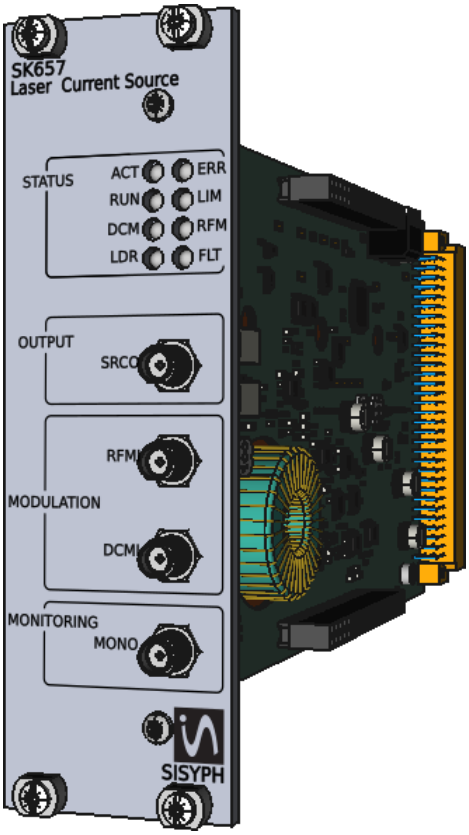
User's Guide

SK657*Gavarnie*
Laser Diode Current Controller

SK-Series Modules



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General Information

Scope

This document provides the user with information on how to operate the SK657 Laser Diode Current Controller module.

Safety and Preparation for Use

Because of the variety of uses for the SK657 *Laser Diode Current Controller*, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The SK657 *Laser Diode Current Controller* is not designed, intended, or sold for use in hazardous environments requiring fail-safe operation, including without limitation, operation of nuclear facilities, aircraft or spacecraft control systems, and life support or weapons systems. The user must assure that any failure or misapplication of the SK657 *Laser Diode Current Controller* cannot lead to a consequential failure of any interconnected equipment that could lead to loss of life or limb, or property damage.

The illustrations, charts, and discussions shown in this manual are intended solely for purposes of example. Since there are many variables and requirements associated with any particular control application, *Signals and Systems for Physics* does not assume responsibility or liability for actual use based upon the examples shown in this publication.

Do not install substitute parts or perform any unauthorized modifications to this instrument.

The SK657 *Laser Diode Current Controller* is a module designed to be used with the SPK-Series Platforms. Do not turn on the power to the platform or apply voltage inputs to the module until the module is completely inserted and locked in place. Do not exceed the specified voltages at any input or output connector.

Specifications and Related Documentation

Complete information (specifications, datasheet, programming guide, block diagram ...) is available online. These additional documents can be downloaded from the product page at www.sisyph.com.

Contents

1 Getting Started

This section provides the user with the necessary information to get started quickly with the SK657 *Laser Diode Current Controller*. Each part of the front-panel as well as the rear and the top sides of the module are explained in the following sections. Circled numbers beginning a paragraph help the user to locate these features on the module sides (see Figs 1 and 2).

1.1 Overview

The SK657 *Gavarnie* Laser Diode Current Controller is a low-noise programmable current source for operating laser diodes. *The module is designed to drive lasers whose anode terminal is grounded or floating from ground.*
The DC operating current of the laser diode is primary 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. This latter source is used to precisely adjust the output current.
The laser's 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 100 MHz typically.
Safe operation of the laser is assured through a series of features, including a current limiter and a slow turn-on circuit. The SK657 is also able to switch the current source off whether one or more power supply is detected under its nominal value. Once the shutdown procedure is triggered, the output current is set to 0 mA and a shorting relay is closed to protect the laser diode. 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.
The SK657 provides the user with several interfaces to connect the module to the laser device. The interlock switch terminals and the DC-modulation source can be likewise connected to the module through different interfaces. These functionalities should facilitate the integration of the SK657.

1.2 Front-Panel Connections

1.2.1 Current Source Output (SRCO)

(12) The laser diode's primary connection to the current source is made through this SMA coaxial connector. Since the SK657 is designed for driving anode grounded lasers, the cathode must be connected to the inner conductor and the shield wired to the anode. Because alternative connections schemes are also provided, this front-panel connector should be selected as output interface using the `REAR` remote command.

1.2.2 RF Modulation Input (RFMI)

(13) This SMA coaxial connector is provided for modulating the laser current at RF frequencies. Connect the 50-Ω output of a function generator to this input using a coaxial cable. Can be left open if not used. The RF input port is enabled by executing the `RFME` remote command.

1.2.3 DC Modulation Input (DCMI)

(14) In order to modulate the laser current at low frequencies, connect the signal source to this SMA coaxial connector. Prior using this functionality, both the `DCMS` and `DCME` remote commands must be executed in

order to select the input interface and enable the modulation circuit. This input can be left open if not used. In this case, the DC-modulation circuit should be disabled for preserving the ultra-low noise performance of the SK657.

1.2.4 Laser Monitoring Output (MONO)

(15) A copy of the measurements provided by the laser's voltage (1 V/V) and current (10 V/A) sensing circuits can be routed to this SMA connector for monitoring purpose. The master summary /STATUS signal is also available. The signal selection is done by executing the `MONS` remote command. This output can drive light loads, it can be left open if not used.

1.3 Front-Panel Indicators

1.3.1 Remote Interface Activity (ACT)

(6) Any data coming from or going to the host interface will cause this indicator to flash green.

1.3.2 Remote Interface Error (ERR)

(6) Command errors or buffer overruns will cause the error indicator to illuminate red. Because this led reflects the state of the flags **RXQ**, **EXE** and **CMD** in the Event Status register (**EVTS**), the indicator can be cleared by invoking any remote commands clearing these flags. For instance, executing `CLS?` will clear the error indicator.

1.3.3 Laser Is Running (RUN)

(11) This indicator displays the status of the laser output. It is switched off when the laser output is disabled and blinks green during the slow-turn on sequence upon executing the remote command `LDEN`. At the end of this transient, the indicator illuminates green to indicate that the laser is running.

1.3.4 Current Limiting (LIM)

(11) The operation of the current limiting circuit is displayed by this indicator. It illuminates red when the current limiter is engaged. It is automatically switched off during normal operation.

1.3.5 DC-Modulation Enabled (DCM)

(11) The status of the DC-Modulation is monitored by this indicator. It is switched on (green) when the functionality is enabled by issuing the remote command `DCME`.

1.3.6 RF-Modulation Enabled (RFM)

(11) This indicator displays the current status of the RF-modulation port. It illuminates green when the relay used for routing the RF input to the laser output terminals is closed. The relay's state is controlled using the remote command `RFME`.

1.3.7 Laser Rear Interface Enabled (LDR)

(11) This indicator illuminates green when the rear output interfaces are used to connect the laser. In this case the front-panel laser output is disconnected from the current source. The rear output interface is selected by executing the remote command `REAR`.

1.3.8 Fault Detected (FLT)

(11) This indicator is switched on when i) the interlock loop is open, ii) an excessive laser voltage has been detected or iii) one (or more) power supply operates under its nominal level. Because this red indicator is lit if any of the **IPWR**, **XPWR** and **ILKO** flags is set in the Instrument Status register (**INSS**), any remote command clearing these flags will also clear the fault indicator. Note that a laser shutdown consecutive to an excessive compliance voltage will also switch the indicator on. In this case, the led will be turned off by querying the Overload Status (**OVLS**) register. Invoking the `*CLS` command will always clear the indicator regardless of the fault source.

1.4 Backplane Connector

(1) The primary connection to the SK657 module is the rear DIN41612-96C connector (see Fig.4 for its generic pin assignments). Typically, the module is mated into the backplane of an SPK-Series Platform using this connector. It is also possible to operate the SK657 directly, without any platform. In such stand-alone operation, 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 (see SKN-Series *Module Adapters* online). DIN41612 connector's pins are used to power the module and connect its communications lines to the remote controller. Some pins are also used for sharing signals with other slave modules plugged on the same backplane. Wiring external signals to the module from the rear-side of the backplane is also provided using dedicated terminal blocks.

1.4.1 Power Supply

The pins used for powering the SK657 module are listed in the following table. It mentions only pins that are effectively used. For detailed information on power requirements, refer to the *Datasheet* available online.

CAUTION - *Because the SK657 uses some power supplies without any local post-regulation circuitry, always use clean, well regulated power sources with adjustable current limitation.*

Pin	Label	Functionality	Source	Destination
A2, B2, C2	P5V	Digital +5 V	Platform	SK657
A27, B27, C27	P15V	Analog +15 V	Platform	SK657
A31, B31, C31	N15V	Analog −15 V	Platform	SK657
A3, B3, C3	DGND	Digital Ground (0 V)	Platform	SK657
A7, B7, C7				
A7, B7, C7				
A11, B11, C11				
A24, B24, C24	AGND	Analog Ground (0 V)	Platform	SK657
A28, B28, C28				
A32, B32, C32				
C14	Power Good	Monitoring	Platform	SK657
A1	Chassis	Chassis Ground - Earth	Platform	SK657

Table 1: SK657's power supplies – DIN4161 connector pin assignments.

The +5 V power supply is connected to the module through the **P5V** and **DGND** pins. This power supply is used for the digital circuits. Their analog counterparts are powered from the +15 V and −15 V sources connected through the **P15V**, **N15V** and **AGND** pins. The Earth safety line is routed to the module *via* the **Chassis Ground** pin, which is used for grounding the mechanical parts. The SK657 also uses the **Power Good** signal provided by the SPK-Platform for monitoring the power supply inputs. This signal is asserted-low by the platform whether one or more power supply is under its nominal operating value.

1.4.2 Grounding

The **AGND** and **DGND** power lines of the backplane connector are not tied together by the internal circuitry of the SK657. They are instead connected through back-to-back Schottky diodes, so the digital and analog grounds cannot be more than ±350 mV apart. When the SK657 module is assembled into an SPK-Platform, its digital and analog ground lines are tied together through the backplane to a single point (star connection).

Caution – *When the module is used stand-alone, the digital and analog ground lines should be separately wired to a single, low-impedance ground source at the power supply.*

(2A) (2B) (2C) Alternative grounding schemes can be also wired using the dedicated optional jumpers, which are accessible from the top-side of the printed circuit board.

1.4.3 Host Interface

The pins used for operating the SK657 module over the host interface are listed in the following table. It mentions only pins that are effectively used. For detailed information on serial communications settings, refer to the *Programming Guide* available online.

Pin	Label	Functionality	Source	Destination
B1, C1, B4, C4	ID[3-0]	Slot identification	Platform	SK657
A20	/STATUS	Master Summary	SK657	Platform
A23	/SLOT	Occupied slot	SK657	Platform
A9	UART-TX	Async data	Platform	SK657
A16	UART-RX	Async data	SK657	Platform

Table 2: SK657's host interface – DIN41612 connector pin assignments.

The SK657 communicates with the host through **TX-** and **RX-UART** lines without any hardware handshaking. The **Slot Identification** lines are used by the module to retrieve the number of the slot (0 to 15) where the module is mated. Because these lines are coded by the platform hardware, no such identification can be provided for a stand-alone operation. In this case, the identification pins are automatically asserted-high by the internal module hardware to detect a stand-alone operation, which corresponds to the virtual slot number 255. The **/STATUS** line is driven by the module to indicate whether one or more of the enabled status messages in the Master Summary Status (**MSTS**) register is true. The signal is then asserted-low and remains in this state until the register has been queried by the `MSTS?` remote command. When the SK657 is used with an SPK-Platform, the **/STATUS** signal is monitored and reported to the host controller *via* the communications link. The **/SLOT** line, which is driven-low by the module, is used by the platform circuitry to detect whether or not a module occupies this slot.

1.4.4 Shared Lines

Some pins of the DIN41612 connector are reserved for sharing signals with others modules through the backplane. *Always contact us before using this functionality.*

A jumper has to be mounted in order to route each signal to its associated shared line. For instance, if one has to route the laser output to the backplane, two jumpers must be installed across the pins 11-12 and 9-10 of the dedicated header.

Pin	Label	Functionality	Direction	Jumper
C9	ILK-SRC	Interlock switch – Sourcing	Output	J8-3/4
B9	ILK-RTN	Interlock switch – Sensing	Input	J8-1/2
A25, B25, C25	LDA	Laser Anode	Output	J8-11/12
A26, B26, C26	LDC	Laser Cathode	Output	J8-9/10
C29	DCMOD	DC-Modulation	Input	J8-7/8
B29	IMON	Current Monitoring	Output	J8-5/6

Table 3: SK657's shared lines – DIN41612 connector pin assignments.

The two lines **ILK-SRC** and **ILK-RTN** are provided to connect the interlock loop wires. The **LDA** and **LDC** lines provide an alternative connection for the laser. For example, they can be used to connect the current source's outputs to a laser device without using any cables. Likewise, the source signal used for the

DC-modulation of the laser's current can be alternatively connected to the **DCMOD** line. A copy of the laser current measurement (10 V/A) is also available *via* the **IMON** line.

1.4.5 User's Terminal Blocks

SPK-Series Platforms feature a backplane where each slot is provided with 16 additional User's Terminal Blocks (**UTB**). These connectors, located at the rear-side of the backplane, are wired to the module through dedicated pins of its DIN41612 connector. They can be used for specific module wiring, *e.g.* for connecting some signals to the rear-panel of the platform. *Always contact us before using this functionality.* The SK657's pins routed to the terminal blocks are listed in the following table.

Pin	Label	Functionality	Direction
B16	DCMOD	DC-modulation	Input
B17	VMON	Laser voltage monitoring	Output
B18	IMON	Laser current monitoring	Output
B19	LDSWI	Laser on/off switch	Input
B20	/STATUS	Master summary signal	Output
B23	AGND	Analog ground	Output
C16, C17, C18	LDA	Laser anode	Output
C19, C20, C21	LDC	Laser cathode	Output
C22	ILK-SRC	Interlock switch – Sourcing	Output
C23	ILK-RTN	Interlock switch – Sensing	Input

Table 4: SK657 User's terminal blocks – DIN41612 connector pin assignments.

The **DCMOD** line is used to connect the modulation source. In order to select this source for the modulation, the `DCMS` remote command must be issued prior using this functionality. The **VMON** and **IMON** lines are respectively a copy of laser voltage and current measurements. The **LDSWI** and **AGND** lines are provided to connect a switch for controlling the laser operation. Because the current source output's state is primary controlled using the remote command `LDEN`, these optional connections allow the user to install an external switch for enabling the laser instead using the remote command. This functionality must be activated using the `FPSE 1` remote command. Alternative laser connections can be wired using the **LDA** and **LDC** lines. The `REAR` remote command must be executed for using these connections. **ILK-SRC** and **ILK-RTN** allow the user to wire an interlock loop. All these signal connections should use the **AGND** line as ground return.

1.4.6 Synchronization

(1) The differential pair (**SYN-P**, **SYN-N**) is distributed to all modules *via* the dedicated backplane lines. These lines are driven by the SK810 *Interfaces Controller* to provide a **Synchronization**/**Timebase** of 10 MHz.

Pin	Label	Functionality	Source	Destination
A14	SYNC-N	Negative Synchronization	Backplane	SK657
B14	SYNC-N	Positive Synchronization	Backplane	SK657

Table 5: SK657 Synchronization – DIN41612 connector pin assignments.

1.4.7 Synchronization

The SPK-Platform distributes a **Synchronization timebase** of 10 MHz to the modular instruments *via* the (**SYN-P**, **SYN-N**) backplane lines. The SK657 uses this differential pair to synchronize the clock of its microcontroller. When operating stand alone, the SK657 automatically switches the 10-MHz clock to an internal source.

1.5 Expansion Connectors

These connectors are reserved for customization or factory testing purposes. *Always contact us before using this functionality.*

1.5.1 Analog I/O Expansion

(3B) The following table provides the pin assignments of the Analog I/O Expansion connector. It mentions only pins that are effectively used by the SK657 module. Refer to the Section 2.1 for more information.

Pin	Label	Functionality	Direction
1	LIMITER	Copy of the current limiter's threshold	Output
11	MOD-SRC	Control voltage for DC-modulation	Input
13	VMON	Copy of laser voltage measurement	Output
15	IMON	Copy of laser current measurement	Output
23, 24	LDC	Laser cathode connection	Output
25, 26	LDA	Laser anode connection (0 V)	Output
35, 36	P15V	+15 V power supply	Output
37, 38	N15V	−15 V power supply	Output
9, 10, 19, 20, 39, 40	AGND	Analog ground (0 V)	Output

Table 6: SK657 Analog I/O Expansion connector – Pin assignments.

The **P15V**, **N15V** and **AGND** pins can be used to bring ±15 V power supplies to the loading circuitry. The **LDA** and **LDC** pins provide alternative connections for the laser. In order to use this output interface, the `REAR` remote command must be issued. The DC-modulation signal source can be connected using the **MOD-SRC** pin. This source is selected with the `DCMS` remote command. The **VMON** and **IMON** lines

are respectively a copy of laser voltage (1 V/V) and current (10 V/A) measurement. A copy of the voltage used as trigger level by the current limiter is also available through the **Limiter** pin.

1.5.2 Digital I/O Expansion

(3A) The following table provides the pin assignments of the Digital I/O Expansion connector. It mentions only pins that are effectively in use by the SK657 module.

Pin	Label	Functionality	Direction
24	/LIMITING	Current limiting (asserted low).	Output
27	ILK-SRC	Interlock switch – Source	Output
28	ILK-RTN	Interlock switch – Sense	Input
37, 38	P5V	+5 V power supply	Output
9, 10, 19, 20, 39, 40	DGND	Digital ground (0 V)	Output

Table 7: SK657 Digital I/O Expansion connector – Pin assignments.

The **P5V** and **DGND** pins provide the +5 V power supply required for the digital parts of the additional board. The /**Limiting** pin is driven low when the current limiter is engaged. The two lines **ILK-SRC** and **ILK-RTN** are provided to connect the interlock loop wires.

1.6 On-Board Settings and Connectors

Some functionalities of the SK657 are controlled or configured using switches located on its printed circuit board. Connectors can be also installed on the component-side of the board when they are rarely used, *e.g.* for test or calibration purposes.

1.6.1 Configuration Switches

(4) This 4-position switch array is not used in this version of the module. Nevertheless, it is mounted for future use or software customization purpose.

1.6.2 Grounding Jumpers

Three jumpers are provided to modify the initial arrangement for connecting the ground lines. By default, these jumpers are not mounted. They must be left open if not used.

(2A) Mounting this jumper will tie the **Digital Ground** to the **Chassis Ground** (power earth).

(2B) Installing this jumper will tie the **Analog Ground** to the **Chassis Ground** (power earth).

(2C) This jumper can be used to tie the **Digital and Analog Ground** lines together since they are connected only through back-to-back Schottky diodes. When the SK657 is mounted into a platform, the **Digital and Analog Ground** lines are tied together through the backplane to a single point.

1.6.3 DC-Modulation Jumper

(16) The DCM jumper provides the user with bypassing the input multiplexer circuit of the DC-modulation. When the jumper is mounted on the **DCMS** location (default), the modulation source signal is selected *via* the DCMS command. In order to extend the available bandwidth beyond 10 MHz, the jumper must be installed at the **DCMI** position. In this case, the modulation signal must be applied to the DCMI input connector. Because the multiplexer is bypassed, the DCMS remote command is no longer effective and the only allowed interface for the modulating signal is the front-panel connector.

1.6.4 Interfacing through SPK-Series Platform

The SKP-Series Platform is designed to assemble a system based on SK-Series modules. The platform carries all the power and communications lines to the mounted modules through the internal backplane. The platform also provides an USB interface for communications with the host controller (see SK810 *Interfaces Controller* module online). The power supply voltages are provided to the platform by external sources *via* a rear panel DSUB7W2 connector. This should reduce the exposition of the modules to the power supplies' EMI.

1.6.5 Direct Interfacing

It is also possible to operate the SK657 module directly, without using any platform.

Caution – *Misapplication of power may cause circuit damage.* Signals and Systems for Physics *recommends using the SK657 together with the SPK-Platform for most applications.*

The mating connector needed is a standard 96-pin DIN41612 female receptacle. Clean, well-regulated power supplies must be provided. Refer to the Grounding section for appropriate connection of the different ground lines. The communication is possible by directly connecting the appropriate interface lines to an USB-to-UART bridge as explained in the related section. *Signals and Systems for Physics* also provides the user with several module adapters to wire the required signals and power supplies. Among them, the SKN10 features an USB-to-UART bridge and several spring clamping terminal blocks.

1.7 Operating the Current Source

1.7.1 Connecting the Laser

The laser is primary connected to the current source output *via* the coaxial SMA connector of the front-panel. The expansion connectors, the shared lines of the backplane and the user's terminal blocks provide alternative interfaces for connecting the laser device to the SK657.

Caution – *The SK657 Laser Diode Current Controller is designed to operate with anode grounded lasers. Floating terminals lasers can be also used. In doubt, contact us for confirmation.*

It is recommended to operate the laser diode floating without connection to ground. Note that many laser packages connect one terminal of the laser to the package case. It is still recommended to use configurations where the package case does not connect to ground. In situations where the laser case must be connected to the ground, be careful to understand all potential ground paths in your system to avoid inadvertent ground loops or short circuits. *In such situations, only the laser anode can be grounded.*

1.7.2 Setting the DC-Output Current

The laser is supplied through two current sources acting in parallel. The remote command `ICRS` allows the user to program the first current source from 0 mA to 500 mA with a resolution of 1 mA. Any change of the coarse current is carried out in a linear fashion in order to preserve the laser from abrupt changes.
Fine adjustment of the DC output current is provided by the second source, which is programmed using the `IFIN` remote command. This source is able to bring an additional current ranging from 0 mA to 10 mA with a resolution of 12-bit.
The laser output is automatically switched off upon powering the module. Executing the command `LDEN` will start the slow turn-on sequence to safely settle the output current : once the 5-s safety delay has elapsed, the shorting relay is opened and the coarse current is linearly increased from 0 mA to its programmed value. At the end of the sequence, the fine current source is enabled to provide small adjustments. The **RUN** indicator blinks green during the first 5 seconds of the sequence to indicate that the laser is close to operate. Enabling the laser could also be done using an optional switch connected to the dedicated interface pins. Two bits (**STAB** and **LDEN**) of the Instrument Status register (**INSS**) are also used to store information about the laser operation.

1.7.3 Setting the Current Limitation

The SK657 includes a current limiting circuit in order to prevent the laser to operate at excessive current. The threshold value above which this functionality will operate is programmed using the `ILIM` remote command. The current limitation value ranges from 0 mA to 1000 mA with a resolution of 1 mA.

CAUTION – *Note that the current noise density may increase if the limiter's threshold is too close to the operating current.* To prevent this degradation, set the threshold value at least 10 % higher than the operating current.

The current limiter operates from the measurement of the output current and compares its value to the programmed threshold. A local feedback loop is then used to control the conduction of the power transistors for lowering the output current if required. The front-panel indicator illuminates when the limiter is engaged. A status bit (**ILIM**) of the Overload status register (**OVLS**) is also provided to store this information.

1.7.4 Monitoring the Compliance Voltage

The voltage across the current source's terminals is continuously monitored in order to prevent the laser to operate at excessive voltage levels. An analog comparator is used to start a laser shutdown sequence when the laser voltage is measured above a threshold value. The remote command `VCMP` is provided to program this threshold value from 1000 mV to 5000 mV with a resolution of 8-bit.
When an excessive compliance voltage has been detected, the current sources are immediately set to 0 mA and the protecting relay is closed to short the laser diode's terminals. Regardless the operation of this protection circuit, an additional provision for protecting the laser against both reverse and excessive forward voltages uses a high-speed 5-V breakdown diode. This feature is always operating whatever the programmed value of the threshold.
A compliance over-voltage event will be reported using the dedicated flag (**VCMP**) of the Overload Status register (**OVLS**). The **FLT** led indicator on the front-panel will be also switched on. The remote commands `*CLS` or `OVLS ?` can be used to clear the indicator.

1.7.5 Modulating the Current at Low Frequency

This functionality is provided for applications where the laser's current has to be modulated from DC up to 10 MHz. The interface where to connect the modulating signal is selected by the remote command `DCMS`: the

front-panel SMA, the backplane shared lines, the expansion connectors pins and the user's terminal blocks can be all used as input interfaces. With a gain of 1 mA/V and an input range of ±10 V, small current deviations up to ±10 mA are achieved. The DC-modulation functionality is enabled using the remote command `DCME 1`. For most demanding closed-loop applications, the phase shift introduced by the input circuitry (60° at 10 MHz) may be to large. In order to extend the bandwidth well above 10 MHz, the **DCM** jumper can be moved from the **DCMS** to the **DCMI** location. The input circuitry is then bypassed and the signal applied to the DCMI connector is directly routed to the modulation circuit, which results in a phase shift less than 10° at 10 MHz.

NOTE – *Because enabling the DC-Modulation will result in a slight increase of the minimal output current noise density (from* 8 pA/$\sqrt{\text{Hz}}$ *to* 15 pA/$\sqrt{\text{Hz}}$*), this functionality should be disabled if not used.*

1.7.6 Modulating the Current at RF-Frequency

An RF input port is provided for modulating the laser current at high frequencies. The input signal applied to the front-panel connector is first attenuated by a fixed 6-dB attenuator and then routed to the current source's output *via* a high-frequency relay. A 10-nF DC-block capacitor is also used on the signal path to preserve the laser's bias voltage. The functionality is enabled by executing the `RFME 1` remote command, which closes the contacts of the relay. When the coaxial connector of the front-panel is selected as laser output interface, the RF-modulation port can be used for carrier frequencies ranging from 10 MHz to 100 MHz. Note that functionality is not recommended when the laser is wired using the alternative connections since they are not appropriate for the transmission of high-frequency current components.

CAUTION – *Excess level on this input could damage the laser diode. Always refer to the datasheet of the laser diode for maximum admissible ratings since the SK657 does not provide any limiting device on this input.*

1.7.7 Laser Monitoring

The SK657 module provides the user with both analog and digital readouts of the laser's operating current and voltage : i) a front-panel connector can be used to measure either the compliance voltage or the output current while ii) a dedicated remote command is used to query the analog-to-digital converter (ADC).
The remote command `MONS` is used to select which monitoring signal is routed to the front-panel connector **MONO**. Indeed, executing `MONS 0` will connect the voltage output of the compliance buffer (1 V/V) to the front-panel interface connector, while `MONS 1` will instead connect the output voltage of the current sensing circuit (10 V/A). The master summary /STATUS signal is also available at the **MONO** output.
Digital reading is likewise provided : the remote command `ADCR ?` can be used to query the last conversions of the ADC, which scans periodically (100 ms) the output voltages of the current and compliance sensing circuits. The last acquired compliance voltage is queried by the command `ADCR ? 0`, while `ADCR ? 1` is used to return the last sampled value of the output current sensor. This reading is provided for test and diagnostic purposes only since it is not enough accurate to measure the source current settings. Nevertheless, its accuracy is sufficient to measure the contribution of the DC-modulation input to the laser output current.

1.7.8 Using the Interlock

The interlock functionality is used to shut the laser down when the interlock loop is broken. In order to operate the laser, a low-resistance electrical connection between the **ILK-SRC** and **ILK-RTN** lines must be provided. Neither of these lines may be allowed to contact ground or any other signal. Opening the interlock loop will i) cause the laser to immediately shut off, and ii) set the related bit in the **INSS** status register. The front-panel indicator **FLT** is also lit, which is cleared upon executing the `*CLS` remote command. Several

interfaces can be used to connect the loop's wires to the SK657: some shared backplane lines, user's terminal blocks or expansion connector pins are indeed provided for this purpose. The interlock functionality is enabled using the remote command `ILKE 1`.
Before wiring the interlock loop, the user must check whether the related pins of the EXP-DIO connector are not shorted. Indeed, a small wire may have been mounted on these pins to close the interlock loop during the tests. It must be removed for proper operation of the interlock functionality.

1.7.9 Installing the Optional Laser Control Switch

Whereas the remote command `LDEN` is the primary way to enable the current source's output, an optional switch can be also used for this purpose. Its two contacts have to be wired to the dedicated terminals provided by some shared backplane lines, user's terminal blocks or digital I/O expansion connector's pins. The remote command `FPSE` must be invoked for the switch to operate. Upon a power-on sequence, the current source's output is always disabled regardless of the switch position, open or closed.

1.7.10 Turning On Power

The instrument retains the values of the parameters in nonvolatile memory. Upon power-on, those settings are restored to their values before the last execution of the `*SAV` command. When the module is powered for the first time, the factory default values are used instead. The power-on configuration of the remote interface and the default parameters' values are detailed in the *Programming Guide* available online.

1.7.11 Paralleling Several Modules

A single SK657 module is able to sink up to 500 mA under a compliance voltage of 5 V. While such intensity should be enough to bias a wide range of telecom laser diodes, it is possible to increase the load current by paralleling several SK657 units. Indeed, since the SK657 acts as a true current source, several paralleled modules can be used for delivering higher current to the load. For instance, by paralleling four modules, up to 2 A can be delivered while maintaining the ultra-low noise specifications of the SK657: when n modules operate in parallel, the maximal available output current is given by $n \times 500\,\mathrm{mA}$, but the current noise density is only increased by $\sqrt{n}$. With four SK657 modules acting in parallel, an ultra-low noise 2-A current source featuring a current noise density of $20\,\mathrm{pA}/\sqrt{\mathrm{Hz}}$ can be achieved.

1.7.12 Restoring the Default Configuration

To reset the SK657 to its factory defaults, execute the remote command `*RST`. The reset values of the parameters are shown in bold in the *Programming Guide* available online.

2 Description of Operation

This chapter provides the user with a number of additional details of the operation of the SK657 *Laser Diode Current Controller* module.

2.1 Expansion Connectors

The SK657 module provides the user with two expansion connectors for mounting an additional board (see Fig.3). Indeed, specific functionalities can be obtained by mounting a dedicated board on these connectors. This feature can be useful for customization purposes. The expansion connectors' pins are identified on the *Functional Block Diagram* using the **EXP** label. Analog signals and power supplies of the SK657 are routed to the Analog I/O Expansion connector while their digital counterparts are available through the Digital I/O connector. Some pins are reserved for programming the microcontroller and should not be used. Refer to the Section 1.5 for information on which pins are actually used in the SK657.

2.2 Shared Backplane Lines

Some lines of the backplane are dedicated for sharing analog and digital signals between modules. They correspond to the AIO, PWR-AIO, DIO and PWR-DIO lines listed in the generic pin assignments. This functionality can be useful for customizing a system where the number of front-panel connections has to be reduced by using these backplane lines instead. Refer to the Section 1.4.4 for information on which SK657's signals can be routed to the shared lines of the backplane.

CAUTION – *The SK657 has no internal protection against short-circuits on the shared lines. Contact us before using this functionality.*

2.3 User Terminals Blocks

The SK657 is primary designed to be assembled into a platform. Some pins of the mating connector are not connected to the bus, they are instead directly routed to 16 terminal blocks located at the rear-side of the backplane. This arrangement provides the user with specific wiring schemes. Indeed, acting as many independent connectors, the **user terminal blocks** can be used to wire SK657's signals regardless of the backplane operation.
The SK657's signals routed to the **user terminal blocks** are identified on the *Functional Block Diagram* using **UTB** labels. See Figure 4 for their generic pin assignments and Section 1.4.5 for information about which signals of the SK657 are routed to the the terminal blocks.

CAUTION – *By design, an SK657 module can be plugged anywhere into the platform since there is no assigned slot. The only reserved location (the rightmost slot) is dedicated to the master module, which is in fact a part of the platform. Therefore, using the user terminal blocks functionality of a specific slot will, in practice, assign the module to this slot. Contact us before using this functionality.*

3 Remote Operation

This chapter describes how to operate the SK657 *Laser Diode Current Controller* over the host interface.

3.1 Commands

For a complete and detailed information, please refer to the *Programming Guide* available online at the product page.

3.2 Status Model

The *Status Model Diagram* of the SK657's is available online at the product page. The *Programming Guide* also provides the user with detailed information about the Status registers.

4 Accessories

This chapter describes related products and accessories that are available for use with the SK657 *Laser Diode Current Controller*. These optional parts must be ordered separately.

4.1 Optional Module Adapters

Like all SK-Series modular instruments, the SK657 module is primary designed to be assembled into a platform. But stand-alone operation of the SK657 *Laser Diode Current Controller* is also possible (see section 1.6.5). In this case, the user has to wire all required power supplies and remote control lines to the DIN41612 connector. In order to help the user in this operation, *Signals and Systems for Physics* provides several module adapters, namely the SKN10 and SKN11. For instance, the SKN10 *Module Adapter* features a mating DIN41612 connector, an USB-to-UART bridge and several spring clamp terminals blocks. Refer to the adapters' pages online for detailed information.

5 Figures

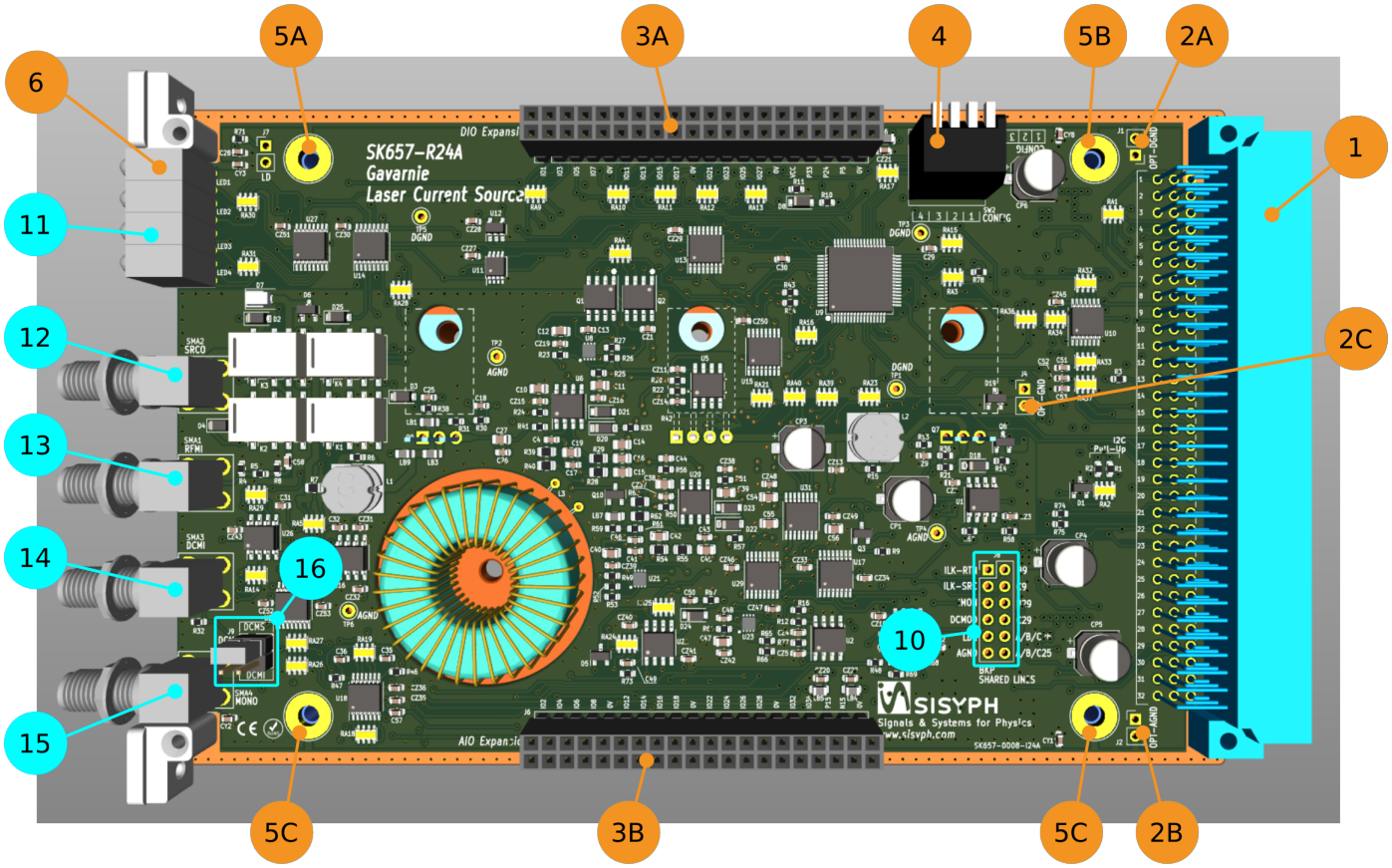

Figure 1: View of the SK657's top side. The module is shown without its front-panel. Circled numbers refer to features detailed in the Section 1. While the orange colored numbers denote generic parts of the SK-Series modules, their blue-color counterparts refer to specific features of the SK657.

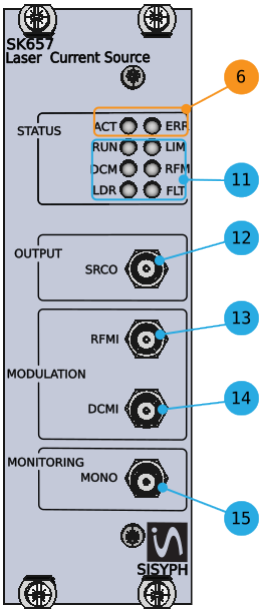

Figure 2: The SK657's front view. Circled numbers refer to features detailed in the Section 1. While the orange colored numbers denote generic characteristics shared by all SK-Series modules, their blue-color counterparts refer to specific features of the SK657.

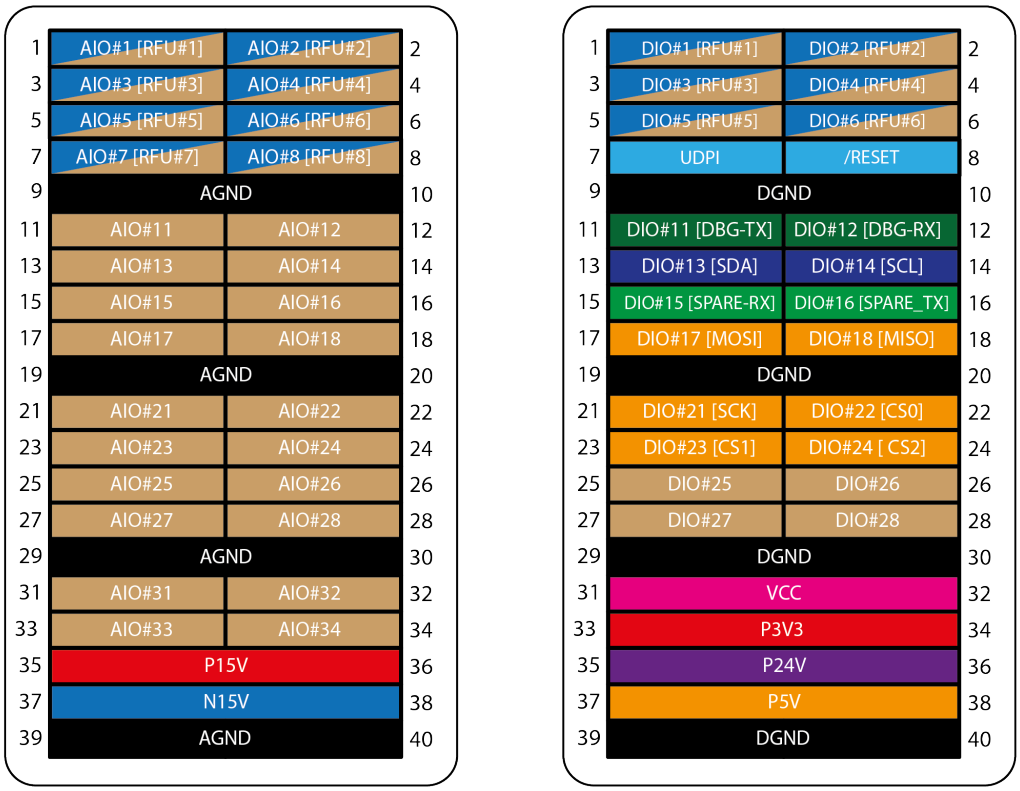

Figure 3: Generic pin assignments of the Expansion connectors. Analog power supplies and signals are routed to the AIO Expansion connector (left). Their digital counterparts are routed to the DIO Expansion connector (right). Refer to the Section 1.5 for information on the pin assignments used in SK657.

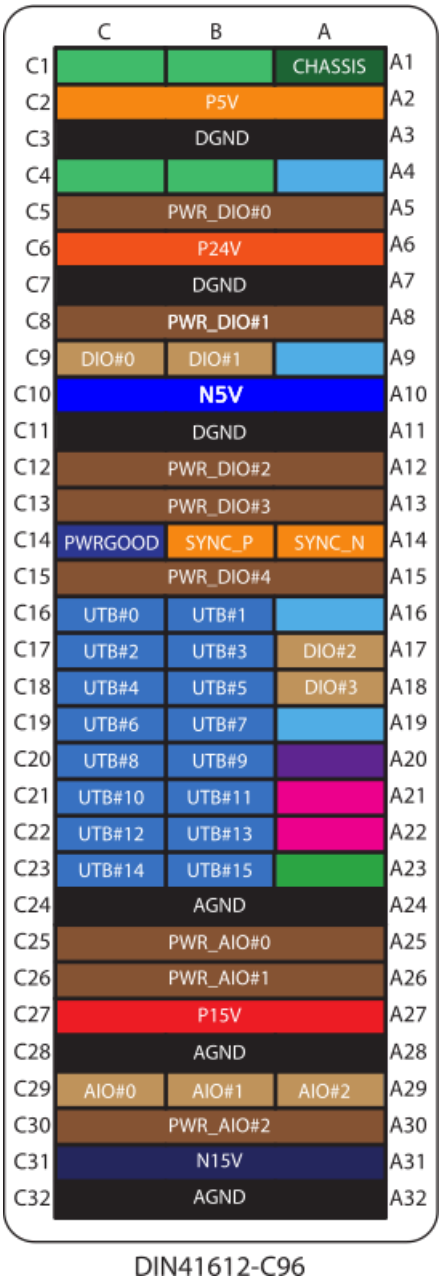

Figure 4: Generic pin assignments of the DIN41612 connector. The DIN41612-96C connector carries all the power and communication lines to the module. Additional lines are provided for i) sharing signals with other slave modules plugged on the same backplane, ii) reception of the 10-MHz synchronization signals and iii) module status information. The presence of a slave module on the backplane is detected by the platform controller using a dedicated line.

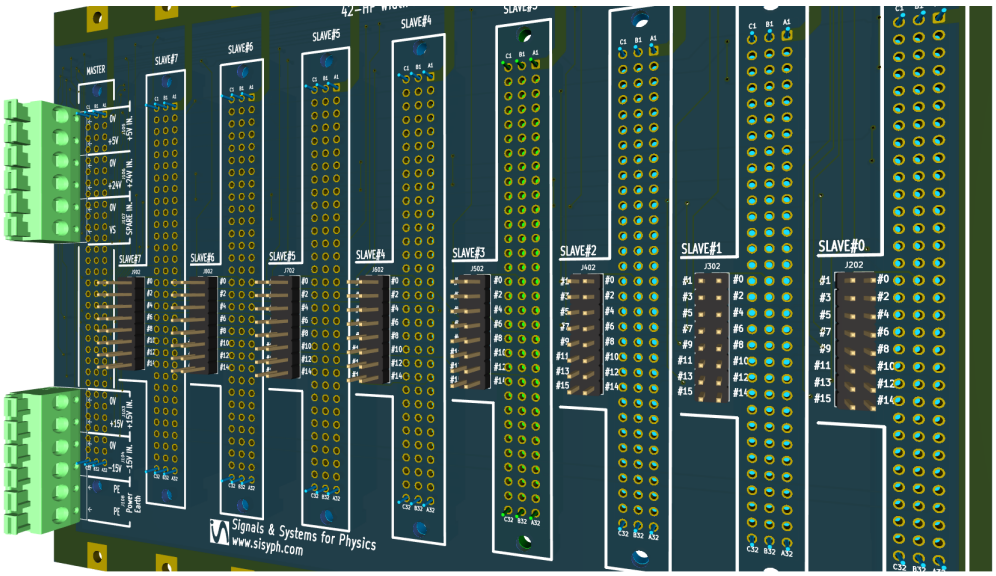

Figure 5: User's terminal blocks viewed from the rear of the backplane. Each slot of the SPK-Platform is associated with 16 independent terminals providing the user with specific wiring schemes. These connectors are accessible from the rear-side of the backplane. Note that if a 16-pin header has been used here as an exemplifying interface, the backplane is shipped without any populated parts to increase versatility.

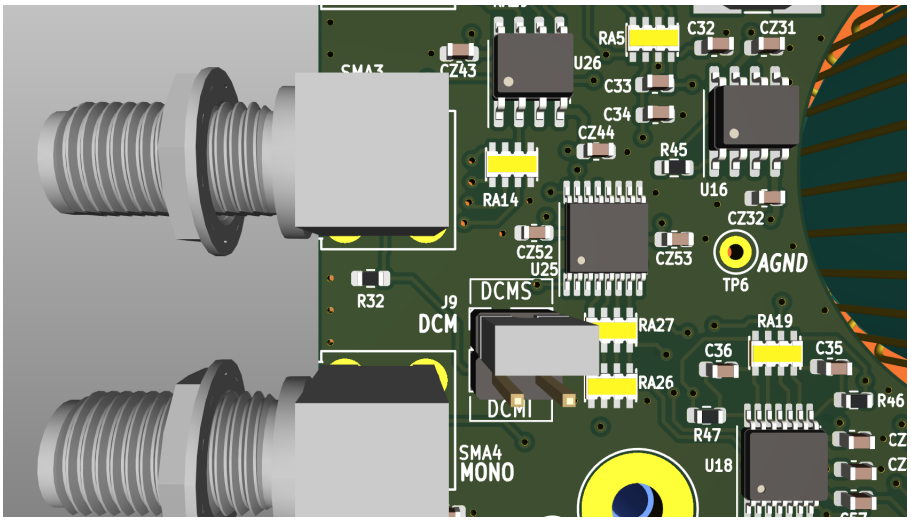

Figure 6: DC-Modulation source option. The **DCM** jumper is by default mounted on the **DCMS** location. In this case, the source signal used for the modulation is selected using the DCMS remote command. Installing the jumper on the DCMI position will route the signal from the DCMI connector directly to the modulation circuit. The modulation bandwidth will be then extended above 10 MHz.

6 Document Revision History

6.1 Version Number

This document is identified as SK657-SU02-P24A.

6.2 Revision History

P24A (2024-05-21)

Initial version