LOW PHASE NOISE REGENERATIVE DIVIDER

For calibration and testing of oscillators by frequency standard laboratories, there is a need to convert 10 MHz signals to a frequency of 5MHz, without affecting the original stability and phase noise characteristics of the 10 MHz input signal.

This paper presents a high performance regenerative frequency divider with excellent short-term stability and ultra-low phase noise as a useful high performance tool for the time and frequency laboratory. The input and output impedance and phase noise of a frequency divider are not the only important parameters that need to be considered. Other important terms such as the gain, stability over temperature, harmonic distortion, construction techniques, and design practices must be taken into account. Most of these parameters can be rigorously related in an equation to deliver an expected level of performance from the system. Typical manufacturing and design practices that are necessary to ensure a reliable device are presented.

Simplest method to divide is the use of Digital dividers. In order to make compatible the analog level sinusoidal with the digital dividers thresholds a converter or squaring is necessary. This stage is sensitive to the trigger uncertainty due to various factors such as the distortion of the waveform of input or noise associated, or even temperature changes that vary the reference voltages used to set the trigger threshold.
To avoid any analog to digital transformation and having phase continuity associated with low phase noise one of the best solution is to use a regenerative divider. This circuit is essentially a frequency converter, it use the same output frequency as LO source to have Fin/2. The block diagram is in Fig1.

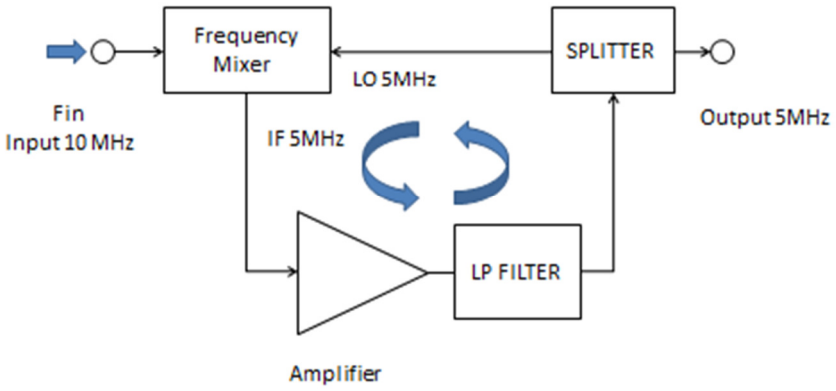

Fig 1 Regenerative divider Basic circuit

The oscillation is stimulated by the amplifier thru the LO and IF port of the mixer as feedback loop but it is engaged only with the presence of the input signal applied to the RF port of the mixer. The Low Pass Filter eliminates the higher mixer and distortion products.
To improve the input level range and the operational characteristics some modification are necessary as described in Fig 2.

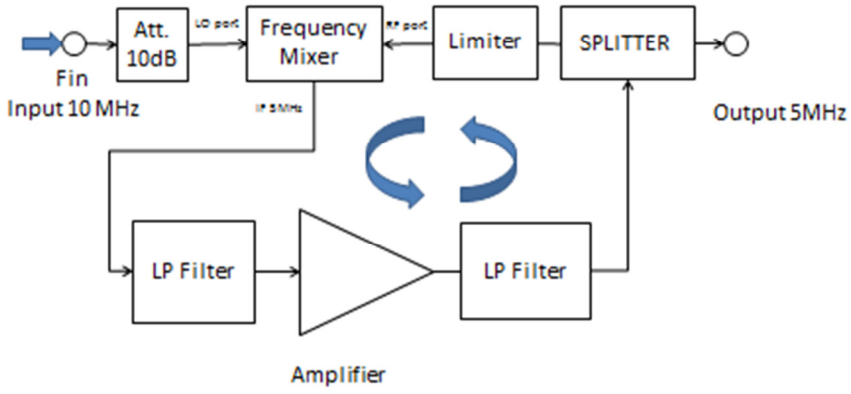

Fig 2 Regenerative divider improved circuit

The circuit starts the regeneration when the input level is sufficient to engage the oscillations. With small positive variation of the input level the amplifier reach the saturation point. To limit this occurrence, it is introduced a Limiter Stage to have an input level capability from +6 to +17 dBm that produce a 5MHz output range level from +10 to +15 dBm on 50 Ohm load. An additional attenuation between the diode limiter and the splitter port is necessary to avoid the output port distortion; this is provided by a resistive voltage divider who set also the operational input range level. The output harmonic distortion is about to -50dBc.

Several other solutions can be implemented for the amplifier stage with less power consumption using a discrete components amplifier.

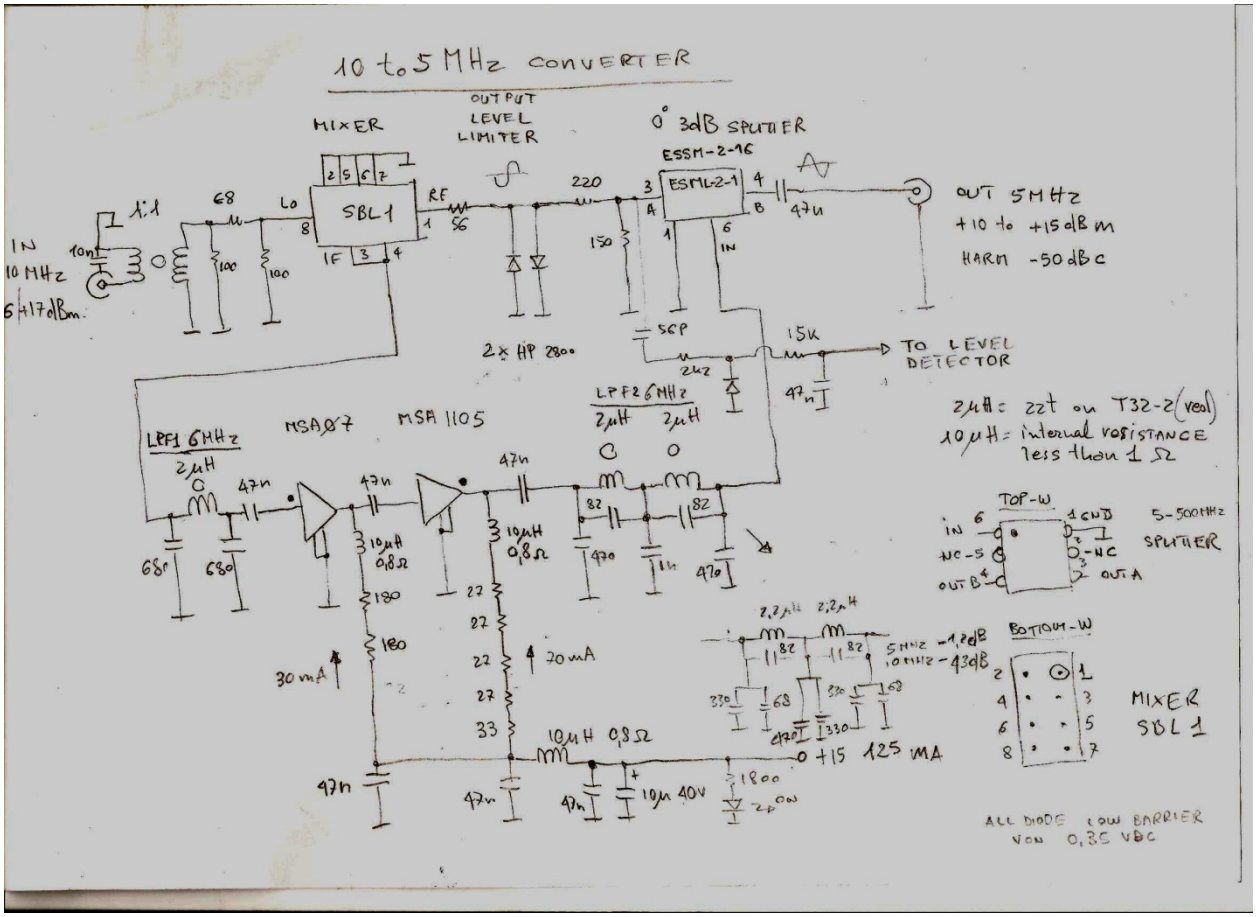

Fig 3 Schematic diagram

-Luciano Paramithiotti Italy Designer.

Reference 1) Notes on Low-Noise Regenerative Dividers. John Miles www.ke5fx.com/regen.htm

Reference 2) Phase noise in Frequency Regenerative dividers. Enrico Rubiola, Marcel Olivier, Jacques Groslambert

Reference 3) Misurare il tempo ela frequenza Renato Mannucci, Franco Cordara ed.: Il Rostro 1997