

Module:	OSC_LP_180	Locus Ltd
Description:	Low power oscillator insensitive variations of power supply voltage and temperature	Status: First silicon
Version:	1.0	Date: 16.03.2016.

Description

The oscillator block schematic is presented in Fig. 1. It consists of a low-power current-voltage reference circuit, comparator (operational amplifier), voltage controlled oscillator (5-stage current starved ring oscillator, VCO), frequency divider and frequency-to-voltage converter (FVC). The FVC input is the signal that has the frequency equal to the output frequency divided M times and the output is the voltage V_{FVC} .

The FVC input is the signal that has the frequency equal to the output frequency divided M times and the output is the voltage V_{FVC} . In addition to the frequency, the voltage V_{FVC} depends also on the current I_{FVC} . Together with the divider, the FVC circuit forms a negative feedback loop. The loop is locked when the reference voltage V_{REF} , which is proportional to the current I_R , is equal to the voltage V_{FVC} at the FVC output. The operational amplifier forces $V_{REF}=V_{FVC}$ by changing the oscillator frequency.

The idea is to make both V_{REF} and V_{FVC} proportional to the currents I_R and I_{FVC} , which are generated in the same I-V reference circuit. Since $V_{REF}=V_{FVC}$, the current variations will cancel each other and the oscillator frequency will be stable and independent of the current variations. The frequency is trimmable using one bit digital control.

The oscillator is implemented in 0.18 μm CMOS technology.

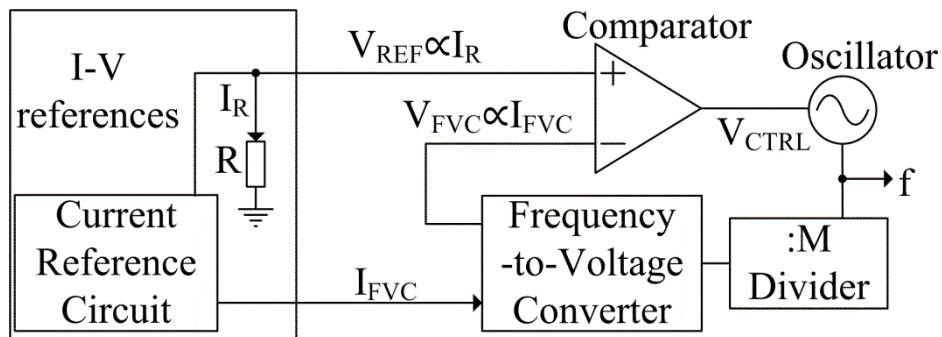


Figure 1 Block schematic of the oscillator

Pins

Table 1 Oscillator pins

Pin	Type	Description	Condition		
			Min.	Typ.	Max.
AVDD	I(nput)/O(utput)	Supply voltage	1.2 V	1.4 V	1.8 V
AVSS	I/O	Ground	0 V	0 V	0 V
Fout	O	Oscillator output	-	-	-
Fout_div2	O	Oscillator output ÷2	-	-	-
EN_OSC	I	Enable oscillator	0	-	AVDD
TRIMM	I	1-bit freq. trimming	0	-	AVDD

Measured characteristics

The oscillator does not require a stable reference current or stable reference voltage to obtain stable frequency independent of voltage and temperature variations because of the used negative feedback. The oscillator performance is measured for three supply voltages (1.2 V, 1.4 V and 1.8 V) in the temperature range from -20 °C to 80 °C. The measured frequency varies -1.66%/+0.36% while the simulated variation of the reference current is much larger, i.e. -11/+25%, which proves that the frequency is practically independent of the reference current variations. The frequency temperature coefficient of the oscillator is 135 ppm/°C and it depends only on the temperature coefficient of the resistor R, as predicted by the derived equation for the oscillator frequency. The measured oscillator consumption is 7.4 °W at 1.4 V/ 3.66 MHz. Fig. 2 presents frequency dependence on temperature and the supply voltage variations with respect to frequency at room temperature which is 3.66 MHz. Table 2 presents the oscillator characteristics. Fig. 3. presents measured frequency captured on the oscilloscope Agilent Infinivisiond MSO7034B.

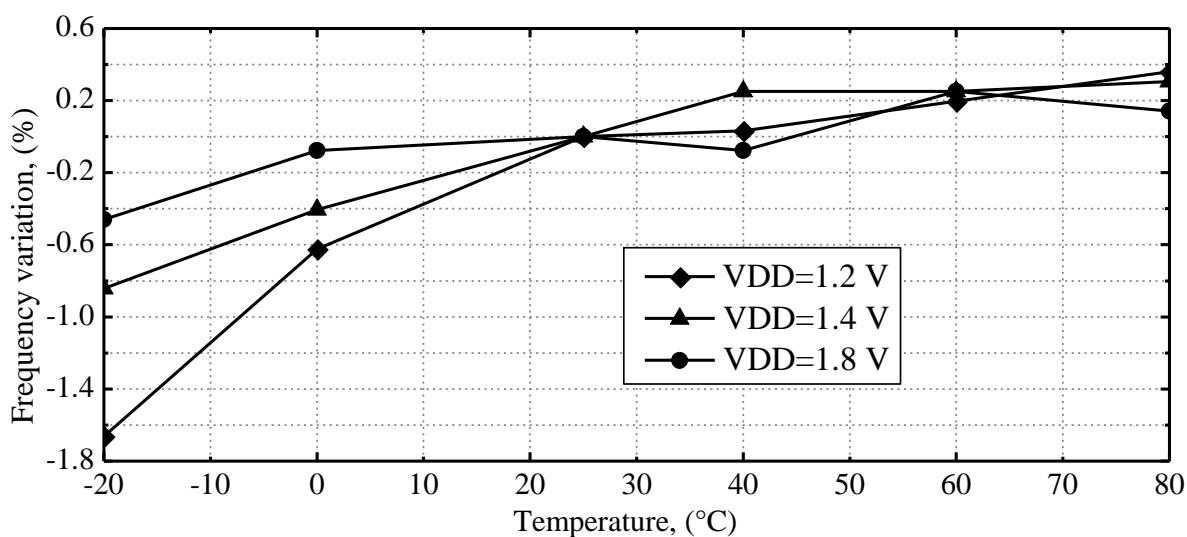


Figure 2 Measured frequency variations

Table 2 Oscillator performance

Description	Units	Condition		
		Min.	Typ.	Max.
Power consumption	µW	-	7.4	-
Supply voltage	V	1.2	1.4	1.8
Frequency	MHz	-	3.66	-
Temperature range	°C	-20	-	80
Frequency temp. coefficient	ppm/°C	-	135	-

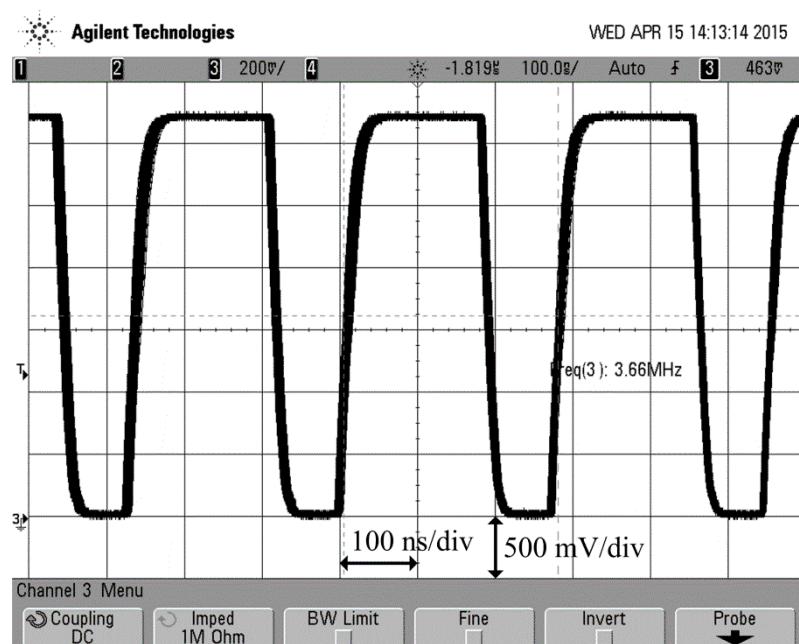


Figure 3 Example of the captured oscillator waveform