Datasheet

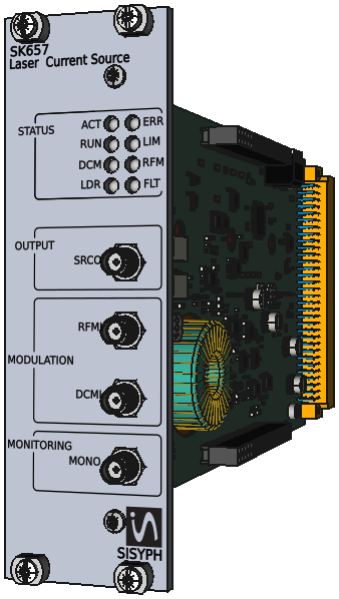
SK657*Gavarnie*
Laser Diode Current Controller

SK-Series Modules

The lowest noise, highest bandwidth of any commercially available products

Features

- Sinking current from 0 mA to 500 mA
- Ultra-low current noise :
  - 10 pA/$\sqrt{\text{Hz}}$ at $f = 100$ kHz
  - 50 nA_{rms}, 100 Hz to 3 MHz
- RF modulation : 10 MHz to 200 MHz
- Fast modulation : DC to 30 MHz
- Paralled operation for higher current
- Full remote control
- Stand-alone or platform operation



Applications

- Laser manufacturing, quantum technologies, Time & Frequency, AMO Physics.

General Description

Overview

The SK657 *Gavarnie* Laser Diode Current Controller is a low-noise programmable current source for operating *lasers whose anode terminal is grounded or floating from ground*. While the laser biasing current is controlled using two paralleled current sources for a fine adjustment between 0 and 500 mA, two inputs are provided for DC- and RF-modulation. Several interfaces are available to connect the laser diode in order to facilitate the integration of the SK657. Usual functionalities for a safe operation are also provided : slow turn-on, interlock, compliance over-voltage detection, current limitation... Acting as true independent current sources, several SK657 modules can thus operate in parallel to increase the output current while maintaining ultra-low noise operation. Due to its unique specifications, the SK657 is the right choice for most demanding applications.

Online Documentation

More information is available online : the last versions of the *Functional Block Diagram*, *User's Guide* and *Programming Guide* can be downloaded from the product page. Additional information (performances, application notes...) are also provided online.

Communications

The SK657's settings are changed through the remote interface. All instrument settings can also be queried *via* the remote interface. The module generates a status signal to report a specific event to the host computer. The SK657 can be operated either inside or outside the dedicated SPK-Series platform.

Front-Panel Display

The front panel of the SK657 provides the user with minimal information about the status of the instrument.

DC-Current Source

The DC operating current of the laser diode is controlled using two paralleled current sources. The first one sets the coarse value between 0 and 500 mA while the second source controls the laser's current over a range of 10 mA. Two dedicated remote commands are provided to control these sources. Several SK657 modules can be paralleled to increase the current delivered to the load while maintaining the ultra-low noise operation.

Current Modulation

The output current can be also controlled through the voltages applied to the modulation input connectors. The DC-Modulation input is used to control the current at frequencies ranging from DC to 10 MHz. The second input allows modulation at radio-frequencies, up to 200 MHz typically.

Safety

Safe operation of the laser is assured through a series of features, including usual current limiter and slow turn-on circuit. The current source is also switched off whether one or more power supply is below its nominal value. A compliance over-voltage or a broken interlock loop can also trigger a laser shutdown. In addition, a fast recovery diode is connected between the laser terminals to protect the device against reverse voltage transients.

Specifications

Current Source Output

Current Source

Interface	SMA, EXP, UTB, BKP.
Coarse value	0 mA to −500 mA.
Fine value	0 mA to −10 mA, 12-bit.
Compliance	≤ 5 V
Limiter	0 mA to −510 mA.
Stability	< ±10 ppm/K at $I = 500$ mA.
1-Hour Drift	< 10 µA at $I = 510$ mA.
Delay	5 s before turning the driver on.

Noise Spectral Density

$I = 500$ mA, DC-modulation disabled.

$f = 100$ Hz	$< 600\,\mathrm{pA}/\sqrt{\mathrm{Hz}}$
$f = 1$ kHz	$< 50\,\mathrm{pA}/\sqrt{\mathrm{Hz}}$
$f = 10$ kHz	$< 15\,\mathrm{pA}/\sqrt{\mathrm{Hz}}$
$f = 100$ kHz	$< 10\,\mathrm{pA}/\sqrt{\mathrm{Hz}}$
$f = 1$ MHz	$< 20\,\mathrm{pA}/\sqrt{\mathrm{Hz}}$

RMS Noise

$I = 500$ mA, DC-modulation disabled.

100 Hz to 100 kHz	$< 5\,\mathrm{nA_{rms}}$
100 Hz to 3 MHz	$< 50\,\mathrm{nA_{rms}}$

Current Modulation Inputs

DC-Modulation Input

Interface	SMA, EXP, UTB, BKP.
Gain	+1 mA/V (−60 dB)
Range	±10 V
Impedance	≥ 1 kΩ
$f_{3\text{-dB}}$, SSBW	≥ 10 MHz, jumper DCMS.
$f_{3\text{-dB}}$, SSBW	≥ 30 MHz, jumper DCMI.

RF-Modulation Input

Interface	SMA
Impedance	50 Ω
Transmission	−6 dB
Frequency	from 10 MHz to 200 MHz.
Max. Level	0 dBm

Monitoring Output

Interface	SMA, EXP, UTB, BKP.
Impedance	100 Ω

IMON Channel

Gain	+10 V/A
Accuracy	±2 %

VMON Channel

Gain	+1 V/V
Accuracy	±2 %

General Characteristics

This module is designed to be operated in laboratory environment.

Operating Temperature

Range	+15 °C to +40 °C, non-condensing.

Host PC Communications

UART format	9600 baud, 8-bit data, 1 stop-bit, no flow control.
Interface	DIN41612 backplane connector.

Connectors

Backplane	DIN41612 96C male.
Expansion	
AIO	40-pin PC/104 header.
DIO	40-pin PC/104 header.
Front-Panel	
SRCO	SMA
DCMI	SMA
RFMI	SMA
MONO	SMA

Front Panel Indicators

Remote Op.	ERR, ACT.
Laser	RUN, LIM, LDR.
Modulation In.	DCM, RFM.
Fault	FLT

Power Supply Inputs

Analog	+15 V × 80 mA
Analog	−15 V × 600 mA
Digital	+5 V × 80 mA

Printed Circuit Board

Form factor	Eurocard.
Dimensions	100 × 160 × 1.6 mm.
Technology	6-layer FR4.

Physical Properties

Height	128.4 mm (3U)
Width	Double-wide, 40 mm (8HP)
Depth	174.5 mm
Weight	≈ 500 g
Front-Panel	Anodized aluminium with rear conductive.

Warranty

One (1) year parts and labor on defects.

Typical Performance Characteristics

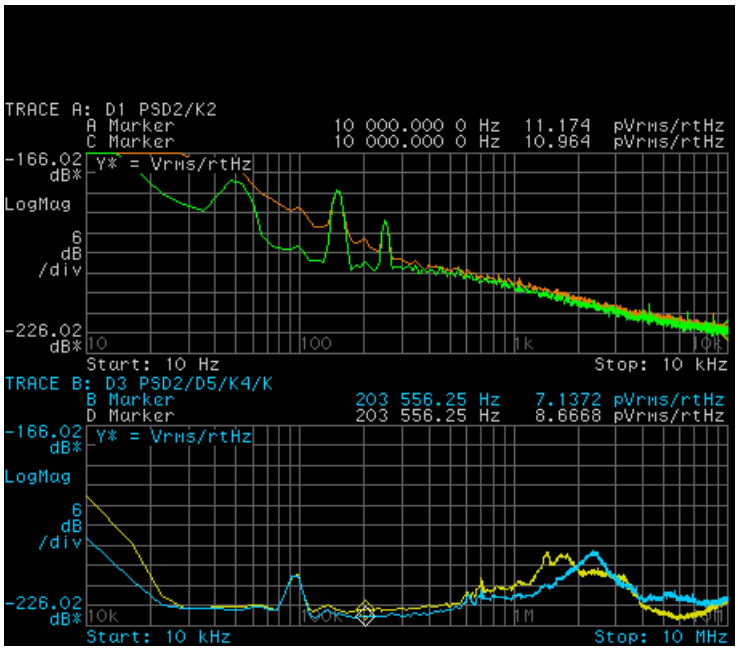


Figure 1: Current noise density measurement. The noise spectra were measured for SK657 operating at $100\,\mathrm{mA}$ and $500\,\mathrm{mA}$ (DC-modulation was disabled). In order to see details, the measurement is divided into two frequency bands. Because the conversion gain of the current preamplifier is taken in account using the analyzer's math functions, the density values expressed in volt can be directly read as ampere. Trace A (resp. Trace C), top grid, displays the current noise spectral density from $10\,\mathrm{Hz}$ to $10\,\mathrm{kHz}$ for an operating current of $100\,\mathrm{mA}$ (resp. $500\,\mathrm{mA}$). The density at $10\,\mathrm{kHz}$ 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 to perform the spectral analysis. Here, Trace B (resp. Trace D) displays the noise spectrum when the SK657 operates at $100\,\mathrm{mA}$ (resp. $500\,\mathrm{mA}$). The densities reach their minimal values - below $10\,\mathrm{pA}/\sqrt{\mathrm{Hz}}$ - around $100\,\mathrm{kHz}$. 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 $10\,\mathrm{kHz}$ to $600\,\mathrm{kHz}$. The maximum value, obtained around $2\,\mathrm{MHz}$, is $15\,\mathrm{dB}$ above the plateau, resulting in a density below $45\,\mathrm{pA}/\sqrt{\mathrm{Hz}}$. The overall integrated noise (from $100\,\mathrm{Hz}$ to $3\,\mathrm{MHz}$) is below $50\,\mathrm{nA_{rms}}$.

Typical Performance Characteristics

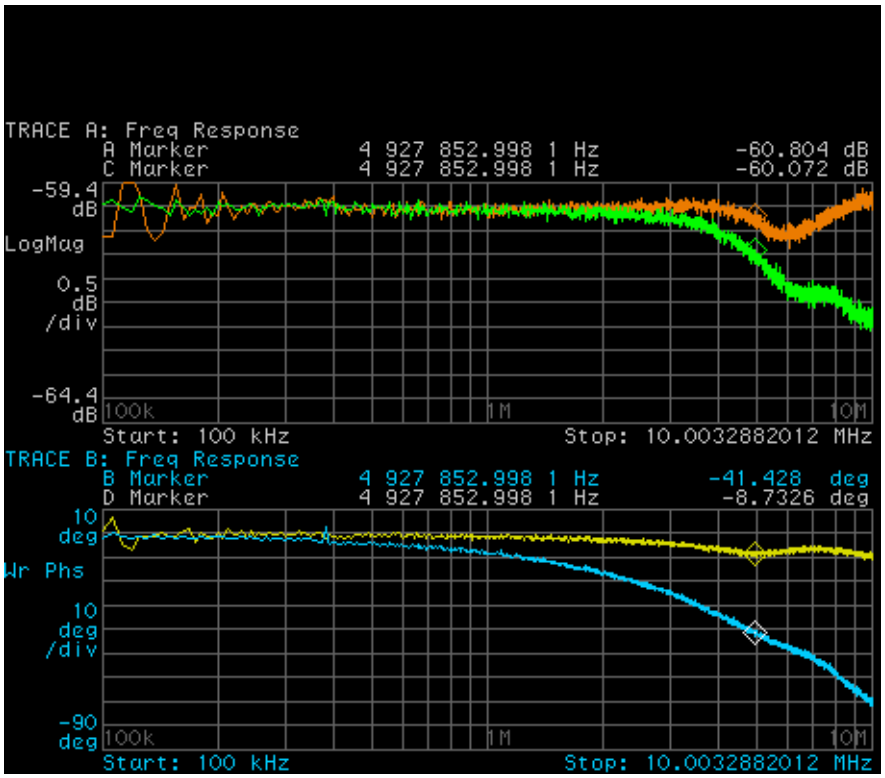


Figure 2: DC-modulation transfer measurement. The measurements were carried out for SK657 operating at $500\,\mathrm{mA}$. The DC-modulation's transfer function is recorded from $100\,\mathrm{kHz}$ to $10\,\mathrm{MHz}$. The transfer's magnitude (resp. phase) is displayed on the top grid (resp. bottom 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 $5\,\mathrm{MHz}$ and $f_{-3\,\mathrm{dB}} \approx 10\,\mathrm{MHz}$), the DCMI option provides the utmost modulation bandwidth with a phase shift below $10°$ over the entire small-signal functional bandwidth (DC-$10\,\mathrm{MHz}$). Variations of the nominal gain ($+1\,\mathrm{mA/V}$ or $-60\,\mathrm{dB}$) are maintained within $0.5\,\mathrm{dB}$ for DCMI operation.

Ordering Information

SK657 Module

The SK657 module can be ordered with different options.

Ordering Code	Front Panel Options
SK657-FP	Shielded 3U-8HP front-panel (standard).
SK657-NP	No front-panel.

Accessories

Accessories and optional parts described in this section are not included in the SK657's package and must be therefore ordered separately if required.

Module Adapters

While the SK657 module was designed to operate within an SPK-Series Platform, it is also possible to use it stand-alone. In such case, the user has to externally wire all required signals and power supplies through the DIN41612 connector. To help the user in this operation, *Signals and Systems for Physics* provides several module adapters. Thus, the SKN10 features several terminal blocks to wire the power supplies without any soldering. An isolated USB bridge is also available to directly connect the module to the host PC without introducing common-mode noise. On the other hand, the SKN11 module adapter just provides the user with a small break-out board where the user has to solder the mating connector's pads.

Ordering Code	Description
SKN10	SK-Series module adapter with USB interface and terminal blocks.
SKN11	SK-Series module adapter.

Document Identifier

This document is identified as SK657-SU03-P24A.

Document Revision History

P24A (2024-05-24)
Initial version.

Important Notice

Information in this document is subject to change without notice.

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