1 MHz – 6 GHz RF Mixer with built in PLL Synthesizer

Features
- Open source Labview GUI software control via USB
- Run hardware functions with or without a PC
- Use as an RF Mixer or as an RF Signal Generator
- Upconvert or Downconvert
- 1Hz frequency resolution PLL
- Mixer input frequencies from 1MHz – 6GHz
- Mixer output frequencies from 5MHz – 4.5GHz
- LO output frequencies from 85MHz – 5GHz
- 3mS LO RF lock time standard
- Up to +7dBm signal generator output power
- 10MHz – 100MHz external reference input
- 2.5ppm internal 10MHz reference
- Internal and external Frequency Shift Modulation
- 2.5” X 1.375” X 0.75” (6.35cm X 3.5cm X 1.9cm)

Overview Description
The Windfreak MixNV is a 1MHz to 6GHz software programmable RF mixer which can up-convert, down-convert, or act as an RF Signal Generator. It has a built-in Phase Locked Local Oscillator controlled and powered by a PC running Windows, Android or Linux via its USB port. (Android and Linux require free 3rd party command line terminal software).

The oscillator will tune from 85MHz to 4.2GHz in 1Hz steps using an advanced sigma-delta modulator PLL that delivers low fractional spurious products and excellent phase noise. (Tunes to 5GHz with reduced performance.)

The MixNV also has nonvolatile on board memory so it can be programmed to fire up by itself to any LO frequency, FSK modulation, or other settings. This allows the end user to put it in a box or rack without the need for PC control.

Applications
- Wireless communications systems
- RF and Microwave radios
- Software Defined Radio (SDR)
- $20 RTL-SDR 6GHz Frequency Extender
- Superheterodyne Receiver
- Frequency Up Conversion
- Frequency Down Conversion
- Frequency Shift Key Modulator
- Automated Test Equipment (ATE)
- Radar
- Quantum device research

© Windfreak Technologies, LLC. 2016. All rights reserved.
Contents

1 Characteristics ............................................................................................................................................. 3
  1.1 Electrical Characteristics ....................................................................................................................... 3
  1.2 Thermal Operating Characteristics ....................................................................................................... 4

2 Typical Performance .................................................................................................................................... 5
  2.1 LO Mode RF Output Power ...................................................................................................................... 5
  2.2 LO Mode RF Output Harmonic Content ................................................................................................. 6
  2.3 Mixer Mode Conversion Gain ................................................................................................................ 7
  2.4 LO Feedthrough ..................................................................................................................................... 9
  2.5 LO Phase Noise ..................................................................................................................................... 10
  2.6 Mixer Mode Intermodulation Distortion ............................................................................................... 11

3 Device Information ..................................................................................................................................... 12
  3.1 Mechanical Dimensions ....................................................................................................................... 12
  3.2 Typical Product Photos .......................................................................................................................... 13
# 1 Characteristics

## 1.1 Electrical Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Notes</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>From Power Plug</td>
<td>4.0</td>
<td>5.0</td>
<td>6.0</td>
<td>V</td>
</tr>
<tr>
<td>Supply Voltage *1</td>
<td>From USB Connector</td>
<td>4.5</td>
<td>5.0</td>
<td>6.0</td>
<td>V</td>
</tr>
<tr>
<td>Supply Current</td>
<td></td>
<td>120</td>
<td>200</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>Mixer Input Frequency Range</td>
<td></td>
<td>1</td>
<td>-</td>
<td>6000</td>
<td>MHz</td>
</tr>
<tr>
<td>Mixer Output Frequency Range</td>
<td></td>
<td>5</td>
<td></td>
<td>4500</td>
<td>MHz</td>
</tr>
<tr>
<td>LO Frequency Range Over full temperature range</td>
<td></td>
<td>85</td>
<td></td>
<td>4200</td>
<td>MHz</td>
</tr>
<tr>
<td>LO Frequency Range At room temperature</td>
<td></td>
<td>85</td>
<td></td>
<td>5000</td>
<td>MHz</td>
</tr>
<tr>
<td>LO RF Output Power See Section 2.1 Graphs</td>
<td></td>
<td>7</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Down Conversion Gain Output at 5MHz – 500MHz</td>
<td></td>
<td>-7</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Up Conversion Gain See Section 2.3 Graphs</td>
<td></td>
<td>-10</td>
<td>-7</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>RF Input / Output Impedance</td>
<td></td>
<td>50</td>
<td></td>
<td></td>
<td>Ω</td>
</tr>
<tr>
<td>RF Input Maximum Power</td>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>dBm</td>
</tr>
<tr>
<td>RF Input P1dB</td>
<td>Mixer Mode Linearity = 7</td>
<td>10</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Phase Noise (LO = 1GHz) 10KHz Offset</td>
<td>100MHz Ext Reference</td>
<td>-108</td>
<td></td>
<td></td>
<td>dBc/Hz</td>
</tr>
<tr>
<td></td>
<td>10MHz Int Reference</td>
<td>-98</td>
<td></td>
<td></td>
<td>dBc/Hz</td>
</tr>
<tr>
<td>Phase Noise (LO = 2GHz) 10KHz Offset</td>
<td>100MHz Ext Reference</td>
<td>-102</td>
<td></td>
<td></td>
<td>dBc/Hz</td>
</tr>
<tr>
<td></td>
<td>10MHz Int Reference</td>
<td>-92</td>
<td></td>
<td></td>
<td>dBc/Hz</td>
</tr>
<tr>
<td>Phase Noise (LO = 3GHz) 10KHz Offset</td>
<td>100MHz Ext Reference</td>
<td>-98</td>
<td></td>
<td></td>
<td>dBc/Hz</td>
</tr>
<tr>
<td></td>
<td>10MHz Int Reference</td>
<td>-88</td>
<td></td>
<td></td>
<td>dBc/Hz</td>
</tr>
<tr>
<td>Phase Noise (LO = 4GHz) 10KHz Offset</td>
<td>100MHz Ext Reference</td>
<td>-96</td>
<td></td>
<td></td>
<td>dBc/Hz</td>
</tr>
<tr>
<td></td>
<td>10MHz Int Reference</td>
<td>-86</td>
<td></td>
<td></td>
<td>dBc/Hz</td>
</tr>
<tr>
<td>Mixer Noise Figure Mixer Mode Linearity = 7</td>
<td></td>
<td>15</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>Mixer Mode Linearity = 2</td>
<td></td>
<td></td>
<td>11</td>
<td>dB</td>
</tr>
<tr>
<td>IIP3 (See Section 2.6)</td>
<td>Mixer Mode Linearity = 5</td>
<td></td>
<td></td>
<td>23</td>
<td>dBm</td>
</tr>
<tr>
<td></td>
<td>Mixer Mode Linearity = 1</td>
<td></td>
<td></td>
<td>10</td>
<td>dB</td>
</tr>
<tr>
<td>Internal Reference Frequency</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>MHz</td>
</tr>
</tbody>
</table>
Notes: *1 Keep power plug voltage at or above Vusb to draw current from the power plug, rather than Vusb. A diode protects Vusb from reverse current back into the computers USB port.

1.2 Thermal Operating Characteristics

<table>
<thead>
<tr>
<th>Description</th>
<th>Notes</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temperature</td>
<td>By design</td>
<td>-40</td>
<td>85</td>
<td>°C</td>
</tr>
</tbody>
</table>
2 Typical Performance

2.1 LO Mode RF Output Power

The typical LO Mode output power of the MixNV is shown below. The MixNV has two modes, Mixer Mode and LO Mode. LO Mode biases the mixer and allows maximum LO feedthrough so the device can be used as a basic RF Signal Generator. The MixNV has a 3-bit power setting in LO Mode, settable from 0 (minimum power) to 7 (maximum power).
The minimum power setting of 0 is LO feed through and very low power as shown in the next graph.

![MixNV 1.4a LO Mode Typical Output Power for LO Power Setting 0](image)

### 2.2 LO Mode RF Output Harmonic Content

The typical MixNV LO Mode harmonic distortion is shown below for the second and third harmonics. This data is taken at the maximum LO power setting of 7 and shown in dBc.

If lower harmonic levels are needed, Windfreak Technologies suggest the use of low cost SMA filters from Crystek. A $25 1GHz example would be the CLPFL-1000. There are usually many different frequency cut-offs in stock at Digikey.

![MixNV LO Mode Harmonic Suppression at Max Power Setting](image)
2.3 Mixer Mode Conversion Gain

The MixNV has a dedicated input and output. It is not bi-directional. The Gilbert Cell mixer itself is passive and thus has negative gain. To use this device as an upconverter or downconverter it should be treated as a normal mixer with consideration to LO feedthrough, Upper Side Band and Lower Side Band images with associated spectral inversions, input RF feedthrough and all associated harmonics and their products.

All plots in this section are made with a Mixer Linearity Setting of 3.
Downconversion Gain with various RF Input Frequencies using Low Side LO Injection (RFout = RFin - LO)

Downconversion Gain to 100MHz RF out

Upconversion Gain with Input Signals 1MHz, 60MHz, 150MHz
2.4 LO Feedthrough

LO feedthrough in Mixer Mode with 50 ohm terminated input and no input signal.
2.5 LO Phase Noise

Phase noise in LO Mode and Mixer Mode will be similar. Phase noise on the local oscillator is better at low RF carrier frequencies and gets worse at higher frequencies. See plot for typical phase noise at 2.6GHz with two different reference options. Phase noise (and frequency accuracy in general) can be made better with an external reference. Higher reference frequencies yield higher phase comparison frequencies and thus better phase noise. The MixNV highest phase comparison frequency is 50 MHz, so it automatically divides the reference frequency by 2 when the reference frequency is over 50MHz.
2.6 Mixer Mode Intermodulation Distortion

In the Down Conversion example below the MixNV is fed two tones on either side of 1GHz at -10dBm with a 1MHz separation in each tone. The LO is set to 900 MHz low side injection giving a 100MHz IF output with 7dB of loss in the fundamental signal giving -17dBm of fundamental power in each output tone. IMD is measured at roughly -83dBm. This gives an OIP3 of +16dBm. Factoring in the gain of the mixer stage gives +23dBm of IIP3.
3 Device Information

3.1 Mechanical Dimensions

Figure 1. Outer Dimensions in Inches
3.2 Typical Product Photos

Reference and ROut

USB, Power and RFin