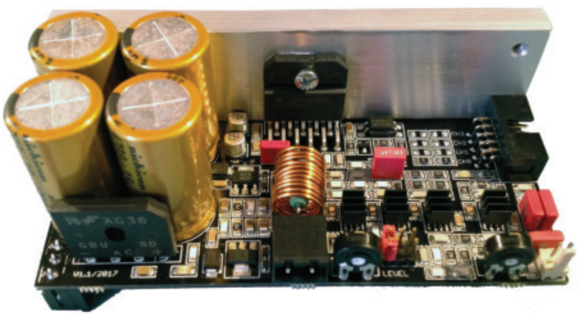
schanks

Amplifier Module SKVM

Compound technology amplifier, delivering 75 W / 50 W into 4 or 8 Ω loads with highest fidelity.



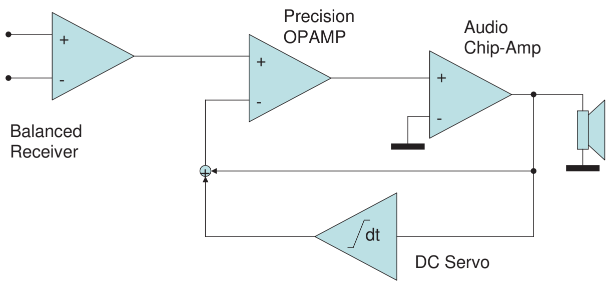


Fig. 1: Simplified internal structure of one amplifier module.

Key Features

- 75 W / 50 W (RMS) into 4 / 8 Ω loads
- < 0.00032% THD (1 kHz, 50 W, 8 Ω, 20 Hz - 24 kHz)
  < 0.0012% IMD (19+20 kHz 1:1, 50 W, 8 Ω)
  < 0.0020% SMPTE IMD (60 Hz+7 kHz 4:1, 50 W, 8 Ω)
  < 0.0040% THD+N (Gain = +20 dB, unweighted, 20 Hz - 24 kHz)
- -120 dBV noise floor (Gain = +20 dB)
- Integrated power supply with dual 9.400 μF rail decoupling capacity
- Integrating DC servo loop ensures low output offset voltage
- Precision balanced input and opto-isolated control signals

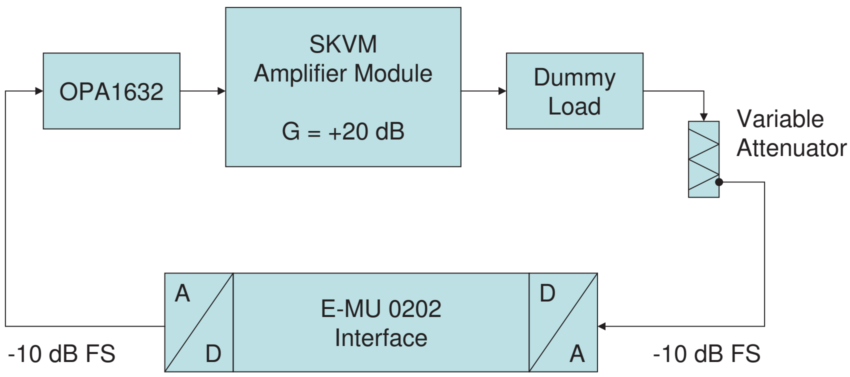


Fig. 2: Measurement setup. An E-MU 0202 interface ist used for spectrum and time-domain analysis. Loopback evaluation of the interface exhibits minimum intrinsic distortion at -10 dB FS. A variable attenuator is used to scale the amplifier output accordingly. An OPA1632 buffer circuit serves as a single-ended/balanced converter between the SKVM and the E-MU 0202.

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Measurements

1 W into 8 Ω, 10 Hz - 24 kHz bandwidth unless otherwise stated. Digital I/O level is -10 dB FS.

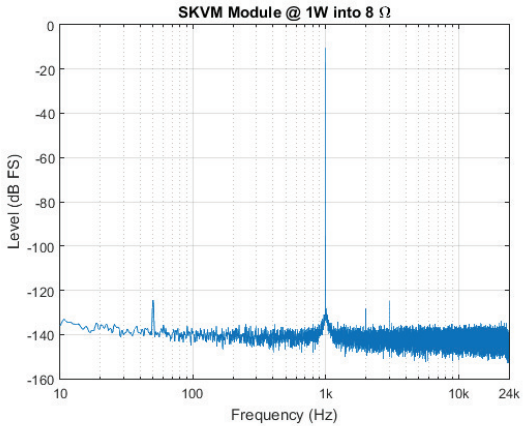

Fig. 3: Distortion is less than 0.00029 % and is dominated by the residual distortion of the E-MU 0202.

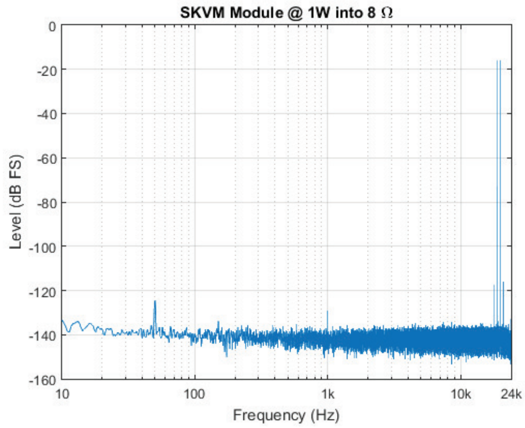

Fig. 4: IMD in the upper frequency range is below the residual of the measurement interface at 0.00095 %.

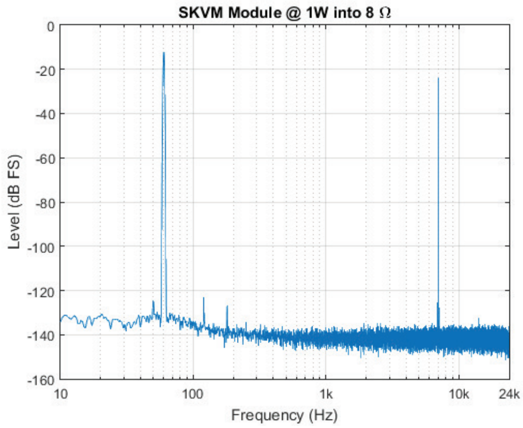

Fig. 5: SMPTE intermodulation is below the measurement interface residual at less than 0.002 %

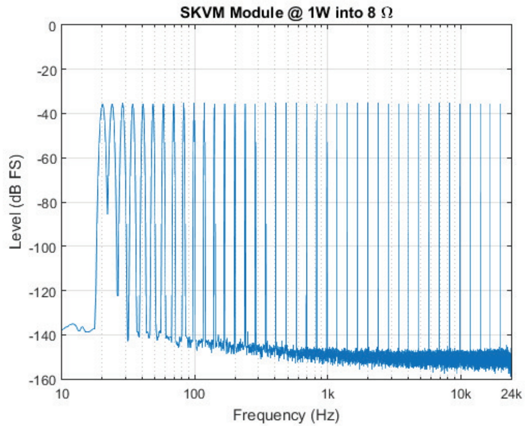

Fig. 6: Clean response to a 1/3 octave spaced stimulus. Distortion products are below the measurement noise floor.

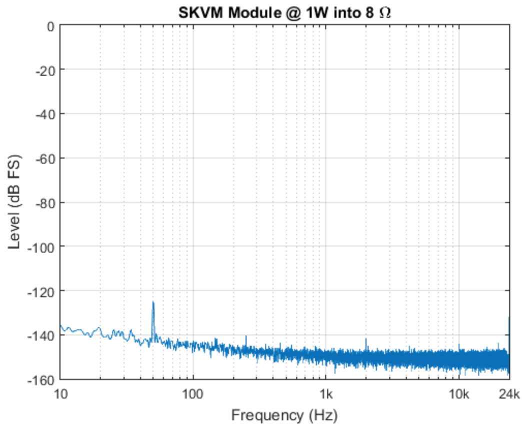

Fig. 7: Complete absence of 100 Hz products and multiples constates a very high PSRR. 50 Hz residuals down at almost 120 dB SNR. Essentially hum-free.

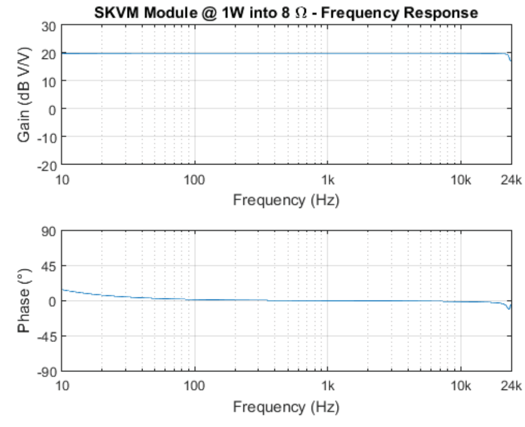

Fig. 8: Gain + Phase error at 20 Hz: -0.2 dB, +10.1°. Gain + Phase error at 20 kHz: -0.3 dB, -7.6°. Clean transfer behaviour with little and smooth phase transitions.

Measurements

50 W into 8 Ω, 10 Hz - 24 kHz bandwidth unless otherwise stated. Digital I/O level is -10 dB FS.

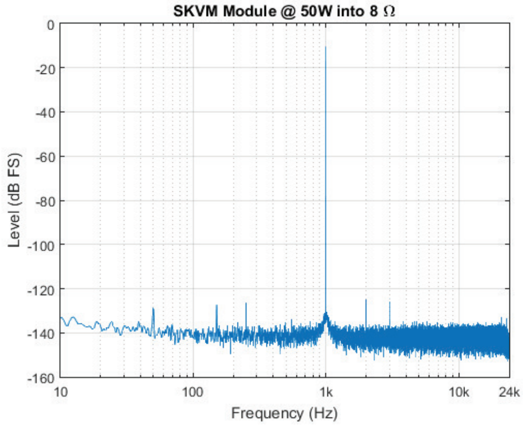

Fig. 9: Distortion is less than 0.00032 % and is dominated by the residual distortion of the E-MU 0202. Minimal hum from input.

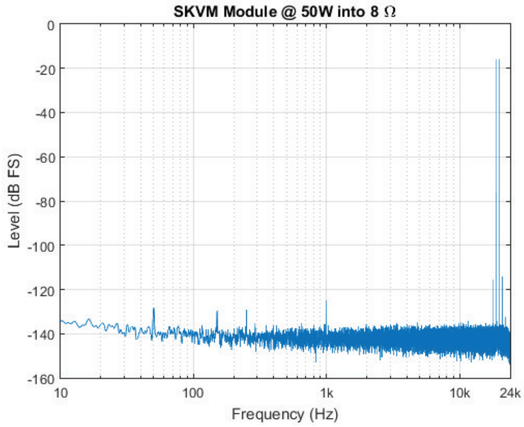

Fig. 10: IMD in the upper frequency range is just touching the residual of the measurement interface at 0.0012 %.

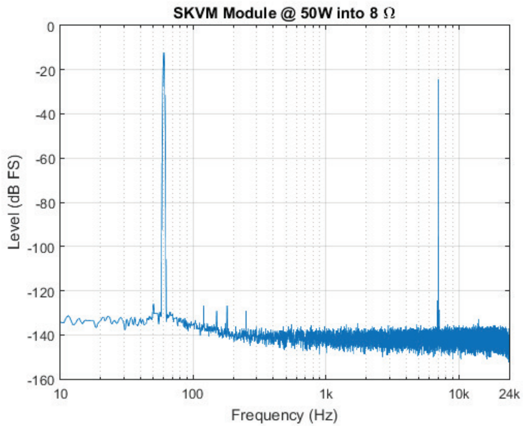

Fig. 11: SMPTE intermodulation is below the measurement interface residual at less than 0.0020 %

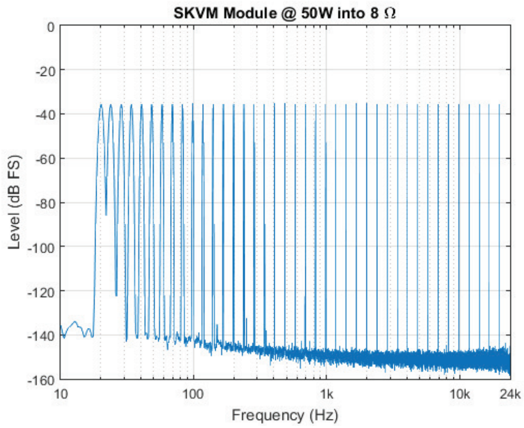

Fig. 12: Clean response to a 1/3 octave spaced stimulus. Distortion products are below the measurement noise floor.

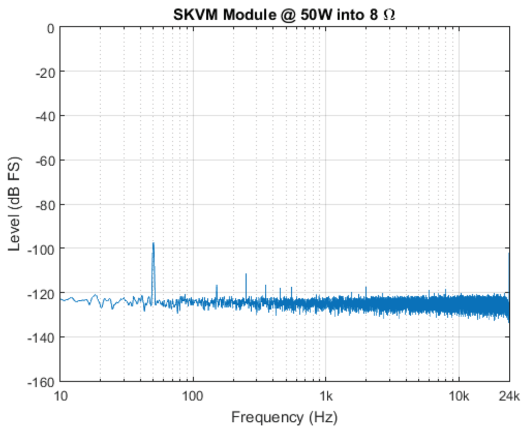

Fig. 13: Complete absence of 100 Hz products and multiples constates a very high PSRR. The 50 Hz etc. components results from test rig shielding imperfections.

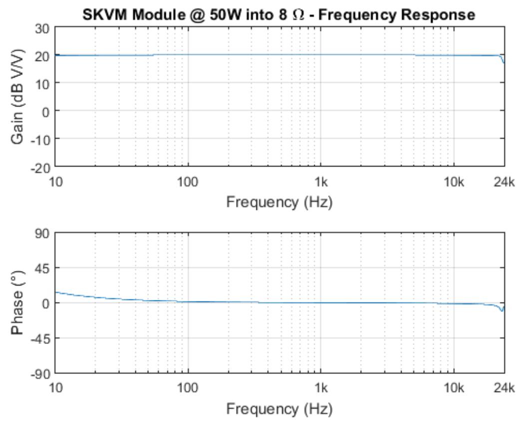

Fig. 14: Gain + Phase error at 20 Hz: -0.2 dB, +10.1°. Gain + Phase error at 20 kHz: -0.3 dB, -7.6°. Clean transfer behaviour with little and smooth phase transitions.

Measurements

1 W into 4 Ω, 10 Hz - 24 kHz bandwidth unless otherwise stated. Digital I/O level is -10 dB FS.

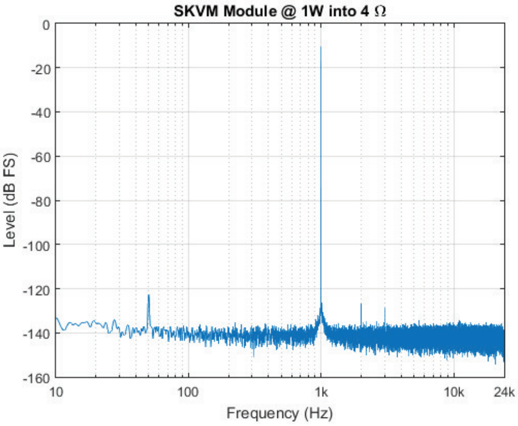

Fig. 15: Distortion is less than 0.00027 % and is dominated by the residual distortion of the E-MU 0202.

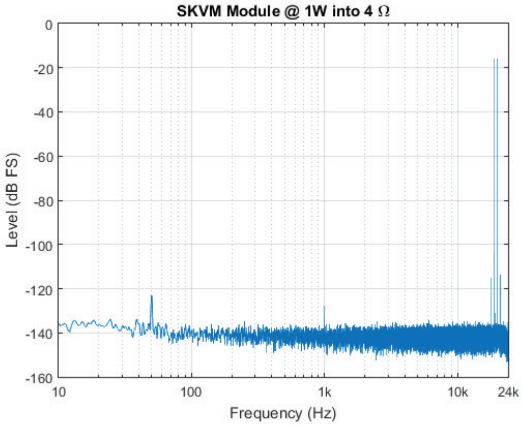

Fig. 16: IMD in the upper frequency range is just touching the residual of the measurement interface at 0.0013 %.

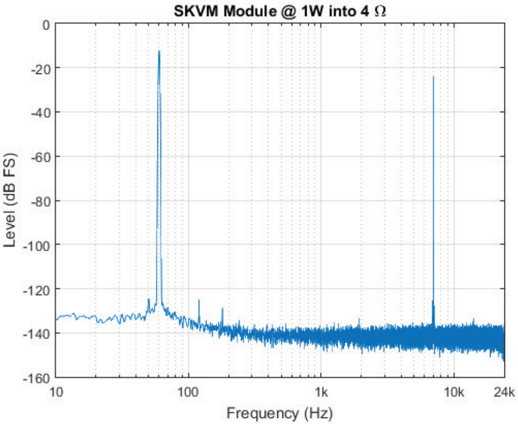

Fig. 17: SMPTE intermodulation is below the measurement interface residual at less than 0.0018 %

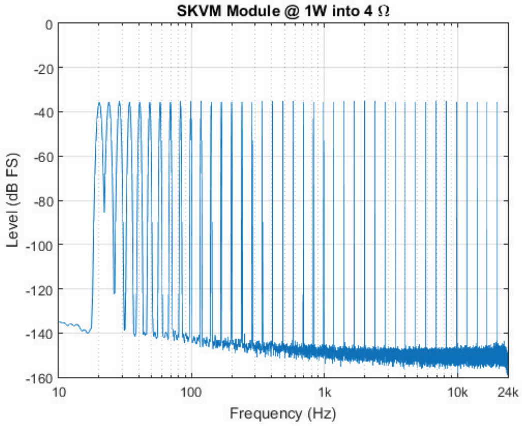

Fig. 18: Clean response to a 1/3 octave spaced stimulus. Distortion products are below the measurement noise floor.

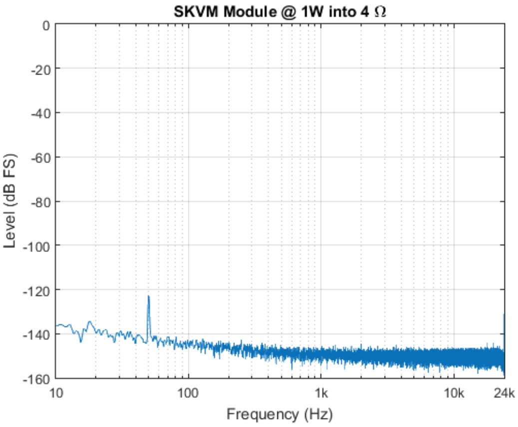

Fig. 19: Complete absence of 100 Hz products and multiples constates a very high PSRR. 50 Hz residuals down at almost 120 dB SNR. Essentially hum-free.

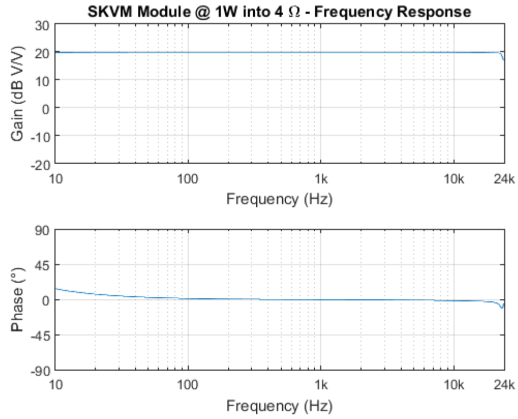

Fig. 20: Gain + Phase error at 20 Hz: -0.2 dB, +10.1°. Gain + Phase error at 20 kHz: -0.3 dB, -7.6°. Clean transfer behaviour with little and smooth phase transitions.

Measurements

50 W into 4 Ω, 10 Hz - 24 kHz bandwidth unless otherwise stated. Digital I/O level is -10 dB FS.

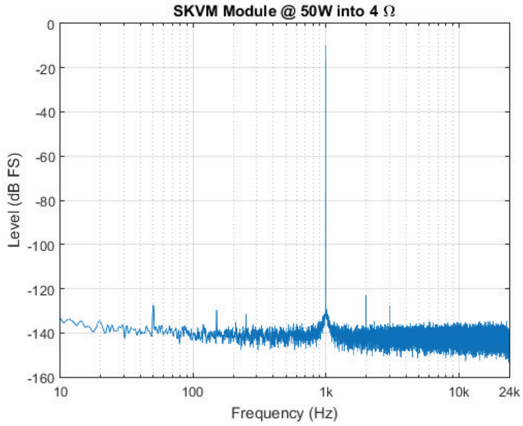

Fig. 21: Distortion is less than 0.00032 % and is still dominated by the residual distortion of the E-MU 0202.

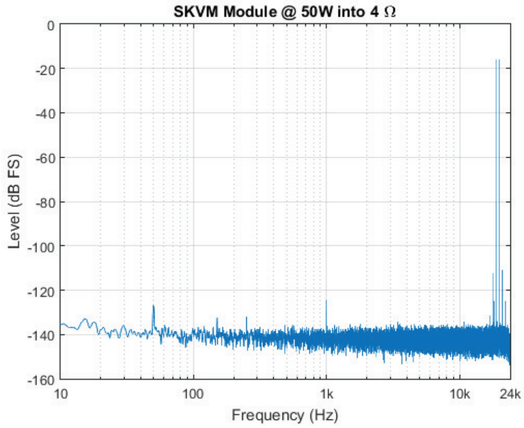

Fig. 22: IMD in the upper frequency range is very low at 0.0017 %.

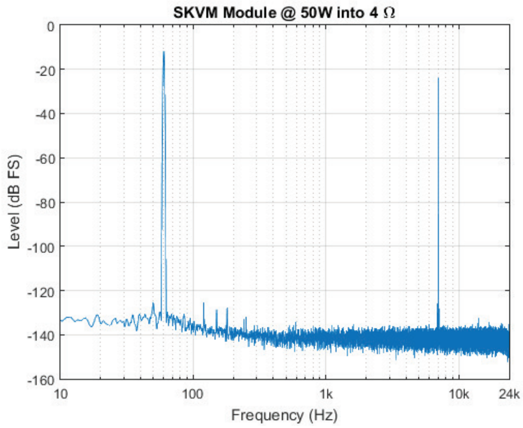

Fig. 23: SMPTE intermodulation is just below the measurement interface residual at less than 0.0021 %

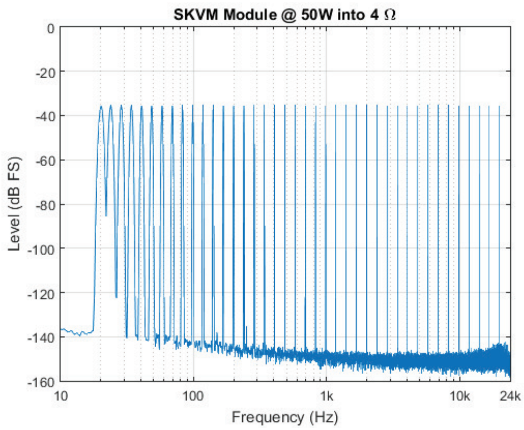

Fig. 24: Clean response to a 1/3 octave spaced stimulus. Just a hint of rising distortion above 10 kHz, 100 dB below the spectral line.

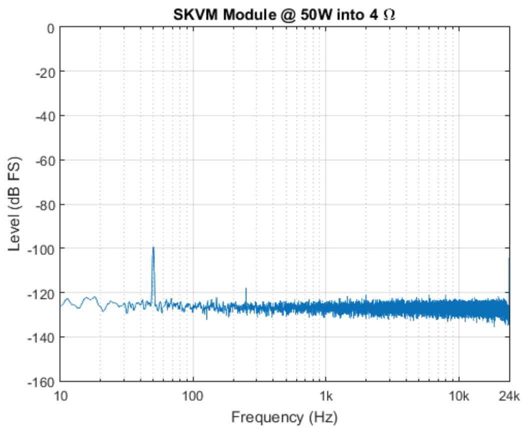

Fig. 25: Complete absence of 100 Hz products and multiples constates a very high PSRR. 50 Hz residuals down at almost 120 dB SNR. Essentially hum-free.

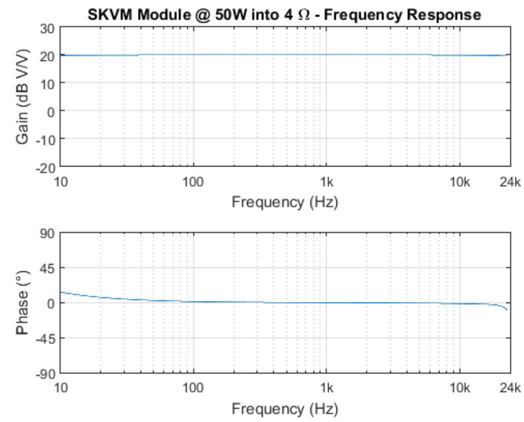

Fig. 26: Gain + Phase error at 20 Hz: -0.2 dB, +10.1°. Gain + Phase error at 20 kHz: -0.3 dB, -7.6°. Clean transfer behaviour with little and smooth phase transitions.

Measurements

50 W into 4 Ω, 10 Hz - 24 kHz bandwidth unless otherwise stated. Digital I/O level is -10 dB FS.

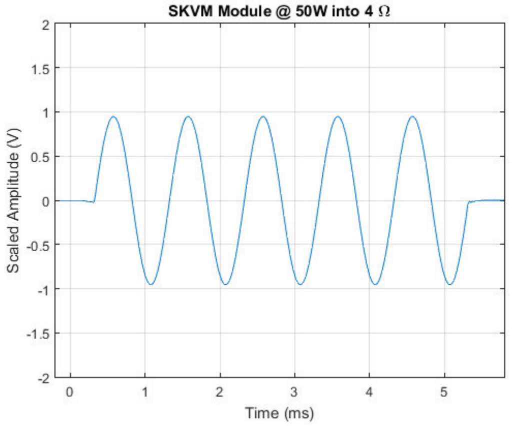

Fig. 27: Response to sine burst at 1 kHz. Clean reproduction of the amplified stimulus without edge artifacts.

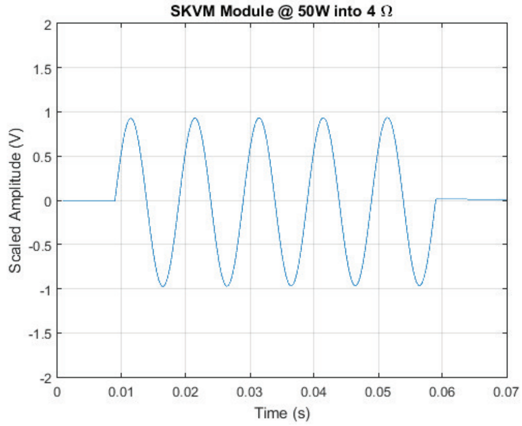

Fig. 28: Response to sine burst at 100 Hz. Clean reproduction of the amplified stimulus without edge artifacts.

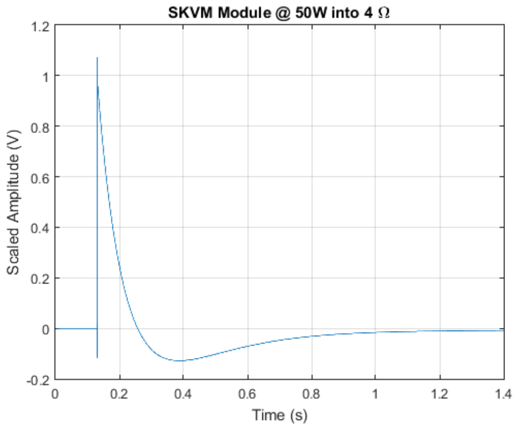

Fig. 29: Step response. Super-fast rise time (with digital filter ringing of the measurement system), followed by clean aperiodic settling. The bandwith-limit of the measurement system must be considered.

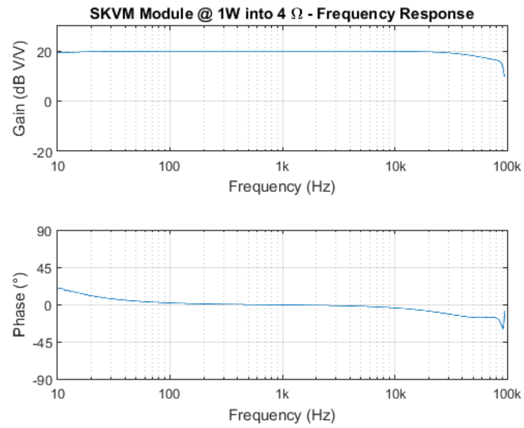

Fig. 30: Frequency response measured with 192 kHz sampling rate. Amplifier gain is 3 dB down at 70 kHz and 2 Hz, respectively (not shown). The 2 Hz cut-off is defined by the E-MU, not the SKVM amplifier module.

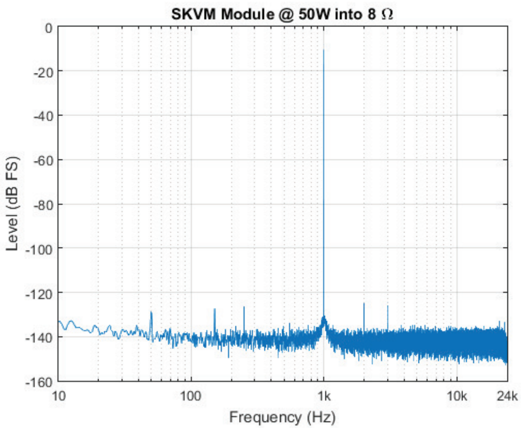

Fig. 31: Harmonic spectrum at 50 W into 8 Ω (1 kHz input).

The harmonic spectrum (Fig. 31) is dominated by low-order harmonics. Only 2nd and 3rd order harmonics can be distinguished from the noise floor, which is generally accepted as a "pleasing" harmonic signature. Non-rectified hum components are approx. 120 dB below the signal and are clearly inaudible. Rectified mains components (from power supply) are attenuated below the system noise floor, constating the amplifier a very high PSRR and hum-free operation from an unregulated power supply even at full power.

Description

The SKVM amplifier module features a compound (or nested feedback) structure to achieve greatly improved performance over conventional single chip amplifiers.

In the SKVM, an audio chip amplifier with high output power capable of driving 4 Ω and 8 Ω speaker loads, is controlled by a precision small signal operational amplifier (Fig. 1). To ensure low DC output offset voltage, an integrating controller formed by another opamp with high DC accuracy, is used in a secondary feedback loop. Low output offset is especially important when directly connecting HF drivers to an amplifier, as typically seen in active speakers. The use of an active DC error correction makes it possible to discard any electrolytic capacitors otherwise needed for AC coupling. Electrolytics may cause distotion when they see a significant AC voltage drop across them.
The dominant-pole compensation typically implemented in chip amplifiers causes the error-correcting loop gain to fall at 20 dB/dec. towards high frequencies. The fact that these amplifiers have stability issues at low closed-loop gains, further reduces the available high frequency loop gain. The overall distortion performance suffers and exhibits rising distortion above approx. 1 kHz.

The precision op amp used in the SKVM offers additional open-loop gain at high bandwidth, linearizing the chip amp in the upper audio band and reducing higher order harmonics. The resulting amplifier exhibits very low distortion figures both in THD and IMD (intermodulation distortion). In the measuerments presented, distortion is dominated by the intrinsic distortion of the measurment interface (E-MU 0202) itself. Thus, it can be stated that the SKVM remains "acoustically transparent" over its full rated power, behaving much like the "amplifying piece of wire" often demanded by audiophiles.
SKVM amplifier modules include a classical unregulated power supply. The very high PSRR of the small signal op amp pushes any hum components of the power supply below the measurement noise floor, even at full power into 4 Ω.

Frequency response shows very little gain and phase error across the whole audio range. The low frequency cut-off characteristics depicted in the measurements are primarily defined by the AC coupling of the E-MU 0202, which exhibits first-order roll-off at 2 Hz (-3 dB). While completely irrelevant concerning the amplifier gain error, the phase error rises earlier in the audio frequency range, being 45° at the cut-off already. SKVM amplifiers offer extended low frequency range to reduce phase shift (and group delay) in the audio band. The bandwidth of the SKVM is large enough to reproduce HF content of high resolution audio files (while it is questionable if any speaker system existent can faithfully reproduce such frequencies), while providing low phase shift and smooth phase response in the upper audio band.

The very low noise floor of the SKVM offers near-complete silence during quiet music passages or in between tracks.

Further Reading

[1] Bohn, Dennis, *"RaneNote 145: Audio Specifications"*, Rane Corporation, Mukilteo WA, 2000

[2] Williams, Jim, *"Application Note 21: Composite Amplifiers"*, Linear Technology Corporation, Milpitas, CA, 1986

[3] Kalthoff, Tim, et al., *"Classical Op Amp or Current-Feedback Op Amp? This Composite Op Amp Gives You the Best of Both Worlds"*, Burr Brown, Tucson, AZ, 2000

[4] Jung, Walt, Kester, Walt *"Op-Amp Applications, Chapter 6: Signal Amplifiers"*, Analog Devices, 2002

[5] Texas Instruments, *"Application Report SNAA021B AN-1192 Overture Series High Power Solutions"*, Texas Instruments, 2002 – Revised 2013

[6] Self, Douglas, *"Small-Signal Audio Design"*, Taylor & Francis, 2010