TELEMAKUS LLC

APPLICATION NOTE

A/D Conversion Testing using USB Signal Generators reduces evaluation costs

Developers of Analog to Digital Converters (ADC) continue to introduce new component designs with increased levels of integration and performance. These new designs not only have faster clock rates at greater accuracies but also offer frequency down conversion capabilities. As these devices become increasingly sophisticated, the requirements for evaluating their suitability for a given product design grow as well.

Most supplier companies such as Texas Instruments, Linear Technology, Maxim, Analog Devices and others, provide evaluation boards for their products. These boards will generally contain the ADC device, some power supply decoupling components and a set of connectors for providing a System Clock, an LO source, an RF test signal and finally the digital result. While these evaluation boards somewhat simplify the evaluation process, the customer must still provide a significant list of equipment to perform the evaluation. A summary of the required equipment is provided in Table 1 below.

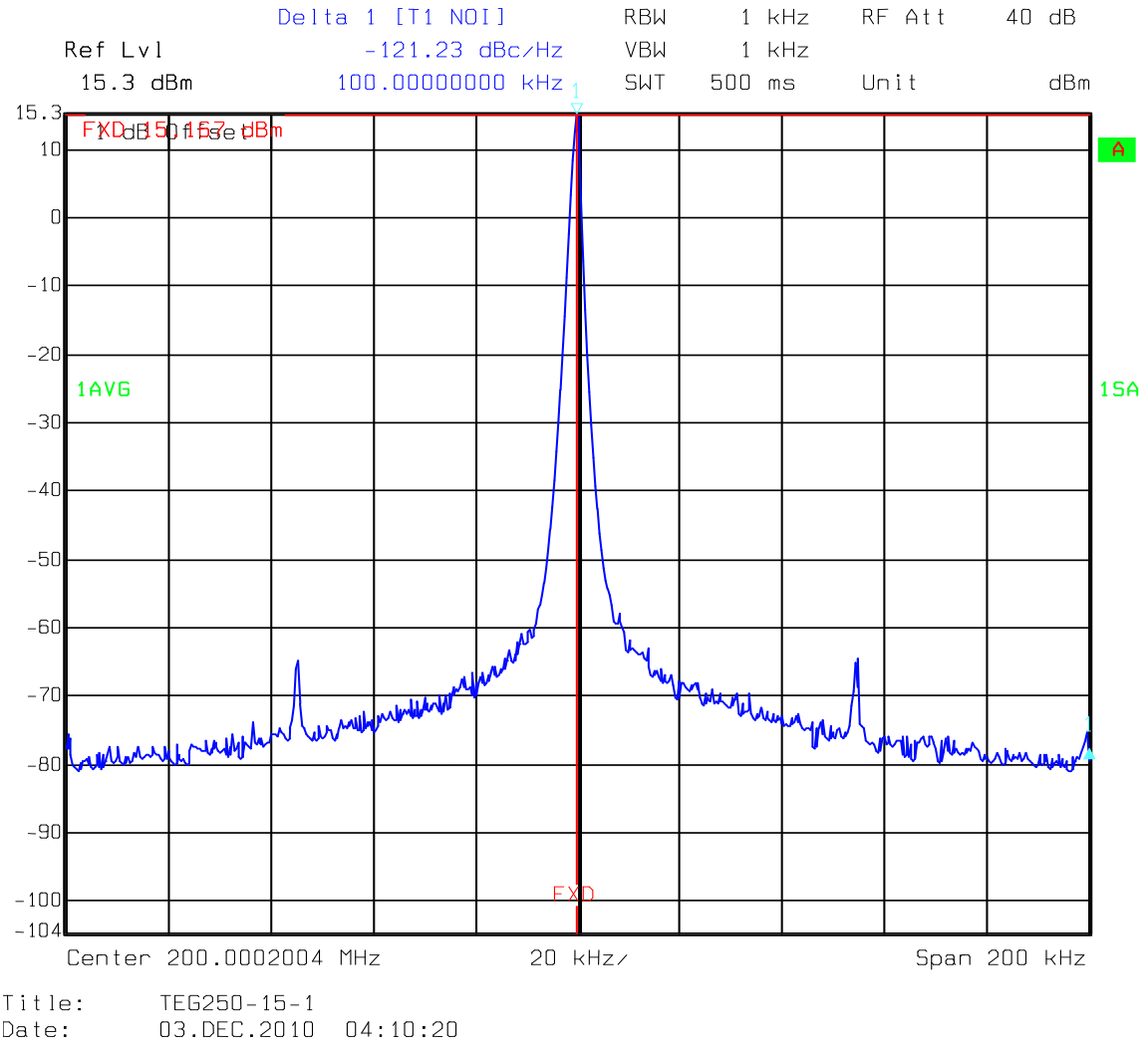
Test Instrument Function	**Key Performance Parameters**	**Box Style Equipment Cost**	**Telemakus Equivalent Device**	**USB style Equipment Cost**
A/D Clock Source	Low Clock Jitter	$2K - $10K	TEG250-15	$320
Down Conversion LO	Low Phase Noise	$5K - $30K	TEG Series	$320 - $385
RF Test Signal Source	Low Spurious Noise Modulation Capability	$15K - $60K	TEG Series TEV Series	$320 -$385 $320
Digital Data Capture	Fast Memory Deep Storage Data Analysis (FFT)	> $100K	Under Development	< $15K

The table not only lists the required equipment but also details some of the key performance parameters needed to accurately assess the ADC's operation. Performing a survey of conventional "box-style" instruments that meet those key parameters leads to the range of costs found in column 3. The table shows that the combined cost of three conventional "box-style" signal sources can range anywhere from $20K to upwards of $100K. This represents an enormous cost

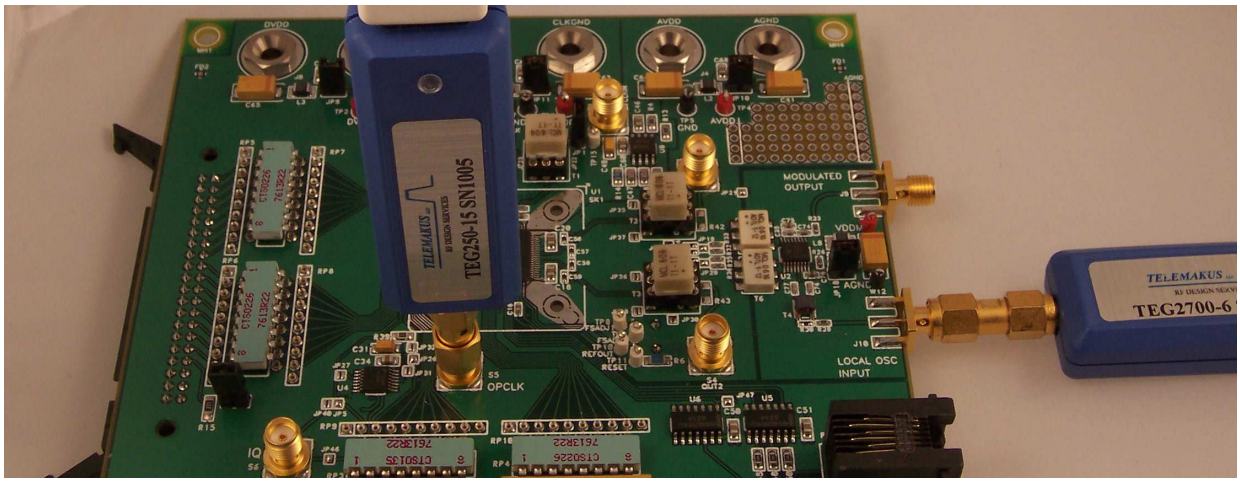
barrier to companies where this kind of RF test equipment is not readily available.

In comparison, the Telemakus product line of USB Signal Generators can produce the required ADC test signals for a fraction of the cost. This not only saves money for the end user of the ADC, but also removes a significant barrier for the ADC supplier to ensure their component will receive a proper evaluation and increase the likelihood of winning the design in.

The TEG250-15 was developed specifically for use as an ADC clock generator. The clock frequency range of the device is 140MHz – 250MHz which covers most high speed ADC uses. The output power is typically greater than +15dBm providing a clock voltage in excess of 1.25Vpp into a 50Ω load. The frequency accuracy is driven by an internal 10MHz reference with a stability of 2ppm over the full temperature range. With a typical phase noise of -108 dBc/Hz@10KHz and -120dBc/Hz@100KHz offset as seen in the figure below, the clock jitter is typically a very low 2psec-rms.



The other USB devices in the TEG family are well suited for use as the Down Converter LO. These devices cover the frequency range of the most popular communications bands from 700MHz through 3.5GHz. The output power is usually sufficient to directly drive the Down Converter input of most ADC devices. The phase noise of this device family is generally better than -100dBc/Hz@100KHz offset making them well suited for Zero-IF type systems.



The small size of the TEG devices allow them to be directly connected to the Evaluation board

The TEG device family can also be used as a spurious free substitute for the RF test signal source. Generally, the customer will initially test the ADC conversion accuracy with a pure un-modulated CW signal at various power levels and measure the linearity of the ADC. The testing will progress by gradually adding modulation to the test signal and eventually the test signal may be replaced with the signal from an actual transmitter. Combining one of the TEV series Vector Modulators with the TEG Signal Generator fills the need for initial testing of the ADC. The spurious level of the TEG family is typically better than -80dBc which is better than all but the most expensive Arbitrary Waveform Generators on the market. This makes the TEG the ideal low cost source for linearity testing. Adding the TEV device to the setup gives the user the ability to control the level of the test signal over a 25-30dB range and also to add simple modulation to the signal such as BPSK, QPSK and 8PSK.

Evaluating the new generation of ADC devices is a complex and potentially expensive undertaking using traditional “box-style” signal sources that may not always be available. Using the Telemakus TEG series of USB Signal Generators removes many of those barriers. This not only allows the end user of the ADC the opportunity to evaluate and select the best product for their requirement but also allows the ADC supplier to ensure that their product does not get left out of the evaluation.