# Simple Multichannel Phase Supervising Circuit at ELBE

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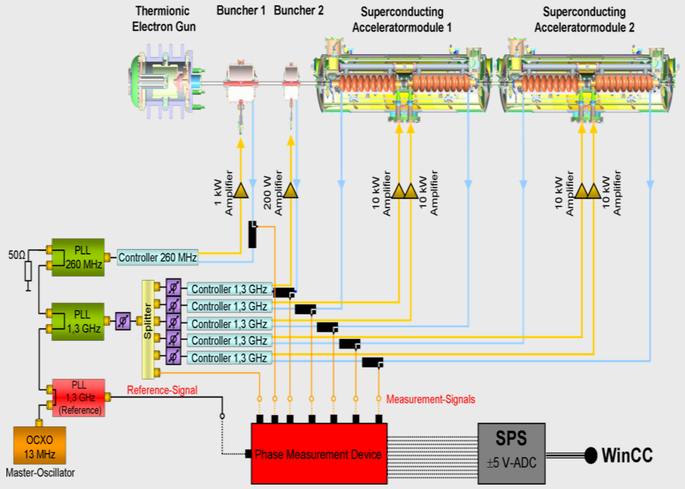
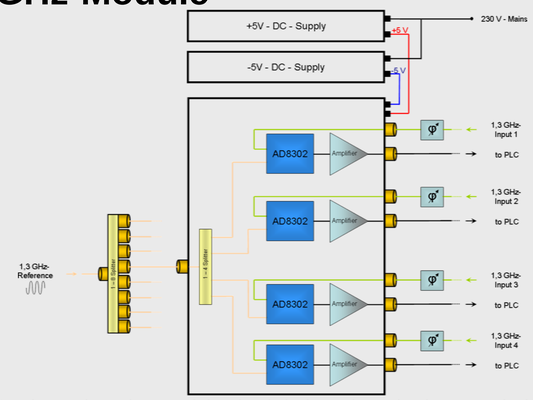
## ▶Introduction




For good operating the ELBE linear accelerator it is essential to have RF signals with high phase stability and purity on all cavities and buncher RF signals. Therefore a large number of low level RF control loops are used. But sometimes problems with these circuits occur. For further investigations a multichannel phase supervising device is required to have knowledge of phase noise and long term drifts. The circuit under development at ELBE allows the simultaneous phase measurement of up to 32 signals of 1.3 GHz (accelerator), 260 MHz (buncher) or 13 MHz (gun) frequency with 2 deg accuracy. Using an additionally 1.3 GHz PLL locked to the 13 MHz master oscillator (OCXO) of the machine as reference the phase measurement device is completely independent to the circuits used in the accelerator low level RF. Under normal conditions a programmable logic controller (SIMATIC) is used for data acquisition. This leads to approx. 5 measurements per second for all channels. But the measurement device is much faster, feeding the signals to a National Instruments PXI-6115 12-Bit, 10 MS/s/channel simultaneous sampling multifunction DAQ card enables also microphonic and phase noise measurements up to 10 kHz. First measurements have shown very sophisticating results.

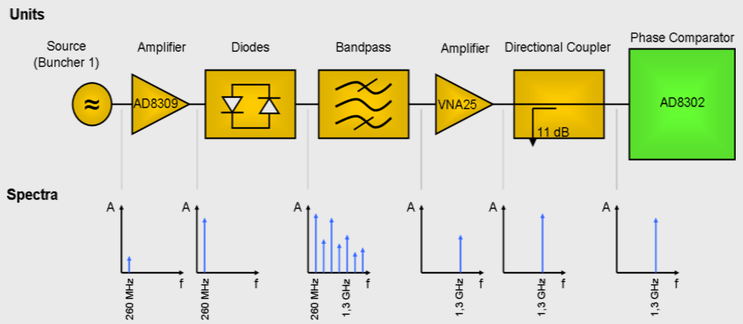
| | |
|---|---|
| Phase Measurement Range | -75 deg to +75 deg |
| Operating Frequencies | 260 MHz; 1.3 GHz |
| Measurement Error | < 2° |
| Time Resolution | 4 µs |

## ▶1.3 GHz-Module



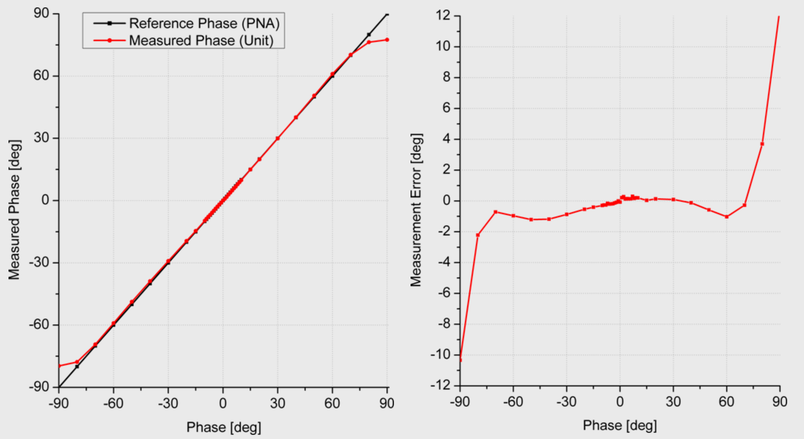

The 1.3 GHz phase detection module circuit is based on the integrated phase and amplitude detector AD8302 from Analog Devices. This integrated circuit delivers an dc voltage proportional to the phase shift between the measurement and the reference signal. The reference signal was derived from the master oscillator by an additionally PLL and a 1 to 8 Wilkinson splitter. Therefore it is independently from the normal frequency generation circuits.

## ▶260 MHz-Module

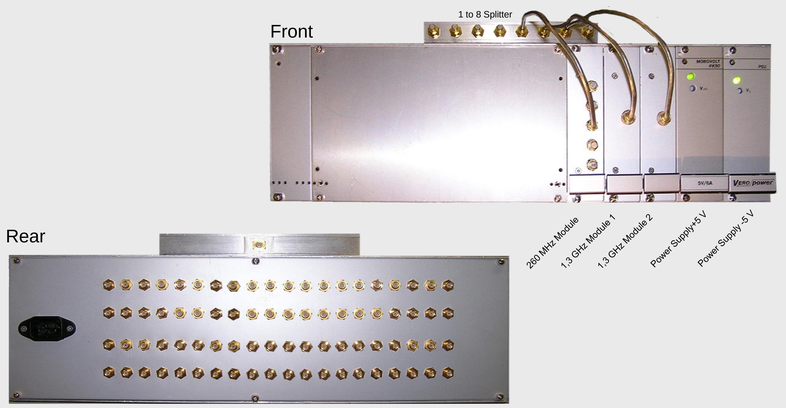



In a second step a 260MHz phase detection module was developed. For this purpose the 1.3 GHz module was extended by a frequency conversion circuit. By this circuit the 260 MHz input signal was first amplified and limited with an AD8309. Then this signal was multiplied by two anti-parallel diodes and the fifth harmonics was taken by an ceramic resonator filter. After this the signal was amplified and given to the input of the AD8302. For testing purposes an additionally directional coupler was added.

## ▶Conclusion




With the presented modules for 260 MHz and 1.3 GHz the developed unit was able to reach a phase measurement error minor than Δφ < 2°. This was verified by reference measurements using a fast scope and a Agilent PNA. In the meanwhile the unit is in experimental operation at the ELBE linear accelerator and was integrated in the ELBE software operating systems. The results are very sophisticating and it is planned to extend the measurement system further.

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