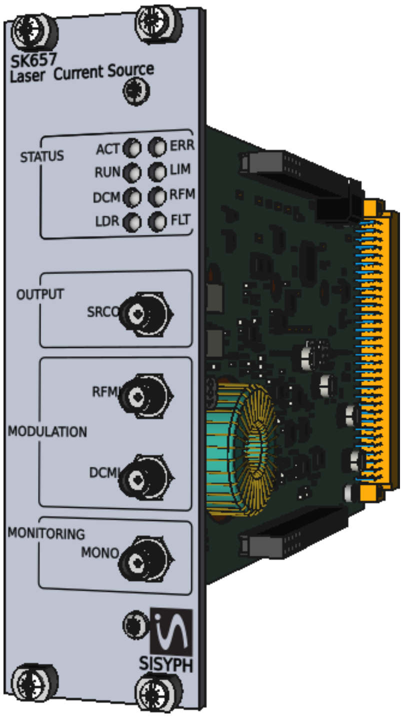
Typcal Performance Curves

SK657 *Gavarnie*
Laser Diode Current Controller

SK-Series Modules



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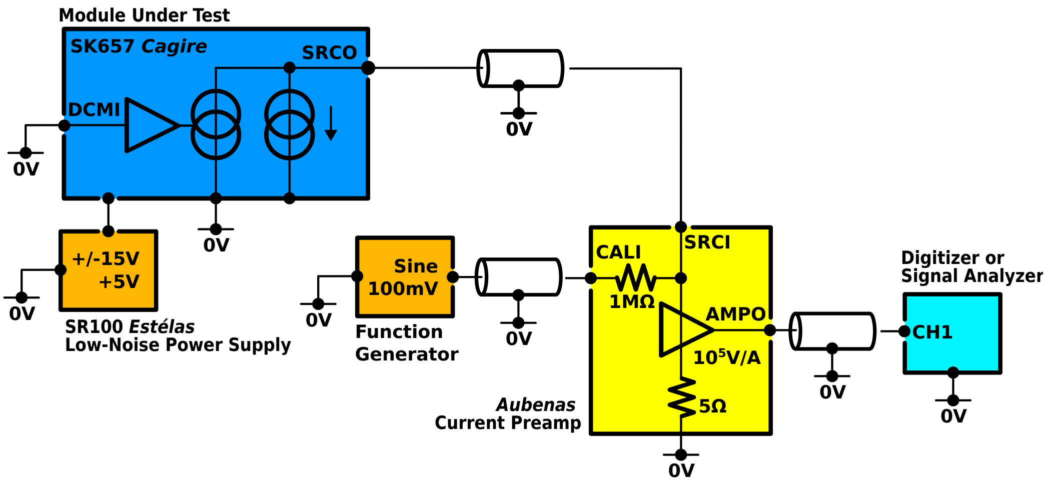

Figure 1: **Current noise spectral density measurement setup.** Due to the ultra-low noise performances of the SK657, a dedicated measurement setup is required. Indeed, with a current noise density as low as $10\,\mathrm{pA}/\sqrt{\mathrm{Hz}}$, a simple resistor-based setup is not able to resolve pico-ampere range densities. Usual noise measurement circuits rely on a resistor which provides both current-to-voltage conversion and current source output biasing. The voltage across the sensing resistor is then amplified and digitized for spectral analysis. For instance, in order to bias the current source output at 2.5 V under 500 mA, a 5-Ω sensing resistor could be used. Unfortunately, such a resistor would introduce an unavoidable noise contribution which can be approximated by $i_{\mathrm{sense}} = 130\,\mathrm{pV}/\sqrt{R_{\mathrm{sense}}} \approx 60\,\mathrm{pA}/\sqrt{\mathrm{Hz}}$. Therefore, even if the thermal noise of the sensing resistor were the only noise source contributor in this simple setup, the resulting resolution would be clearly unable to resolve the SK657's current noise. In order to measure ultra-low noise current densities, *Signals and Systems for Physics* has developed its own current preamplifier. The *Aubenas* preamplifier features a resolution better than $5\,\mathrm{pA}/\sqrt{\mathrm{Hz}}$ for frequencies above 100 Hz. With a conversion gain of $1 \times 10^5\,\mathrm{V/A}$ over a bandwidth of 3 MHz, the *Aubenas* preamplifier is able to resolve the SK657's current noise. Due to the gain peaking around 2 MHz, its transfer is first measured *via* the dedicated calibration input and then used for the deconvolution of the measured spectra.

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Current Noise Spectrum

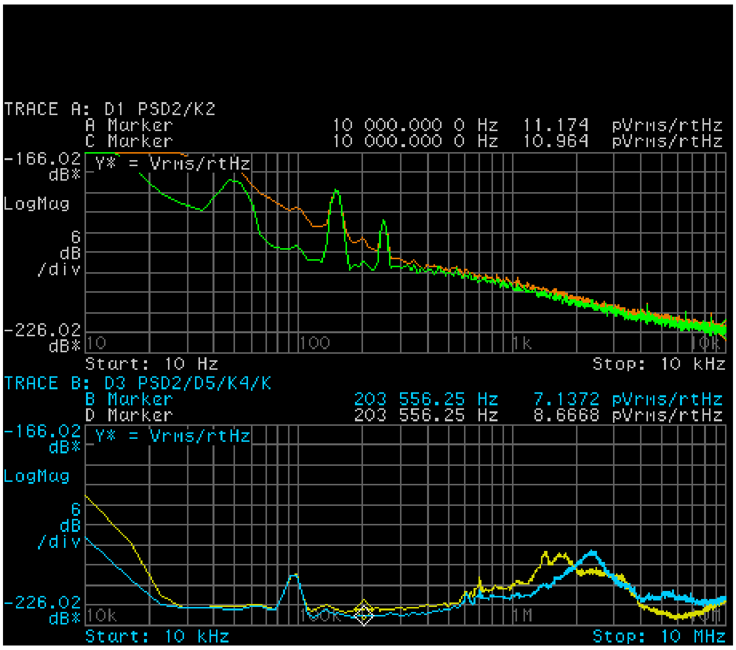

Figure 2: **Current noise density measurement.** The noise spectra were measured using an HP89410 signal analyzer according to the setup depicted in Fig. 1. The screens captured from HP89410 display the current noise spectral density for SK657 operating at 100 mA and 500 mA (DC-modulation was disabled). In order to see details, the measurement is divided into two frequency bands. Because the conversion gain of the *Aubenas* current preamplifier is taken in account using the analyzer's math functions, the density values expressed in volt can be directly read as ampere. While a simple scalar (1×10^5 V/A) is used for lower frequency bands, the transfer function of the preamplifier is used for the deconvolution of upper frequency band spectra. This helps to reduce the degradation of the measured density due to the preamplifier's gain peaking, which is located around 2 MHz. Trace A (resp. Trace C), top grid, displays the current noise spectral density from 10 Hz to 10 kHz for an operating current of 100 mA (resp. 500 mA). The density at 10 kHz is below $12\,\mathrm{pA}/\sqrt{\mathrm{Hz}}$ in both cases. The first spectra values displayed in the bottom grid can be discarded since they are artifacts due to the finite (small) number of samples used by the HP894410 to perform the spectral analysis. Here, Trace B (resp. Trace D) displays the noise spectrum when the SK657 operates at 100 mA (resp. 500 mA). The densities reach their minimal values - below $10\,\mathrm{pA}/\sqrt{\mathrm{Hz}}$ - around 100 kHz. The peak seen near this frequency is not related to the current source. The minimal spectral density is therefore reached over a frequency band ranging from 10 kHz to 600 kHz. The maximum value, obtained around 2 MHz, is 15 dB above the plateau, resulting in a density below $45\,\mathrm{pA}/\sqrt{\mathrm{Hz}}$. The overall integrated noise (from 100 Hz to 3 MHz) is below $50\,\mathrm{nA_{rms}}$.

DC-Modulation Transfer Measurement Setup

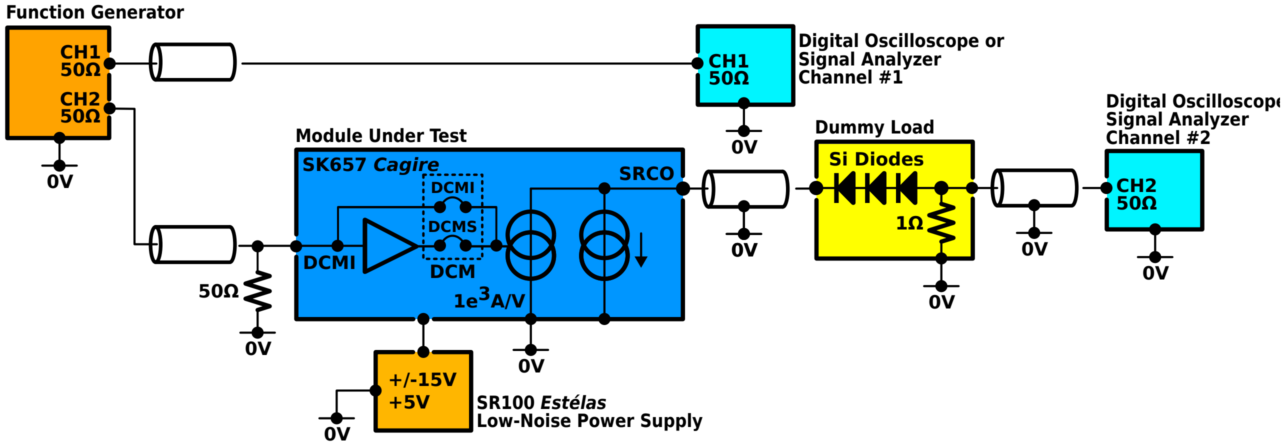

Figure 3: **DC-modulation transfer measurement setup.** The combination of 3 silicon rectifier diodes and the 1-Ω sensing resistor is used for current-to-voltage conversion and current source output biasing. The SK657 module provides the user with a jumper that can be used to maximize the modulation bandwidth. Indeed, the DCM jumper can be positioned (DCMI) to bypass the input buffer-multiplexer. In this case the conversion gain remains (1×10^3 A/V), but the bandwidth is extended above 30 MHz. Only the DCMI front-panel connector can be used here for the input signal source. When the jumper is positioned at DCMS, the remote command `DCMS` applies and the modulation source can be chosen among several interfaces.

DC-Modulation Transfer

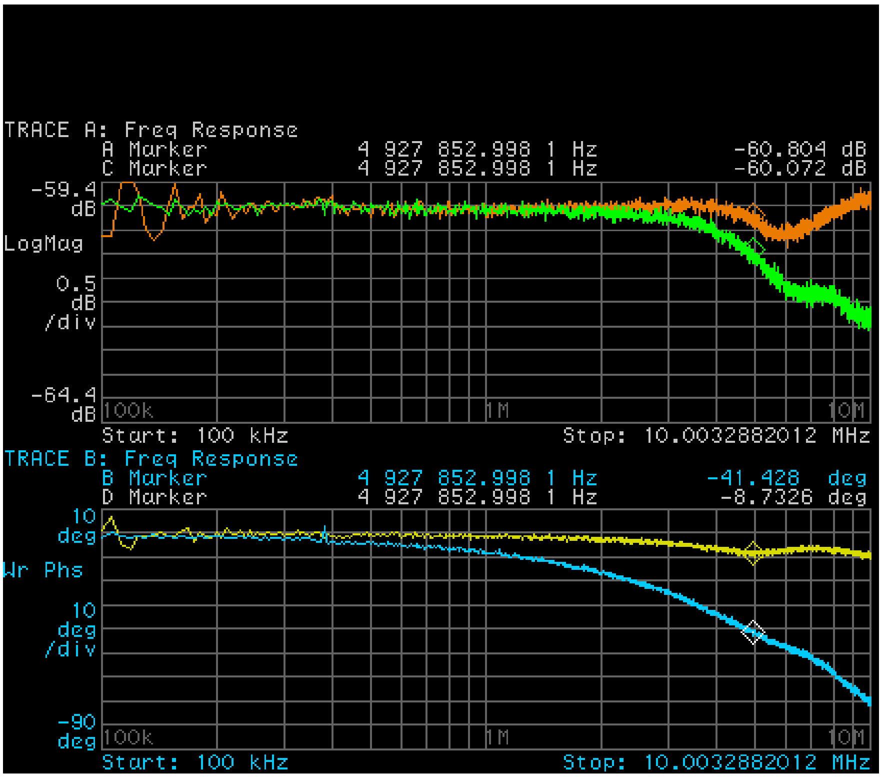

Figure 4: **DC-modulation transfer measurement.** The measurements were carried out for SK657 operating at 500 mA with the setup depicted in Fig. 3. Here, an HP89410 signal analyzer was used to record the transfer function from 100 kHz to 10 MHz. The transfer's magnitude (resp. phase) is displayed on the top grid (resp. bottom grid) for DCM jumper positioned at DCMS (Trace A and Trace C) or DCMI (Trace B and Trace D). It can be seen that the phase shift is significantly reduced when the DC-modulation operates directly from the DCMI input, without any intermediate multiplexer stage. Whereas the default setting (jumper at DCMS) should provide enough bandwidth for most applications (phase shift below 45° at 5 MHz and $f_{-3\,\mathrm{dB}} = 10$ MHz), the DCMI option provides the utmost modulation bandwidth with a phase shift below 10° over the entire small-signal functional bandwidth (DC-10 MHz). Variations of of the nominal gain (+1 mA/V or −60 dB) are maintained within 0.5 dB for DCMI operation.

1 Document Revision History

1.1 Version Number

This document is identified as SK657-SU05-P24A.

1.2 Revision History

P24A (2024-05-25)

Initial version