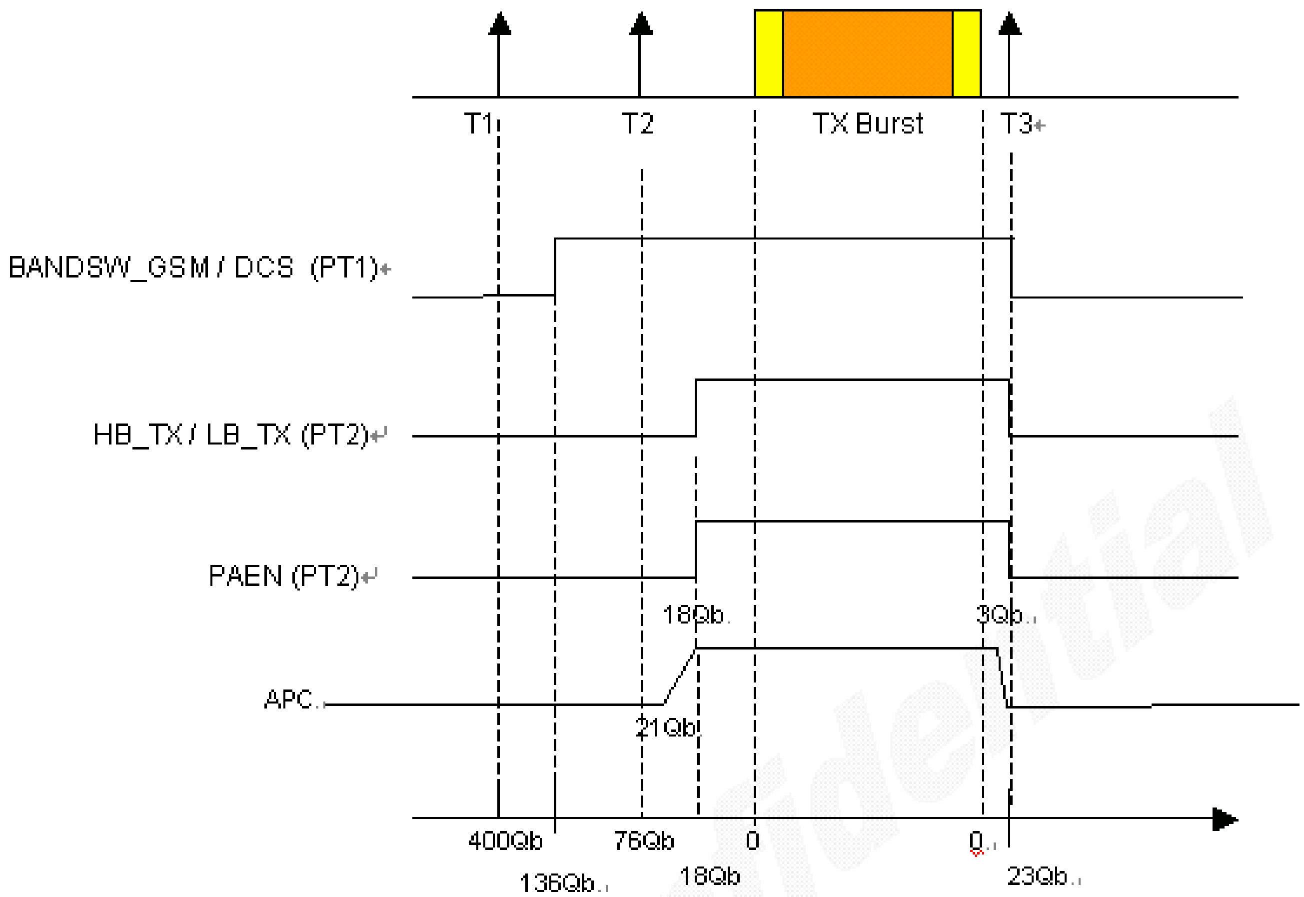
Timing Definition for Tx Window

PT1 : Set PA Band Selection
PT2 : Set TRSW Mode, PA Enable

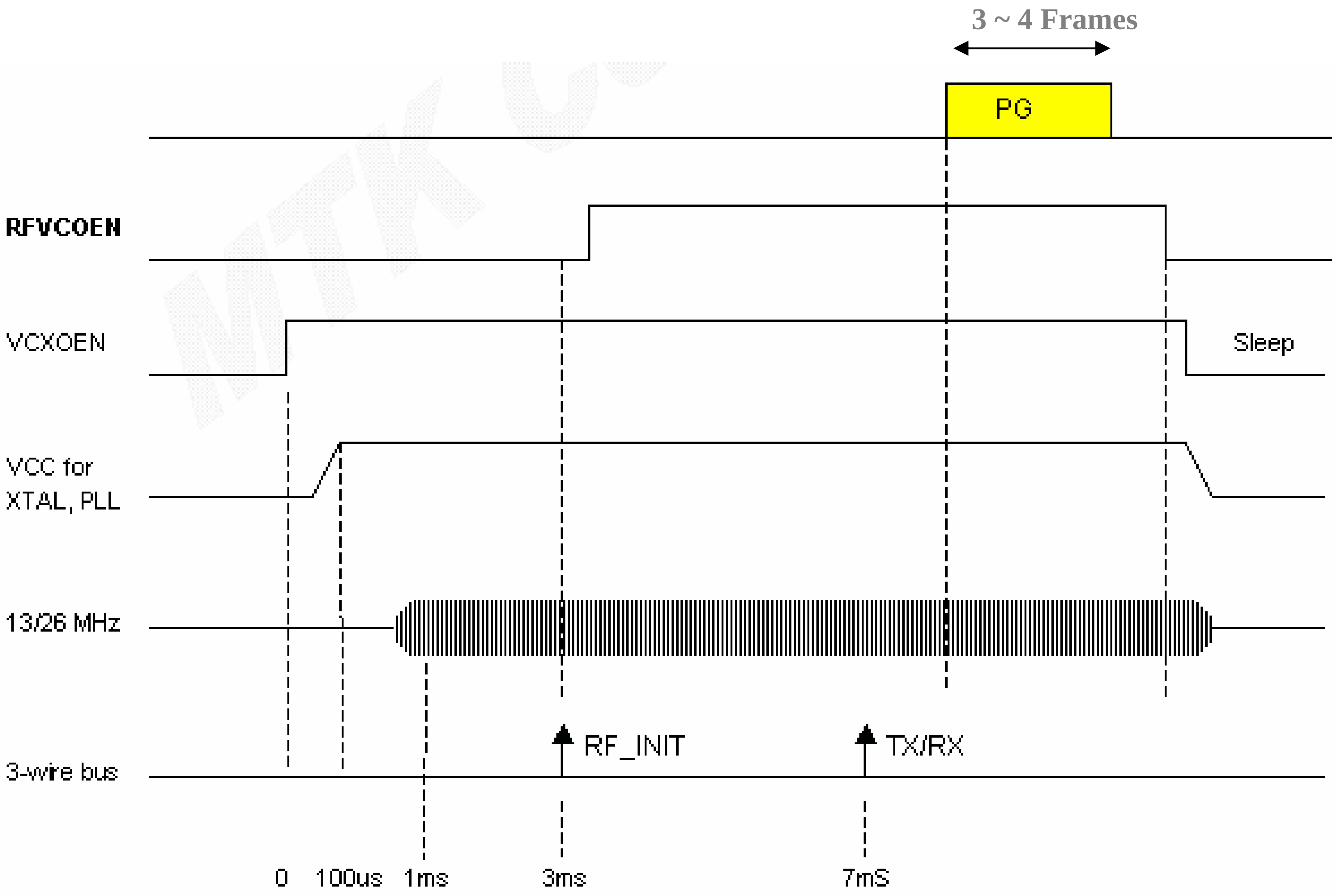
ST1 : Set PLL frequency (TRx warm-up)
ST2 : Set TRx TX Mode, Enable TXVCO



Tx Timing – GSM Example (PA3146 + ASM)



Low Power Timing



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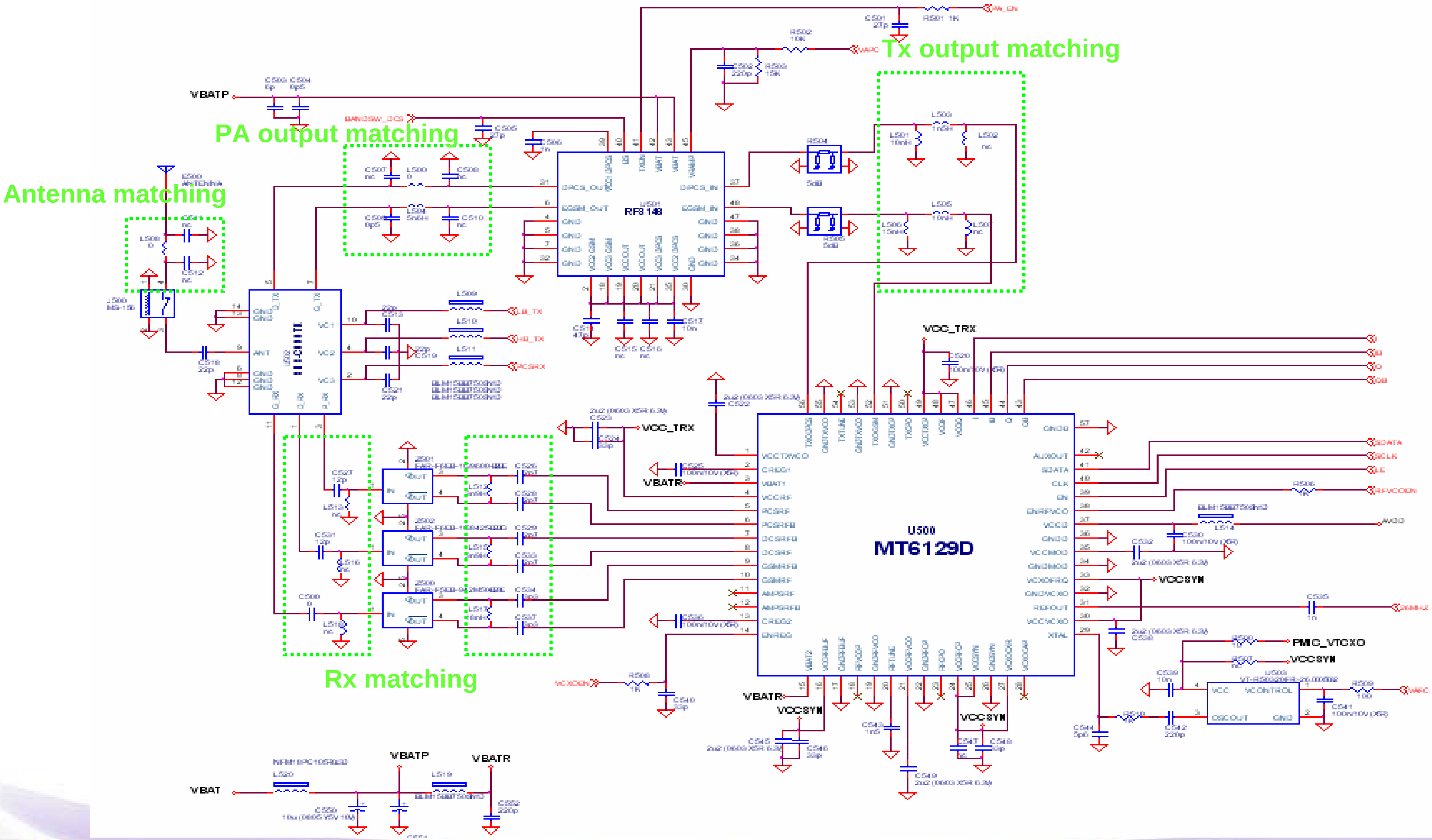
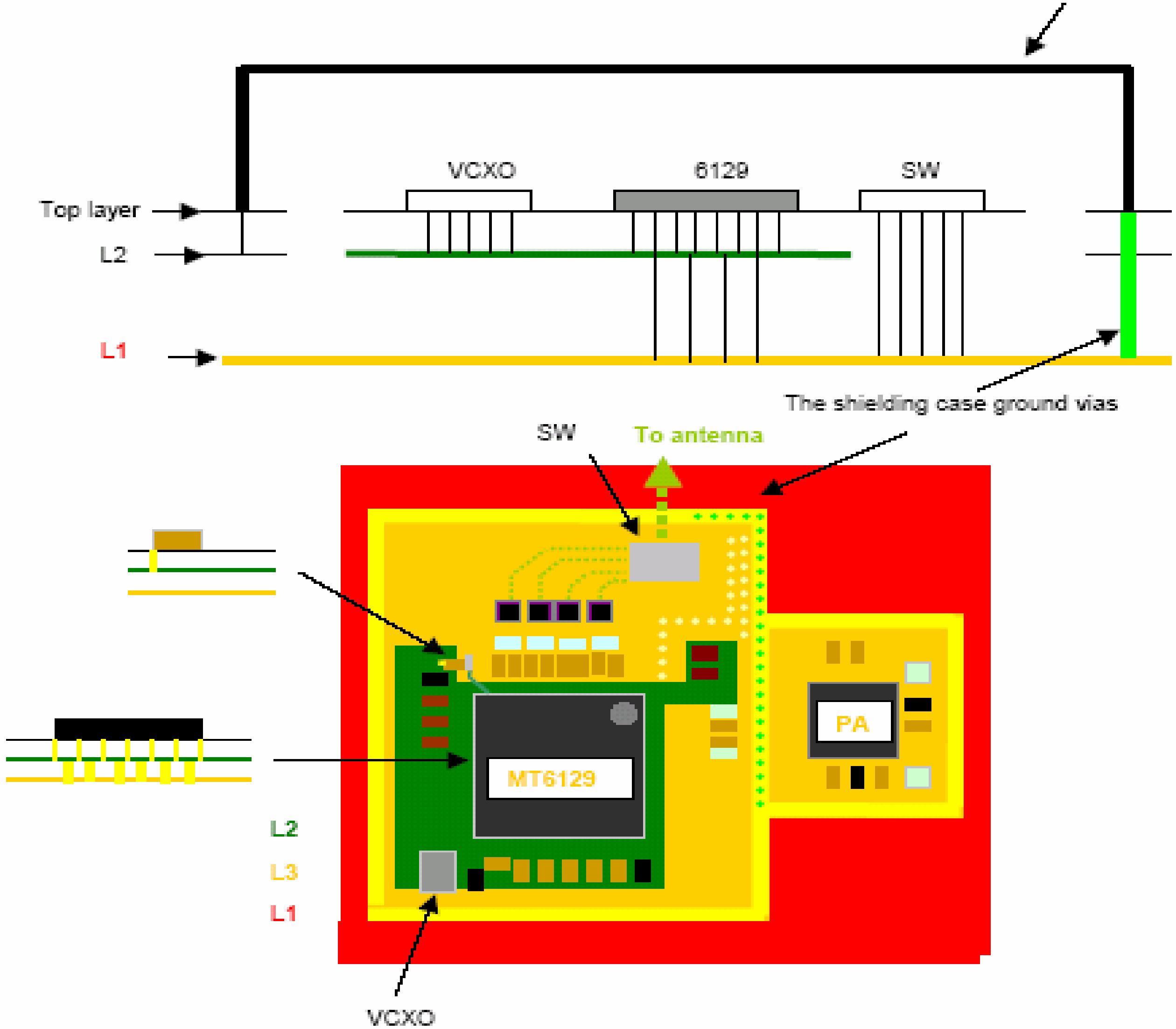
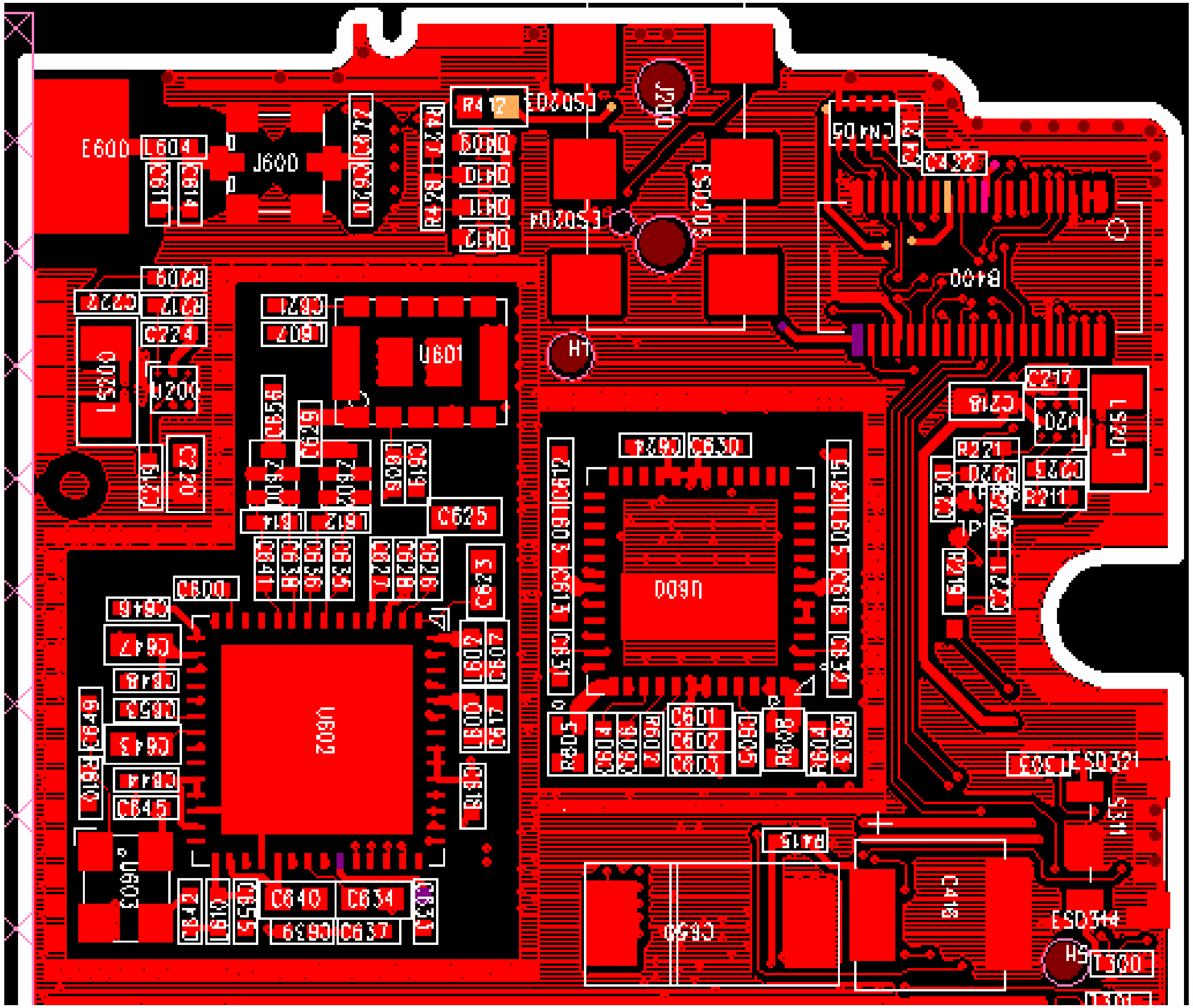
MT612X RF Application Schematic



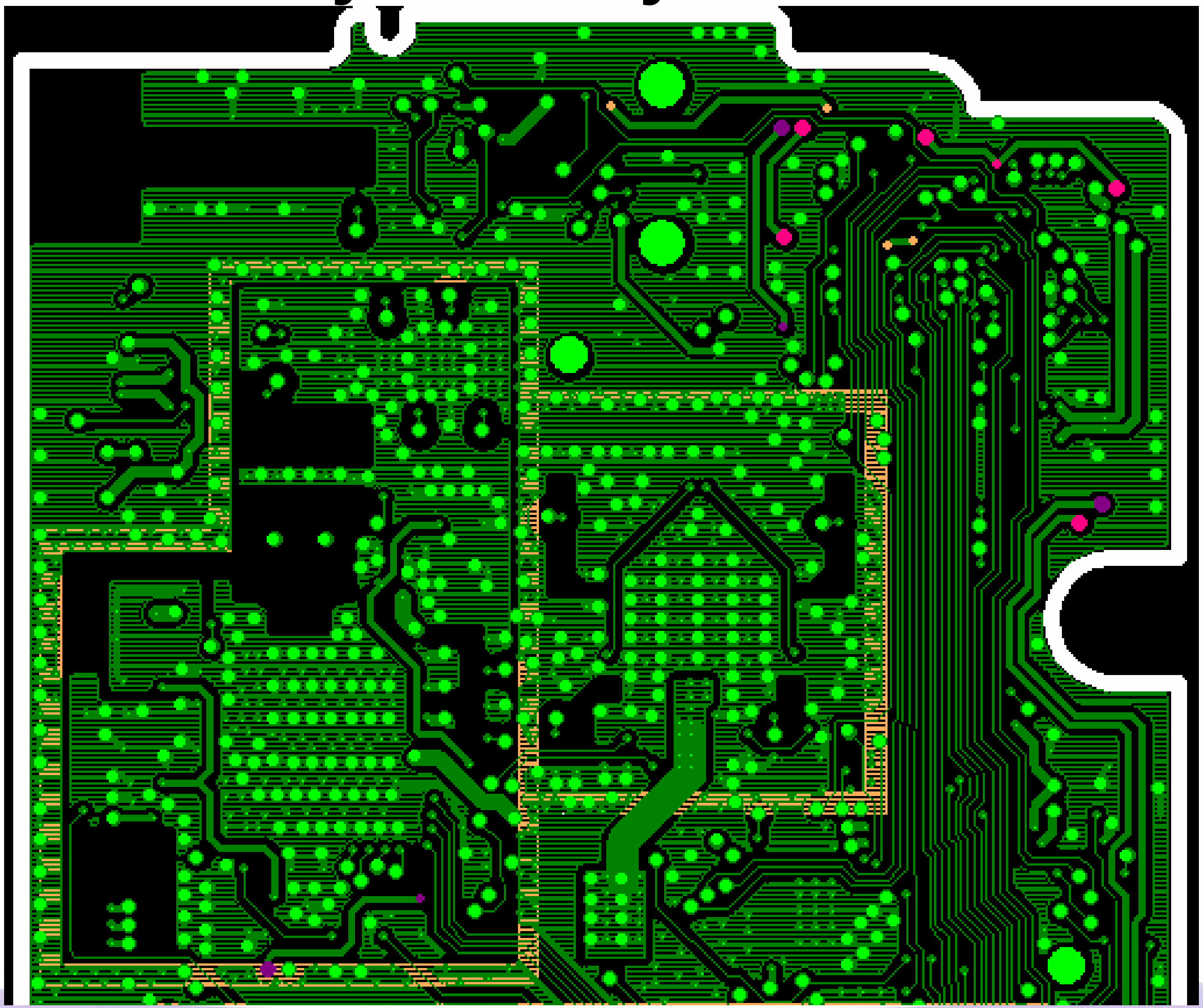
MT612X Layout Guideline



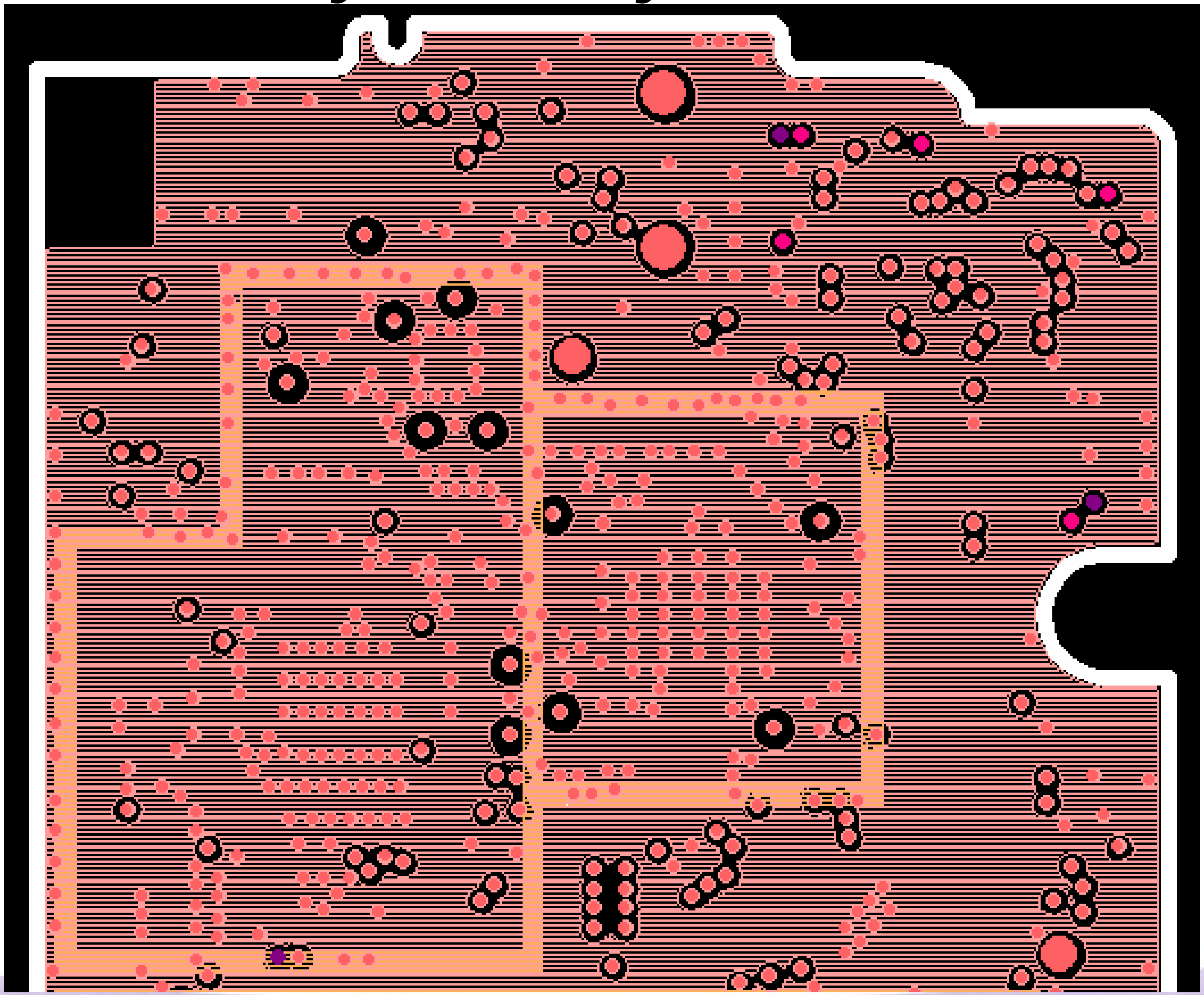
RF Circuit Layout – Layer1



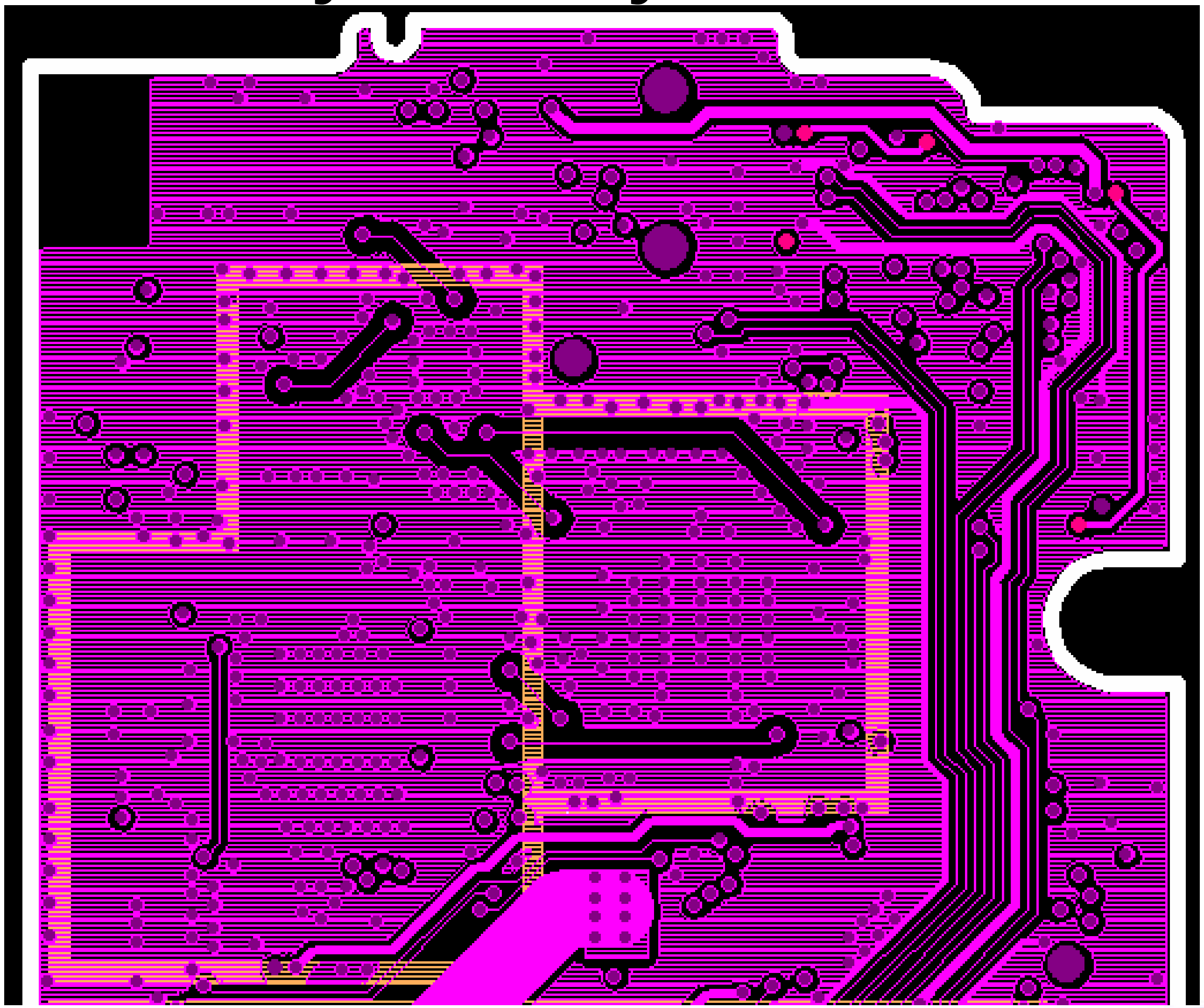
RF Circuit Layout – Layer2



RF Circuit Layout – Layer3



RF Circuit Layout – Layer4



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RF Specification - 1

- Tx Path
  - Frequency Error : 0.1ppm
  - Phase Error
    - ✓ Peak Phase Error : 20 degree
    - ✓ RMS Phase Error : 5 degree
  - ORFS (Output Radio Frequency Spectrum)
    - ✓ 200KHz : -30dB
    - ✓ 250KHz : -33dB
    - ✓ 400KHz : -60dB
    - ✓ 600KHz~1.8MHz : -60dB

Table 13-6: GSM 400, GSM 700, GSM 850 and GSM 900 Spectrum due to modulation out to less than 1 800 kHz offset

	power levels in dB relative to the measurement at FT				
Power level	Frequency offset (kHz)				
(dBm)	0-100	200	250	400	600 to <1800
39	+0,5	-30	-33	-60	-66
37	+0,5	-30	-33	-60	-64
35	+0,5	-30	-33	-60	-62
<= 33	+0,5	-30	-33	-60	-60
The values above are subject to the minimum absolute levels (dBm) below.					
	-36	-36	-36	-36	-51

Table 13-7: DCS 1 800 Spectrum due to modulation out to less than 1 800 kHz offset

	power levels in dB relative to the measurement at FT				
Power level	Frequency offset (kHz)				
(dBm)	0-100	200	250	400	600 to <1800
<= 36	+0,5	-30	-33	-60	-60
The values above are subject to the minimum absolute levels (dBm) below.					
	-36	-36	-36	-36	-56

RF Specification - 2

- Switching Spectrum
  - ✓ GSM PCL5
    - 400KHz : -19dBm
    - 600KHz : -21dBm
    - 1.2MHz : -21dBm
    - 1.8MHz : -24dBm
  - ✓ DCS PCL0
    - 400KHz : -22dBm
    - 600KHz : -24dBm
    - 1.2MHz : -24dBm
    - 1.8MHz : -27dBm

Table 13-11: GSM Spectrum due to switching transients

Power level	Maximum level for various offsets from carrier frequency			
	400 kHz	600 kHz	1 200 kHz	1 800 kHz
39 dBm	-13 dBm	-21 dBm	-21 dBm	-24 dBm
37 dBm	-15 dBm	-21 dBm	-21 dBm	-24 dBm
35 dBm	-17 dBm	-21 dBm	-21 dBm	-24 dBm
33 dBm	-19 dBm	-21 dBm	-21 dBm	-24 dBm
31 dBm	-21 dBm	-23 dBm	-23 dBm	-26 dBm
29 dBm	-23 dBm	-25 dBm	-25 dBm	-28 dBm
27 dBm	-23 dBm	-26 dBm	-27 dBm	-30 dBm
25 dBm	-23 dBm	-26 dBm	-29 dBm	-32 dBm
23 dBm	-23 dBm	-26 dBm	-31 dBm	-34 dBm
<= +21 dBm	-23 dBm	-26 dBm	-32 dBm	-36 dBm

Table 13-12: DCS 1 800 Spectrum due to switching transients

Power level	Maximum level for various offsets from carrier frequency			
	400 kHz	600 kHz	1200 kHz	1 800 kHz
36 dBm	-16 dBm	-21 dBm	-21 dBm	-24 dBm
34 dBm	-18 dBm	-21 dBm	-21 dBm	-24 dBm
32 dBm	-20 dBm	-22 dBm	-22 dBm	-25 dBm
30 dBm	-22 dBm	-24 dBm	-24 dBm	-27 dBm
28 dBm	-23 dBm	-25 dBm	-26 dBm	-29 dBm
26 dBm	-23 dBm	-26 dBm	-28 dBm	-31 dBm
24 dBm	-23 dBm	-26 dBm	-30 dBm	-33 dBm
22 dBm	-23 dBm	-26 dBm	-31 dBm	-35 dBm
<= +20 dBm	-23 dBm	-26 dBm	-32 dBm	-36 dBm

- Rx Path
  - Rx Sensitivity
    - ✓ -102dBm @ RBERII=2.4%

GSM Rx Performance – GSM Band

Chapter	Item	Mode	Unit	ETSI SPEC. dBm	ETSI SPEC. %	NVNT	Condition
14.2	Reference Sensitivity	RA250	dBm	-102	7.5	**2.45**	RBERII, Ch70
			dBm	-102	0.2	**0.047**	RBERIb, Ch70
			dBm	-102	2	**0.71**	FER, Ch70
		HT100	dBm	-102	9.3	**4.18**	RBERII, Ch70
			dBm	-102	0.5	**0.085**	RBERIb, Ch70
			dBm	-102	7	**0.495**	FER, Ch70
		TU50	dBm	-102	8.3	**2.1**	RBERII, Ch70
			dBm	-102	0.42	**0**	RBERIb, Ch70
			dBm	-102	6.742	**0.055**	FER, Ch70
		Static	dBm	-102	2.439	**0.016**	RBERII, Ch70
			dBm	-102	0.41	**0**	RBERIb, Ch70
			dBm	-102	0.122	**0**	FER, Ch70
14.3	Usable Receiver Input Level Range	EQ50	dBm	-82	3.25	**0.88**	BERII =3.25%
14.4	Co-channel Rejection	TU3/Non hopping	dBc	9	4.3	**2.67**	Wanted=-82dBm, RBERII
			dBc	9	2.091	**0.55**	Wanted=-82dBm, RBERIb
			dBc	9	24	**12.23**	Wanted=-82dBm, FER
14.5	Adjacent Channel Rejection	+200K, RBERII	dBc	-9	8.3	**2.92**	Wanted=-82dBm and interferer TU50 fading
		+200K, RBERIb	dBc	-9	0.42	**0.028**	
		+200K, FER	dBc	-9	6.742	**0.985**	
		-200K, RBERII	dBc	-9	8.3	**1.52**	
		-200K, RBERIb	dBc	-9	0.42	**0.01**	
		-200K, FER	dBc	-9	6.742	**0.11**	
		+400K, RBERII	dBc	-41	8.3	**0.065**	Wanted=-82dBm TU50 fading, Interferer static
		+400K, RBERIb	dBc	-41	0.42	**0**	
		+400K, FER	dBc	-41	6.742	**0**	
		-400K, RBERII	dBc	-41	8.3	**1.15**	
		-400K, RBERIb	dBc	-41	0.42	**0**	
		-400K, FER	dBc	-41	6.742	**0**	

GSM Rx Performance – DCS Band

Chapter	Item	Mode	Unit	ETSI SPEC. dBm	ETSI SPEC. %	NVNT	Condition
14.2	Reference Sensitivity	RA130	dBm	-102	7.5	**4.67**	RBERII, Ch700
			dBm	-102	0.2	**0.012**	RBERIb, Ch700
			dBm	-102	2	**0.4**	FER, Ch700
		HT100	dBm	-102	9.33	**7.06**	RBERII, Ch700
			dBm	-102	0.5	**0.19**	RBERIb, Ch700
			dBm	-102	7	**2.34**	FER, Ch700
		TU50	dBm	-102	8.33	**4.15**	RBERII, Ch700
			dBm	-102	0.32	**0.011**	RBERIb, Ch700
			dBm	-102	4.478	**0.4**	FER, Ch700
		Static	dBm	-102	2.439	**0.16**	RBERII, Ch700
			dBm	-102	0.41	**0**	RBERIb, Ch700
			dBm	-102	0.122	**0**	FER, Ch700
14.3	Usable Receiver Input Level Range	EQ50	dBm	-82	3.25	**1.04**	BERII =3.25%
14.4	Co-channel Rejection	TU1.5/Non hopping	dBc	9	4.3	**3.1**	Wanted=-82dBm, RBERII
			dBc	9	2.091	**0.57**	Wanted=-82dBm, RBERIb
			dBc	9	24	**18.18**	Wanted=-82dBm, FER
14.5	Adjacent Channel Rejection	+200K, RBERII	dBc	-9	8.3	**4.5**	Wanted=-82dBm and interferer TU50 fading
		+200K, RBERIb	dBc	-9	0.27	**0.09**	
		+200K, FER	dBc	-9	3.371	**1.47**	
		-200K, RBERII	dBc	-9	8.3	**2.56**	
		-200K, RBERIb	dBc	-9	0.27	**0**	
		-200K, FER	dBc	-9	3.371	**0.28**	
		+400K, RBERII	dBc	-41	9.167	**0.44**	Wanted=-82dBm TU50 fading, Interferer static
		+400K, RBERIb	dBc	-41	0.483	**0.006**	
		+400K, FER	dBc	-41	5.714	**0**	
		-400K, RBERII	dBc	-41	9.167	**4.29**	
		-400K, RBERIb	dBc	-41	0.483	**0.14**	
		-400K, FER	dBc	-41	5.714	**1.15**	

GPRS Rx Performance – GSM Band

Test	Channel	CScheme	Fading	Spec	Blocks	Level	Result	P/F
14.16.1	FBLER	CS1	STATIC	10	2000	-102	0	Pass
	FBLER	CS2	STATIC	10	2000	-102	0	Pass
	FBLER	CS3	STATIC	10	2000	-102	0	Pass
	FBLER	CS4	STATIC	10	2000	-99	0	Pass
	FBLER	CS1	TU_High	10	6000	-102	1.1693	Pass
	FBLER	CS2	TU_High	10	6000	-98	1.2309	Pass
	FBLER	CS3	TU_High	10	6000	-96	0.8206	Pass
	FBLER	CS4	TU_High	10	6000	-88	4.2959	Pass
	FBLER	CS1	RA	10	6000	-102	1.3836	Pass
	FBLER	CS2	RA	10	6000	-99	3.0328	Pass
	FBLER	CS3	RA	10	6000	-97	4.5387	Pass
	FBLER	CS1	HT100	10	6000	-101	2.6777	Pass
	FBLER	CS2	HT100	10	6000	-97	3.7579	Pass
	FBLER	CS3	HT100	10	6000	-94	3.9967	Pass
	USF	CS1	STATIC	1	20000	-102	0	Pass
	USF	CS2	STATIC	1	20000	-102	0	Pass
	USF	CS3	STATIC	1	20000	-102	0	Pass
	USF	CS4	STATIC	1	20000	-102	0	Pass
	USF	CS1	TU_High	1	20000	-99	0.03	Pass
	USF	CS2	TU_High	1	20000	-101	0.025	Pass
	USF	CS3	TU_High	1	20000	-101	0	Pass
	USF	CS4	TU_High	1	20000	-101	0.01	Pass
	USF	CS1	RA	1	20000	-101	0.025	Pass
	USF	CS2	RA	1	20000	-102	0.0299	Pass
	USF	CS3	RA	1	20000	-102	0.025	Pass
	USF	CS4	RA	1	20000	-102	0.02	Pass
	USF	CS1	HT100	1	20000	-99	0.0799	Pass
	USF	CS2	HT100	1	20000	-102	0.065	Pass
	USF	CS3	HT100	1	20000	-102	0.09	Pass

GPRS Rx Performance – GSM Band

	FBLER	CS1	TU_Low	10	6000	-13	5.5556	Pass
	FBLER	CS2	TU_Low	10	6000	-15	5.7095	Pass
	FBLER	CS3	TU_Low	10	6000	-16	5.6299	Pass
	FBLER	CS4	TU_Low	10	6000	-21	4.2574	Pass
	FBLER	CS1	TU_High	10	6000	-10	6.332	Pass
	FBLER	CS2	TU_High	10	6000	-14	5.2989	Pass
	FBLER	CS3	TU_High	10	6000	-16	4.4419	Pass
	FBLER	CS4	TU_High	10	6000	-24	7.5641	Pass
	FBLER	CS1	RA	10	6000	-9	7.1571	Pass
	FBLER	CS2	RA	10	6000	-13	7.3818	Pass
	FBLER	CS3	RA	10	6000	-16	6.8909	Pass
14.16.2	USF	CS1	TU_Low	1	60000	-19	0.3298	Pass
	USF	CS2	TU_Low	1	60000	-18	0.2932	Pass
	USF	CS3	TU_Low	1	60000	-18	0.2582	Pass
	USF	CS4	TU_Low	1	60000	-18	0.2516	Pass
	USF	CS1	TU_High	1	60000	-12	0.1616	Pass
	USF	CS2	TU_High	1	60000	-10	0.1966	Pass
	USF	CS3	TU_High	1	60000	-10	0.1883	Pass
	USF	CS4	TU_High	1	60000	-10	0.2299	Pass
	USF	CS1	RA	1	60000	-10	0.1649	Pass
	USF	CS2	RA	1	60000	-8	0.185	Pass
	USF	CS3	RA	1	60000	-8	0.185	Pass
	USF	CS4	RA	1	60000	-8	0.2115	Pass

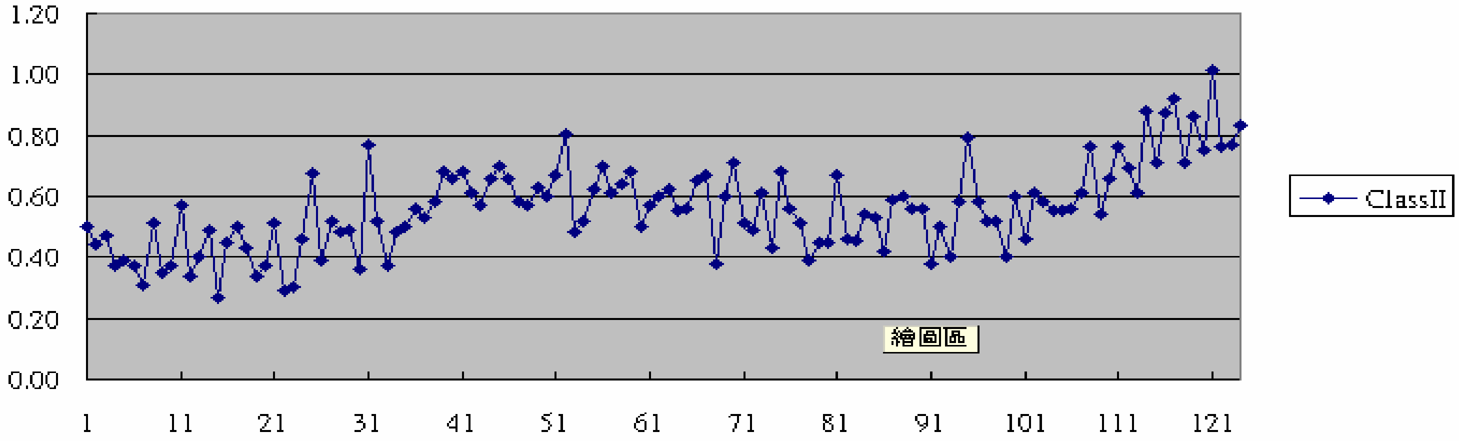
GPRS Rx Performance – DCS Band

Chapter	Channel	CScheme	Fading	Spec	Blocks	Level	Swp	Result	P/F
	FBLER	CS1	STATIC	10	2000	-100	N	0	Pass
	FBLER	CS2	STATIC	10	2000	-100	N	0	Pass
	FBLER	CS3	STATIC	10	2000	-100	N	0	Pass
	FBLER	CS4	STATIC	10	2000	-97	N	0	Pass
	FBLER	CS1	TU_High	10	6000	-100	N	0.2133	Pass
	FBLER	CS2	TU_High	10	6000	-96	N	0.164	Pass
	FBLER	CS3	TU_High	10	6000	-94	N	0.2833	Pass
	FBLER	CS4	TU_High	10	6000	-84	N	5.2273	Pass
	FBLER	CS1	RA	10	6000	-100	N	0.6234	Pass
	FBLER	CS2	RA	10	6000	-97	N	1.7628	Pass
	FBLER	CS3	RA	10	6000	-94	N	3.0099	Pass
	FBLER	CS1	HT100	10	6000	-99	N	1.6073	Pass
	FBLER	CS2	HT100	10	6000	-95	N	3.4323	Pass
	FBLER	CS3	HT100	10	6000	-90	N	5.028	Pass
	FBLER	CS3	STATIC	10	2000	-100	N	0	Pass
	FBLER	CS3	STATIC	10	2000	-100	N	0	Pass
14.16.1	FBLER	CS3	STATIC	10	2000	-100	N	0	Pass
	USF	CS1	STATIC	1	20000	-100	N	0	Pass
	USF	CS2	STATIC	1	20000	-100	N	0	Pass
	USF	CS3	STATIC	1	20000	-100	N	0	Pass
	USF	CS4	STATIC	1	20000	-100	N	0	Pass
	USF	CS1	TU_High	1	60000	-99	N	0.0033	Pass
	USF	CS2	TU_High	1	60000	-100	N	0.0033	Pass
	USF	CS3	TU_High	1	60000	-100	N	0.0033	Pass
	USF	CS4	TU_High	1	60000	-100	N	0.005	Pass
	USF	CS1	RA	1	60000	-99	N	0.0133	Pass
	USF	CS2	RA	1	60000	-100	N	0.015	Pass
	USF	CS3	RA	1	60000	-100	N	0.0067	Pass
	USF	CS4	RA	1	60000	-100	N	0.01	Pass
	USF	CS1	HT100	1	60000	-97	N	0.0733	Pass
	USF	CS2	HT100	1	60000	-100	N	0.0533	Pass
	USF	CS3	HT100	1	60000	-100	N	0.0517	Pass
	USF	CS4	HT100	1	60000	-100	N	0.0649	Pass

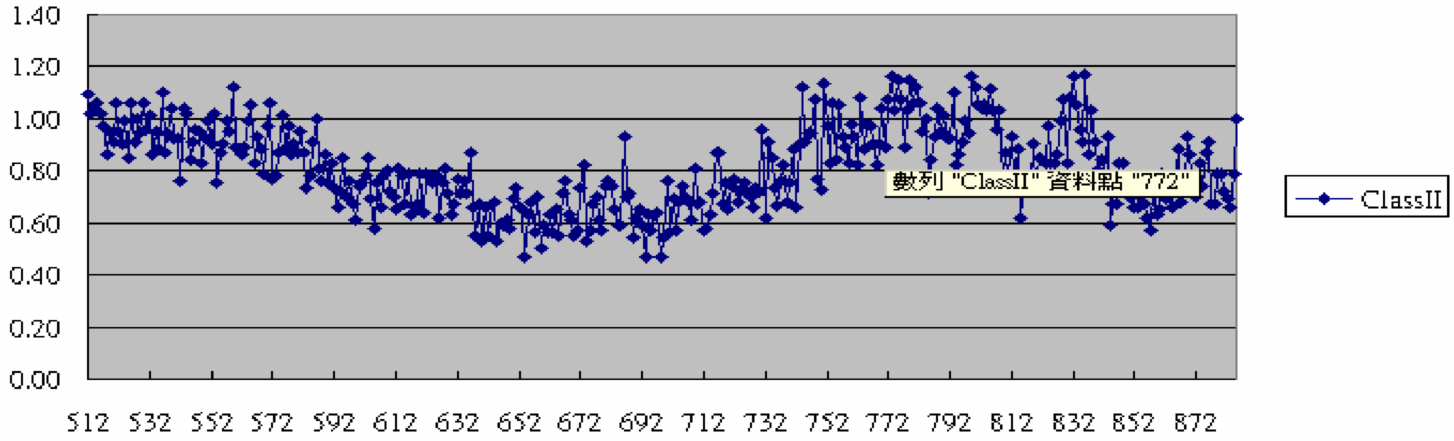
GPRS Rx Performance – DCS Band

14.16.2	FBLER	CS1	TU_Low	10	25000	-13	N	5.0351	Pass
	FBLER	CS2	TU_Low	10	25000	-15	N	5.3744	Pass
	FBLER	CS3	TU_Low	10	25000	-16	N	4.5416	Pass
	FBLER	CS4	TU_Low	10	25000	-21	N	4.3685	Pass
	FBLER	CS1	TU_High	10	6000	-9	N	5.0797	Pass
	FBLER	CS2	TU_High	10	6000	-13	N	4.4828	Pass
	FBLER	CS3	TU_High	10	6000	-16	N	2.1996	Pass
	FBLER	CS4	TU_High	10	6000	-27	N	7.2842	Pass
	FBLER	CS1	RA	10	6000	-9	N	4.0813	Pass
	FBLER	CS2	RA	10	6000	-13	N	5.6663	Pass
	FBLER	CS3	RA	10	6000	-16	N	5.4804	Pass
	USF	CS1	TU_Low	1	60000	-19	N	0.2681	Pass
	USF	CS2	TU_Low	1	60000	-18	N	0.2597	Pass
	USF	CS3	TU_Low	1	60000	-18	N	0.2299	Pass
	USF	CS4	TU_Low	1	60000	-18	N	0.2264	Pass
	USF	CS1	TU_High	1	60000	-10	N	0.3415	Pass
	USF	CS2	TU_High	1	60000	-9	N	0.3097	Pass
	USF	CS3	TU_High	1	60000	-9	N	0.2464	Pass
	USF	CS4	TU_High	1	60000	-9	N	0.2763	Pass
	USF	CS1	RA	1	60000	-10	N	0.3216	Pass
	USF	CS2	RA	1	60000	-7	N	0.6757	Pass
	USF	CS3	RA	1	60000	-7	N	0.5976	Pass
	USF	CS4	RA	1	60000	-7	N	0.6397	Pass

Rx GSM/DCS Static Sensitivity



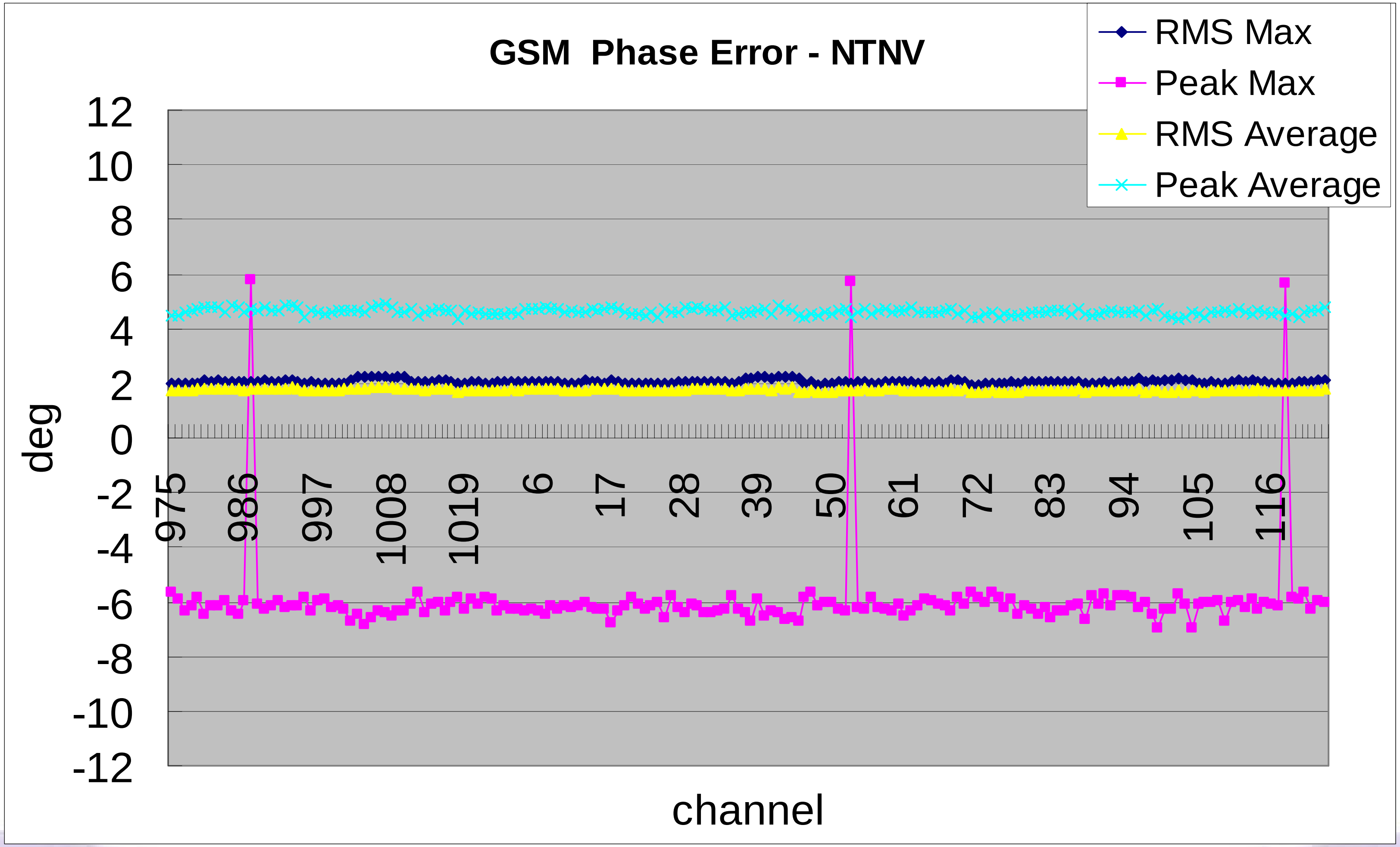
GSM Static BER Measurement @-108dBm vs. ARFCN



DCS Static BER Measurement @-106.5dBm vs. ARFCN

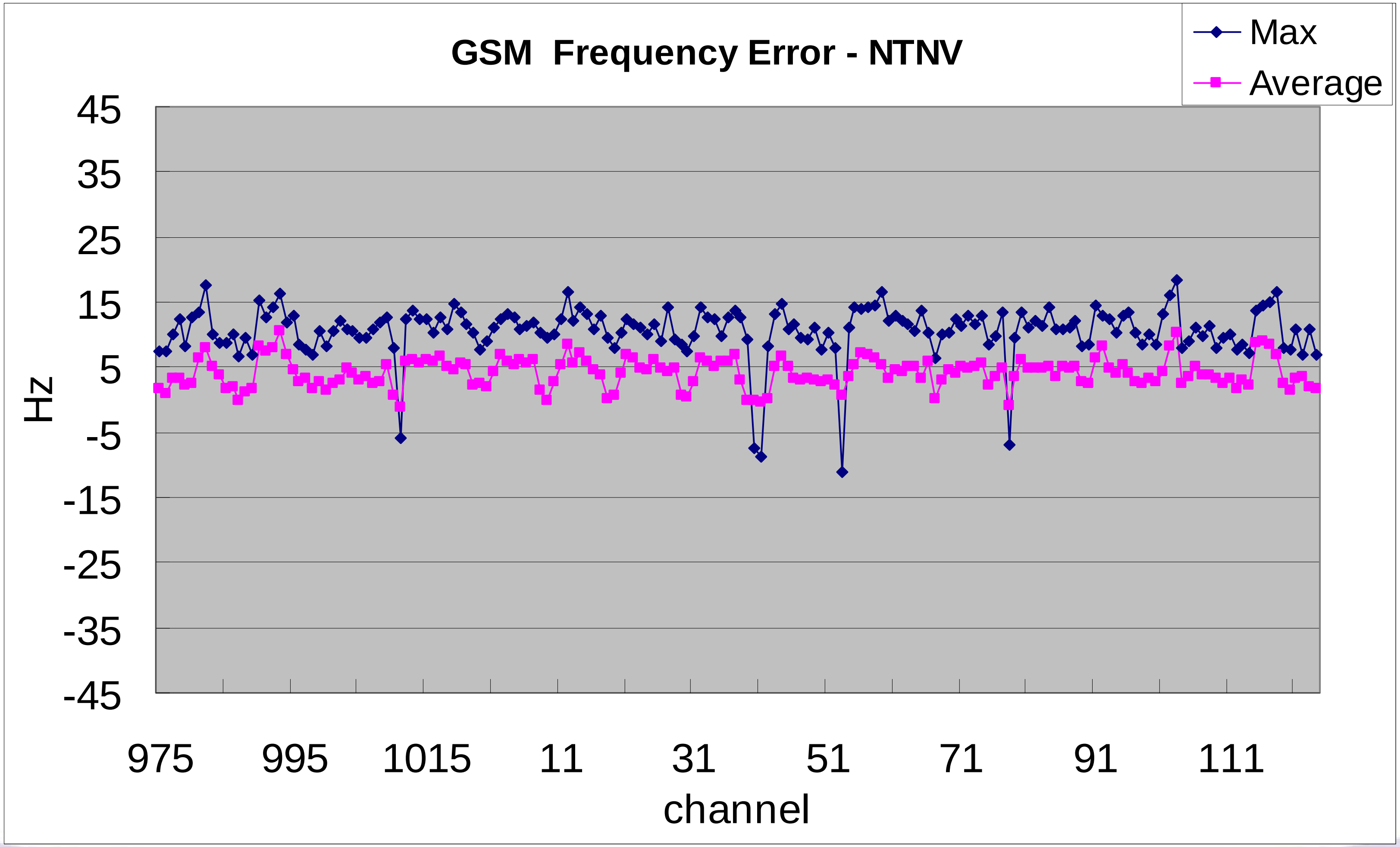
Tx Performance – Phase Error in GSM Band

MT612X + MT6218 solution, ETSI 13.1 Phase Error RMS < 5 deg. , Peak < 20 deg.



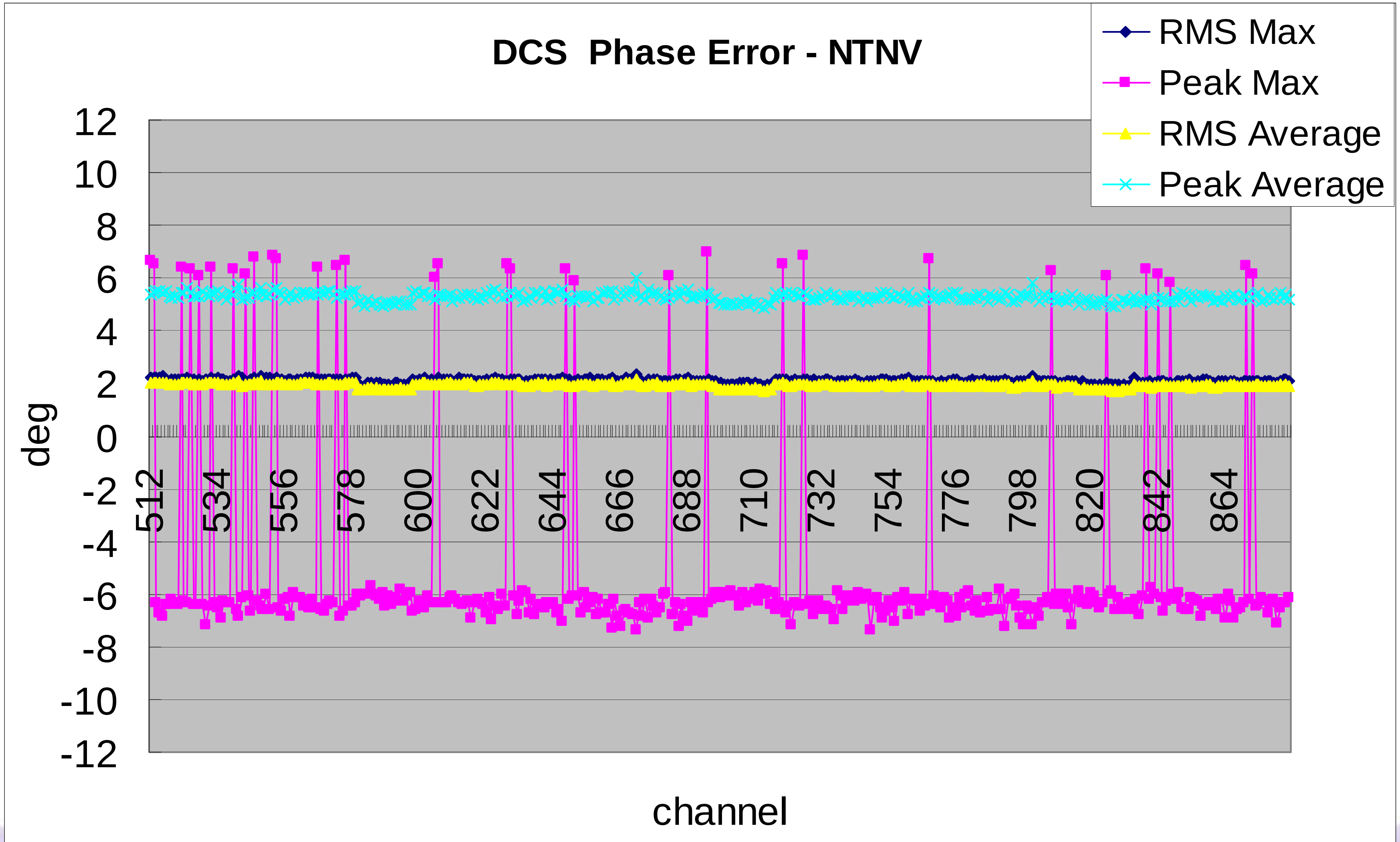
Tx Performance – Freq. Error in GSM Band

MT612X + MT6218 solution, ETSI 13.1 Frequency Error < 90Hz (0.1ppm)



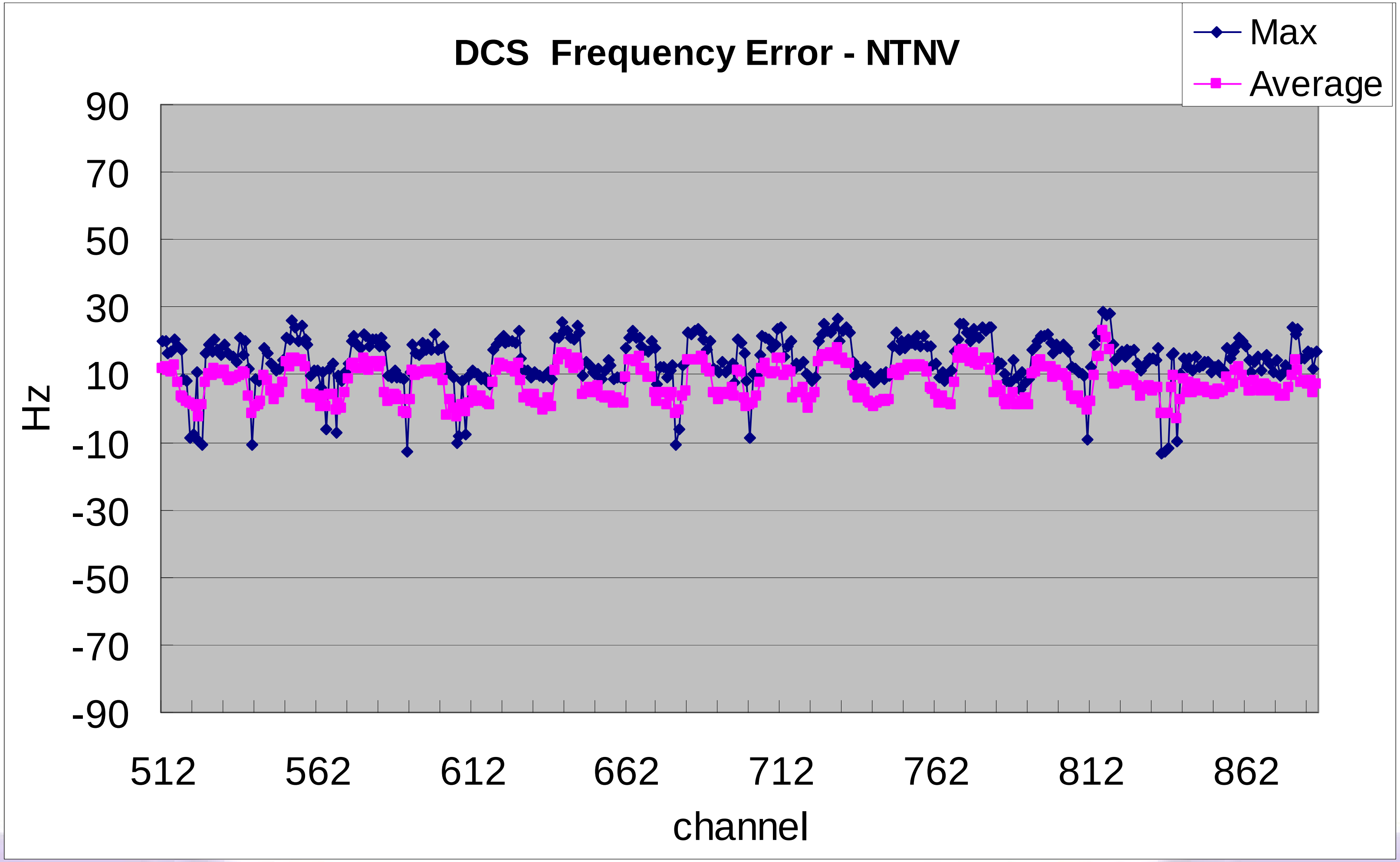
Tx Performance – Phase Error in DCS Band

MT612X + MT6218 solution, ETSI 13.1 Phase Error RMS < 5 deg. , Peak < 20 deg.



Tx Performance – Freq. Error in DCS Band

MT612X + MT6218 solution, ETSI 13.1 Frequency Error < 180Hz (0.1ppm)



ORFS in Extreme Condition in GSM/DCS Band

GSM Band

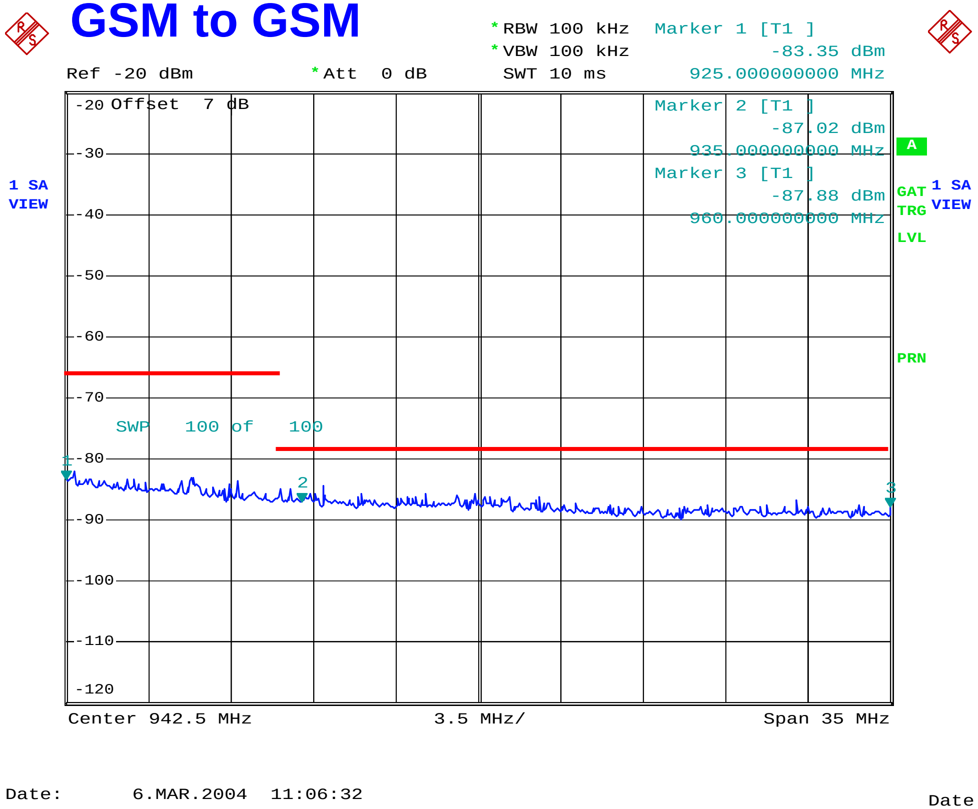
Offset\Cond	Normal	HTHV	HTLV	HTNV	LTHV	LTLV	LTNV
200KHz	-34.4	-34.5	-34.6	-34.6	-34.4	-34.3	-34.3
250KHz	-38.9	-38.8	-38.8	-38.8	-38.9	-38.8	-38.8
400KHz	-64.4	-63.9	-63.8	-63.7	-64.4	-64.5	-64.3
600KHz	-67.6	-67.3	-67.3	-67.2	-67.4	-67.7	-67.3
800KHz	-68.1	-68.3	-68.2	-68.3	-68.6	-68.2	-68.4
1200KHz	-70.3	-70.6	-70.5	-70.5	-70.7	-70.6	-70.6
1800KHz	-74.4	-74.6	-74.5	-74.5	-74.9	-74.7	-74.6
Above							

DCS Band

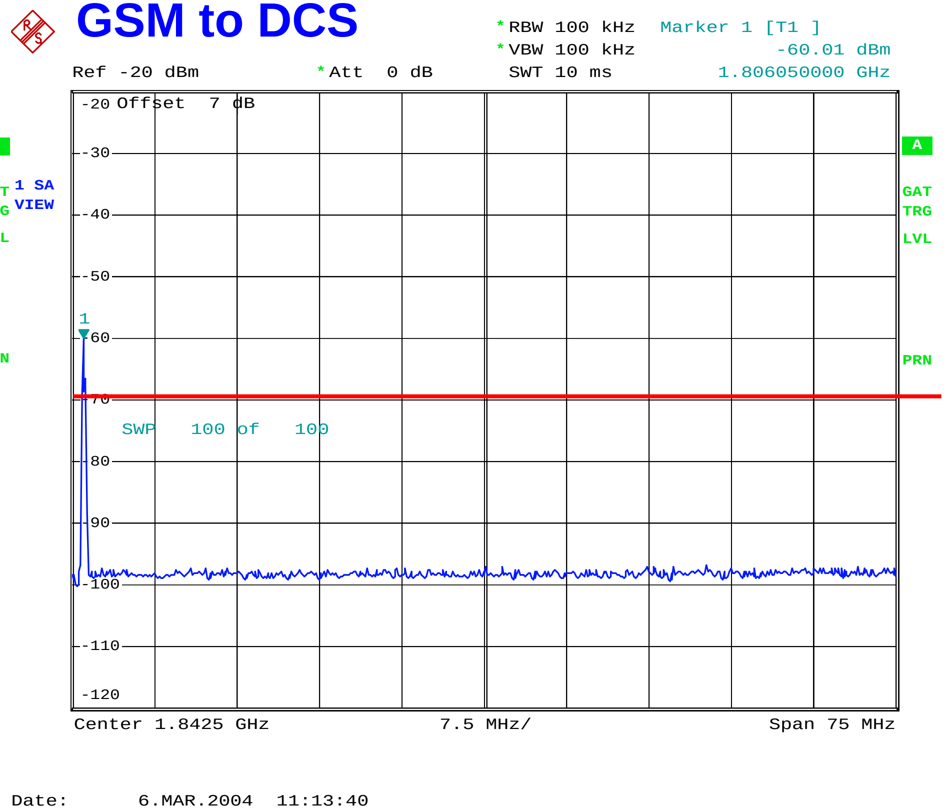
Offset\ Cond	Normal	HTHV	HTLV	HTNV	LTHV	LTLV	LTNV
200KHz	-34.4						
250KHz	-38.7						
400KHz	-64.3	-62.9	-62.4	-62.9	-62.5	-62.7	-62.8
600KHz	-65	-64.4	-64.4	-64.3	-65.1	-65.2	-65.3
800KHz	-66.3	-65.9	-66	-65.9	-66.8	-66.6	-66.6
1200KHz	-67.9	-68.9	-68.9	-68.9	-69.3	-69.3	-69.2
1800KHz	-72	-72.8	-72.3	-73.3	-73.3	-73.0	-73.4
Above							

Tx Performance – Rx Band Noise G2G, G2D

GSM to GSM

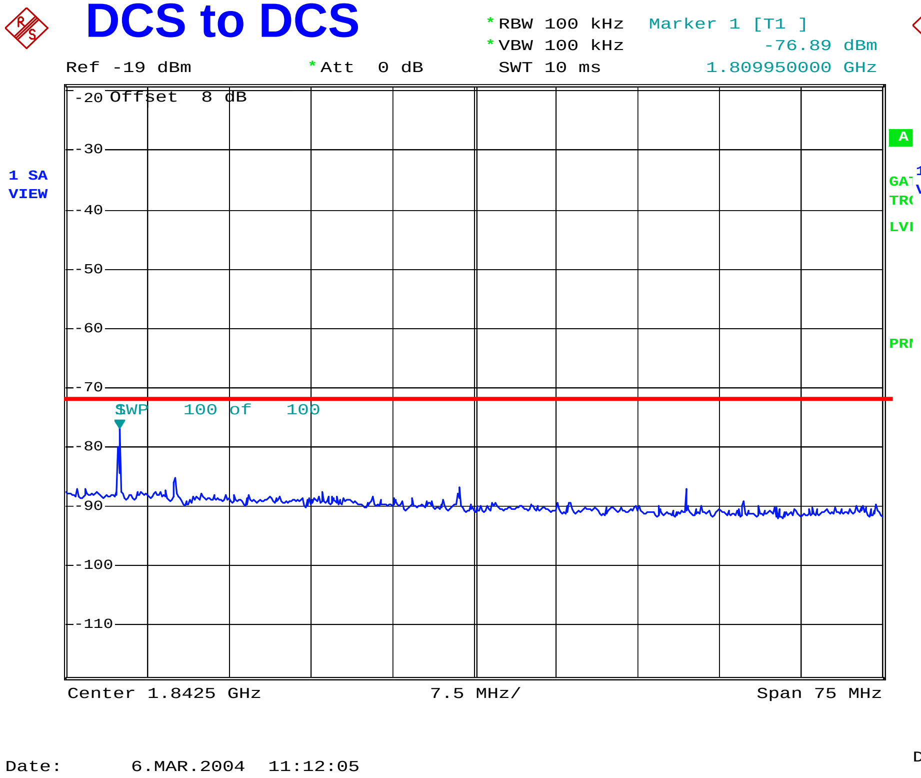


GSM to DCS

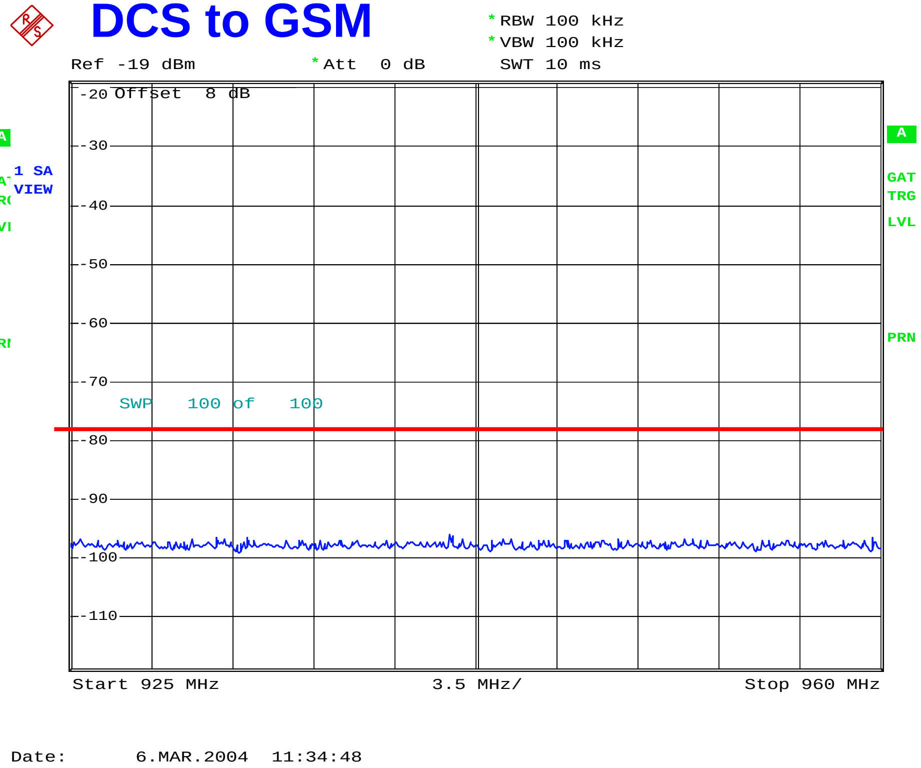


Tx Performance – Rx Band Noise D2G, D2D

DCS to DCS



DCS to GSM



Transceiver Performance Summary

Technology	0.35μm BiCMOS	
Package	56-pin QFN	
Rx/Tx Mode Cur.	68/120mA	All bands
Rx NF	4/4/5.5/5.5dB	All bands
Rx IIP2	44/44/26/26dBm	All bands, static
Tx Phase Error	1.5/1.5/1.7/2°	All bands, rms
	5/5/5.5/6°	All bands, peak
Tx ORFS	-66/-66/-65/-65dBc@400kHz	All bands, RBW=30kHz
	-75/-75/-71/-72dBc@1.8MHz	All bands, RBW=100kHz
	-118/-118/-113/-113dBc@20MHz	All bands, RBW=100kHz
Tx Output Power	> 5dBm	All bands
Sx Locking Time	< 180μs	All bands, error < 1kHz

➢ *All numbers are listed in 850/900/1800/1900MHz order.*

MT612X RF Transceiver Benefits

- Low Rx power consumption to ensure long standby time
- Ease of use with universal baseband interface
- Designed and fabricated in Taiwan
  - ✓Cost and time effective to the market
- MediaTek full support
  - ✓Real time system application support in Taiwan
  - ✓Full baseband and software team support
- Mass production ready → Q2 2004
- Fully FTA proven with low design risk

- MTK GSM/GPRS RF HW Solution
- MT612X Functional Block and Feature
- Rx/Tx Architecture
- Hardware and Register Control
- L1 Driver Timing Control
- RF Application Schematic and Layout
- Rx/Tx Performance
- **RF 2nd Source Component Qualification**

RF 2nd Source Component Qualification

- RF SAW
  - Return Loss from Antenna (S11 parameter)
  - Rx Sensitivity
  - Attenuation Performance
  - Blocking Test
- ASM (Antenna Switch Module)
  - Rx Sensitivity
  - Tx Output Power
  - Tx Harmonic for High Order Term
  - Isolation
- VCTCXO
  - Frequency Error
  - Phase Error (Peak, RMS)
  - ORFS (200K, 400K, 800K, 1.8MHz)
  - In Extreme Condition

Antenna Switch Module

ASM Components List					
Company	Bnad	Size	Used Project	Part No.	Qualification
Hitachi Metal	Dual	5.4x4.0	KLM	SHS-**M090C**	OK
	Triple	5.4x4.0		SHS-**M090TK**	OK
	Triple	4.5x3.2	Cannon+	SHS-**C085TK**	OK
Murata	Dual	5.4x4.0	FP2120	LMSP54AA-097	OK
	Triple	5.4x4.0	Chicago	LMSP-0043TEMP	OK
TDK	Daul	5.4x4.0	Bull600	ASM5417475T-2406	OK (by Kevin)
	Triple	5.4x4.0	Bull100	ASM-2419	OK (by Kevin)
	Triple	4.5x3.2	Bull888	ASM4518806T-2510A	OK (by Kevin)

RF SAW Filter

RF SAW Components List					
Company	Bnad	Part No.	Size	Impedence	Qualification
EPCOS	GSM	B7820	5pin 2.0x1.4	50-150	OK
	DCS	B7821	5pin 2.0x1.4	50-150	OK
	PCS	B7825	5pin 2.0x1.4	50-150	OK
SEMCO	GSM	H942MS1	5pin 2.0x1.4	50-150	OK (by JP)
	DCS	HG42JS1	5pin 2.0x1.4	50-150	OK (by JP)
	PCS	SFHG60PS101	5pin 2.0x1.4	50-150	OK but need re-matching (by JP)
Temex	GSM	TMXS004	5pin 2.0x1.4	50-150	OK (by JP)
	DCS	TMXS005	5pin 2.0x1.4	50-150	OK (by JP)
Fujitsu	GSM	FAR-F5EB-942M50-B28E	5pin 2.0x1.4	50-150	OK but need re-matching (by Kevin)
	DCS	FAR-F6E8-1G8425-B2BG	5pin 2.0x1.4	50-150	OK but need re-matching (by Kevin)
	PCS	FAR-F6EB-1G9600-B2BE	5pin 2.0x1.4	50-150	OK (by JP)
Panasonic	GSM	EFCH942MTCA7	5pin 2.0x1.4	50-150	OK but need re-matching (by JP)
	DCS	EFCH1842TCA7	5pin 2.0x1.4	50-150	OK but need re-matching (by JP)
	PCS	EFCH1960TCA7	5pin 2.0x1.4	50-150	OK (by JP)

VCTCXO 26MHz

26MHz VCTCXO Components List			
Company	Size	Part No.	Qualification
TEW	5.0x3.2	TTS14VA-26Mhz	OK
	3.2x2.5	TTS18VSA-A5-26Mhz	OK
Kyocera	5.0x3.2	KT18B-ECU27A-26.000M-T	OK(by JP)
	3.2x2.5	KT21P-DCU28A-26.000M-T	OK(by JP)
KDS	5.0x3.2	DSA535SB-1XTQ26000RDA	OK (by JP)
	3.2x2.5	DSA321SA-1XTV26000RCA	OK (by JP)
SEMCO	5.0x3.2	TOB2600DPI4CNB	OK (by JP)
	3.2x2.5	TOH2600DPI4KRD	OK (by JP)
	3.2x2.5	**TOH2600DPM4DKA**	**OK (by JP)**
Murata	5.0x3.2	HFX323QN26M0A1	OK (by JP)
	3.2x2.5	HFX423QN26M0A3	OK (by JP)
Toyocom	3.2x2.5	TCO-5871	OK (by JP)
HDK	**3.2x2.5**	**VT-R32250FR**	**OK (by JP)**
NDK	**3.2x2.5**	**ENG3049A**	**OK (by JP)**
Delta	**3.2x2.5**	**V26.00Y2C3**	**OK (by JP)**

Thank You