

Calibration

The V16 is designed not to require alignment during its life time.

During manufacture a few characteristics are measured, compensation factors calculated and permanently stored in a dedicated memory inside the processor chip. The items are:

I/Q phase angle error compensation

I/Q gain balance correction

I/Q DC offset correction

Reference frequency error compensation

These items require recalibration under the following circumstances:

a) Replacement or blank state reprogramming of the processor chip (note: During ordinary firmware upgrades settings are preserved.

b) Replacement of the CMX994 I/Q receiver chip

Calibration is carried out automatically and requires a MGL Avionics NAV/COM tester. Should this device not be available, the V16 must be sent to an authorized repair station that has this equipment. It is not possible to perform these calibrations by hand.

Self test

The V16 transceiver includes automated self testing which is able to perform a number of checks on power up as well as during operation. Fault conditions are communicated to the host device via a clear text message.

Items tested:

- 1) Audio codec
- 2) I/Q codec
- 3) CMC994 receiver chip
- 4) RX functionality by injection of a test signal at the input of the CMX994
- 5) Power supply voltage from the 8V Buck regulator
- 6) Frequency comparison of the reference frequency with a frequency source in the CPU to detect out of bounds conditions.
- 7) LMX2571 PLL synthesizer and VCO (including VCO lock)
- 8) TX power
- 9) TX modulation
- 10) Internal temperature

Calibration procedure

Calibration is not required during the life time of the V16 transceiver unless repairs or component replacements have been carried out.

Repairs and calibration must be carried out by suitably qualified personnel in facilities approved for these tasks by MGL Avionics.

Unqualified work may invalidate the V16 certifications.

Receiver calibration

Calibration of the receiver is required if the CMX994 chip or the I/Q ADC chip require replacement or any of the passive components directly connected to these chips have been replaced.

Calibration method if MGL Avionics NAV/COM tester available:

Plug NAV/COM tester via D25 connector into V16. Connect antenna output to NAV/COM tester via short SMA to SMA cable.

Power up NAV/COM tester (which also powers the V16).

Allow system to stabilize for 30 seconds or more.

On NAV/COM tester select: "Auto calibrate V16". Observe the result, the NAV/COM tester will perform the calibration and report PASS or FAIL with a reason.

Calibration method if MGL Avionics NAV/COM tester not available:

Equipment required:

VHF signal source with AM modulator 1Khz 30%. Frequency stability 1ppm. RF level -30dbm.

Audio spectrum analyser. PC with sound card and spectrum analyser software such as

DG8SAQ Audiometer V3.8.3 which is freely available works well.

MGL Avionics V16 interface application (free download from www.MGLAvionics.co.za).

Procedure:

Connect V16 audio output to PC sound card input and start audio spectrum analyser. Set up for a sample rate of 12Khz or nearest option available on your system.

Connect V16 interface application via RS232 (USB converter is OK) to V16 RS232 port 1.

Connect RF source tuned to 127Mhz to V16 antenna port.

Power up V16. V16 interface program should report V16 online and show tuned frequencies etc. Tune main frequency to 127Mhz, scanning off. RX volume at about 22.

Audio analyser should show the 1Khz modulated signal at very good signal to noise ratio (better than 60 db).

Tune RF source so there is a slight difference (a few hundred hertz) between tuned frequency and RF source frequency. You should see one or more spurs on the audio spectrum analyser related to the difference between the two frequencies (beat frequency spurs).

On the V16 interface select technical setup. Select "phase correct". Adjust this setting so the beat frequency spur is minimized. When this is done, select "IGAIN". Now adjust this setting to minimize the beat frequency spur. With these two settings you should be able to almost eliminate these spurs to a level typically -50db below the 30% modulated 1Khz tone.

Note: Most RF AM sources may show significant spurs, even professional equipment may have distortion of no better than 1%. This will show as significant spurs at multiples of 1Khz. The V16 receiver itself has no distortion as the demodulator is implemented mathematically with near infinite accuracy. Additional spurs may show to the left and right of the 1Khz tone typically evenly spaced – this is due to AM modulation of the 1Khz tone itself which can occur in test equipment, sometimes related to mains frequency or multiples thereof.

Spurs created in the test equipment do not react to the calibrations done here.

When done select "DC Calib". This takes a few seconds and is done automatically.

Calibrating the transmitter

Calibration of the transmitter is required if any of the components in the transmitter chain have been replaced, including the LMX2571 PLL/VCO.

Equipment required:

RF spectrum analyser able to handle at least 40dbm of power (typically via power attenuator) or alternatively a RF power meter may be used. If that is not available either you can use the built in RF power meter via the V16 interface application or a suitable control head configured to show TX power.

50 ohm dummy load able to handle 10W of power.

Connect V16 to a 50 ohm RF dummy load, RF power meter or spectrum analyser if available.

Tune the V16 to 127Mhz.

Key the transmitter.

Maximize power by tuning variable capacitor next to inductor L21 (there is only a single tunable capacitor on the PCB). If this capacitor is not fitted, skip this step.

Maximize power by lifting the tip of inductor L22 away from the PCB or press it towards the PCB. L22 is a small wire loop. Use a non-conductive, non-metallic tool. Secure the inductor with a small blob of mastic when done.

Note: With the V16 selected for 10W output power your typical output power should be in the range of 10-12W (unmodulated carrier). If you use any antenna cable between V16 and measuring equipment be sure to compensate for cable losses (RG-58 cable loses about 0.35W per meter at 10W in).

Note: keep transmissions short for this (less than 10 seconds) to avoid any power changes due to self heating of the DMOS power transistor.

There is a setting for frequency calibration via the V16 interface application, technical settings. This can be used to calibrate the internal TXCO provided you have a very accurate (better than 1ppm) frequency reference. Note that it is not expected that the TCXO will need recalibration over the products life time.