



## Wireless Components

Optimized RF/IF Dual PLL Frequency Synthesizer

PMB 2349 Version 1.0

Specification May 2000

**CONFIDENTIAL****Revision History: Current Version: May 2000**

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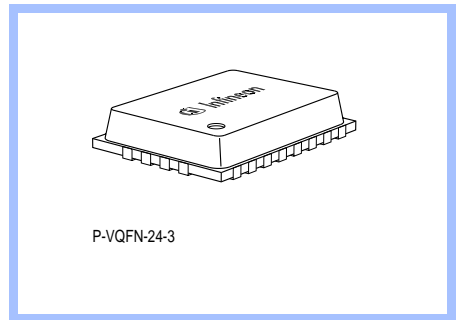
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## Product Info

### General Description

The PMB 2349 is a RF/IF Dual-PLL frequency synthesizer implemented in Infineon's high speed BiCMOS technology B6HFC. The device contains two PLLs with integrated prescalers especially designed for use in battery powered radio equipment and mobile telephones. Primary applications are single- and dual-band digital cellular systems e.g. GSM, PCN (DCS 1800) and PCS systems.

### Package



### Features

- Operation range 2.7 to 5.0 V
  - Ultra low phase noise
  - Ultra low spurious
  - Faster lock-in times
  - New bipolar power modes
  - New programmable Reference Amplifier
  - External or internal reference current setting for PD outputs
  - Low operating current consumption
  - Programmable power down modes
  - High input sensitivity and high input frequencies: PLL1 (RF): 2.8 GHz  
PLL2 (IF): 600 MHz
  - Programmable dual modulus prescaler divide ratio:  
PLL1: 1:64/65 or 1:32/33  
PLL2: 16/17 or 1:8/9
- Dividing ratios:  
A counters: PLL1: 0 to 63  
PLL2: 0 to 15  
N counters: PLL1: 3 to 16,383  
PLL2: 3 to 16,383  
R counters 3 to 16,383 for PLL1 and PLL2
  - Fast phase detectors and charge pump outputs without dead zone
  - Switchable polarity and programmable phase detector currents
  - Fast serial 3-wire bus interface with low threshold voltage Schmitt-Trigger inputs for interfacing with low voltage baseband circuits
  - Two data registers in PLL2 for fast IF band switching
  - A programmable output port for lock detect or general purpose (VCO switch etc.).

### Ordering Information

Type	Ordering Code	Package
PMB 2349		P-VQFN-24

# 1

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# 2 Product Description

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## 2.1 Overview

The PMB 2349 is a RF/IF Dual-PLL frequency synthesizer implemented in Infineon's high speed BiCMOS technology B6HFC. The device contains two PLLs with integrated prescalers especially designed for use in battery powered radio equipment and mobile telephones. Primary applications are single- and dual-band digital cellular systems e.g. GSM, PCN (DCS 1800) and PCS systems.

## 2.2 Features

- Operation range 2.7 to 5.0 V
- Ultra low phase noise
- Ultra low spurious
- Faster lock-in times
- New bipolar power modes
- New programmable Reference Amplifier
- External or internal reference current setting for PD outputs
- Low operating current consumption
- Programmable power down modes
- High input sensitivity and high input frequencies:  
PLL1 (RF): 2.8 GHz, PLL2 (IF): 600 MHz
- Programmable dual modulus  
prescaler divide ratio:  
PLL1: 1:64/65 or 1:32/33  
PLL2: 16/17 or 1:8/9  
Dividing ratios:  
A counters: PLL1: 0 to 63  
                  PLL2: 0 to 15  
N counters: PLL1: 3 to 16,383  
                  PLL2: 3 to 16,383  
R counters 3 to 16,383 for PLL1 and PLL2
- Fast phase detectors and charge pump outputs without dead zone
- Switchable polarity and programmable phase detector currents
- Fast serial 3-wire bus interface with low threshold voltage Schmitt-Trigger inputs for interfacing with low voltage baseband circuits
- Two data registers in PLL2 for fast IF band switching
- A programmable output port for lock detect or general purpose (VCO switch etc.).

## 2.3 Package Outlines

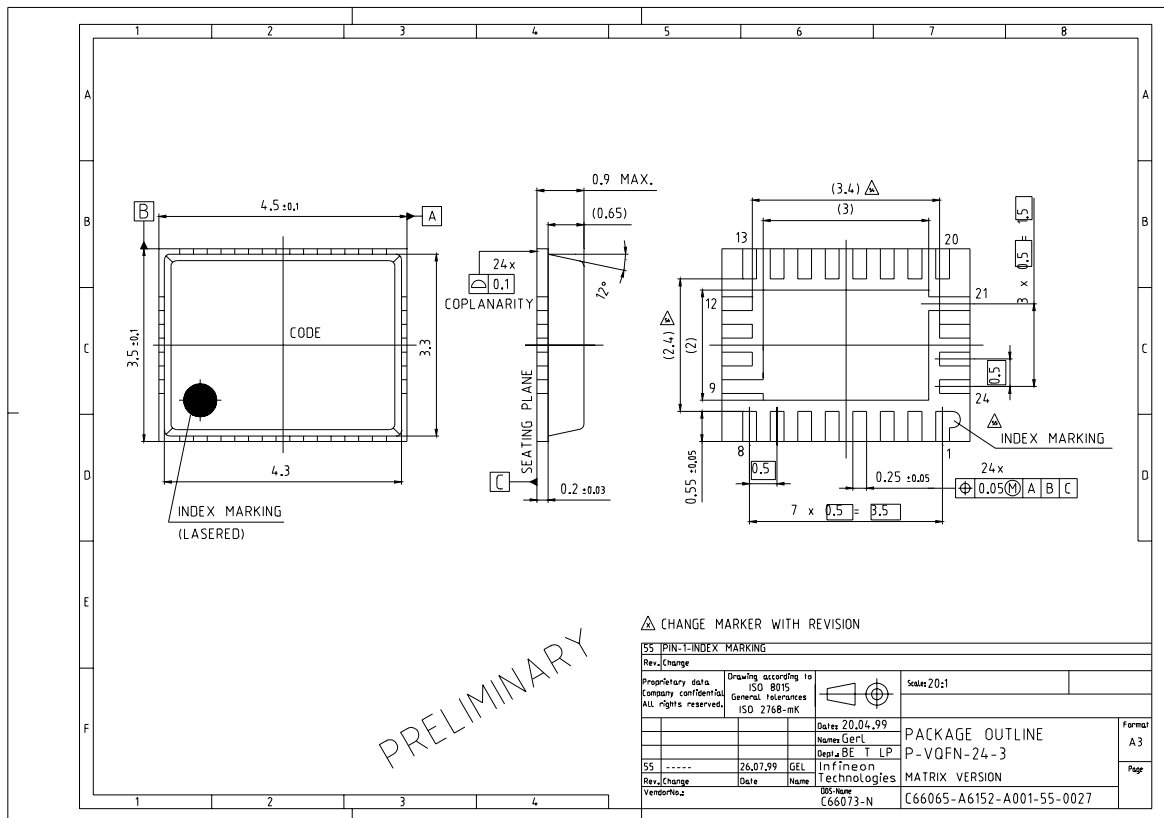


Figure 2-1 P-VQFN-24

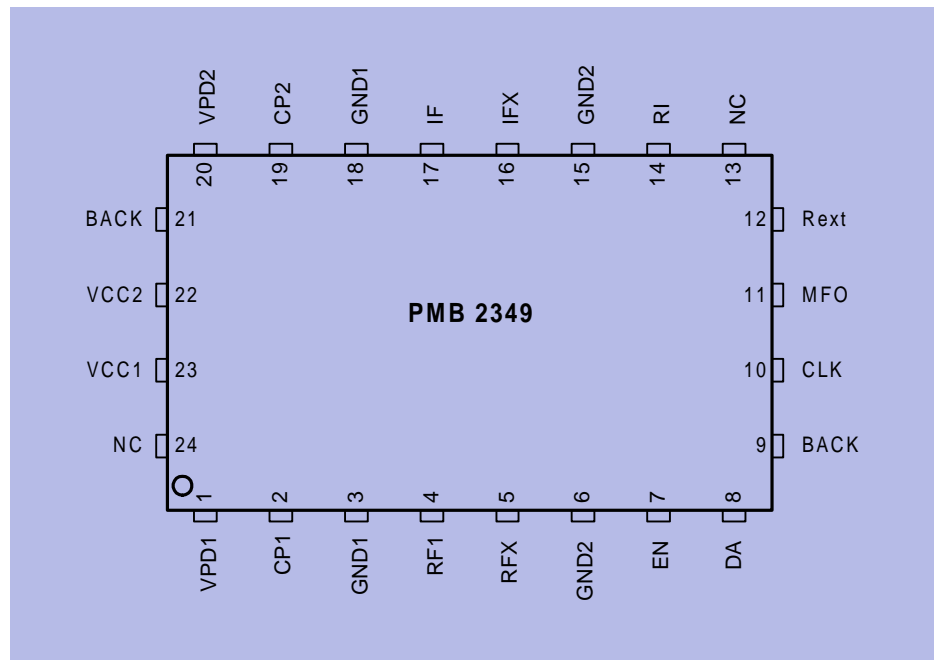
# 3 Functional Description

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### 3.1 Pin Configuration

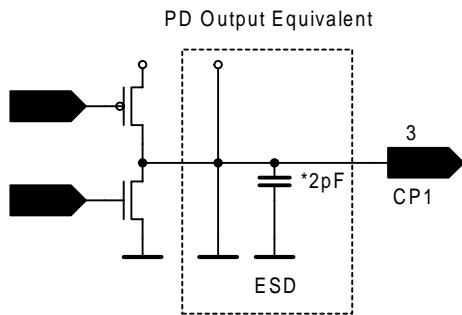
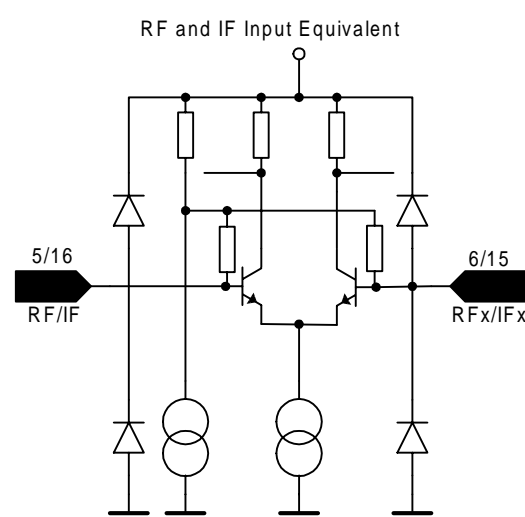


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Figure 3-1 Pin Configuration

### 3.2 Pin Definition and Function

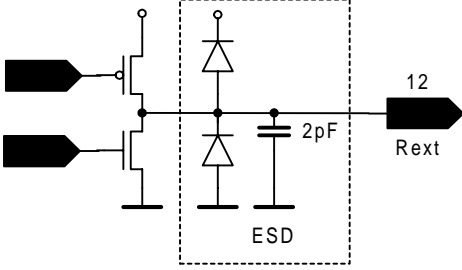
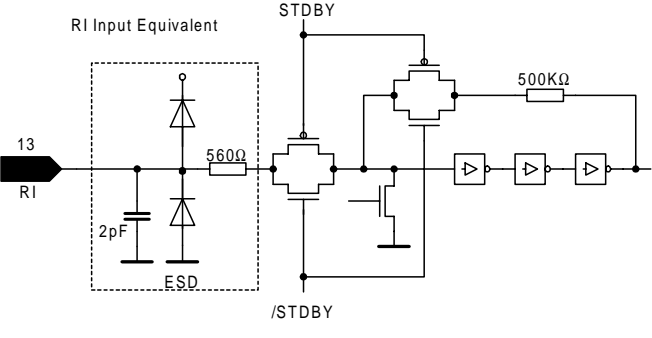
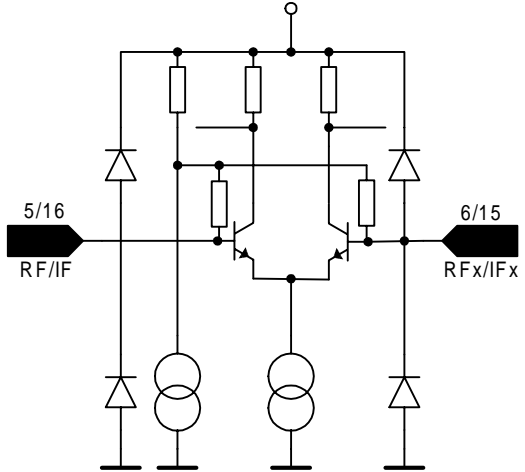
Table 3-1 Pin Definition and Function

Pin No.	Symbol	Equivalent I/O-Schematic	Function
23	VCC1		Positive supply voltage for CMOS circuitry
1	VPD1		Positive supply voltage for charge pump of PLL1
2	CP1	 <p>PD Output Equivalent</p>	PLL1 charge pump output Phase detector tristate charge pump output
3	GND1		Ground for CMOS circuitry
4	RF1	 <p>RF and IF Input Equivalent</p>	<b>RF frequency input 1</b> RF input with highly sensitive preamplifier for PLL1. AC coupling must be set up.
5	RFX		<b>RF frequency input (inverted)</b> RF input with highly sensitive preamplifier for PLL1. AC coupling must be set up
6	GND2		Ground for bipolar circuitry

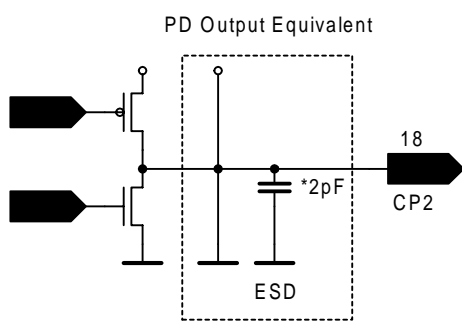
**Table 3-1 Pin Definition and Function (continued)**

Pin No.	Symbol	Equivalent I/O-Schematic	Function
7	EN	<p>Serial Control Input Equivalent</p>	<p><b>3-Wire bus input: Enable</b>                      Enable input of the serial control interface with Schmitt-Trigger input stage. When EN=H the input signals CLK and DA are disabled. When EN=L the serial control interface is enabled. The received data are transferred to the registers with the positive edge of the EN-signal.</p>
8	DA	<p>Serial Control Input Equivalent</p>	<p><b>3-Wire bus input: Data</b>                      Data input of the serial control interface with Schmitt-Trigger input stage. The serial data are read into the internal shift register with the positive edge of CLK.</p>
10	CLK	<p>Serial Control Input Equivalent</p>	<p><b>3-Wire bus input: Clock</b>                      Clock input of the serial control interface with Schmitt-Trigger input stage</p>
11	MFO	<p>LD as Lock Detector</p>	<p><b>Lock detector output</b>                      Unipolar output of the phase detector in the form of a pulse-width modulated signal. In the locked state the output signal is at H-level. In standby mode the output is resistive. For test purpose the push pull output fo is enabled.</p>

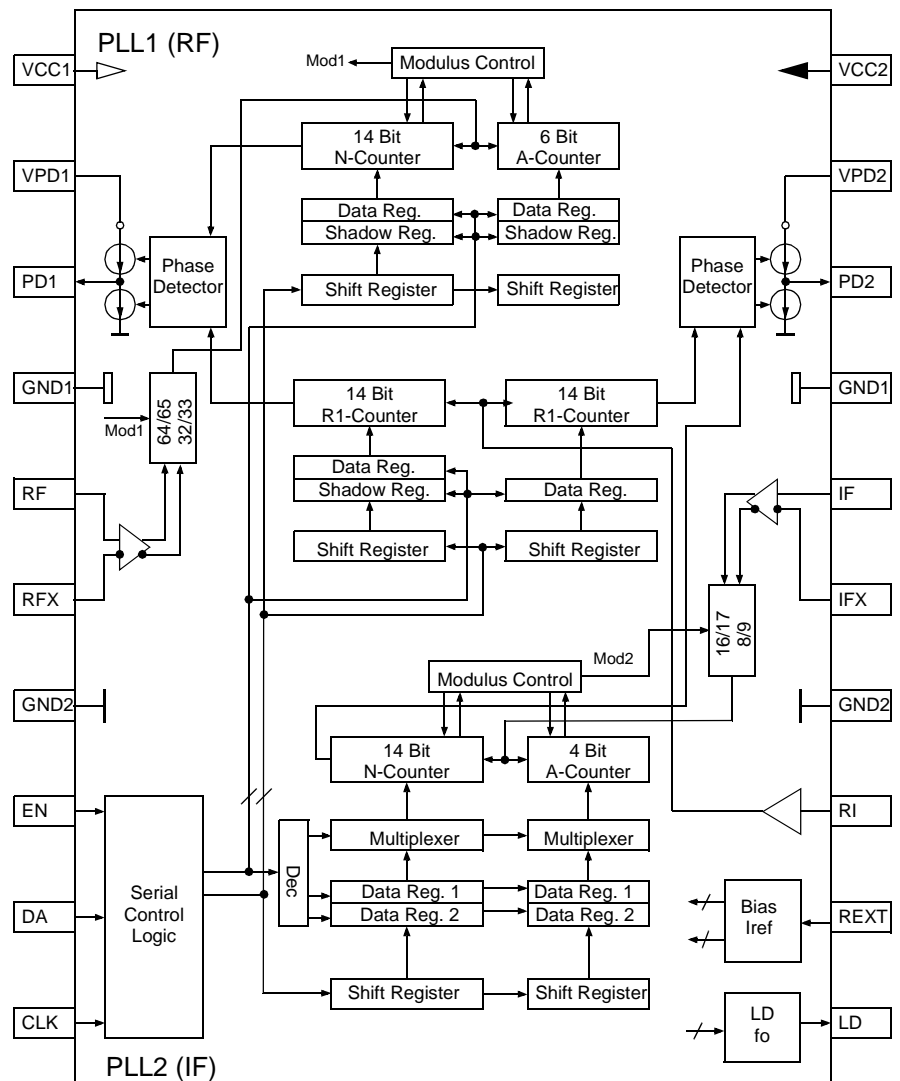
**Table 3-1 Pin Definition and Function (continued)**

Pin No.	Symbol	Equivalent I/O-Schematic	Function
12	Rext	<p>OSW Output Equivalent</p> 	<b>CP &amp; Prescaler reference current setting</b> External resistor for CP & Prescaler reference current setting.
14	RI	<p>RI Input Equivalent</p> 	<b>Reference frequency input</b> Input with highly sensitive preamplifier. With small input signals AC coupling must be set up, where DC coupling can be used for large input signals.
15	GND2		Ground for bipolar circuitry
16	IFX	<p>RF and IF Input Equivalent</p> 	<b>IF frequency input (inverted)</b> IF input with highly sensitive preamplifier for PLL2. AC coupling must be set up.
17	IF		<b>IF frequency input</b> IF input with highly sensitive preamplifier for PLL2. AC coupling must be set up.
18	GND1		Ground for CMOS circuitry

**Table 3-1 Pin Definition and Function (continued)**

Pin No.	Symbol	Equivalent I/O-Schematic	Function
19	CP2		Phase detector tristate charge pump output for PLL2
20	VPD2		Positive supply voltage for charge pump 2.
22	VCC2		Positive supply voltage for bipolar circuitry
9+21	BACK		Backplane - BIPOLAR ground recommended
13+24	NC		not connected

### 3.3 Functional Block Diagram



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Figure 3-2 Functional Block Diagram

## 3.4 Circuit Description

### 3.4.1 General Description

The PMB 2349 consists of two fully programmable PLLs, one for the RF and one for the IF frequency range. Each PLL contains a high frequency dual modulus prescaler, an A- and a N-counter with dual modulus control logic, a reference- (R-) counter, and a phase detector with charge pump output. The two synthesizers are controlled via the common serial 3-wire interface.

The reference frequency is applied at the common RI-input and divided by the R-counter of each PLL. Its maximum value is 45 MHz. The RF and IF input frequencies will be divided by the corresponding prescalers with a programmable 32/32 or 64/65 (RF) and 8/9 or 16/17 (IF) divide ratio and the following programmable A/N-counters. The maximum RF frequency value is 2.8 GHz and 600 MHz for the IF frequency.

The phase and frequency detectors with the charge pumps have a linear operating range without a dead zone for very small phase deviations.

The multifunctional output port LD/MFO can be programmed as lock detector and general purpose output.

### 3.4.2 Programming

Programming of the IC is done via the serial data interface. The content of the bus telegram (serial data format) is assigned to the functional units according to the address.

The most significant bit (MSB) of the serial data formats is shifted first.

The *short control data format* allows a fast PD-current change.

The *long control data format* allows the programming of asynchronous or synchronous data acquisition of PLL1 (RF), 4 different PD-output current modes for the PLL1 and 1 PD-output current modes for PLL2, polarity setting of the PD-output signals, 2 standby modes, charge pump pulse width and the prescaler divide ratio.

The *A/N-counter data format* of PLL1 contains the A/N-counter value.. The data format of PLL2 comprise the counter values as well.

The *R-counter data format* contains the R-counter values.

The PLL1 (RF) of PMB 2349 offers the possibility of synchronous counter and charge pump current programming to avoid phase errors at the phase detector when R- and A-/N-counter are programmed one after another or the charge pump current is altered.

*Asynchronous Mode:*

The serial data is written directly to the data registers of the addressed counter with the Enable pulse. As each counter is loading the new starting value after it is decremented to „zero“, the counters changes therefore their counter values asynchronously to the others.

*Synchronous Mode (only for RF):*

In this mode counter programming is controlled by the R- and N-counters. The serial data (exception: higher part of long control data format) is first written with the Enable pulse to the corresponding shadow registers. From there the values for R-counter, A-/N-counter and charge pump current values of short/long control data format are loaded into the corresponding data register when the N-counter reaches „zero+1“. Therefore the change of all counter states is synchronised to the reloading of the N-counter to avoid additional phase error caused by the programming. The transfer of the charge pump current values into the corresponding data register is tied to the N-counter loading, but follows the loading of the N-data register in the distance of one N-counter dividing ratio. This guarantees that a new PD-current value becomes valid at the same time when the counters are loaded with the new data.

Synchronous programming sequence:

1. Setting of synchronous counter programming by bit c13 of long control data format.
2. Programming of the R-counter, and optional short control data format. With the Enable signal data is loaded into the shadow registers.
3. Programming of the A/N-counter. Data is loaded into shadow registers, the EN-signal starts the synchronous transfer to the data registers.

Synchronous data programming is of especial advantage, when large frequency steps are to be made in a short time. For this purpose a high reference frequency can be programmed in order to achieve rapid – “rough” – transient response. This method increases the fundamental frequency by nearly the square root of the reference frequency ratio and therefore the settling time is reduced. When rough lock is achieved, another synchronous data transfer is needed to switch back to the original channel spacing. A “fine” lock in will finish the total step response. It may not be necessary to change reference frequency, but it make sense to perform synchronous data acquisition in any case. Especially for GSM, PCN (DCS 1800) and PCS systems the synchronous mode should be used to achieve best performance of the PMB 2347.



### 3.4.3 Standby Condition (power down)

Each PLL of the PMB 2349 has two programmable standby modes to reduce the current consumption (standby 1, standby 2).

**Standby 1:** The corresponding PLL is switched off, the current consumption is reduced below 1  $\mu$ A.

**Standby 2:** The corresponding counters, the charge pump and the outputs are switched off. Only the preamplifier of RI-input stays active. **(See standby table)**

### 3.4.4 Divide ratio programming

The frequency of an external VCO controlled by the PMB 2347 is given below:

$$f_{VCO} = [(P \cdot N) + A] \cdot \frac{f_{RI}}{R} = \frac{M}{R} \cdot f_{RI}$$

with  $A \leq N$ .

$f_{VCO}$ :	frequency of the external VCO
$f_{RI}$ :	reference frequency
N:	divide ratio of the N-counter
A:	divide ratio of the A-swallow counter
P:	divide ratio of the prescaler
R:	divide ratio of the R-counter
$M=P \cdot N + A$ :	total divide ratio

Note: for continuous frequency steps following condition is necessary  
 $[P \cdot N + A] \geq P \cdot (P - 1)$

### 3.4.5 Prescaler Divide Ratio

For the highest input frequencies of the prescalers the larger divide ratio is necessary:

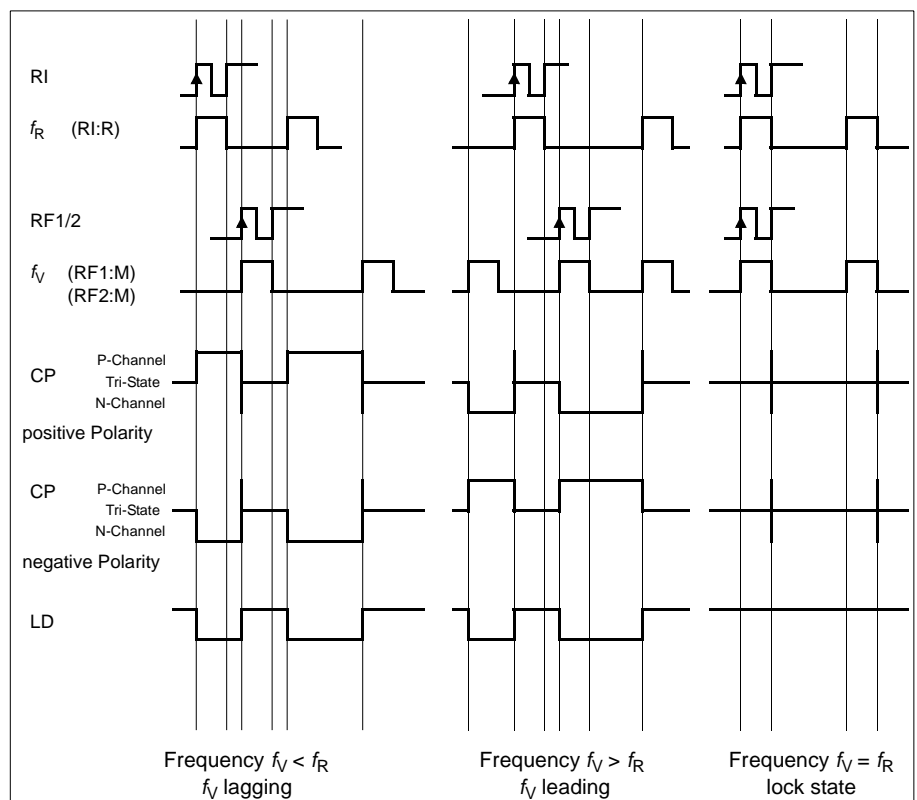
RF-PLL:	64/65 for frequencies greater 1500 MHz
IF-PLL:	16/17 for frequencies greater 375 MHz

### 3.4.6 Fast wake-up programming

When the circuit is connected to the supply voltage all registers are undefined. Due to the fact that each counter is loading its new start value after it is decremented to „zero“, the start-up time of the counters with the programmed values is too long for some applications. If the counters are programmed in standby mode 2 and the PLLs are switched afterwards in operating mode, the counters are starting immediately with the programmed values. Therefore following data transfer sequence is recommended:

Table 3-2 Fast Wake Up Data Transfer Sequence	
Step	Serial Data Transfer Sequence
1	Long Control Word: Asynchronous Mode, Standby2
2	R-Counter
3	A-/N-Counter
4	Long Control Word: Synchronous Mode, Operating Mode

### 3.4.7 Phase Detector Outputs



The timing diagram is valid for PLL1 and PLL2.

# 4 Applications

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## 4.1 Hint

More Information about "Application" see in separate Document

**APPLICATION NOTE PMB 2349.**

# 5 Reference

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## 5.1 Electrical Data

### 5.1.1 Absolute Maximum Ratings



#### WARNING

The maximum ratings may not be exceeded under any circumstances, not even momentarily and individually, as permanent damage to the IC will result.

Table 5-1 Absolute Maximum Ratings

#	Parameter	Symbol	Limit Values		Unit	Remarks
			min	max		
1	Supply Voltage	$V_{CC1/2}$	-0.3	5.5	V	
2	Input Voltage	$V_I$	-0.3	$V_{CC1/2}+0.3$	V	
3	Output Voltage	$V_O$	GND	$V_{CC1/2}$	V	
4	Total power dissipation	$P_{tot}$		300	mW	
5	Ambient temperature	$T_A$	-40	85	°C	in operation
6	Storage temperature	$T_{Stg}$	-50	125	°C	
7	Thermal Resistance	$R_{thJA}$		170	K/W	
8	ESD Integrity (according to MIL 883 Method 3015.7) except Pins Vpd1[2] and Vpd2[19]	$V_{ESD}$		0.5	KV	preliminary

### 5.1.2 Operating Range

Within the operational range the IC operates as described in the circuit description.

The AC/DC characteristic limits are not guaranteed.

**Table 5-2 Operating Range,  $V_{CC1/2} = 2.7V - 5.0V$ ,  $T_{AMB} = -27^{\circ}C$**

#	Parameter	Symbol	Limit Values		Unit	Test Conditions	L	Item
			min	max				
1	Supply Voltage	$V_{CC1/2}$	2.7	5.0	V			
2	Input frequency RF	$f_{RF}$	250	2800	MHz	$V_{CC1/2} = 3.6V$		
3	Input frequency IF	$f_{IF}$	100	600	MHz			
4	Input reference frequency	$f_{Ri}$	1	45	MHz			
5	CP-output current of PLL1	$I_{CP1}$		4 +20%	mA			
6	CP-output current of PLL2	$I_{CP2}$		1 +20%	mA			
7	CP-output voltages	$V_{CP1/2}$	0.5	$V_{PD1/2}$ - 0.5	V			
8	Ambient temperature	$T_A$	-40	85	$^{\circ}C$			

■ This value is guaranteed by design.

### 5.1.3 Typical Supply Current $I_{CC}$

**Table 5-3 Typical Supply Current  $I_{CC}$**

#	Parameter	Symbol	Limit Values			Unit	Test Conditions	Item
			min	typ	max			
1	Supply Voltage	$V_{CC1/2}$		2.7		V		
2	Supply current:							
3	PLL1 & PLL2 active	$I_{CC1/2}$	-20%	9402	+20%	$\mu A$	Note 1)	
4	PLL1 active, PLL2 standby	$I_{CC1/2}$	-20%	7840	+20%	$\mu A$		
5	PLL1 standby2, PLL2 active	$I_{CC1/2}$	-20%	3065	+20%	$\mu A$		
6	PLL1 & PLL2 standby 2	$I_{CC1/2}$		120		$\mu A$		
7	PLL1 & PLL2 standby 1	$I_{CC1/2}$		< 1		$\mu A$		

1)  $V_{CC1/2} = 2.7V$ ,  $R_{EXT} = 12k$ , RF-/IF- and Ri-inputs are open, 3WB optical interface,  $I_{CP1} = 4.0mA$ ,  $I_{CP2} = 2.0mA$ ,  $I_{ref} = 100 \mu A$

### 5.1.4 AC/DC Characteristics

AC/DC characteristics involve the spread of values guaranteed within the specified supply voltage and ambient temperature range. Typical characteristics are the median of the production.

Table 5-4 AC/DC Characteristics with  $V_{CC1/2}=2.7 \dots 5.0 \text{ V}$ , Ambient temperature  $T_{AMB}=27^{\circ}\text{C}$

	Symbol	Limit Values			Unit	Test Conditions	D	Item
		min	typ	max				
<b>Input Signals DA, CLK, EN (Schmitt-Trigger input stage)</b>								
H-input voltage	$V_{IH}$	$0.7 V_{CC}$		$V_{CC}$	V			
L-input voltage	$V_{IL}$			$0.3 V_{CC}$	V			
Input capacity	$C_I$			5	pF			
H-input current	$I_H$			10	$\mu\text{A}$	$V_I=V_{CC2}=3.6\text{V}$		2.3
L-input current	$I_L$	-10			$\mu\text{A}$	$V_I=\text{GND}$		2.4
<b>Input Signal RI</b>								
Input voltage	$V_I$	100			mVrms	$f=4 - 45 \text{ MHz}$ , $V_{CC1}=3.6\text{V}$		2.10
Slew rate		4			V/ $\mu\text{s}$	$V_{CC1}=2.7 - 5.0 \text{ V}$		
Input capacity	$C_I$			3	pF			
H-input current	$I_H$			30	$\mu\text{A}$	$V_I=V_{CC1}=3.6\text{V}$		2.13
L-input current	$I_L$	-30			$\mu\text{A}$	$V_I=\text{GND}$		
<b>Input Signals RF</b>								
Input voltage	$P_I$	-10		0	dBm	$f=150-500 \text{ MHz}$		3.1
Input voltage	$P_I$	-10		0	dBm	$f=500-1500 \text{ MHz}$		3.2
Input voltage	$P_I$	-20		-10	dBm	$f=1500-2500 \text{ MHz}$		3.3
Input voltage	$P_I$	-15		-10	dBm	$f=2500-2800 \text{ MHz}$		3.4
<b>Input Signals IF</b>								
Input voltage	$P_I$	-15		+4	dBm	$f=50 - 300 \text{ MHz}$		4.1
Input voltage	$P_I$	-25		-5	dBm	$f=200 - 450 \text{ MHz}$		4.2
Input voltage	$P_I$	-25		-15	dBm	$f=450 - 600 \text{ MHz}$		4.3



**Table 5-4 AC/DC Characteristics with  $V_{CC1/2}=2.7 \dots 5.0$  V, Ambient temperature  $T_{AMB}=27^{\circ}\text{C}$  (continued)**

	Symbol	Limit Values			Unit	Test Conditions	D	Item
<b>Output Current ICP1</b>								
"1.2 mA"	$I_{CP1}$	-20%	1.2	+20%	mA	$V_{PD1}=3.6\text{V}$ , $V_{CP1}=V_{PD1}/2$ $I_{REF}=100\mu\text{A}$	◆	5.1
"2.0 mA"	$I_{CP1}$	-20%	2.0	+20%	mA		◆	5.2
"2.8 mA"	$I_{CP1}$	-20%	2.8	+20%	mA		◆	5.3
"4.0 mA"	$I_{CP1}$	-20%	4.0	+20%	mA		◆	5.4
"Tristate"	$ I_{CP1} $		0.1	10*)	nA		■	5.5
<b>Output Current ICP2</b>								
"1.0 mA"	$I_{CP2}$	-20%		+20%	mA	$V_{PD1}=3.6\text{V}$ , $V_{CP2}=V_{PD2}/2$ $I_{REF}=100\mu\text{A}$	◆	
"Tristate"	$ I_{CP2} $		0.1	10*)	nA		■	
<b>Output Current Offset CP1 &amp; CP2</b>								
CP Supply Voltage	$V_{PD1/2}$	2.7	3.6	5.0	V	$V_{CP1/2} = V_{PD1/2}/2$		
CP Current Offset	$I_{CP-OFF}$	-4	0	+13	%			
<b>Current Mismatch</b>								
"1.2 mA"	$I_{CPMM}$				%	$V_{PD1}=3.6\text{V}$ , $V_{CP1} = V_{PD1}/2$ $I_{REF}=100\mu\text{A}$		
"2.0 mA"	$I_{CPMM}$				%			
"2.8 mA"	$I_{CPMM}$				%			
"4.0 mA"	$I_{CPMM}$				%			
<b>Output Rext</b>								
$V_{Rext}$	$V_{Rext}$		1.2		V	$V_{CC2} = 3.6\text{V}$ , $R_{ext}=12\text{k}$		10.1
$I_{Rext}$	$I_{Rext}$		100		$\mu\text{A}$	$V_{CC2} = 3.6\text{V}$ , $R_{ext}=12\text{k}$		
<b>Output Signal BSW at BSW/LD-Pin (n-channel open drain)</b>								
L-output voltage	$V_{OL}$			0.4	V	$V_{CC1} = 2.7 - 3.6\text{V}$ , $I_{OL} = 0.3\text{ mA}$		
Fall time	$t_F$		3	10	ns	$V_{CC1} = 3.6\text{V}$ , $C_1 = 10\text{pF}$		

■ these values are guaranteed by design

 ◆ see chapter 5.5.2 (Charge Pump Performance - Typical Performance) for  $V_{CP}$ -range CONSERVATIVE

## 5.2 Serial Control Data Format Timing

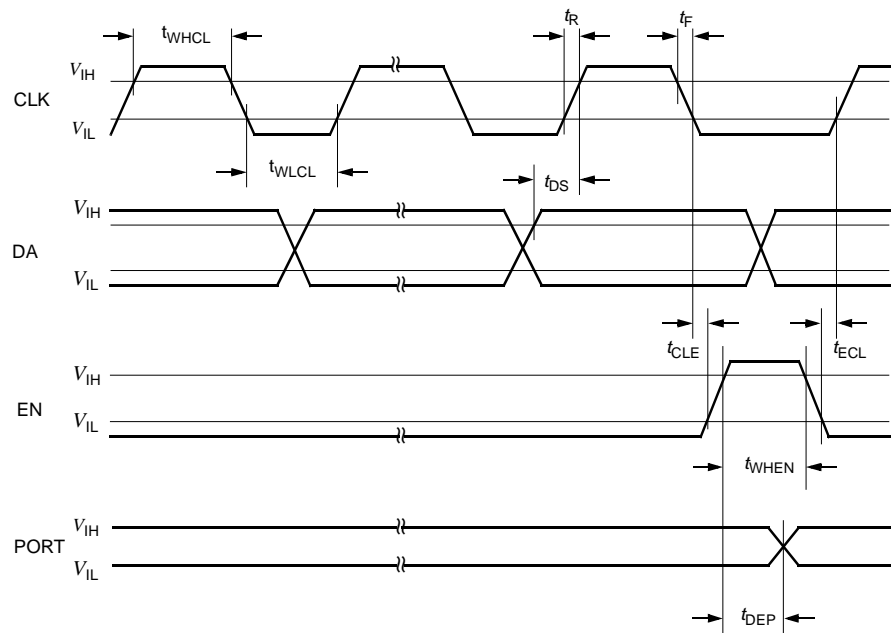


Table 5-5

Parameter	Symbol	Limit Values		Unit
		min.	max.	
Clock frequency	$f_{CL}$		15	MHz
H-pulsewidth (CLK)	$t_{WHCL}$	30		ns
L-pulsewidth (CLK)	$t_{WLCL}$	30		ns
Data setup	$t_{DS}$	20		ns
Setup time Clock-Enable	$t_{CLE}$	20		ns
Setup time Enable-Clock	$t_{ECL}$	20		ns
H-pulsewidth (Enable)	$t_{WHEN}$	60		ns
Rise, fall time	$t_R, t_F$		10	$\mu$ s
Propagation delay time EN-PORT	$t_{DEP}$		1	$\mu$ s

### 5.3 Serial Control Data Formats

Table 5-6 Address of Data Formats

Address			Data Format	Addressed PLL
a2	a1	a0		
0	0	0	Short Control Data Format	PLL1 (RF)
0	1	0	Long Control Data Format	PLL1 (RF)
1	0	0	A-/N-Counter	PLL1 (RF)
1	1	0	R-Counter	PLL1 (RF)
0	0	1	Short Control Data Format	PLL2 (IF)
0	1	1	Long Control Data Format	PLL2 (IF)
1	0	1	A-/N-Counter	PLL2 (IF)
1	1	1	R-Counter	PLL2 (IF)

In general each PLL can independently be addressed without affecting the other PLL (See also Test Modes).

**NOTE:** MSB of all serial data is shifted first

Table 5-7 Short Control Data Formats

PLL 1				PLL 2			
Bit		Bit	Function	Bit		Bit	Function
LSB				LSB			
0	0	a0	Address	0	1	a0	Address
1	0	a1	Address	1	0	a1	Address
2	0	a2	Address	2	0	a2	Address
3		c0	LD InActive	3		c0	reserved
4		c1	CP current 2	4		c1	reserved
5		c2	CP current 1	5		c2	CP current
6		c3	PLLSel	6		c3	reserved
MSB				MSB			

Table 5-8 Long Control Data Formats

PLL 1				PLL 2			
Bit		Bit	Function	Bit		Bit	Function
LSB				LSB			
0	0	a0	Address	0	1	a0	Address
1	1	a1	Address	1	1	a1	Address
2	0	a2	Address	2	0	a2	Address
3		c0	LD inactive	3		c0	RiAmp 2
4		c1	CP current 2	4		c1	RiAmp 1
5		c2	CP current 1	5		c2	CP current 1
6		c3	PLLSel	6		c3	Data-Reg Select
7		c4	PSC Div. Ratio	7		c4	PSC Div. Ratio

**Table 5-8 Long Control Data Formats (continued)**

PLL 1			PLL 2		
Bit	Bit	Function	Bit	Bit	Function
8	c5	reserved	8	c5	MFO
9	c6	CPP width 2	9	c6	CPP width 2
10	c7	CPP width 1	10	c7	CPP width 1
11	c8	standby 2	11	c8	standby 2
12	c9	standby 1	12	c9	standby 1
13	c10	CP polarity	13	c10	CP polarity
14	c11	Mode 2	14	c11	IBip 2
15	c12	Mode 1	15	c12	IBip 1
16 MSB	c13	Sync/Async Mode	16 MSB	c13	Rest / Rint

**Table 5-9 A/N-counter Data Formats**

PLL 1				PLL 2			
Bit	Bit	Bit	Function	Bit	Bit	Bit	Function
LSB				LSB			
0	0	a0	Address	0	1	a0	Address
1	1	a1	Address	1	0	a1	Address
2	0	a2	Address	2	1	a2	Address
3	LSB	n0		3	LSB	n0	
4		n1		4		n1	
5		n2		5		n2	
6		n3		6		n3	
7		n4		7		n4	
8		n5		8		n5	
9		n6	N1-Counter	9		n6	N2-Counter
10		n7		10		n7	
11		n8		11		n8	
12		n9		12		n9	
13		n10		13		n10	
14		n11		14		n11	
15		n12		15		n12	
16	MSB	n13		16	MSB	n13	
17	LSB	ac0		17	LSB	ac0	
18		ac1		18		ac1	A2-Counter
19		ac2		19		ac2	
20		ac3	A1-Counter	20	MSB	ac3	
21		ac4					
22	MSB	ac5					

**Table 5-10 R-counter Data Formats**

PLL 1				PLL 2			
Bit	Bit	Bit	Function	Bit	Bit	Bit	Function
LSB				LSB			
0	0	a0	Address	0	1	a0	Address
1	1	a1	Address	1	1	a1	Address
2	1	a2	Address	2	1	a2	Address
3	LSB	r0	R1-Counter	3	LSB	r0	R2-Counter
4		r1		4		r1	
5		r2		5		r2	
6		r3		6		r3	
7		r4		7		r4	
8		r5		8		r5	
9		r6		9		r6	
10		r7		10		r7	
11		r8		11		r8	
12		r9		12		r9	
13		r10	13		r10		
14		r11	14		r11		
15		r12	15		r12		
16	MSB	r13	16	MSB	r13		
MSB			MSB				

**Table 5-11 Programming of Operation and Test Modes**

c12 Mode 1	c11 Mode 2	c3 PLLsel	Functional Mode	Affected Output:
0	0	0	TEST MODE FVN - N/A-Counter	CP1 + CP2
1	0	0	TEST MODE FRN - R-Counter	CP1 + CP2
0	1	0	NORMAL OPERATION, MFO active	LD / MFO Pin
1	1	0	NORMAL OPERATION, LD of PLL1 active	LD / MFO Pin
0	0	1	TEST MODE FVN - N/A-Counter	CP1 + CP2
1	0	1	TEST MODE FRN - R-Counter	CP1 + CP2
0	1	1	NORMAL OPERATION, MFO active	LD / MFO Pin
1	1	1	NORMAL OPERATION, LD of PLL2 active	LD / MFO Pin

**Table 5-12 Programming of CP Current of PLL1**

c2 CP current 1	c1 Mode 2	CP Current [mA]	Remark
0	0	1.2 mA	with 100µA reference current ( Rext = 12k ohms )
1	0	2.0 mA	
0	1	2.8 mA	
1	1	4.0 mA	

**Table 5-13 Programming of CP Current of PLL2**

c2 CP current 1	CP Current [mA]	Remark
0	Tristate	with 100µA reference current
1	1.0 mA	

**Table 5-14 Programming of Charge Pump Pulse Width of both PLLs**

c7 CPP width 1	c6 CPP width 2	Pulse Width [ns] typ.	Remark
0	0	1.8 ns	
1	0	2.7 ns	
0	1	3.6 ns	
1	1	4.5 ns	

**Table 5-15 Standby of Power Down Programming of both PLLs**

Control Bits		Mode	Affected Output Pins Z: High Impedance (Tristate)		
c9 standby 1	c8 standby 2		Pin 11 LD/fo	Pin 3 CP1	Pin 18 CP2
0	0	standby1	off	Z	Z
1	0	standby2	off	Z	Z
0	1	standby1	off	Z	Z
1	1	Operation Mode	active	active	active

**Table 5-16 Programming of Synchronous/Asynchronous Mode of PLL1**

c13 Sync/Async	Synchronous/Asynchronous Mode
0	Asynchronous Mode of PLL 1
1	Synchronous Mode of PLL 1

**Table 5-17 Programming of PD Polarity of both PLLs**

Control Bit	PD Polarity
c10 PD Polarity	
0	negative Polarity
1	positive Polarity

**Table 5-18 Programming of Prescaler Divide Ratio of both PLLs**

Control Bit	Prescaler Divide Ratio	
<b>c4 PSC Div. Ratio</b>		
0	PLL1: 32/33	PLL2: 8/9
1	PLL1: 64/65	PLL2: 16/17

**Table 5-19 Programming of PLL Select**

Control Bit	PLL Select (LD mode)
<b>c3 of PLL1</b>	
0	PLL1 (RF)
1	PLL2 (IF)

**Table 5-20 Programming of Data Register Select**

Control Bits	IF Data Register Select
<b>c3 of PLL2</b>	
0	Data Register 1
1	Data Register 2

**Table 5-21 Programming of Reference Input Amplifier - RiAmp**

c0 of PLL2 RiAmp 2	c1 of PLL2 RiAmp 1	RiAmp Resonance Pole Position typical	Remark VCC1=VCC2= 2V7 (2V8)
0	0	9.0 MHz	nominal / recommended
1	0	11.2 MHz	
0	1	19.5 MHz	
1	1	28.2 MHz	

**Table 5-22 Programming of Bipolar Power Mode - IBip**

c11 of PLL2 IBip 2	c12 of PLL2 IBip 1	Bipolar Power Consumption	$f_{RF\ MAX}$	$f_{IF\ MAX}$	Remark
0	0	nominal	2.8 GHz	0.6 GHz	nominal / recommended
1	0	nominal + 20 %	2.8 GHz	0.6 GHz	not recommended
0	1	nominal - 40 %	2.0 GHz	0.4 GHz	powersave mode II
1	1	nominal - 20 %	2.5 GHz	0.5 GHz	powersave mode I

**Table 5-23 Programming of Rext / Rint Mode**

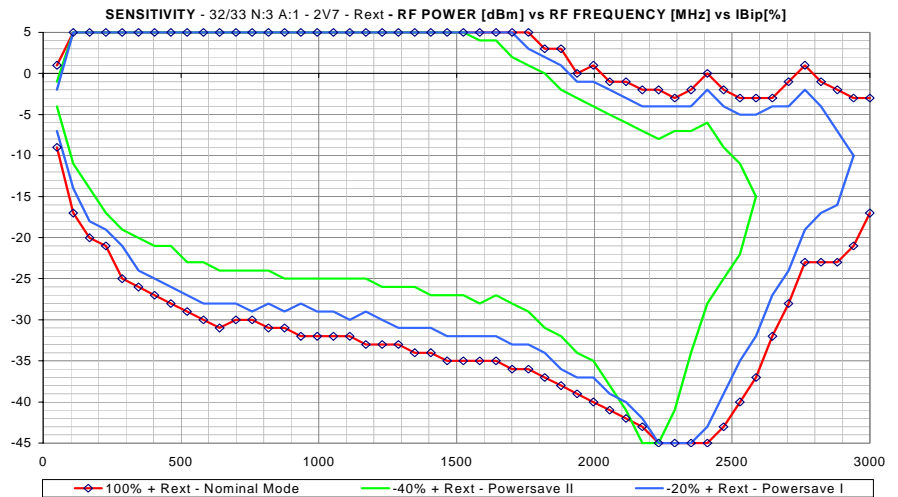
c13 of PLL2 Rext / Rint	External or Internal Reference Resistor
0	External @ Pin 12 - recommended
1	Internal Polysilicone Resistor - not recommended

## 5.4 Input Sensitivity

The following sections show the typical performance at +25°C.

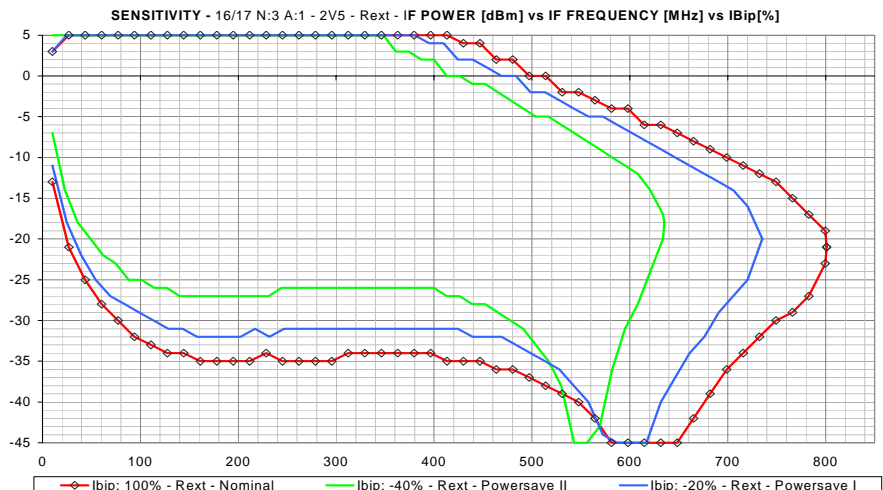
### 5.4.1 Typical RF Sensitivity

The PLL setup is: Psc:32/33, N:3, A:1, IF-PLL is in standby mode.  $V_{CC}$  is 2.7 V. Chip Mode is set to 'TEST MODE FVN'. This causes the N/A divider output to be fed to the SINK part of the chargepump (source is switched off all time.) Therefore a resistor which provides a current path from pin CPx to VCP (CP supply) is needed.



### 5.4.2 Typical IF Sensitivity:

The PLL setup is: Psc:16/17, N:3, A:1, RF-PLL is in standby mode.  $V_{CC}$  is 2.7 V..

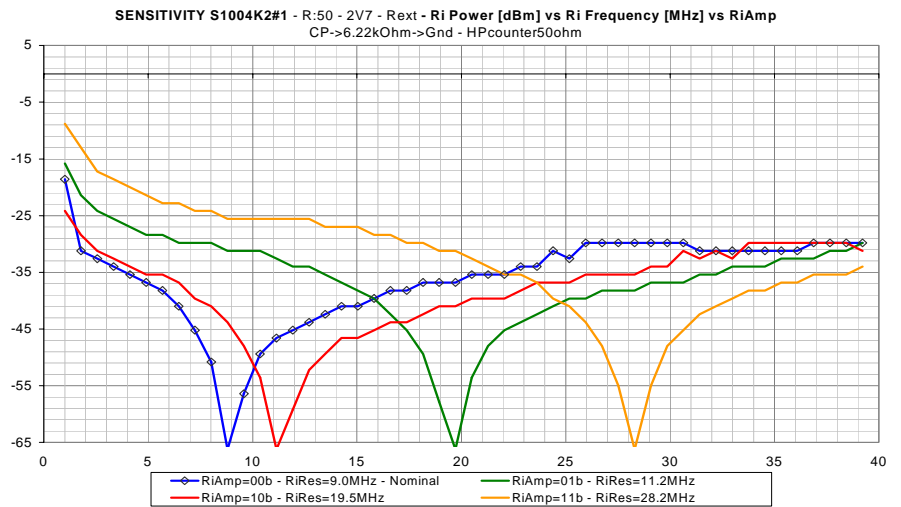




### 5.4.3 Typical Ri Sensitivity

The PLL setup is: R:50.  $V_{CC}$  is 2.7V.

Chip Mode is set to 'TEST MODE FRN'. This causes the R divider output to be fed to the SOURCE part of the chargepump (sink is switched off all time.) Therefore a resistor which provides a current path from pin CPx to GND (CP gnd) is needed.



## 5.5 Charge Pump Performance

### 5.5.1 Charge Pump Definition

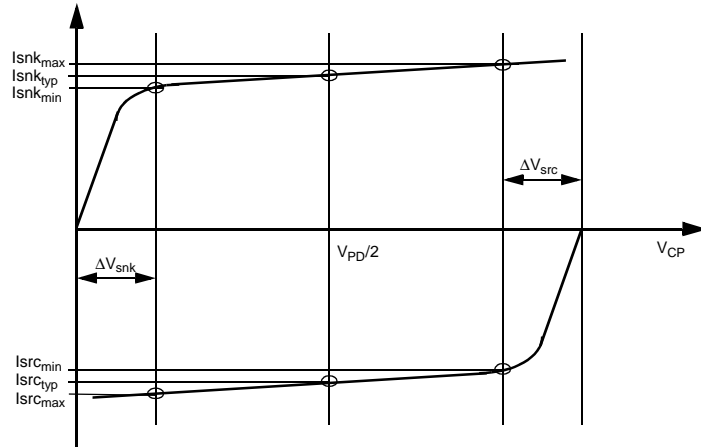


Figure 5-1 Definition of Charge Pump Currents

#### Terms and Abbreviations:

$V_{PD}$	Supply Voltage of Charge Pump
$\Delta V_{src/snk}$	Offset Voltage from GND or $V_{PD}$
$I_{snk_{max}}$	Maximum Sink Current @ $V_{PD}-\Delta V_{SRC}$
$I_{src_{max}}$	Maximum Source Current @ $GND+\Delta V_{SNK}$
$I_{snk_{typ}}$	Typical Sink Current @ $V_{PD}/2$
$I_{src_{typ}}$	Typical Source Current @ $V_{PD}/2$
$I_{snk_{min}}$	Minimum Sink Current @ $GND+\Delta V_{SNK}$
$I_{src_{min}}$	Minimum Source Current @ $V_{PD}-\Delta V_{SRC}$

#### Specification of Charge Pump Characteristics:

##### Charge Pump Output Magnitude Variation CPMV:

$$\frac{I_{snk_{max}} - I_{snk_{min}}}{\frac{I_{snk_{max}} + I_{snk_{min}}}{2}} \cdot 100\% \quad \frac{I_{src_{max}} - I_{src_{min}}}{\frac{I_{src_{max}} + I_{src_{min}}}{2}} \cdot 100\%$$

##### Charge Pump Current Mismatch CPCM:

$$\frac{I_{snk_{typ}} - I_{src_{typ}}}{\frac{I_{snk_{typ}} + I_{src_{typ}}}{2}} \cdot 100\%$$

### 5.5.2 Typical Performance

$V_{CP}$  is intended to be within  $\Delta V_{SNK}$  and  $V_{PD} - \Delta V_{SRC}$

System: standard GSM-application  
 RF: 900MHz, PD frequency: 200kHz,  $V_{CC}$ : 3.6V,  $T_A$ : -40...+85°C  
 $K_{VCO}$ : 10MHz/V,  $I_{CP}$ : 4mA  
 Loopfilter (C1,R2-C2,R3,C3): 270pF, 18kΩ-2.2uF, 12kΩ, 100pF

The following *typical* performance can be expected:

Table 5-24 Typical Performance	
<b><math>V_{CP}</math>-range #1 - LIBERAL</b> $\Delta V_{SNK} = 200mV$ $\Delta V_{SRC} = 500mV$	
	spurious suppression @200 kHz - better than -80 dB
	phase noise @ 1kHz / 2V7 - typical 85 dBc/Hz
	phase noise @ 1kHz / 3V6 - typical 88 dBc/Hz
<b><math>V_{CP}</math>-range #2 - CONSERVATIVE</b> $\Delta V_{SNK} = 600mV$ $\Delta V_{SRC} = 900mV$	
	performance of <b><math>V_{PD}</math>-range #1</b>
	CP current variation below +/-20%

### 5.6 Threshold Voltages of Schmitt-Trigger Input

