

# Low pass filter

## SPECIFICATION

### 1 FEATURES

- TSMC 0.18  $\mu\text{m}$
- Low noise figure
- High linearity
- Low pass filter cut-off frequency adjustment system
- Very low amplitude ripple
- Supported foundries: TSMC, UMC, Global Foundries, SMIC, iHP, AMS, Vanguard, SilTerra

### 2 APPLICATION

- Receivers
- IF signal processing

### 3 OVERVIEW

The IP1\_LPF\_01NT1 is the 8<sup>rd</sup> order Butterworth low pass filter with cut-off frequency adjustment. The block has two channels of differential inputs and outputs and based on a pseudodifferential circuit and Sallen-Key circuit. CO frequency can be set by the digital code LPF\_ctrl<7:0>.

The block is fabricated on TSMC 0.18  $\mu\text{m}$  technology.

### 4 STRUCTURE

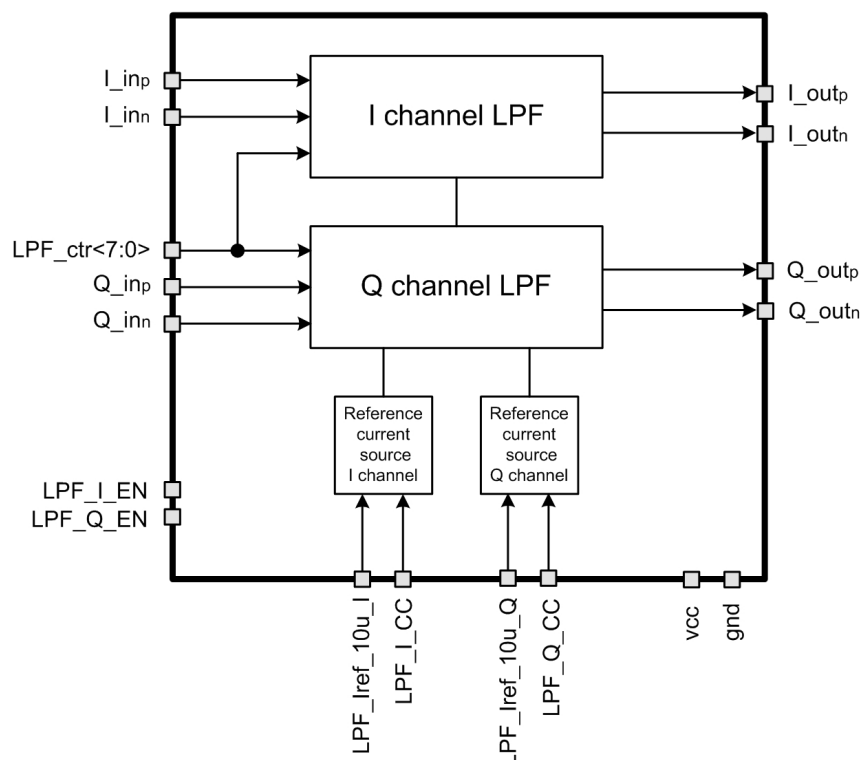


Figure 1: Low pass filter structure.

## 5 PIN DESCRIPTION

Name	Direction	Description
LPF_Iref_10u_I	IO	Reference current 10 $\mu$ A for I channel
LPF_Iref_10u_Q	IO	Reference current 10 $\mu$ A for Q channel
I_inp	I	LPF I channel differential input for
I_inn	I	
Q_inp	I	LPF Q channel differential input
Q_inn	I	
LPF_ctr<7:0>	I	Digital code of LPF cut-off frequency adjustment system
LPF_I_EN	I	LPF enable/disable for I channel
LPF_Q_EN	I	LPF enable/disable for Q channel
LPF_I_CC	I	I channel LPF current consumption control
LPF_Q_CC	I	LPF Q channel current consumption control
I_outp	O	LPF I channel differential output
I_outn	O	
Q_outp	O	LPF Q channel differential output
Q_outn	O	
vcc	IO	LPF supply voltage
gnd	IO	LPF ground

## 6 LAYOUT DESCRIPTION

Low pass filter dimensions are given in the table 1.

Table 1: Block dimensions.

Dimension	Value	Unit
Height	1360	$\mu\text{m}$
Width	1160	$\mu\text{m}$

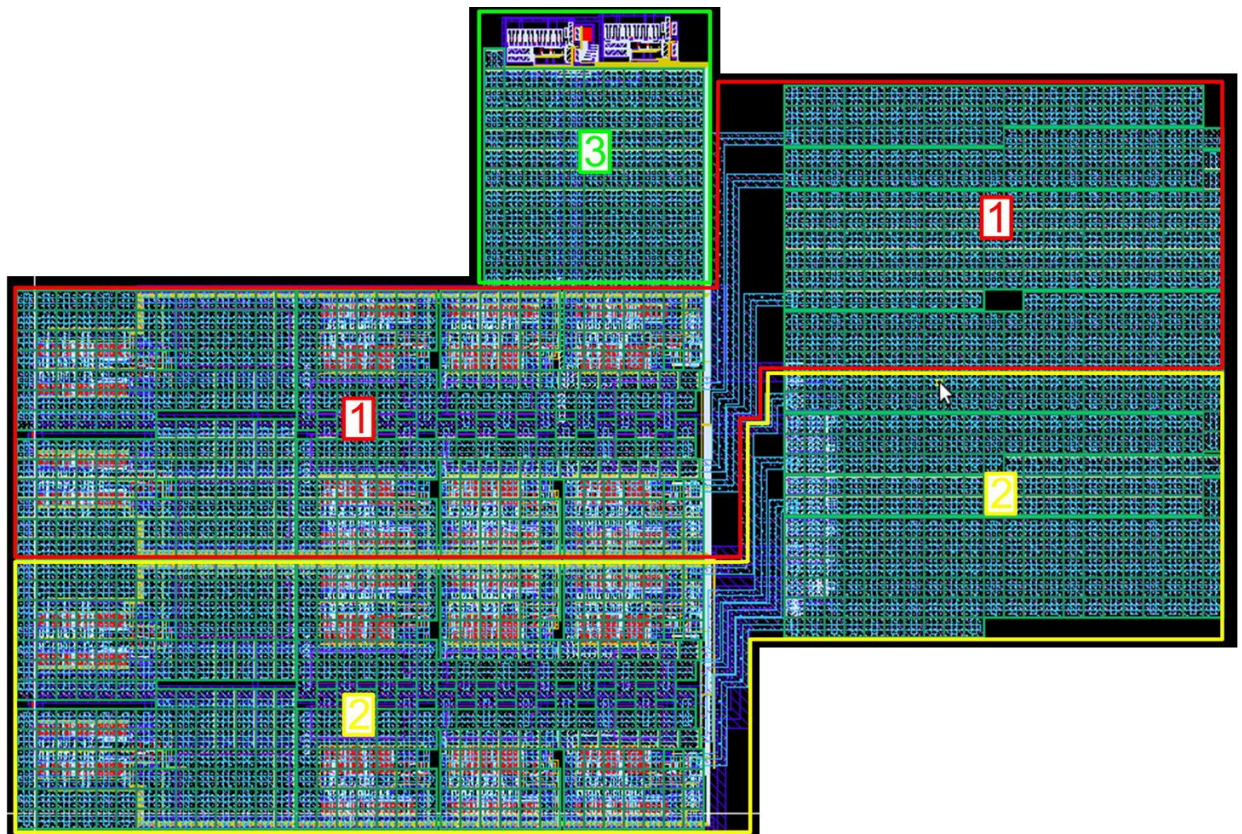


Figure 2: Low pass filter layout view.

1. The 1<sup>st</sup> differential stage
2. The 2<sup>nd</sup> differential stage
3. Reference current sources

## 7 OPERATING CHARACTERISTICS

### 7.1 TECHNICAL CHARACTERISTICS

Technology \_\_\_\_\_ TSMC 0.18  $\mu\text{m}$   
 Status \_\_\_\_\_ silicon proven  
 Area \_\_\_\_\_ 1.24  $\text{mm}^2$

### 7.2 ELECTRICAL CHARACTERISTICS

The values of electrical characteristics are specified for  $V_{cc} = 2.8 \div 3.6 \text{ V}$  и  $T = -45 \div +85^\circ\text{C}$ . Typical values are at  $V_{cc} = 3.0 \text{ V}$ ,  $T = +27^\circ\text{C}$ , unless otherwise specified.

Parameter	Symbol	Condition	Value			Unit
			min	typ	max	
Supply voltage	$V_{cc}$	-	2.8	3.0	3.6	V
Operating temperature range	T	-	-45	+27	85	$^\circ\text{C}$
Filter order	k	-	-	8	-	-
Insertion loss	G	In passband	1.5	0.1	-	dB
Cut-off frequency	F	-1 dB	6.5	-	23	MHz
Filter adjustment range	F	- 1 dB	1.5	-	5	MHz
		- 3 dB	1.6	-	7	MHz
		- 40 dB	3.2	-	17.5	MHz
Filter bandwidth*	F	- 1 dB	3.4	3.9	4.0	MHz
		- 3 dB	3.7	4.3	5.0	MHz
		- 40 dB	6.7	8.5	11.0	MHz
Noise figure	NF	Differential input 500 $\Omega$		24	26	dB
1 dB compression point	$P_{1dB}$	Differential input 500 $\Omega$	-3	1	-	dBm
Input impedance	R	Differential input 500 $\Omega$	530	600	680	$\Omega$
Supply current	$I_{cc}$	-	-	6.25	6.35	mA
Stand-by current	$I_{stb}$	-	-	0.01	0.1	$\mu\text{A}$
Input logic-level high	$V_{IH}$	For digital inputs	$0.7V_{cc}$	-	$V_{cc}+0.25$	V
Input logic-level low	$V_{IL}$		-0.25	-	0.3	V

Note:

\* – LPF\_ctr<7:0> = “01100100”.

## 8 DELIVERABLES

IP contents:

- Schematic or NetList
- Layout or blackbox
- Extracted view (optional)
- GDSII
- DRC, LVS, antenna report
- Test bench with saved configurations (optional)
- Documentation