HOW TO SELECT THE BEST LNB FOR YOUR DIGITAL SATELLITE SYSTEM

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Over the past few years satellite systems have been replacing the traditional FM or FSK transmission systems with more complex digital modulations formats such as BPSK and QPSK. These digital forms of modulation enable the satellites to deliver more information in the same satellite capacity that was used to deliver the older analogue formats and with an improvement in the quality of the delivered signal. To say it another way, digital modulated signals can deliver a greater amount of data, with fewer errors, and using less of the satellites capacity than previous analog modulation systems.

In order to take full advantage of the benefits of the more efficient digital modulation systems the LNB used in the receiver terminal must be matched to the digital signal characteristics. From a technical perspective there are more than fifty individual parameters that should be considered when making an LNB selection. RF leakage, rejection of transmit signals, in-band spurious performance, out-of-band spurious performance, long term aging effects, vibration effects, corrosion resistance, connector types, intermodulation performance, dynamic range considerations, environmental effects, reliability concerns and the list goes on. There are however a few key specifications that need to be addressed before getting into the finer details of an LNB.

Noise Figure

The noise figure of the LNB is a measurement of how sensitive the LNB is or how much noise the LNB will add to the signal you may be intending to receive. The lower the noise figure of the LNB the better the LNB will be able to receive weaker signals. For a C-band LNB that cover the frequency range of 3.4 to 4.2 GHz the noise figure is expressed in Kelvin or K. Kelvin is a scientific unit of measurement that relates absolute “ZERO” or the level of molecular activity. Many people refer to degrees Kelvin but that is technically incorrect. Kelvin is a unit of mea- surement on it’s own and is not related to degrees on it’s own. “0” Kelvin represents the level of no molecular activity or no noise in a system or substance. A very good number for a C-band

LNB Oscillator Type	Frequency Stability	Application
DRO	± 1.0 MHz to ± 150 KHz Frequency stability	Broadcast Television Wideband Data Broadcast
Internal Reference PLL	± 150 KHz to ± 5 KHz	SCPC audio New gathering VSAT
External Reference PLL	0 ± 1 KHz	Satellite paging Narrowband data

Table Of LNB applications and typical frequency stability

LNB would be 15 Kelvin a more typical number 30 Kelvin.

Unlike C-band, the noise figure of Ku-band (10.7 to 12.7 GHz) LNBs are expressed in decibels or “dB.” It is possible to convert between Kelvin and dB using a set of formulas for comparison purposes if need be. A good point of reference however is 35 Kelvin = 0.5 dB. A very good noise figure for a Ku-band LNB would be 0.6 dB but a more typical value would be 0.8 dB.

Gain The gain of an LNB is amount the LNB will amplify the input signal which is expressed in dB. The input signal is very weak when it arrives at the receiving antenna and must be amplified many time before it can be transported down a coaxial cable. If the signal is not amplified the signal would be absorbed by the losses in the coaxial cable and never reaches the receiver. When selecting an LNB for a digital system it is important that the gain does not change significantly with temperature or over the received frequency range as digital systems are much more sensitive to these changes than previous analogue systems.

Digital systems typically require an LNB gain to be 55 dB to 65 dB under all conditions. Gain flatness across a 500 or 800 MHz band should be better than ±5.0 dB and less than ±1.0 dB in 27 MHz segments. Variations greater than this can introduce gain distortion onto the incoming signals resulting in reduced receiver performance.

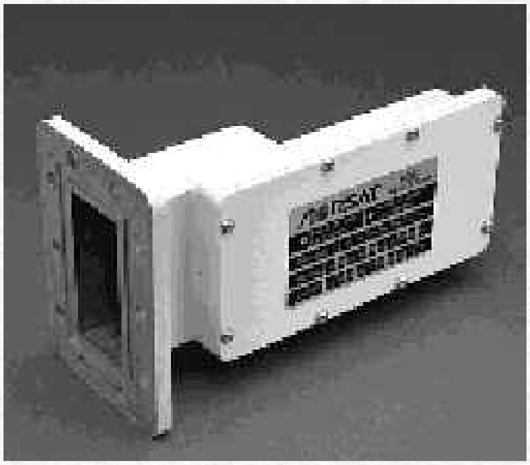
Local Oscillator Frequency Stability

There are three main types of frequency conversion oscillators used in LNBs:

1. Dielectric Resonant Oscillator (DRO) Types – The LNBs conversion oscillator frequency is determined by a free running oscillator whose frequency determining element is a piece of feroceramic material refered to as a puck.

2. Phase Locked Loop (PLL)Types – The LNBs conversion oscillator frequency is determined by an internal located temperature compensated crystal oscillator and a digital phase locking circuit.

External Referenced Phase Locked Types - The LNBs conversion oscillators frequency is determined by a reference oscillator located outside of the LNB and is usually provide over the center conductor of the coaxial cable that connects the LNB to the receiver. It is usually the responsibility of the satellite receiver to provide this reference signal to the LNB. The reference frequency in most cases is 10MHz. Different types and bandwidths of digital signals will require LNBs with different frequency stability in order to provide optimum receiver performance.



A wideband signal such as an MPEG II television broadcast will require an LNB with low frequency selectivity because the transmitted signal occupies quite a wide bandwidth and the receiver tuning can be wider. A narrow band SCPC radio broadcast uses a very narrow signal and will require a high stability PLL type so that the receiver is able to track the signal.

LNB PHASE NOISE PERFORMANCE

The phase noise specification of an LNB is an indication of the level of noise introduced on to the received signal at various frequency distances from the converted carrier. This noise is generated by the conversion oscillator within the LNB and is a direct function of the quality of that oscillator. The phase noise specification of an LNB is defined at 100Hz, 1.0kHz, 10kHz, 100kHz and 1.0MHz distances from the center frequency of the converted frequency.

In a digital system the bit error rate (BER) of the receiver will be directly affected by the level of the phase noise in the received signal. The higher the phase noise level the more errors there will be in the received signal.

SUSCEPTIBILITY TO MICROPHONICS

When an LNB is installed on an antenna it will be subjected to environmental factors such as wind, rain, and hail. Rain or hail hitting the LNB will cause small disturbances in the electrical performance of the LNB. Wind will move or vibrate the antenna which causes a similar effect. These disturbances are then superimposed or modulated onto the incoming signal.

It is not uncommon for these disturbances to distort the incoming signal such that the incoming signal cannot be received. The local oscillator in the LNB is the circuit most commonly affected by these disturbances. Great care must be taken in the mechanical and electrical design of an LNB to minimize this effect. In the early days of radio, unwanted vibrations applied to the receiving equipment would show up in the demodulated audio as sounds, and were thus referred to as Microphonics because they behaved in much the same way as a microphone would. Today this effect is still referred to as Microphonics.

There are no standards or units of measurement associated with evaluating an LNB's sensitivity to Microphonics. Some people use simulated rain drops, some use a specialized tool they have developed, some use very elaborate shock table setups; while others just use a screw driver to tap on the LNB to check how the received signal is affected. The method used is dictated by the individual system designer.

INPUT VSWR

VSWR is an abbreviation for Voltage Standing Wave Ratio which can also be referred to as Return Loss. The technical description of VSWR is the ratio of incident voltage or primary wave of voltage present on a transmission line or waveguide versus any reflected voltage on that line that may be present as a result of a mismatch condition.

Offset From Carrier	Analogue DRO	Digital DRO	PLL Internal Reference	PLL External Reference
100 Hz	Not Specified	Not Specified	-70 dBc/Hz	-65 dBc/Hz
1.0 KHz	- 55 dBc/Hz	-65 dBc/Hz	-75 dBc/Hz	-75 dBc/Hz
10 KHz	- 70 dBc/Hz	-80 dBc/Hz	-80 dBc/Hz	-85 dBc/Hz
100 KHz	- 85 dBc/Hz	-100 dBc/Hz	-85 dBc/Hz	-95 dBc/Hz
1.0 MHz	- 95 dBc/Hz	- 100 dBc/Hz	-95 dBc/Hz	-105 dBc/Hz

Table Of Typical phase noise specifications for different types of Ku-band LNBs.

In a perfect situation where the transmission line (feed) is absolutely matched to the load (LNB) there would be no reflected voltage and the VSWR would be stated as being 1:1 or a perfect match. As with most things this is not the case in the real world. Variations of electrical and physical parameters on the transmission line and the load are seldom perfectly matched. This mismatch will result in some of the energy contained in the primary wave (the received signal) being reflected back from the load (LNB) and lost. To make things worse the reflected wave will also interfere with the incident (incoming) wave causing the signal to be reduced as well.

It is most important to maintain a good match between the feed and the LNB in order to ensure that the maximum amount of signal is transferred to the LNB. The chart below shows approximate effects of VSWR on measured noise figures or temperatures of an LNB. An LNB with a measured C band noise figure (NF) of 30 K is used as an example.

As you can see, the effect of VSWR on the noise figure of an LNB can be substantial. Therefore it is most important to consider the effects of VSWR when making your LNB selection.

SOME EXAMPLES OF LNB APPLICATIONS

There are many applications where selecting the correct LNB will make the difference between a system operating to it's full potential and providing far less then satisfactory performance. Listed below are examples of some applications and the types of LNB which will provide the best performance:

- Satellite digital paging networks require a high stability PLL or even External Reference PLL LNB such as the Norsat 1000 or 3000 series LNB.
- MPEG II digital video applications require high stability DRO LNBs such as the Norsat 4000 series.
- VSAT and Point of Sale (POS) systems may use a DRO LNB but most users prefer a PLL to ensure the highest possible system reliability.
- Radio and TV broadcast stations use PLL types to ensure the most reliable performance of their station.
- Satellite News Gathering (SNG) trucks use Norsat 1000 Series PLL LNBs for the most reliable performance in the worst conditions.

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