SCU™-100
SIGNAL CONDITIONING UNIT

USER MANUAL

Hinds Instruments, Inc.
P/N: 020-2650-975 UM Rev B

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1
Introduction

Overview

The SCU-100 Signal Conditioning Unit takes a composite input signal, splits the signal into its broadband AC and low-pass DC signals, amplifies these signals, then applies the amplified signals to AC and DC outputs.

The AC output voltage can be determined using a lock-in amplifier and a digital voltmeter and can be used to measure the DC output voltage. The ratio of the AC to DC voltage is a necessary computation for the measurement of linear and circular dichroism.

The SCU-100 provides signal amplification via AC and DC gain controls, which is useful in many experimental setups. A 9 volt, 150mA detector power output is provided for powering the Hinds Instruments, Inc. detector/preamplifier units.

Accessories

Photo Detector/Preamplifiers

The SCU-100 is designed to power the DET-100 family of photo detector/preamplifiers available from Hinds Instruments, Inc.

The following detector/preamplifiers are available: See table 1.1 on the following page.

Model	Type	Spectral Range, nm	Active Area	-3dB Measured Bandwidth
DET100-001	Si-PC	350-1100	5 mm^2	DC to 1.00 MHz
DET100-002	Si-PC	350-1100	16 mm^2	DC to 1.05 MHz
DET100-003	Si-PV	350-1100	5 mm^2	DC to 350 KHz
DET100-004	Si-PV	350-1100	16 mm^2	DC to 310 KHz
DET100-005	Si-PV	200-1000	5 mm^2	DC to 260 KHz
DET100-006	Si-PV	200-1000	20 mm^2	DC to 200 KHz
DET100-007	Ge-PV	800-1800	2 mm^2	DC to 260 KHz

Table 1.1 Available Photo Detector/Preamplifiers

PC = Photoconductive PV = Photovoltaic Si = Silicon Ge = Germanium

The following options are available for powering the Hinds Instruments family of photo detector/preamplifiers:

- An AC powered universal power supply with a line cord for the country of choice.
- A DC power cable for powering the photo detector from the SCU-100 Detector Power output jack.

Please contact Hinds Instruments at 1-800-688-4463 for questions regarding these accessories.

Rack Mounting Kits

The SCU-100 can be mounted in a standard 19-inch rack using a Hinds Instruments, Inc. rack mount kit, P/N 023-0000-015. Installation instructions are provided with the kit. Mounting in a half-rack application can be done using a Hinds rack mount handle kit, P/N 023-0000-016.

2
Installation

Unpacking and Inspection

Carefully open the SCU-100 shipping container and inspect the instrument for damage. Immediately contact Hinds Instruments or the place of purchase if damage or missing items are noted. It is recommended to save the container and packing in the event the instrument needs to be returned for service.

The following items should be present:

- SCU-100 Instrument
- SCU-100 User Manual (on CD)
- Power Cord

Rack Mounting

The SCU-100 can be mounted in a standard 19-inch rack using a Hinds Instruments, Inc. rack mount kit, P/N 023-0000-015. Installation instructions are provided with the kit. Mounting in a half-rack application can be done using a Hinds rack mount handle kit, P/N 023-0000-016.

Setting the Tilt-Stand for Angled Table-Top Use

The tilt-stand is located under the SCU-100, toward the front. The stand is shipped in the collapsed position. Using your fingers, gently pry the stand away from the bottom cover. The stand will snap into place in its upright position.

Figure 2.1 Tilt Stand

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Rear Panel Components and Safety Information

Power Line Connection

Refer to Figure 3.1 “The SCU-100 Rear Panel.” The line power receptacle accepts the power cord supplied with the SCU-100. The instrument can be “universally” powered from any voltage in the 100-240 VAC, 50-60 Hz range with no manual switching required. Power line requirements are listed in the Specifications section and on the rear panel of the instrument.

Power Line Fuses

Two power line fuses are present in the SCU-100; the value and type are listed in the Specifications section and on the rear panel of the instrument. The location of the power line fuses are shown in Figure 3.1. To gain access to the fuses, refer to Figure 3.2 “Opening the Power Fuse Holder” and to properly insert the fuses refer to Figure 3.3 “Fuses Properly Inserted in Fuse Holder.”

CAUTION

In order to maintain proper fire and safety precautions, replace the power line fuses only with the type and value indicated.

Both fuses should be replaced if a fuse blows.

Detector Power Fuse

The front panel detector power output is fused by the detector power fuse on the SCU-100 rear panel, as shown in Figure 3.1. The fuse value and type is shown in the Specifications section and on the rear panel of the instrument.

CAUTION

Replace the detector power fuse only with the type and value indicated.

User Safety Warning

Figure 3.1 shows the user safety warning on the SCU-100 rear panel. The SCU-100 should be operated only by qualified laboratory personnel and the unit should be returned to an authorized service center for repair.

SCU-100 Serial Number and CE Certification Label Location

The serial number and CE certification labels are located at the upper left corner on the SCU-100 rear panel as shown in the figure below.

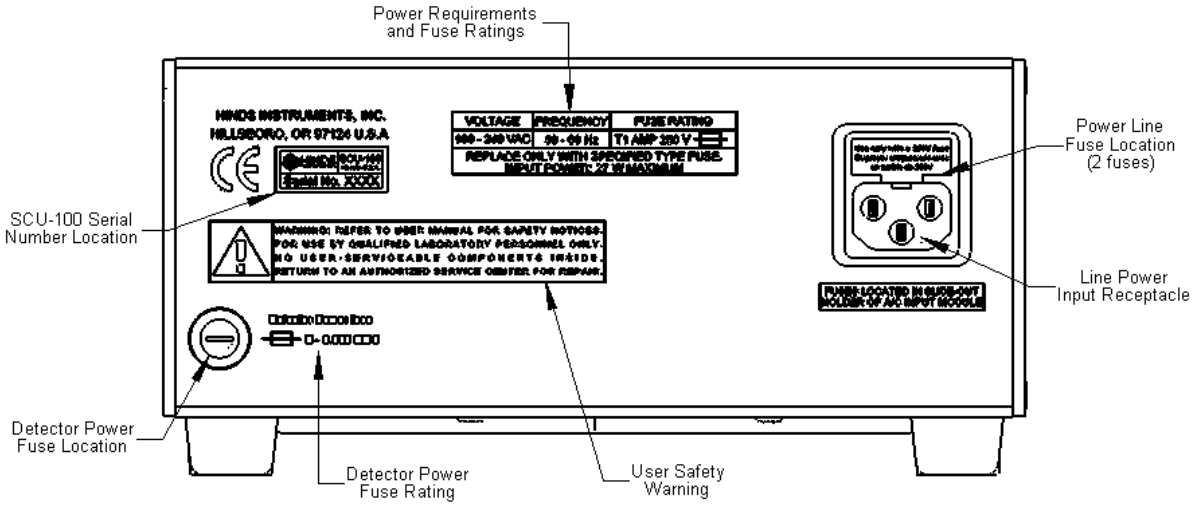

Figure 3.1 The SCU-100 Rear Panel

Figure 3.2 Opening the Power Fuse Holder

Figure 3.3 Fuses Properly Inserted In Fuse Holder

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Front Panel Component Identification

Refer to Figure 4.1 for the locations of the following SCU-100 front panel items.

Power Switch and LED Indicator

Pushing the Power switch to the indented position powers the SCU-100 ON. Pushing the switch again releases the switch to the out position, which powers OFF the unit.

The green power LED will light approximately 1 second after the Power switch is pressed in, indicating the instrument is ready for use.

Detector Power Output Connector

The Detector Power Output is capable of supplying 9 volts DC @ 150mA (approximately). The output is intended for powering the Hinds Instruments, Inc. line of DET-100 photo detectors.

Signal In Connector

This high impedance input (1 Megohm) accepts the signal from the detector. Separate AC and DC signals are derived from the input signal..

AC Out Connector

The AC Out connector output provides the AC component of the input signal after gain and filtering are applied. The AC output amplitude equals the AC input amplitude multiplied by the AC Gain setting. This output is capable of driving a load no less than 10K Ohms.

AC Gain Selector

The AC Gain control selects the gain applied to the AC portion of the input signal. The gain settings are 0.1, 0.2, 0.5, 1, 2, 5, 10, and 20.

AC Saturation LED

The AC Saturation LED lights whenever the AC output exceeds 1VAC RMS.

NOTICE

To ensure AC output accuracy, the instrument should not be operated with the AC Saturation light ON

DC Out Connector

The DC Out Connector output provides the DC component of the input signal after gain and filtering are applied. The output amplitude equals the DC input amplitude multiplied by the DC Gain setting. This output is capable of driving a load no less than 10K Ohms.

DC Gain Selector

The DC Gain control selects the gain applied to the DC portion of the input signal. The gain settings are 1, 2, 5, 10, 20, 50, 100, 200, 500 and 1000.

DC Saturation LED

The DC Saturation LED lights whenever the DC output exceeds 10 VDC.

NOTICE

To ensure DC output accuracy, the instrument should not be operated with the DC Saturation light ON.

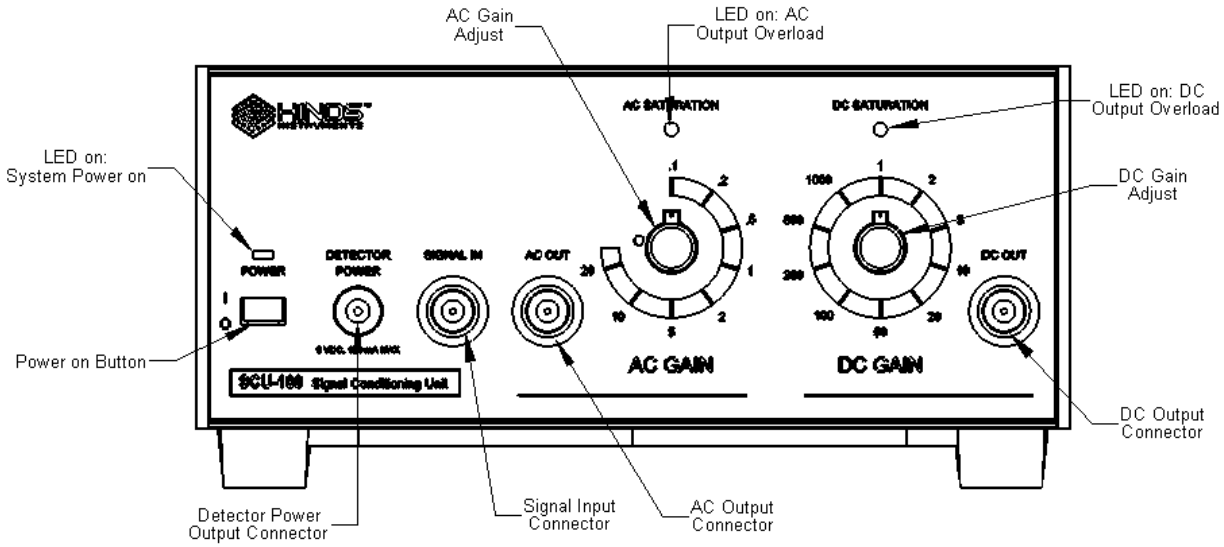

Figure 4.1 SCU-100 Front Panel Items

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Operating and Checking the SCU-100

Operation Check Setup

One way to confirm operation of the SCU-100 is to connect the signal input to the output of a signal generator. The generator sine wave and DC offset output provides an AC and DC signal for testing.

Set the generator AC output to 200 mVACpp and the DC offset amplitude to 5 mVDC. Connect the SCU-100 AC output to an oscilloscope and the DC output to a digital voltmeter.

Figure 5.1 shows an example test setup.

NOTICE

When connecting an oscilloscope or other instrumentation to the SCU-100 outputs, make sure that the input impedance of the instrument is set to 10K Ohms or greater.

The SCU-100 will not drive a 50 Ohm load connected to the outputs!

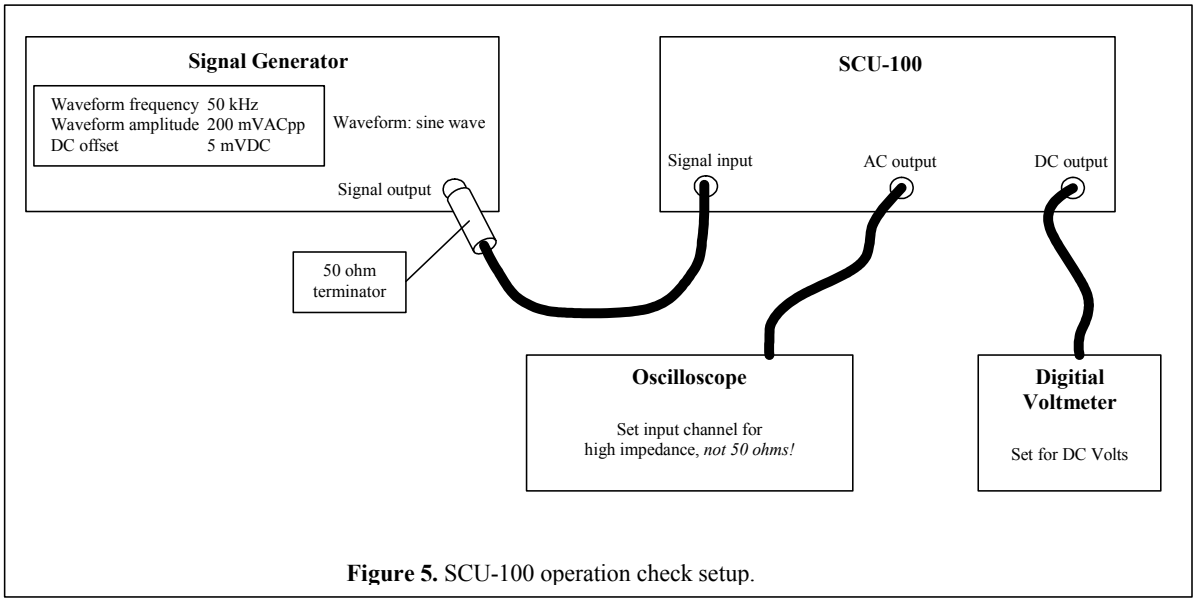

Figure 5. SCU-100 operation check setup.

Figure 5.1 SCU-100 Operation Check Setup

Powering the SCU-100 ON

Plug the power cord, included, into the line power input receptacle on the SCU-100 rear panel. Connect the power cord to line power in the 100-240 VAC range. Press the power button on the left side of the SCU-100. The green power LED should light after a 1 second delay, indicating the SCU-100 is powered and ready for use.

DC Operation Checks

The SCU-100 DC gain control setting determines what voltage is seen on the digital voltmeter (DVM). When the gain control is set to 1, the 5 mV signal from the generator should be seen as 5 mV on the digital voltmeter. When the gain control is set to 5, 25 mV should be seen on the digital voltmeter.

Check that setting the DC gain control to 1000 and increasing the DC offset on the signal generator to 10 mV causes the DC Saturation LED to light. This happens because the 10 mV DC signal to the SCU-100 multiplied by the gain setting of 1000 equals 10 VDC, which is the point at which the DC Saturation LED lights.

NOTICE

Do not operate the SCU-100 with the DC Saturation LED lit since this indicates amplifiers are being saturated and output results will be inaccurate. Turn the DC Gain control to a lower setting to restore proper signal levels and make the light turn OFF.

AC Operation Checks

The SCU-100 AC gain control setting determines what waveform amplitude is seen on the oscilloscope. When the gain control is set to 0.1, the 200 mVpp AC signal from the generator should be seen as 20 mVpp on the oscilloscope. When the gain control is set to 2, a 400 mVpp signal should be seen on the oscilloscope.

Check that setting the AC Gain control to 20 causes the AC Saturation LED to light. This happens because the 200 mVpp AC signal to the SCU-100 multiplied by the gain setting of 20 exceeds the 1 VAC RMS saturation light trip point.

NOTICE

Do not operate the SCU-100 with the AC Saturation LED lit since this indicates amplifiers are being saturated and output results will be inaccurate. Turn the AC Gain control to a lower setting to restore proper signal levels and make the light turn OFF.

6
Applications

For all measurement applications using the SCU-100 Signal Conditioning Unit, please keep the following points in mind:

- The AC and DC outputs are capable of driving a minimum load resistance of 10K Ohms.
- Set an oscilloscope input for high-impedance mode if it is to be connected to an SCU-100 output. A 50 Ohm oscilloscope input impedance setting will overload the SCU-100 output.
- Make sure to consider AC and DC Gain settings when performing calculations.
- The SCU-100 is specified for use with AC and DC output cables not exceeding 3 meters in length.

Detecting the Ratio of I_{AC}/I_{ave} Using the SCU-100

In many experiments using photoelastic modulators (PEMs) it is necessary to compare the time average intensity of the light at the detector with the amplitude of a single frequency component of the light intensity. [1,2] For example, in experiments to measure circular dichroism the effect being measured is proportional to the ratio I_{AC}/I_{AVE} where $I_{AC} = I_{1f}$, is the amplitude of the Fourier series component of the light intensity function at the modulator frequency f and I_{ave} is the average of the light intensity function, integrated over a time interval much longer than the period of oscillation of the PEM.[3] The case for linear dichroism is the same except that the frequency component needed is twice the modulator frequency, or $I_{AC} = I_{2f}$.

In many other experiments these ratios may be used to “normalize” the optical signal so that the results obtained are independent of fluctuations in the intensity of the transmitted light beam, for example changes in the intensity of the light source or changes in absorption, scattering, etc. in the optical components.

The measurement of this average light intensity is not trivial and it presents some important challenges for the experimenter. Of course, what is measured directly is the electrical output of a transducer which converts the light intensity information into an electrical signal, either a current or a voltage. The problem reduces to determining the ratio of electrical signals, rather than optical quantities. The determination of these ratios and especially the measurement of the “average” intensity, current or voltage is the purpose of the SCU-100.

Hinds Instruments' Model SCU-100 signal conditioning unit derives, from an input detector signal, a wide-band AC signal and a low-pass or DC signal. The signal conditioner also provides adjustable gain, primarily for the DC output. The output is an analog signal proportional to I_{ave} which is suitable for input to a digitizing circuit such as is frequently provided by a lock-in amplifier. An example is given in figure 6.1.

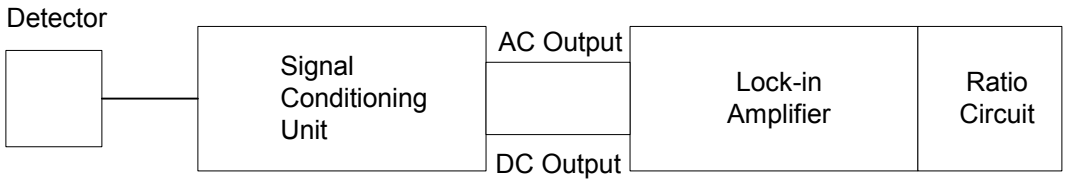

Figure 6.1 Block Diagram for measuring V_{AC}/V_{DC} Ratio

The SCU uses the detector output signal to derive separate AC output (broadband high-pass filter) and DC output (low-output filter) signals. Either or both of these outputs may be amplified, although typically it is the DC output which requires amplification. Many lock-in amplifiers have separate inputs for the AC signal and the DC signal and are capable of calculating the ratio such as V_{1f}/V_{dc}. It is frequently necessary to provide a DC input to the lock-in in the range of 1 to 5 volts to avoid digitization noise. Alternatively, the lock-in output (e.g. V_{1f}) and the DC input may be sensed by a computer through an RS232 interface, with the ratio calculation being done in the computer.

For further information, please see "Detecting the Ratio of I_{AC}/I_{DC}," a Data Bulletin on the Hinds Instruments website, www.hindsinstruments.com.

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[1] K.W. Hipps and G.A. Crosby, "Applications of the photoelastic modulator to polarization spectroscopy," J.Phys. Chem. **83**,555-562 (1979).

[2] A.F. Drake, "Polarization modulation—the measurement of linear and circular Dichroism," J. Phys. E. **19**,170-181 (1986).

[3] Note: In many articles on this subject the notation "I_{DC}" or "V_{DC}" is used rather than I_{ave} and V_{ave}. The latter notation will be used in this application note to avoid confusion when electronic techniques are discussed later.

7
Troubleshooting

Use the following guide for solving the most common problems encountered with SCU-100 operation.

Power Problems

	Symptom	Common Causes	Remedies
1	The SCU-100 will not power ON when the Power button is pressed in.	The unit is not being powered correctly.	Make sure 100-240 VAC, 50-60 Hz, line power is applied to the rear panel power input. Make sure the proper power cord type for your area is being used.
		The power fuses are blown.	Replace both power fuses in accordance with the procedures described in this manual.
2	The Detector Power output does not function.	The Detector Power fuse is blown.	Replace the fuse in accordance with the procedures described in this manual.

Table 7.1 Troubleshooting Power Problems

Signal Problems

	Symptom	Common Causes	Remedies
1	The AC (or DC) signal output appears too low in amplitude or distorted.	The AC (or DC) Saturation light is ON. This indicates the internal amplifiers are being overdriven, which accounts for an incorrect signal amplitude or distorted waveform.	Reduce the AC (or DC) Gain setting or the AC (or DC) signal input amplitude until the AC (or DC) Saturation light goes off.
		The AC (or DC) Out jack is connected to a load less than 10K Ohms, which can result in reduced signal amplitude and distortion. The problem most commonly occurs when a 50 Ohm oscilloscope input is connected to the SCU-100 AC (or DC) output.	Set the oscilloscope input to high-impedance mode.
2	The AC signal output is too high or low relative to the DC signal output.	The AC and DC Gain settings are set for different gains, thus the input signal is not gained the same for both AC and DC signal components.	Set the AC and DC gains the same or account for different gain settings in calculations.

Table 7.2 Troubleshooting Signal Problems

If the troubleshooting guide does not resolve the difficulty you are having, please consult Section 11 of this manual “User support information” for contacting Hinds Instruments, Inc. for assistance and service.

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Maintenance

The SCU-100 is a rugged, dependable instrument that does not require periodic maintenance. However, there are some things that can be done to maintain appearance and ensure the unit is functioning properly.

Cleaning

The SCU-100 may be cleaned with a cloth dampened in water or using a mild detergent solution. Do not clean with aromatic hydrocarbons, chlorinated solvents or methanol-based fluids since these chemicals can damage the front panel overlay and may possibly damage the case paint and printing.

Warning

To guard against electrical shock or instrument damage, never allow water to get inside the case.

Calibration

There are no parts inside the SCU-100 that require calibration. The unit should provide years of operation without service requirements. Hinds Instruments, Inc. suggests, however, that once per year, the SCU-100 operation and accuracy be verified according to the procedure described in Section 5 “Operating and Checking the SCU-100.”

For a thorough verification of operation and accuracy, the unit can be returned to Hinds Instruments, Inc. for fee based testing. A test report will be issued confirming proper operation.

9
Principles of Operation

SCU-100 Electronic Design Description

The SCU-100 Signal Conditioning Unit breaks a complex signal into its AC and DC components, whereupon separate gain and filtering schema are applied. The AC channel utilizes a Fourth Order Sallen-Key Butterworth (maximally flat) filter with an F3dB of approximately 350 Hz in order to eliminate low frequency and DC components to the AC signal. The DC channel utilizes a Fourth Order Sallen-Key Butterworth (maximally flat) filter with an F3dB of around 5 Hz to eliminate any AC leakage.

Two BCD (Binary encoded) switches are employed to allow different switch positions to map to specific gain values. The AC channel offers the following attenuation/gains for the input AC signal: 0.1, 0.2, 0.5, 1.0, 2.0, 5.0, 10.0 and 20.0. The DC channel offers the following gains for the input DC signal: 1.0, 2.0, 5.0, 10.0, 20.0, 50.0, 100.0, 200.0, 500.0 and 1000.0. Precision 0.1% resistors are used throughout the gain circuitry to ensure the highest level of precision possible for both channels. Although the SCU-100 is rated as having 2% error tolerance to 200 KHz, one must realize that this is a maximum value and the accuracy is typically much better than this (<0.5%).

Conditioning filters are employed to both AC and DC channels to clean up any noise which may leak into the system. Over voltage detection is employed on both the AC and DC channels to alert the user that the gain or signal amplitude being applied to the amplifiers may cause them to exhibit non-linear behavior. Should the SCU-100 be overdriven, as indicated by a lit red LED on the front panel, the output signal could exhibit less accurate results (violating the 2% accuracy specification) and the AC signal may possibly appear distorted or clipped at its output. Should this occur, the user simply needs to back off on the gain setting and/or reduce the amplitude of the input waveform for the overdrive circuitry to again indicate proper signal compliance.

The following page presents a simplified block diagram of the SCU-100 electronic circuitry.

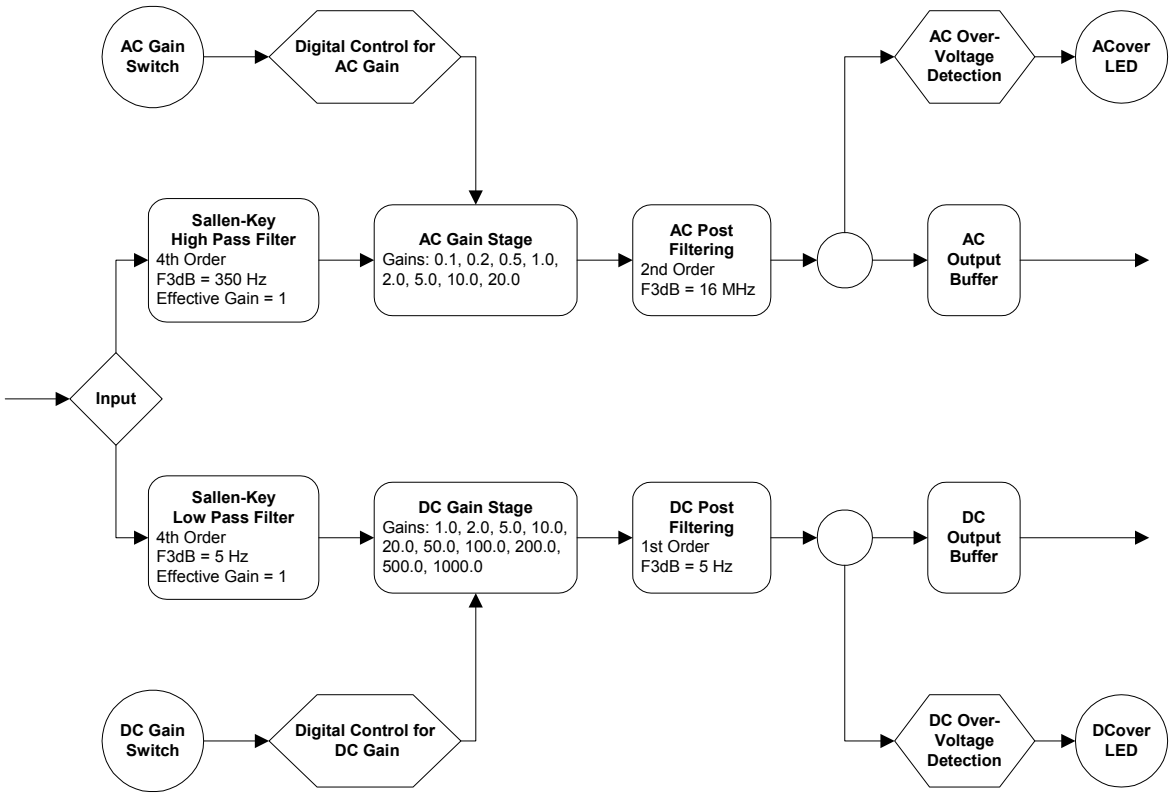

Figure 9.1 SCU-100 Internal Block Diagram

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Specifications

General

Model Number	SCU-100, P/N 020-2650-975
Size	8.37” W x 4.03” H x 12.86” D
Weight	6 Lbs
Power	100-240 VAC (no switching required), 50-60 Hz, 27 Watts maximum
Power Fuses Rating	(2) each, 1 Amp, Slo-Blo, 5 x 20 mm

Composite Signal Input

AC Component	10 VAC peak to peak, maximum
DC Component	0 to 10 VDC
Signal Input Impedance	1 Megohm

AC Output

AC Gain Settings	0.1, 0.2, 0.5, 1, 2, 5, 10, 20
AC Accuracy, typical	+/- 2% throughout signal input, AC gain and AC bandwidth ranges and with AC Saturation LED OFF (1)
AC Bandwidth	10 KHz – 200 KHz
AC Output Saturation Level	1 VAC RMS
Output Load Impedance, minimum	10K Ohms
AC Signal Input to Output Phase Shift	18 degrees maximum, typical
DC Offset	Less than 1 mV
Cable Length	Specified for a AC Output cable length not to exceed 3 meters

(1) This is a maximum value; accuracy is typically < 0.5%.

DC Output

DC Gain Settings	1, 2, 5, 10, 50, 100, 200, 500, 1000
DC Accuracy, typical	+/- 2% throughout DC gain ranges and with DC Saturation LED OFF [1]
DC Output Saturation Level	10 VDC
Output Load Impedance, minimum	10K Ohms
Cable Length	Specified for a DC Output cable length not to exceed 3 meters

Detector Power Output

Detector Power Output Voltage Range	8.55 – 9.45 VDC
Maximum Detector Power Output Current	150 mA
Detector Power Output Fuse Rating	(1) each, 0.200 Amp, Slo-Blo, 5 x 20 mm

Environmental

Operating Temperature, Humidity	0 to +50 degrees C, 20% - 90% RH non-condensing
Storage Temperature, Humidity	-20 to +85 degrees C, 10% to 95% RH non-condensing

Approvals

CE

Safety Standards

EN 61010-1

EMC Standards

EN 61326; FCC Class A

[1] This is a maximum value; accuracy is typically < 0.5%.

11
User Support Information

Hinds Instruments, Inc. makes every attempt to ensure that the instruments we provide are products of superior quality and workmanship. We also aim to provide superior technical user support. If you have any questions, or if you encounter problems in the operation of our instruments or systems, please contact us.

Out customer service staff is available to assist you from 8:00 AM to 4:00 PM Pacific Standard Time, Monday through Friday. The telephone number is 1.503/690.2000. You may also contact us via email at support@hindsinstruments.com.

Limited Warranty

Hinds Instruments, Inc. warrants the SCU-100 Signal Conditioning Unit to be free from defects in materials and/or workmanship when operated in accordance with the manufacturers' operating instructions for one (1) year from the date of purchase, subject to the provisions contained herein. Our warranty shall extend to the original purchaser only and shall be limited to factory repair or replacement of defective parts.

Exclusions

This warranty does not cover normal maintenance, damage resulting from improper use or repair, or abuse by the user. This warranty extends only to repair or replacement, and shall in no event extend to consequential damages. In the event of user repair or replacement, this warranty shall cover neither the advisability of the repair undertaken, nor the sufficiency of the repair itself.

THIS DOCUMENT REFLECTS THE ENTIRE AND EXCLUSIVE UNDERSTANDING OF THE PARITES, AND EXCEPT AS OTHERWISE PROVIDED HEREIN, ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, PARTICULARLY THE WARRANTIES OF MERCHANTABILITY AND/OR FITNESS FOR A PARTICULAR PURPOSE, ARE EXCLUDED.

This warranty gives you specific legal rights, and you may also have other rights that vary from state to state.

Return For Repair Procedure

If your unit ever does need repair, please contact Hinds Instruments, Inc. before attempting repairs yourself or returning it to us. We may be able to provide additional troubleshooting suggestions to help diagnose the problem. In the event it is necessary to return the unit to us, we will give it our prompt and professional attention. In most cases, we can repair and return your instrument to you faster than you could diagnose and repair it yourself.

To arrange for service: In the event of defects or damage to your unit, first contact Hinds Instruments, Inc. by telephone at 1.503/690.2000 or via email at support@hindsinstruments.com. Give us a brief description of the problem. We will then advise whether factory repair is necessary. If factory service is required, we will give you a Return Material Authorization (RMA) number. You should return your instrument as follows:

Packaging

Consider the following guidelines when preparing the instrument for return:

- Wrap the unit in a plastic bag
- Pack the unit in the original shipping carton or in a sturdy oversized carton
- Use plenty of packing materials

Items To Include

- The RMA number
- A brief description of the problem with all known symptoms
- Information on how to contact you
- Your return shipping address (UPS will not deliver to a post office box)

Shipping Arrangements

- Send freight prepaid (UPS recommended)
- Insurance is strongly recommended (we can advise you on the current replacement value of the unit being shipped)
- We are unable to accept COD shipments.

Return Shipping Address

Customer Service

Hinds Instruments, Inc.

3175 NW Aloclek Dr.

Hillsboro, OR 97124-7135

U.S.A.

Shipping Costs To Customer

If the unit is under warranty, after repair or replacement has been completed, we will pay the shipping costs to return the instrument to you via a carrier we choose to any destination within the continental United States. If you desire some other specific form of conveyance, or if you are located outside the continental United States, then you must bear the additional cost of return shipment.

If the unit is not under warranty, we will contact you with an estimate of the charges. If you approve of the indicated repairs and cost, Hinds Instruments, Inc. will return your repaired unit after all charges (including parts, labor and return shipping and handling) have been paid. If you do not approve of our proceeding with the repair, then your unit will be returned as is via UPS COD for the amount of the UPS COD freight charges.

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