

Integrated mixer oscillator PLL for satellite LNB

Rev. 1 — 13 January 2015

Product data sheet

## 1. General description

The TFF1024HN is an integrated downconverter for use in Low Noise Block (LNB) convertors in a 10.70 GHz to 12.85 GHz  $K_u$  band satellite receiver system.

### 2. Features and benefits

- Low current consumption integrated pre-amplifier, mixer, buffer amplifier and PLL synthesizer
- Flat gain over frequency
- Single 5 V supply pin
- Low cost 25 MHz crystal
- Crystal controlled LO frequency generation
- Switched LO frequency (selectable to 9.75 GHz, 10.00 GHz, 10.25 GHz, 10.55 GHz, 10.60 GHz, 10.75 GHz, 11.25 GHz or 11.30 GHz) with a 25 MHz crystal as reference
- Other LO frequencies within the 9.75 GHz to 11.30 GHz range can be realized by using an alternative reference frequency
- Low phase noise
- Low spurious
- Low external component count
- Alignment-free concept
- ESD protection on all pins

## 3. Applications

■ K<sub>u</sub> band LNB converters for VSAT and digital satellite reception (DVB-S / DVB-S2)

### 4. Quick reference data

#### Table 1.Quick reference data

9.75 GHz  $\leq$  f<sub>LO</sub>  $\leq$  11.30 GHz; operating conditions of <u>Table 6</u> apply.

Symbol	Parameter	Conditions	Min	Тур	Max	Unit
V <sub>CC</sub>	supply voltage	RF input and IF output AC coupled [1]	4.5	5	5.5	V
I <sub>CC</sub>	supply current	RF input and IF output AC coupled [1]	-	56	70	mA
NF <sub>SSB</sub>	single sideband noise figure	f <sub>IF</sub> = 1450 MHz; T <sub>amb</sub> = 25 °C; 10.55 GHz ≤ f <sub>LO</sub> ≤ 10.60 GHz	-	9.0	11.0	dB
f <sub>RF</sub>	RF frequency	[2]	10.70	-	12.85	GHz



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Symbol	Parameter	Conditions	Min	Typ	Max	Unit
eynisei				.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	max	•
G <sub>conv</sub>	conversion gain	f <sub>IF</sub> = 1450 MHz				
		f <sub>LO</sub> = 10.55 GHz	29.8	34.3	38.8	dB
		f <sub>LO</sub> = 10.60 GHz	29.8	34.3	38.8	dB
s <sub>11</sub>	input reflection coefficient	10.70 GHz $\leq$ f <sub>RF</sub> $\leq$ 12.85 GHz	-	-10	-	dB
s <sub>22</sub>	output reflection coefficient	950 MHz $\leq$ $f_{IF}$ $\leq$ 2150 MHz; Z_{0} = 75 $\Omega$	-	-10	-	dB
IP3 <sub>o</sub>	output third-order intercept point	carrier power = $-10 \text{ dBm}$ (measured at output)				
		$f_{IF}$ = 1450 MHz; 9.75 GHz $\leq f_{LO} \leq$ 10.75 GHz	14	18	-	dBm
		$f_{IF}$ = 1250 MHz; 11.25 GHz $\leq f_{LO} \leq$ 11.30 GHz	14	18	-	dBm

#### Table 1. Quick reference data ...continued

9.75 GHz  $\leq$  f<sub>LO</sub>  $\leq$  11.30 GHz; operating conditions of <u>Table 6</u> apply.

[1] DC values.

[2] See <u>Table 4</u> for specific values at certain settings of pins HB0, HB1 and HB2.

## 5. Ordering information

#### Table 2.Ordering information

Type number	Package	ackage					
	Name	Description	Version				
TFF1024HN	DHVQFN16	plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads;16 terminals; body $2.5 \times 3.5 \times 0.85$ mm	SOT763-1				

### 6. Functional diagram



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## 7. Pinning information

### 7.1 Pinning



### 7.2 Pin description

#### Table 3. Pin description

Symbol	Pin	Description
GND	0	ground (exposed die pad)
RF_GND3	1	RF ground. Connect this pin to the exposed die pad landing.
RF_GND1	2	RF ground. Connect this pin to the exposed die pad landing and the RF input CPW line.
n.c.	3	not connected. Connect to RF on PCB. [1]
RF	4	RF input.
RF_GND2	5	RF ground. Connect this pin to the exposed die pad landing and the RF input CPW line.
HB0	6	LO frequency selection, LSB. Connect this pin to GND for "0", leave open for "1". Also see Table 4.
n.c.	7	not connected. Use this pin to route the ground layer on top of the PCB to the exposed die pad.
LF	8	Loop filter PLL. Connect loop filter between this pin and VREG (pin 9).
VREG	9	Regulated output voltage for PLL loop filter. Connect loop filter to this pin. Decouple against die pad via pin 7.
HB2	10	LO frequency selection, MSB. Connect this pin to GND for "0", leave open for "1". Also see Table 4.
XO2	11	Crystal connection 2. Connect crystal between this pin and XO1 (pin 12).
XO1	12	Crystal connection 1. Connect crystal between this pin and XO2 (pin 11).
HB1	13	LO frequency selection. Connect this pin to GND for "0", leave open for "1". Also see Table 4.
IF	14	IF output
IF_GND	15	IF output ground. Connect this pin to the exposed die pad landing and the output transmission line ground.
V <sub>CC</sub>	16	Supply voltage

[1] The distance between the outer edges of pin 2 and pin 3 is 740  $\mu$ m. This gives an optimum transition from a 1.1 mm wide, Z<sub>0</sub> = 50  $\Omega$  line to the TFF1024HN on a Rogers RO4223 Printed-Circuit Board (PCB) material of 0.5 mm height.

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## 8. Functional description

### 8.1 LO frequency selection

Table 4.LO frequency selection tableSee Figure 1 for the functional diagram.

		0						
f <sub>LO</sub>	f <sub>xtal</sub>	HB2	HB1	HB1 HB0		f <sub>RF</sub> (GHz)		)
(GHz)	(MHz)	(pin 10)	(pin 13)	(pin 6)	Min	Max	Min	Max
9.75	25	0	0	0	10.70	11.90	950	2150
10.00	25	0	0	1	10.95	12.15	950	2150
10.25	25	0	1	0	11.20	12.40	950	2150
10.45 <mark>[1]</mark>	24.76	0	1	1	11.40	12.60	950	2150
10.55	25	0	1	1	11.50	12.70	950	2150
10.60	25	1	0	0	11.55	12.75	950	2150
10.75	25	1	0	1	11.70	12.85	950	2100
11.25	25	1	1	0	12.20	12.85	950	1600
11.30	25	1	1	1	12.25	12.85	950	1550

[1] For frequencies that cannot be achieved using the 25 MHz crystal choose the closest frequency and adapt the crystal frequency. Example: 10.45 GHz. This can be achieved by choosing 10.55 GHz. The divider ratio is 422. 10.45 GHz will be achieved with a crystal frequency of 10.45 GHz / 422 = 24.76303 MHz.

## 9. Limiting values

#### Table 5.Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>CC</sub>	supply voltage		-0.5	+6	V
Vi	input voltage	on pin HB0	-0.5	+6	V
		on pin HB1	-0.5	+6	V
		on pin HB2	-0.5	+6	V
T <sub>stg</sub>	storage temperature		-40	+125	°C

## **10.** Recommended operating conditions

Table 6.	Operating conditions					
Symbol	Parameter	Conditions	Min	Тур	Max	Unit
V <sub>CC</sub>	supply voltage	RF input and IF output AC coupled [1]	4.5	5	5.5	V
Vi	input voltage	on pin HB0	0	-	2.7	V
		on pin HB1	0	-	2.7	V
		on pin HB2	0	-	2.7	V
I <sub>CC(startup)</sub>	start-up supply current	during 30 ms only at supply power-on	300	-	-	mA
T <sub>amb</sub>	ambient temperature		-40	+25	+85	°C
Z <sub>0</sub>	characteristic impedance		-	50	-	Ω
f <sub>RF</sub>	RF frequency	[2]	10.70	-	12.85	GHz

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Table 0.	Operating conditionscontinued						
Symbol	Parameter	Conditions	Min	Тур	Max	Unit	
f <sub>LO</sub>	LO frequency	HB2 = 0; HB1 = 0; HB0 = 0 [3]	-	9.75	-	GHz	
		HB2 = 1; HB1 = 1; HB0 = 1 [4]	-	11.30	-	GHz	
f <sub>IF</sub>	IF frequency	[2]	950	-	2150	MHz	
C <sub>L(xtal)</sub>	crystal load capacitance		-	10	-	pF	
ESR	equivalent series resistance		-	-	40	Ω	
f <sub>xtal</sub>	crystal frequency		-	25	-	MHz	

#### Table 6. Operating conditions ...continued

[1] DC values.

[2] See Table 4 for specific values at certain settings of pins HB0, HB1 and HB2.

[3] The minimum LO frequency is specified. See Table 4 for other specific values at certain settings of pins HB0, HB1 and HB2.

[4] The maximum LO frequency is specified. See <u>Table 4</u> for other specific values at certain settings of pins HB0, HB1 and HB2.

### **11. Thermal characteristics**

Table 7.	Thermal characteristics				
Symbol	Parameter	Conditions	Тур	Unit	
R <sub>th(i-c)</sub>	thermal resistance from junction to case		35	K/W	

### **12. Characteristics**

#### Table 8. Characteristics

9.75 GHz  $\leq$  f<sub>LO</sub>  $\leq$  11.30 GHz; operating conditions of <u>Table 6</u> apply.

Symbol	Parameter	Conditions	Min	Тур	Max	Unit
I <sub>CC</sub>	supply current	RF input and IF output AC coupled [1]	-	56	70	mA
Φnλ(itg)RMS	RMS integrated phase noise density	loop bandwidth = crossover bandwidth; low ESR crystal used (ESR < 20 $\Omega$ )				
		integration offset frequency = 1 kHz to 1 MHz	-	1.2	2.2	deg
		integration offset frequency = 10 kHz to 13 MHz	-	1.2	2.2	deg
NF <sub>SSB</sub>	single sideband noise figure	f <sub>IF</sub> = 1450 MHz; T <sub>amb</sub> = 25 °C				
		f <sub>LO</sub> = 9.75 GHz	-	8.8	10.8	dB
		10.55 GHz $\leq$ f <sub>LO</sub> $\leq$ 10.60 GHz	-	9.0	11.0	dB
		f <sub>IF</sub> = 1250 MHz; T <sub>amb</sub> = 25 °C				
		11.25 GHz $\leq$ f <sub>LO</sub> $\leq$ 11.30 GHz	-	9.5	11.5	dB
G <sub>conv</sub>	conversion gain	f <sub>IF</sub> = 1450 MHz				
		f <sub>LO</sub> = 9.75 GHz	29.6	34.1	38.6	dB
		f <sub>LO</sub> = 10.00 GHz	29.5	34.0	38.5	dB
		f <sub>LO</sub> = 10.25 GHz	29.5	34.0	38.5	dB
		f <sub>LO</sub> = 10.55 GHz	29.8	34.3	38.8	dB
		f <sub>LO</sub> = 10.60 GHz	29.8	34.3	38.8	dB
		f <sub>LO</sub> = 10.75 GHz	30.2	34.7	39.2	dB
		f <sub>IF</sub> = 1250 MHz				
		f <sub>LO</sub> = 11.25 GHz	30.2	34.7	39.2	dB
		f <sub>LO</sub> = 11.30 GHz	30.1	34.6	39.1	dB

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Symbol	Parameter	Conditions		Min	Тур	Max	Unit
$\Delta G_{conv} / \Delta f$	conversion gain variation	over IF band; –40 °C $\leq$ T <sub>amb</sub> $\leq$ +85 °C; V <sub>CC</sub> = 5.0 V					
	with frequency	f <sub>LO</sub> = 9.75 GHz	[2]	-	-	2.5	dB
		f <sub>LO</sub> = 10.00 GHz	[2]	-	-	3.0	dB
		f <sub>LO</sub> = 10.25 GHz	[2]	-	-	3.6	dB
		f <sub>LO</sub> = 10.55 GHz	[2]	-	-	4.0	dB
		f <sub>LO</sub> = 10.60 GHz	[2]	-	-	4.0	dB
		f <sub>LO</sub> = 10.75 GHz	[2]	-	-	4.0	dB
		f <sub>LO</sub> = 11.25 GHz	[2]	-	-	3.0	dB
		f <sub>LO</sub> = 11.30 GHz	[2]	-	-	3.0	dB
		in every 36 MHz band; –40 °C $\leq$ $T_{amb}$ $\leq$ +85 °C; $V_{CC}$ = 5.0 V		-	-	0.6	dB
s <sub>11</sub>	input reflection coefficient	$10.70 \text{ GHz} \leq f_{RF} \leq 12.85 \text{ GHz}$		-	-10	-	dB
s <sub>22</sub>	output reflection coefficient	950 MHz $\leq$ f_{IF} $\leq$ 2150 MHz; Z_{0} = 75 $\Omega$		-	-10	-	dB
IP3 <sub>o</sub>	output third-order intercept point	carrier power is -10 dBm (measured at the output)					
		$f_{\text{IF}}$ = 1450 MHz; 9.75 GHz $\leq f_{\text{LO}} \leq$ 10.75 GHz		14	18	-	dBm
		$f_{\text{IF}}$ = 1250 MHz; 11.25 GHz $\leq f_{\text{LO}} \leq$ 11.30 GHz		14	18	-	dBm
P <sub>L(1dB)</sub>	output power at 1 dB gain compression	measured at the output					
		$f_{\text{IF}}$ = 1450 MHz; 9.75 GHz $\leq f_{\text{LO}} \leq$ 10.75 GHz		2	6	-	dBm
		$f_{\text{IF}}$ = 1250 MHz; 11.25 GHz $\leq f_{\text{LO}} \leq$ 11.30 GHz		2	6	-	dBm
$\alpha_{L(RF)lo}$	local oscillator RF leakage	$f_c = f_{LO}$ ; span = 100 MHz; RBW = 50 kHz; VBW = 200 kHz		-	-	-35	dBm
V <sub>IL</sub>	LOW-level input voltage	on pin HB0		-	-	0.8	V
		on pin HB1		-	-	0.8	V
		on pin HB2		-	-	0.8	V
V <sub>IH</sub>	HIGH-level input voltage	on pin HB0		1.6	-	2.7	V
		on pin HB1		1.6	-	2.7	V
		on pin HB2		1.6	-	2.7	V
R <sub>pu</sub>	pull-up resistance	on pin HB0		80	110	140	kΩ
		on pin HB1		80	110	140	kΩ
		on pin HB2		80	110	140	kΩ

#### Table 8. Characteristics ...continued

9.75 GHz  $\leq$  f<sub>LO</sub>  $\leq$  11.30 GHz; operating conditions of <u>Table 6</u> apply.

[1] DC values.

[2] See <u>Table 4</u> for the corresponding  $f_{IF}$  ranges.

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#### 12.1 Graphs

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## **13. Application information**



## Table 9. List of netnames See Figure 11

See <u>Figure 11</u> .				
Netname	Description			
GH	Gate voltage of 1st stage LNA. Horizontal polarization			
DH	Drain voltage of 1st stage LNA. Horizontal polarization			
GV	Gate voltage of 1st stage LNA. Vertical polarization			
DV	Drain voltage of 1st stage LNA. Vertical polarization			
G2	Gate voltage of 2nd stage LNA			
D2	Drain voltage of 2nd stage LNA			
HB0	LO frequency selection, LSB			
HB1	LO frequency selection			
HB2	LO frequency selection, MSB			

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### 14. Package outline



#### DHVQFN16: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 16 terminals; body 2.5 x 3.5 x 0.85 mm SOT763-1

Fig 13. Package outline SOT763-1

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## **15. Abbreviations**

Table 10. Abbreviations			
Acronym	Description		
CPW	CoPlanar Waveguide		
DVB-S	Digital Video Broadcasting by Satellite		
DVB-S2	Digital Video Broadcasting - Satellite - Second generation		
ESD	ElectroStatic Discharge		
IF	Intermediate Frequency		
K <sub>u</sub> band	K-under band		
LNA	Low-Noise Amplifier		
LNB	Low-Noise Block		
LO	Local Oscillator		
LSB	Least Significant Bit		
MSB	Most Significant Bit		
pHEMT	Pseudomorphic High Electron Mobility Transistor		
PLL	Phase-Locked Loop		
RBW	Resolution BandWidth		
VSAT	Very Small Aperture Terminal		
V/T	Voltage / Tone		
VBW	Video BandWidth		

## 16. Revision history

#### Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
TFF1024HN v.1	20150113	Product data sheet	-	-

#### Integrated mixer oscillator PLL for satellite LNB

## 17. Legal information

### 17.1 Data sheet status

Document status[1][2]	Product status <sup>[3]</sup>	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
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- Приемлемые сроки поставки, возможна ускоренная поставка.
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- Комплексную поставку.
- Работу по проектам и поставку образцов.
- Формирование склада под заказчика.
- Сертификаты соответствия на поставляемую продукцию (по желанию клиента).
- Тестирование поставляемой продукции.
- Поставку компонентов, требующих военную и космическую приемку.
- Входной контроль качества.
- Наличие сертификата ISO.

В составе нашей компании организован Конструкторский отдел, призванный помогать разработчикам, и инженерам.

Конструкторский отдел помогает осуществить:

- Регистрацию проекта у производителя компонентов.
- Техническую поддержку проекта.
- Защиту от снятия компонента с производства.
- Оценку стоимости проекта по компонентам.
- Изготовление тестовой платы монтаж и пусконаладочные работы.



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