

# Installation and Programming Instructions

## **KSC-2**

### **High-Performance Signal Conditioner for Kulite Sensor Products**

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Rev. A

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<b>Rev Level</b>	<b>Date</b>	<b>Description of Change</b>
-	7/30/2015	Initial release
A	10/25/2015	Corrected Notes about CAL mode; Corrected recommended COM port Flow Control setting in Troubleshooting section

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# Safety Guidelines

This document describes how to use the KSC-2 Signal Conditioner and includes product information, installation and programming instructions, and contact information for support and service.

The safety guidelines and product information in this document are specific to the KSC-2 Signal Conditioner. The other components in your system might not meet the same safety rating and specifications. Please read and understand the documentation for each component in your system to determine the safety rating and specifications of the entire system.

## CAUTION

**A CAUTION statement describes a hazard. It calls attention to a procedure, practice, or condition that, if not correctly performed or adhered to, could result in damage to the product or loss of data. Do not proceed beyond a CAUTION statement until the conditions are fully understood and met.**

## Safety Information

### General

Do not use this product in any manner not specified by the manufacturer. The protective features of this product may be impaired if it is used in a manner not specified in this document. Do not install substitute parts or perform any unauthorized modification to the product.

Return the product for service and repair to ensure that safety features are maintained. See Section 7 of this manual, *Support and Service*, for information on how to contact Kulite Semiconductor Products, Inc.


### Safety Symbols


 Chassis Ground


 Signal Ground

 Direct Current

 Risk of Electric Shock

 Refer to Manual for Additional Safety Information

 On Supply

 Off Supply

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# 1 KSC-2 General Information

## 1.1 Introduction

This manual, *KSC-2 Installation and Programming Instructions*, contains information specific to the configuration, installation, and programming of the KSC-2 signal conditioner. Refer to this document and to the documentation supplied with each component in your system to understand how to operate your entire system safely and correctly.

The *KSC-2 Installation and Programming Instructions* manual comprises the following chapters and supplement:

*KSC-2 General Information* (this chapter) provides an overview and specifications of the KSC-2 system, along with environmental requirements, ISO/IEC conformity, and available accessories.

*KSC-2 Installation and Operation* contains location and power requirements, installation instructions, cable connections, and operating instructions.

*KSC-2 Control Software Programming Instructions* describes how to install and operate the stand-alone KSC-2 Control Graphical User Interface (GUI) software.

*KSC-2 High-Level Command Set* describes the high-level commands that can control the KSC-2 unit using the command interface via USB 2.0.

*KSC-2 Troubleshooting* offers steps to deal with common problems, such as when the unit does not turn on or when the GUI fails to recognize the system.

*Support and Service* tells you where to get technical support and how to obtain service or repair.

## 1.2 Description

The KSC-2 is a compact, rugged dual-channel high precision filter/amplifier with programmable constant voltage excitation optimized for conditioning Kulite pressure sensors and microphone products. Fully programmable bipolar excitation with remote sense provides voltage for bridge-type sensors, and a unipolar excitation mode is supplied to condition sensors that have internal regulation. The unit supports automatic and manual balance modes.

A low-noise, high common mode rejection balanced differential input is supplied with programmable AC/DC input coupling. Sharp, programmable precision low-pass filters support two response characteristics, which are optimized for making time-domain or frequency-domain measurements. Amplification is distributed as pre- and post-filter gain, allowing for elimination of out-of-band energy such as transducer resonant peaking, which can cause nonlinearities due to clipping of the amplifier. Overload detectors alert the user to output overloads as well as prefilter overloads that may be masked by the low-pass filter.

The KSC-2 features optional, patent-pending REZCOMP™ transducer resonant compensation technology, which extends the usable frequency response of sensors with recess mounting, device packaging, or seismic resonances. Based on a characterization of the sensor Q and resonant frequency, the REZCOMP technique extends the usable sensor bandwidth to as much as 80% of the sensor resonant frequency or, in some cases, even beyond the sensor resonant frequency.

A high-level command interface can control the KSC-2 via USB 2.0. In addition, a spreadsheet-style graphical user interface is supplied to control up to eight KSC-2 units as a single system. Configurations may be saved and recalled from the host computer. Settings may be saved to nonvolatile memory for field deployment without a host computer. Front-panel LED indicators alert the user to overloads, excitation faults, and autobalance status. In addition, autobalance can be initiated via a momentary switch on the front panel. The KSC-2 is supplied with an external AC-to-DC universal supply or may be powered using an external 10 to 30 VDC input.

## 1.3 Features

### 1.3.1 Excitation Type

The KSC-2 may be configured for bipolar or unipolar excitation operation. Bridge-type pressure transducers without internal amplification will generally be interfaced to the KSC-2 in bipolar mode. The bipolar excitation voltage is fully programmable from 0 to 12.5 Vdc in 1.25 mV steps. The excitation supply is connected across to the sensor  $\pm$  excitation leads, and the KSC-2 differential amplifier signal leads measure the sensor output. A four-wire connection to the bridge may be used when precise regulation of the excitation voltage at the transducer is not critical. The excitation sense leads can be run to the bridge (6-wire connection) for precise regulation of the excitation supply at the transducer load; these should be connected as close to the sensor as is practical.

Unipolar excitation mode is intended for use with internally amplified sensors. The unipolar excitation supply is 14 Vdc.

### 1.3.2 Input Stage

The KSC-2 features an ultra low-noise, low-drift, high common mode rejection differential input stage for making low-level AC and DC measurements. In bipolar excitation mode, a fully automatic bridge balance circuit is used to zero the sensor DC output for zero measurand.

For unipolar excitation mode, the zero suppress mode may be used to zero the initial sensor DC output. When only the dynamic portion of the signal is to be measured, the programmable AC input coupling feature of the KSC-2 is useful to block any DC voltages on the input in order to emphasize the low-level AC portion of the signal by applying programmable gain.

### 1.3.3 Input Shield

The KSC-2 has a programmable input shield termination for each channel. The shield may be terminated in ground, float (AC terminated in 0.1  $\mu$ F), or driven. In general, it is recommended that the cable shield be terminated at only one end of the cable to prevent ground loop pickup. A driven shield may be employed to guard the differential amplifier input leads ( $\pm$  SIG) to enhance common mode rejection at low frequencies.

### 1.3.4 Input Modes

The KSC-2 amplifier stage input is software configurable to facilitate *in situ* calibration or diagnostics. Three input modes are available:

- OPERATE is the normal operating mode. It connects the sensor signal input pins to the amplifier input.
- SHORT mode disconnects the sensor and internally shorts the amplifier inputs to signal ground. This is a useful diagnostic test mode to measure and document the DC offset and noise contribution of the KSC-2 internal circuitry.

**Note:** Any DC voltage injected to execute an automatic or manual bridge balance is temporarily removed while in SHORT mode.

- CAL mode disconnects the sensor input and internally connects the KSC-2 amplifier to the CAL INPUT on the KSC-2 front panel. CAL mode is a useful feature to accurately measure the AC or DC gain of the KSC-2 amplifier.

**Note:** The signal on the KSC-2 CAL input can be distorted if the prefilter gain stage is driven into heavy saturation by the test signal. This could corrupt a calibration reading on a second channel connected to the same CAL signal. To prevent false calibrations, the KSC-2 GUI allows multiple channels to be in CAL mode only if all channels have the same prefilter gain setting. To further safeguard against false calibrations, the KSC-2 GUI does not allow changes to prefilter gain while in CAL input mode.

### 1.3.5 Flat/Pulse Low-Pass Filters

The KSC-2 has a flexible, high-performance 6-pole low-pass filter characteristic that can be optimized for time- or frequency-domain measurements. Simply program the filter characteristic to match your measurement requirements.

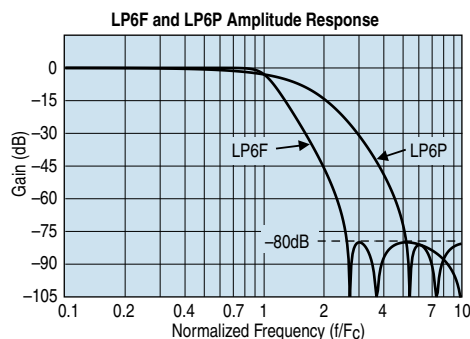
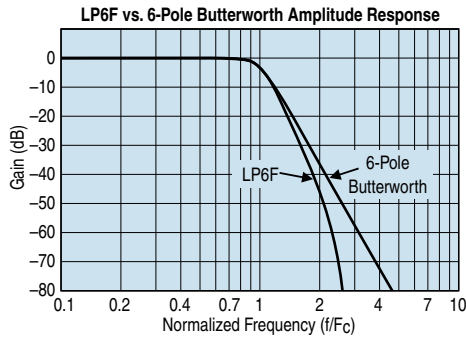


Figure 1 LP6F and LP6P Amplitude Response

## Flat Mode Low-Pass Filters

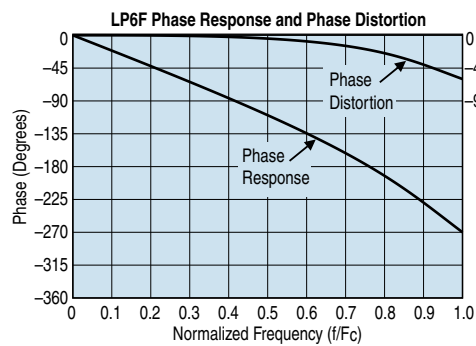
The LP6F FLAT mode characteristic has a pass-band amplitude response nearly identical to the 6-pole Butterworth filter, yet with much sharper roll-off characteristics, as shown in Figure 2. This makes the LP6F a good choice for spectral analysis or for anti-aliasing applications.



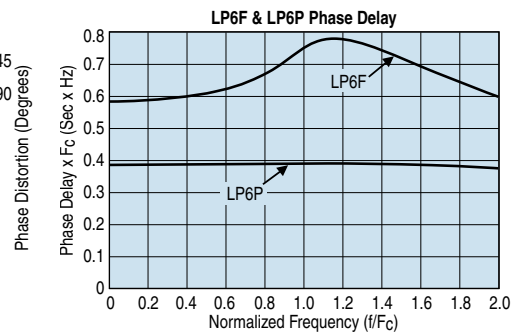
**Figure 2** LP6F vs. 6-Pole Butterworth Amplitude Response

Like the Butterworth low-pass filter, the LP6F has a nonlinear phase response with 60 degrees of phase distortion at the cutoff frequency. See Figure 3.

The nonlinear phase characteristics of the LP6F result in an input-to-output time delay that is not constant versus frequency. Filters with linear phase, such as the LP6P, have constant delay for all frequencies in the pass-band, as shown in Figure 4.



**Figure 3** LP6F Phase Response and Phase Distortion



**Figure 4** LP6F and LP6P Phase Delay

### Pulse Mode Low-Pass Filters

For the time domain, the LP6P PULSE mode low-pass filter has excellent transient response and phase linearity required for time-domain applications such as transient (shock) measurements and time-domain waveform analysis.

A quantitative measure of a filter's transient behavior to evaluate the response to a unit step function input in the time domain. As Figure 5 shows, the LP4F step response exhibits under damped characteristics with 16% overshoot and notable ring-down as the output decays to its final value. In contrast, the LP6P is nearly critically damped and thus exhibits little overshoot and fast settling time in response to a step input. When compared to a 6-pole Bessel filter, the LP6P has similar pass-band characteristics, yet with a much sharper transition slope from pass-band to stop-band (Figure 6).

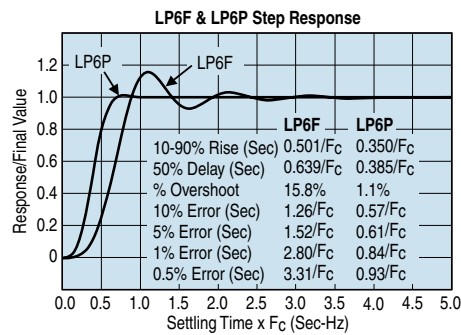


Figure 5 LP6F and LP6P Step Response

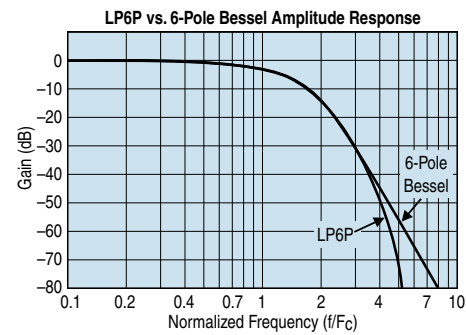
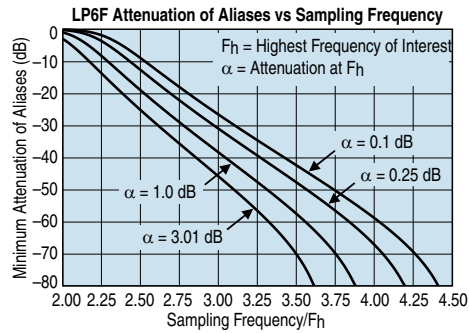


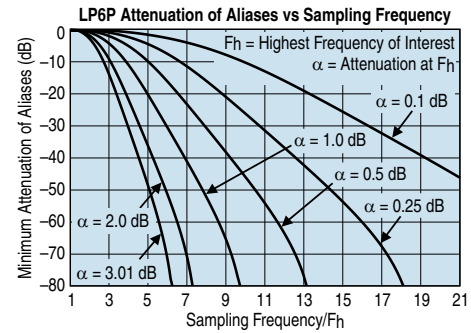
Figure 6 LP6P vs. 6-Pole Bessel Amplitude Response

## Anti-Aliasing Applications

When used for anti-aliasing applications, the LP6F provides more usable bandwidth for a given sampling frequency. In exchange for linear phase and excellent transient response, the LP6P is less selective and thus requires a higher sampling frequency than the LP6F.



**Figure 7** LP6F Attenuation of Aliases vs. Sampling Frequency



**Figure 8** LP6P Attenuation of Aliases vs. Sampling Frequency

Table 1 compares attenuation of aliases versus sampling frequency for the LP6P, 6-pole Bessel (BE6), LP6F, and the 6-pole Butterworth (BU6). The table shows that much lower sampling frequencies are required for the KSC-2 LP6P and LP6F than for traditional filter characteristics.

Table 1 Sampling Frequency for -3.01 dB Attenuation at Fh				
Alias Attn.	BE6	LP6P	BU6	LP6F
20	3.4Fc	3.4Fc	2.5Fc	2.4Fc
40	4.6Fc	4.5Fc	3.2Fc	2.9Fc
60	6.4Fc	5.5Fc	4.2Fc	3.3Fc
80	9.0Fc	6.2Fc	5.6Fc	3.6Fc

### 1.3.6 REZCOMP

The frequency response of a pressure transducer is influenced by numerous factors:

- Natural resonance of the sensor structure
- Spatial resolution of the sensor due to its diaphragm size
- Sensor packaging
- Signal conditioning
- Mounting at the measurement location

In particular, the resonance of the sensor and aerodynamically driven resonances related to sensor packaging and/or mounting can distort dynamic pressure measurements within the range of greatest interest (10 Hz–20 kHz). This typically results in erroneous amplification. Unknown resonant frequencies and damping factors (quality factors) make such errors hard to quantify, so correcting for these errors within the frequency response of a pressure transducer or measurement system can be a challenge. However, with the ability to fully characterize resonant frequencies that lie within 10 Hz–50 kHz using Kulite's proprietary dynamic pressure characterization methodology or other methods, it is possible to apply electrical filtering to substantially extend the flat ( $0 \pm 2$  dB) frequency response of a transducer before any digital signal conversion.

REZCOMP, optional with the KSC-2, is a real-time frequency response compensation scheme that uses electrical filtering to correct for aerodynamically driven packaging- or mounting-related resonances while preventing signal distortion caused by sensor resonances. The compensation extends the usable, flat amplitude bandwidth of the transducer while correcting the phase response to maintain constant time delay over the extended bandwidth.

### 1.3.7 Distributed Gain

Amplifier gain of the KSC-2 is distributed as pre- and postfilter gain. Gain may be apportioned around the compensator and filter to provide headroom for out-band signals that would otherwise clip against the internal  $\pm 10$  V supply rails of the KSC-2. After removal of the out-band energy by the KSC-2 filters, the postfilter gain is used to achieve the desired full-scale output.



### 1.3.8 Overload Detectors

Input overload detectors alert the user to an out-band overvoltage condition that would clip against the internal  $\pm 10$  V supply rails of the KSC-2 and could be masked by the filter.

An output overload detector is provided with a programmable threshold. This is useful for providing visibility to output signals approaching the full-scale capability of the attached recording device.

### 1.3.9 KSC-2 Control

#### Remote Interface

The KSC-2 unit has a USB 2.0 type B interface that uses a high-level command set protocol. Section 5 of this manual, *KSC-2 High-Level Command Set*, discusses these commands and how to use them.

#### Nonvolatile Memory

The KSC-2 module's programmed state can be saved to nonvolatile memory to retain settings through the power cycle or to deploy in the field without a control computer attached.

To save settings to nonvolatile memory, use the Tool menu's Save All command (see Section 4.4.4, *Tools*).

#### KSC-2 Control Software

The KSC-2 comes with spreadsheet-style software for use with Windows OS. Using the GUI, you can control up to eight KSC-2 units as a system. Configurations can be saved to and retrieved from the control computer. Section 4 of this manual, *KSC-2 Control Software Programming Instructions*, explains how to use the GUI Control software.

#### Front Panel Controls and Indicators

Each channel has LEDs to monitor the following conditions:

- Input or output overload
- Excitation fault (short or overvoltage)
- Balance mode status

Momentary switches let you clear overload detectors in latching mode and initiate a balance/suppress operation. A successful balance or suppress operation turns the front-panel AUTO BALANCE light green. Remote commands or the GUI control panel allows you to lock the front-panel switches.

## 1.4 Specifications

### 1.4.1 Input Wiring

**Input Connector:**

9-pin female D-sub at front panel (2 each)

**Channel Input Wires:**

$\pm$ SIG (2);  $\pm$ EXC (2);  $\pm$ SEN (2); SHLD (1); GND; 5<sup>th</sup> wire sensor temperature output (1)

### 1.4.2 Constant Voltage Excitation Supply

**Type:** Programmable constant voltage excitation

**Mode:** Programmable bipolar or unipolar

**Bipolar Mode:**

**Level:** 0 to 12.5 V in 1.25 mV steps

**Accuracy:**  $\pm$ 0.1% of setting  $\pm$ 5 mV

**Current:** 30 mA, short circuit protected

**Noise:** 100  $\mu$ Vrms, 3 Hz to 100 kHz

**Drift:**  $\pm$ 0.0025%/°C of setting or  $\pm$ 50  $\mu$ V/°C

**Stability:**  $\pm$ 0.005% or  $\pm$ 250  $\mu$ V for 8 hours

**Load Regulation:**

$\pm$ 0.03% or  $\pm$ 200  $\mu$ V, whichever is greater, no load to full load

**Sense:**

Programmable local or remote. Sense boost limited to 3 V above programmed setting.

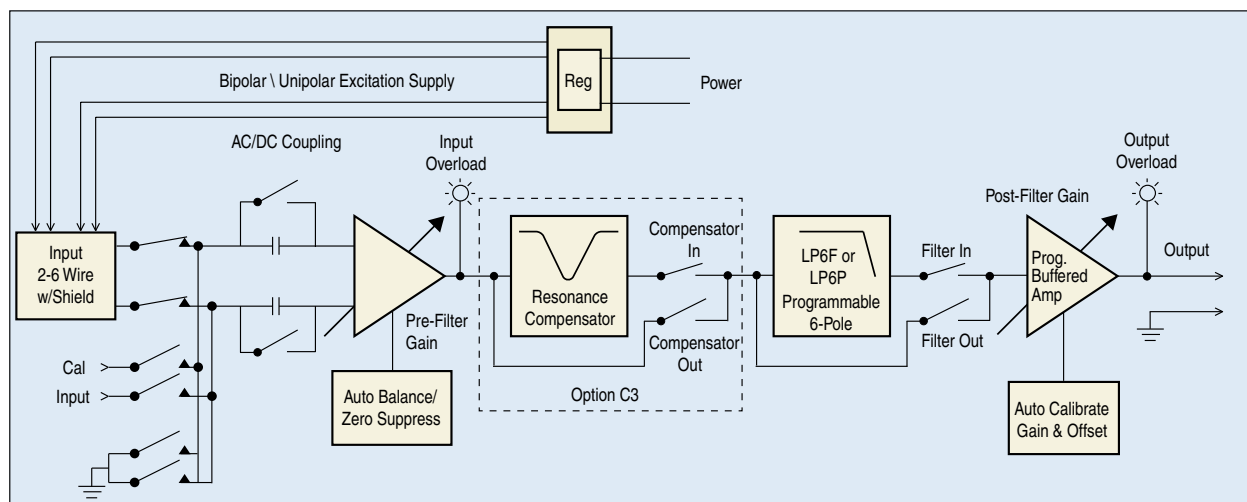


Figure 9 KSC-2 Channel Block Diagram

**Autobalance (Bipolar EXC Mode Only):**

On command, bridge DC output is automatically balanced using voltage insertion at amplifier input.

**Modes:** Automatic or manual entry

**Range (RTI):**

**Prefilter Gain  $\geq 16$ :**  $\pm 32$  mV/V with 1  $\mu$ V/V resolution

**Prefilter Gain  $< 16$ :**  $\pm 512$  mV/V with 16  $\mu$ V/V resolution

**Unipolar Mode:**

**Level:** 14 Vdc  $\pm 5\%$

**Current:** 30 mA, short circuit protected

**Suppress (Unipolar EXC Mode Only):**

Transducer DC output is automatically suppressed using voltage insertion at the amplifier input.

**Modes:** Automatic or manual entry

**Range (RTI):**

**Prefilter Gain  $\geq 16$ :**  $\pm 320$  mV with 10  $\mu$ V resolution

**Prefilter Gain  $< 16$ :**  $\pm 5.12$  V with 160  $\mu$ V resolution

### 1.4.3 Input Characteristics

**Type:** Balanced differential input with programmable AC/DC coupling

**Maximum Input Level:**

$\pm 10$  Vpk (common mode and normal mode signals)

**Level vs. Frequency:**

$\pm 10$  Vpk for  $f \leq 127.5$  kHz;  $\pm 10$  Vpk  $\times (127.5 \text{ kHz}/f)$  for  $f > 127.5$  kHz

**Input Impedance:** 10 M $\Omega$  per side

**Drift:** 1  $\mu$ V/ $^{\circ}$ C, RTI

**CMRR (input gain  $> \times 16$ ):** 110 dB, DC to 1000 Hz

**Spectral Noise:** 7 nV/ $\sqrt{\text{Hz}}$  at 1 kHz and prefilter gain  $> 64$

**Programmable AC Coupling Frequency:** 0.25 Hz ( $-3.01$  dB), 2-pole

**Input Protection:** 24 V continuous

## 1.4.4 Optional KSC-2 Transducer Compensator (C3) Characteristics

### Transducer Cavity Resonance Compensator:

Patent-pending transducer cavity resonance compensation for sensor as characterized by Q and resonant frequency (Fr)

### Compensation Q:

1 to 20 in 0.1 steps; 20 to 50 in 0.5 steps

### Compensation Frequencies (Fr):

**Low Range:** 10 Hz to 2.55 kHz in 10 Hz steps

**Mid Range:** 2.6 kHz to 51 kHz in 200 Hz steps

**High Range:** 52 kHz to 255 kHz in 1 kHz steps

### Accuracy:

#### Low Range:

$\pm 0.1$  dB DC to 0.8 Fr;  $1.25 Fr \leq f \leq 10$  kHz

$Q \leq 10$ :  $\pm 0.2$  dB;  $0.8 Fr < f < 1.25 Fr$

$Q > 10$ :  $\pm 0.02$  dB \* Q;  $0.8 Fr < f < 1.25 Fr$

#### Mid Range:

$\pm 0.15$  dB DC to 0.8 Fr;  $1.25 Fr \leq f \leq 100$  kHz

$Q \leq 10$ :  $\pm 0.25$  dB;  $0.8 Fr < f < 1.25 Fr$

$Q > 10$ :  $\pm 0.025$  dB \* Q;  $0.8 Fr < f < 1.25 Fr$

#### High Range:

$\pm 0.2$  dB; DC to 0.6 Fr;

$\pm 0.5$  dB;  $1.7 Fr \leq f \leq 255$  kHz

$Q \leq 10$ :  $\pm 1.25$  dB;  $0.6 Fr < f < 1.7 Fr$  or 255 kHz, whichever is less

$Q > 10$ :  $\pm 0.125$  dB \* Q;  $0.6 Fr < f < 1.7 Fr$  or 255 kHz, whichever is less

### Phase Match:

$\pm 2^\circ$ , DC to 0.8 Fr low and mid ranges;

DC to 0.6 Fr high range

### Amplitude Match:

$\pm 0.2$  dB, DC to 0.8 Fr low and mid ranges; DC to 0.6 Fr high range

### Compensator Off:

Compensator may be removed from the signal path.

## 1.4.5 Filter Characteristics

**Type:**

Programmable flat/pulse low-pass 6-pole, 6-zero low-pass filter. See Table 2.

Programmable for maximally flat pass-band (LP6F) or linear phase (LP6P)

**Cutoff Frequencies:** 500 Hz to 127.5 kHz in 500 Hz steps

**Pass-Band Accuracy:**  $\pm 0.2$  dB maximum to  $0.8 F_c$

**Amplitude Match:**  $\pm 0.2$  dB maximum to  $0.8 F_c$

**Phase Match:**  $\pm 2^\circ$  maximum to  $0.8 F_c$

**Wideband Mode:**

Filter may be removed from the signal path, resulting in 3-pole Butterworth wideband amplifier frequency response with nominal  $-3$  dB frequency at 500 kHz.

Specification	LP6F 6-Pole Maximally Flat Low-Pass Filter	LP6P 6-Pole Constant Time Delay Low-Pass Filter
Cutoff Frequency Amplitude	-3.01 dB	-3.01 dB
DC Gain	0.00 dB	0.00 dB
Pass-Band Ripple	0.00 dB	0.00 dB
Stop-Band Frequency	2.6113 $F_c$	5.1923 $F_c$
Cutoff Frequency Phase	-270.0 deg	-140.3 deg
Phase Distortion (DC to $F_c$ )	< 60 deg	< 1.45 deg
Zero Frequency Group Delay	0.5834/ $F_c$	0.3924/ $F_c$
Percent Overshoot	15.8%	1.1%
1% Settling Time	2.80/ $F_c$	0.84/ $F_c$
0.1 % Settling Time	4.36/ $F_c$	1.02/ $F_c$
-0.1 dB Frequency	0.766 $F_c$	0.193 $F_c$
-1 dB Frequency	0.9080 $F_c$	0.5983 $F_c$
-2 dB Frequency	0.9624 $F_c$	0.8293 $F_c$
-3.01 dB Frequency	1.0000 $F_c$	1.0000 $F_c$
-20 dB Frequency	1.3822 $F_c$	2.3616 $F_c$
-40 dB Frequency	1.8546 $F_c$	3.5115 $F_c$
-60 dB Frequency	2.3206 $F_c$	4.5462 $F_c$
-80 dB Frequency	2.6113 $F_c$	5.1923 $F_c$

### 1.4.6 Output Characteristics

**Type:** DC coupled, single-ended output, short circuit protected

**Impedance:** 10  $\Omega$

**Max Output:**  $\pm 10$  Vpk,  $\pm 25$  mA pk

**Offset:** < 5 mV after auto-adjust at any gain setting

**Offset Drift:** 1  $\mu$ V/ $^{\circ}$ C, RTI + 150  $\mu$ V/ $^{\circ}$ C RTO, typical

**Noise:** 2.8  $\mu$ V rms RTI + 60  $\mu$ V rms RTO, 3 Hz to 100 kHz

**Crosstalk:** -80 dB, DC to 100 kHz

### 1.4.7 General Characteristics

**Size:** 12.5 x 8.6 x 1.75 inches (L x W x H)

**Weight:** 3.5 lb. net

**Temperature:**

0 $^{\circ}$ C to 55 $^{\circ}$ C (operating); -20 $^{\circ}$ C to 85 $^{\circ}$ C (storage)

**Humidity:**

10% to 90% noncondensing

**Input Connectors:**

2 each 9-pin D-sub on front panel

**Output Connectors:**

2 each isolated BNC on rear panel

**Cal Input Connector:**

Isolated BNC on front panel

**Ground:**

Signal ground post at rear panel. Slider switch connects chassis ground to signal ground or isolates signal ground to accommodate external ground reference.

Chassis ground is referenced to ground pin on power input connector.

**Power Entry Connector:** Mini DIN

## 1.5 ISO/IEC Conformity

### **Product Category:**

Electrical equipment for measurement, control, and laboratory use conforms to the directives and standards listed below.

### **Council Directive 2004/108/EC, Electromagnetic Compatibility, IEC 61326-1:2005**

#### **Emission, group 1 equipment measured on a test site:**

- CISPR 11:2010 Conducted emissions: Class B, 150 kHz to 30 MHz.
- CISPR 11:2010 Radiated emissions: Class B, 30 MHz to 1 GHz.
- 61000-3-2:2009 Harmonics
- 61000-3-3:2008 Flicker

#### **Immunity, equipment intended for use in industrial locations:**

- IEC 61000-4-2:2009 Electrostatic discharge: Performance Criteria B, 4 kV by contact, 8 kV by air discharge
- IEC 61000-4-3:2010 Radiated immunity: Performance Criteria B, 10 V/m, 80 MHz to 2.7 GHz, 80% AM with 1 kHz sine wave modulation, 200 Hz pulsed modulation
- IEC 61000-4-4:2011 Electrical fast transient/burst: Performance Criteria B, 1 kV to AC power line, Ethernet communication line, signal lines
- IEC 61000-4-5:2005 Surge: Performance Criteria B, 1 kV line to line/2 kV line to ground for AC power port, 1 kV for I/O signal/control lines, including functional earth lines
- IEC 61000-4-6:2008 Conducted immunity: Performance Criteria B, 10 V, 150 kHz to 80 MHz
- IEC 61000-4-11:2004 Voltage dips: Performance Criteria B, AC power port, 0% during half cycle, 0% during 1 cycle, 70% during 25 cycles for 50 Hz test, 70% during 30 cycles for 60 Hz test
- IEC 61000-4-11:2004 Voltage interrupts: Performance Criteria C, AC power port, 0% during 25 cycles for 50 Hz test, 0% during 30 cycles for 60 Hz test

### **Council Directive 2006/95/EC, Low-Voltage Safety**

- IEC 61010-1:2010 Product meets the essential requirements for low-voltage safety.

## 1.6 Accessories

### **200-B-84801**

Link kit for joining two KSC-2 units

### **200-B-84802**

Rack mount ear kit

### **910-A-84803**

Spare external AC/DC power supply (one included with KSC-2 unit)

### **908-A-84792**

Mating power entry connector for KSC-2

### **220-A-84804**

9-pin mating input connector with metal backshell and gold-plated screw machined crimp contacts

### **220-A-84805**

9-pin mating input connector with metal backshell and gold-plated screw machined solder cup contacts

### **908-A-84797**

9-pin mating input connector with metal backshell and screw terminal connections

### **910-A-84798**

Locking USB cable accessory (72")

Standard (nonlocking) type A USB connector for host computer to locking type B USB connector for KSC-2

### **910-A-84799**

USB Cable Accessory (36")

High-speed, double-shielded type A USB connector for host computer to type B USB connector for KSC-2 (one included with KSC-2 unit)



## 2 KSC-2 Installation and Operation

### 2.1 Introduction

This section contains instructions for installing and operating the KSC-2 signal conditioner: unpacking, location and power requirements, mounting options, connecting cables, and basic operation.

Before installing the system, read the complete procedure to become familiar with the steps. After installation, the system must be configured using the system configuration instructions in Section 4 of this manual, *KSC-2 Control Software Programming Instructions*.

### 2.2 Site Preparation

This section describes the preparations that are necessary before you install the system.

#### 2.2.1 Power Requirements

The KSC-2 unit includes one external AC/DC power supply. The input power connector is located on the left side of the rear panel.

The KSC-2 requires input power of 10–30 VDC, 25 W maximum, applied at the rear panel POWER IN connector. Mating power entry connectors (KPPX-4P-30) and spare external AC/DC power supplies (KSC-2-ACPS) are available.

#### 2.2.2 Location Requirements

KSC-2 units must be installed and operated in an area that meets and can maintain the environmental specifications listed below:

- Maximum temperature: 55°C (131°F)
- Minimum temperature: 0°C (32°F)
- Relative humidity: 10% to 90% (noncondensing)

#### 2.2.3 Physical Requirements

The KSC-2 unit weighs 3.5 lb. net. The frame can be bench or rack mounted. The unit is 12.5 inches long by 8.6 inches wide by 1.75 inches high. Provide adequate room behind the unit for connecting cables to the rear panel.

## CAUTION

**Use only the supplied flat-head Phillips screws when installing the mounting ears. Longer screws will damage the system hardware.**

## 2.3 Unpacking

Before shipment, this KSC-2 unit was free of electrical and mechanical defects. It was fully tested and burned in.

### 2.3.1 Shipping Container

Inspect shipping containers immediately upon receipt for evidence of mishandling during transit. If a shipping container has been damaged in any way, have the carrier's agent present when the equipment is unpacked.

If the equipment is damaged, file a claim with the carrier and forward a copy to Kulite. Kulite will notify you of the disposition of the equipment and will arrange for repair or replacement without waiting for a settlement of the claim against the carrier. Retain the shipping container and packing material for the carrier's inspection or for reuse. **NOTE: Need Kulite's procedure for this.**

### 2.3.2 Chassis Inspection

Make a visual check of the unit's exterior to ensure that there are no broken controls or connectors and that the panel surfaces are free of dents and scratches.

## 2.4 Storage, Transport, and Shipment

The following environmental conditions must be maintained during storage, transport, or shipment of KSC-2 units:

- Maximum temperature: 85°C (185°F)
- Minimum temperature: -20°C (-4°F)
- Relative humidity: 10% to 90% (noncondensing)

### 2.4.1 Storage Requirements

The unit can be stored or remain in an equipment rack. For prolonged storage, protect the unit with a cover to prevent dust accumulation. The storage area should be free of dust and must meet the environmental conditions described in Section 2.4.

### **2.4.2 Transport Requirements**

The unit may be transported over a short distance if vibration and shock are held to an absolute minimum. Before transport, remove cables. The environmental conditions described in Section 2.4 must be maintained.

### **2.4.3 Shipment Requirements**

Always use the original packaging materials to ship system components. A new container can be purchased from Kulite. The environmental conditions described in Section 2.4 must be maintained.

## 2.5 Mounting the KSC-2

The KSC-2 can be mounted individually on a desk or counter. It has four nonskid feet for stability. In addition, KSC-2 units can be connected vertically or horizontally or mounted to a rack, as described in the following sections.

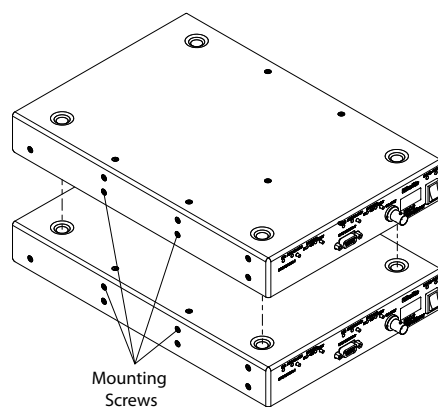
For optimal performance, maintain airflow around the KSC-2 to allow adequate cooling. For example:

- When multiple units are stacked on a bench, the units' sides should remain unobstructed to facilitate airflow between the boxes.
- If a unit's side is obstructed, the top panel should remain open to airflow.
- When an array of KSC-2 units are rack mounted, the top, bottom, and side of the array should allow for airflow.

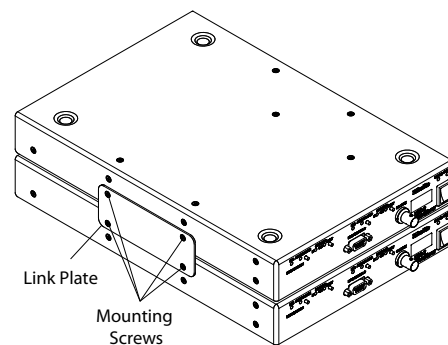
### 2.5.1 Vertically Mounting Two or More Units

The top panel of each KSC-2 unit contains four dimples, one near each corner, that correspond to the positions of the unit's feet. These dimples allow the units to fit together snugly when stacked vertically. The KSC-2 link kit (KSC-2-LINK) consists of two plates, each with four holes. The KSC-2 chassis side panels come with eight preinstalled flat-head Phillips screws to secure the plates.

To mount two KSC-2 units vertically, remove the preinstalled mounting screws. Place one unit on top of another, aligning the upper unit's feet with the dimples on the top panel of the lower unit. See Figure 10. Align a link plate with the side panels' pre-drilled holes and secure the plate with the supplied installation screws (Figure 11). Install the second plate on the units' other side in the same manner.



**Figure 10** Vertically Mounting Two KSC-2 Units



**Figure 11** Vertical Mounting: Attaching the Link Plate

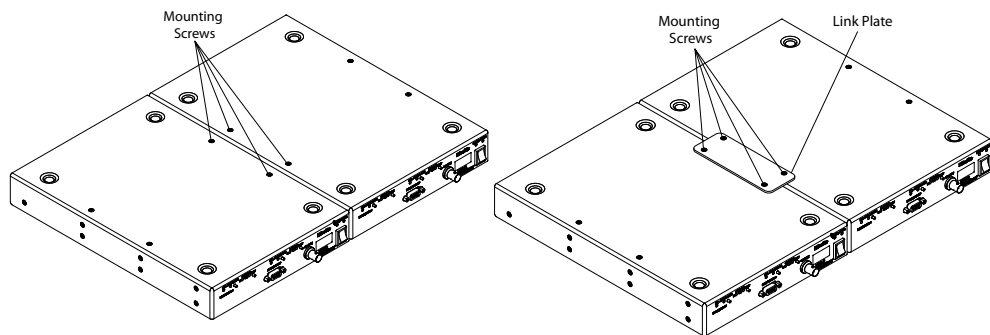
## CAUTION

**Use only the preinstalled flat-head Phillips screws when installing the link plates. Other screws may damage the system hardware.**

### 2.5.2 Horizontally Mounting Two or More Units

Two or more KSC-2 units can be connected side by side. The KSC-2 link kit (KSC-2-LINK) consists of two plates, each with four holes. The KSC-2 frame's top and bottom panels come with eight preinstalled screws for attaching the plates.

To mount two KSC-2 units side by side, remove the preinstalled mounting screws and place the units beside each other. See Figure 12. Align a link plate with the top panels' predrilled holes and secure the plate with four of the supplied installation screws (Figure 13). Install the second plate on the units' bottom panels in the same manner.



**Figure 12** Horizontally Mounting Two KSC-2 Units      **Figure 13** Horizontal Mounting: Attaching the Link Plate

### 2.5.3 Horizontal Rack Mounting

The KSC-2 rack mount kit (KSC-2-RM) consists of a pair of mounting ears. The KSC-2 chassis side panels come with four preinstalled flat-head Phillips screws to secure the mounting ears.

To rack mount two KSC-2 units, connect two units horizontally as described in the previous section. Remove the preinstalled screws on the exposed side panels (see Figure 14 for the locations). Align the rack mounting ears with the holes and secure the ears with the supplied installation screws (Figure 15). Attach the mounting ears to the rack.

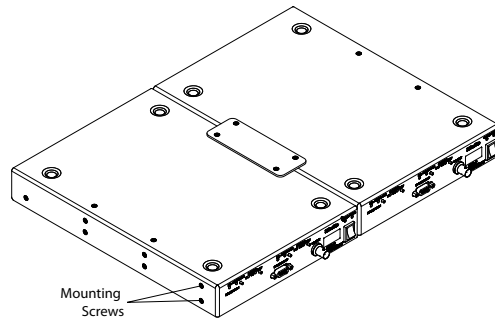


Figure 14 Rack-Mounting Two KSC-2 Units

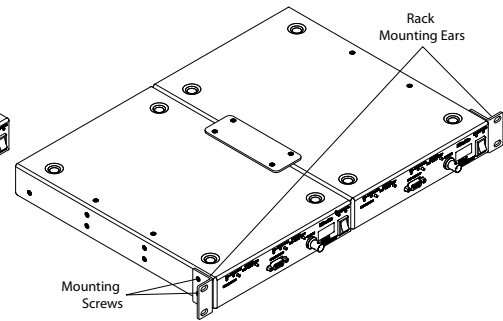


Figure 15 Installing Rack Mounting Ears

**CAUTION**

**Use only the preinstalled flat-head Phillips screws when installing the link plates. Other screws may damage the system hardware.**

## 2.6 Install Cables

### 2.6.1 Front-Panel Input Connections

This section provides information about installing the input signal cables for KSC-2 units. Figure 16 shows the front-panel input connectors.

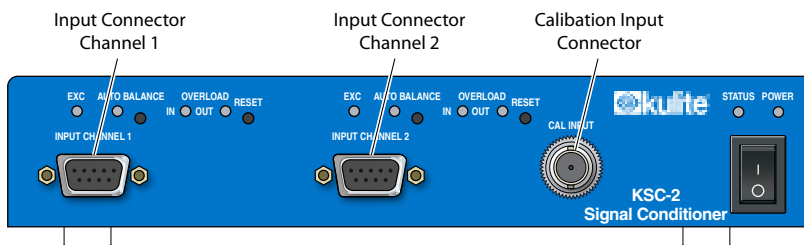


Figure 16 KSC-2 Front Panel

### KSC-2 Input Connectors

The KSC-2 provides two conditioning channels, labeled INPUT CHANNEL 1 and INPUT CHANNEL 2. Two industry-standard DB-9 female input connectors, shown in Figure 17, extend through openings on the front panel of the chassis. Table 3 lists the input connector pin assignments.

Pin	Description
1	Excitation +
2	In +
3	Sense -
4	Signal Ground
5	5th Wire
6	Sense +
7	In -
8	Excitation -
9	Shield

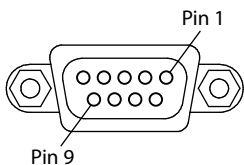


Figure 17 Input Connector Pin Assignments

## Input Cabling and Input Shielding

Twisted and shielded cable should be used for all signal inputs (In+, In-), especially in high-noise environments. The shield should be connected at one end only (i.e., either at the transducer or at the instrument) but not at both ends.

Avoid running signal leads near—or especially in parallel with—current-carrying power cables. In situations where twisted/shielded cable cannot be used, exercise care to avoid any large loop area (separation) in the input wiring pairs.

Twisted and shielded cable is preferred for + and – excitation and for + and – sense lines to minimize noise pickup. If the bridge configuration is physically unbalanced, noise pickup in the excitation or sense leads can degrade signal-to-noise ratio.

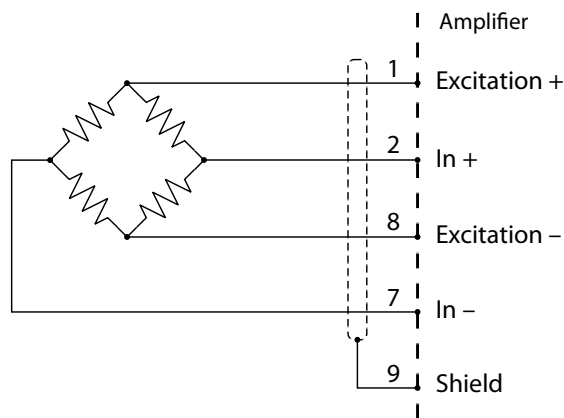
### CAUTION

**It is necessary to provide a high-quality instrument ground to the KSC-2 system. The KSC-2 input is rated for operation at a signal-plus-common-mode level of 10 V and is protected for a signal-plus-common-mode level of 24 V relative to instrument ground.**

**Note:** The upcoming section “Signal Ground Selection” explains how to optimize signal ground quality.

## KSC-2 Full-Bridge 4-Wire Connections

For full-bridge measurements using a 4-wire configuration, the KSC-2 connections should be made as shown in Figure 18. To set up the KSC-2 for 4-wire full bridge measurements, the excitation sense must be set to Local in the GUI or via remote command.



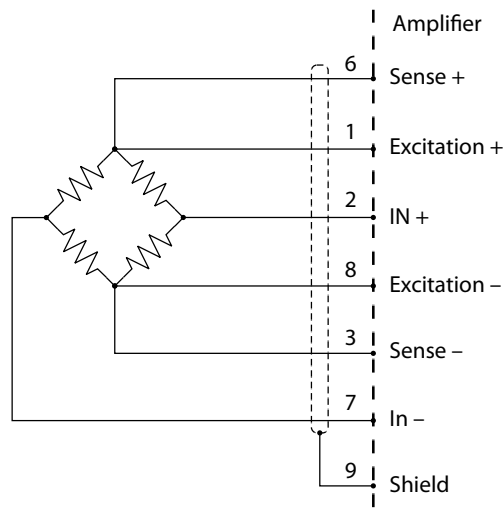
**Figure 18** KSC-2 Full Bridge with Local Sense (4-Wire + Shield)



### KSC-2 Full-Bridge 6-Wire Connections

Resistance in the excitation leads produces error in excitation delivered to the bridge. Remote excitation sense leads may be used to sense the excitation at the bridge in order to correct for the lead resistance drops.

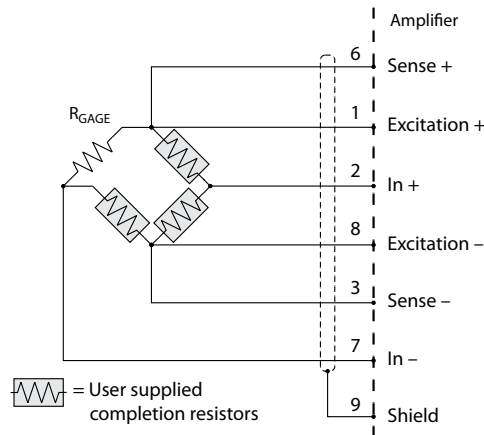
Figure 19 shows the 6-wire configuration that uses the + and – SENSE leads. To set up the KSC-2 for 6-wire full-bridge measurements, the excitation sense must be set to Remote in the GUI or via remote command.



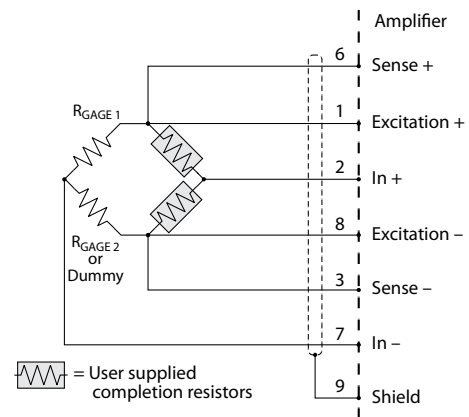
**Figure 19** KSC-2 Full Bridge with Local Sense (6-Wire + Shield)

### Other Bridge Input Configurations Using External Completion Resistors

The KSC-2 does not provide bridge completion; however, the user may wish to provide external completion resistors for quarter- and half-bridge configurations. The completion resistors should be located as close to the active gage as possible to keep the circuit physically balanced and minimize interfering noise sources. Figure 20 shows a typical configurations for a quarter bridge. Figure 21 shows a typical configuration for a half bridge.



**Figure 20** KSC-2 Quarter Bridge with Remote Sense & User-Supplied Completion Resistors



**Figure 21** KSC-2 Half Bridge with Remote Sense & User-Supplied Completion Resistors

### Voltage Input Configuration

The KSC-2 may be used as a low-noise voltage filter/amplifier by connecting a voltage output device to the + and - SIGNAL inputs.

### CAL Input Connector

The KSC-2's front panel has an isolated BNC calibration input connector labeled CAL INPUT.

## 5th Wire

The Kulite 5th wire transducer was developed to allow customers to obtain data about the bridge temperature of the pressure transducer in order to compensate the sensor for thermal errors. Using this temperature signal correctly can result in a very accurate pressure measurement—even over a wide temperature range.

The Kulite 5th wire voltage is proportional to the temperature of the silicon die. The output is approximately 5 V at room temperature and increases by 2 mV/°F nominal. Refer to Kulite application note *Kulite 5th Wire Combination Pressure and Temperature Transducers* for more details.

The KSC-2 features a 5th wire input that allows measurement of the 5th wire voltage with an internal analog-to-digital converter.

### 2.6.2 Rear-Panel Connections

The rear panel contains output connectors, a port for a type B locking USB connector, and a power-in connector. It also has the KSC-2's ground configuration switch. See Figure 22.

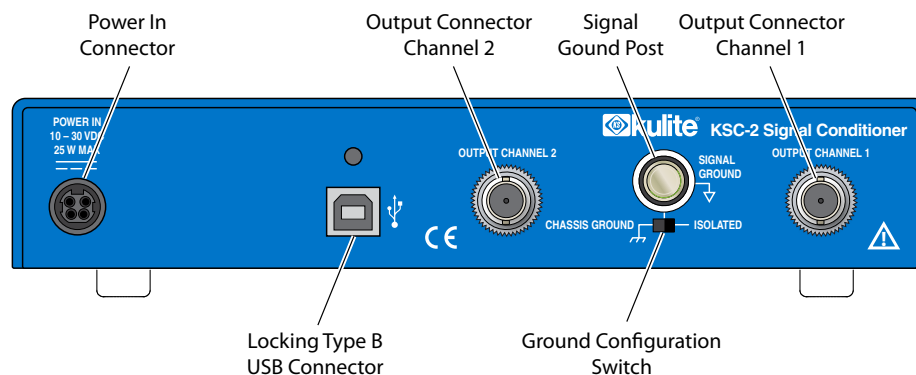


Figure 22 KSC-2 Rear Panel

Before operating the KSC-2 unit, connect the external power supply to the rear panel. Use the supplied USB cable to connect the unit to the host computer. Insert the Type B USB connector into the KSC-2 unit's rear-panel USB port. Insert the standard Type A connector into the desired USB port of the host computer.

## Communication USB 2.0 Connector

For protection against accidental cable disconnection, Kulite offers an accessory cable with a locking type B USB connector (Kulite P/N 910-A-84798). The USB-A/B-6 locking USB cable accessory is a 72-inch cable with a standard (nonlocking) type A connector for the host computer and a locking type B USB connector for the KSC-2.

## Output Connectors

Two isolated BNC connectors are labeled OUTPUT CHANNEL 1 and OUTPUT CHANNEL 2. The KSC-2 has a single-ended output stage with  $10\ \Omega$  output impedance. The rear-panel BNC shell is connected to signal ground.

## Signal Ground Selection

For optimal data quality, it is important to provide a low-noise, low-impedance, earth ground reference to internal amplifier circuitry. As shown in Figure 22, the KSC-2 has rear-panel features to optimize the signal ground used for internal circuits. As shipped from the factory, the amplifier signal ground is connected to the KSC-2 chassis (switch in left position). This provides a convenient ground connection through the attached KSC-2 input power cord to earth ground via the third wire earth ground at the wall outlet.

If the chassis ground connection is found to be unsuitable due to excessive noise on facility earth ground connection, the KSC-2 signal ground can be isolated from chassis ground by moving the rear-panel ground configuration switch to the ISOLATED (right) position and using the rear-panel ground post to connect to a more suitable ground connection. For optimal performance, this ground post should be connected to a quality ground source with a low-impedance connection directly to earth ground.

## Bank Isolation

The KSC-2's ISOLATED mode can be used to reference both channels to a remote reference other than earth ground. Called bank isolation, this can be useful if a distant ground causes the common source (to both channels) to be at some potential beyond the  $\pm 10\ \text{V}$  input range allowable by the KSC-2 amplifier.

If you are using bank isolation in this manner, follow these rules:

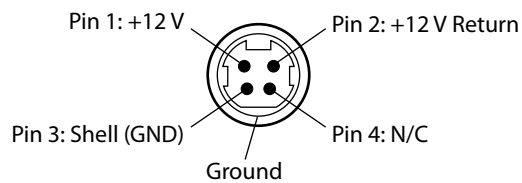
- The remote ground potential must not be more than 20 V from the chassis ground of the KSC-2.
- The input signals to each of the two channels must not differ by more than  $\pm 10\ \text{V}$  from the remote ground reference.
- Any recording device connected to the KSC-2 outputs must also have sufficient isolation capability.

- If input cabling connects the overall cable shield to the shell of the DB9 input connector, this will connect the shield to the remote ground potential through the chassis connection. To prevent ground loop currents, do not terminate the cable shield at the sensor end.

## Power Connector

One KSC-2-ACPS external AC/DC power supply is provided with each KSC-2 system. The input power connector (Figure 23) is located on the left side of the unit's rear panel.

The KSC-2 requires input power of 10–30 VDC, 25 W maximum, applied at the rear panel POWER IN connector. Mating power entry connectors (KPPX-4P-30) and spare external AC/DC power supplies (KSC-2-ACPS) are available.



**Figure 23** KSC-2 Power Connector

## 2.7 KSC-2 Front-Panel Operation

Figure 24 illustrates the front-panel indicators and switches used during KSC-2 operation.

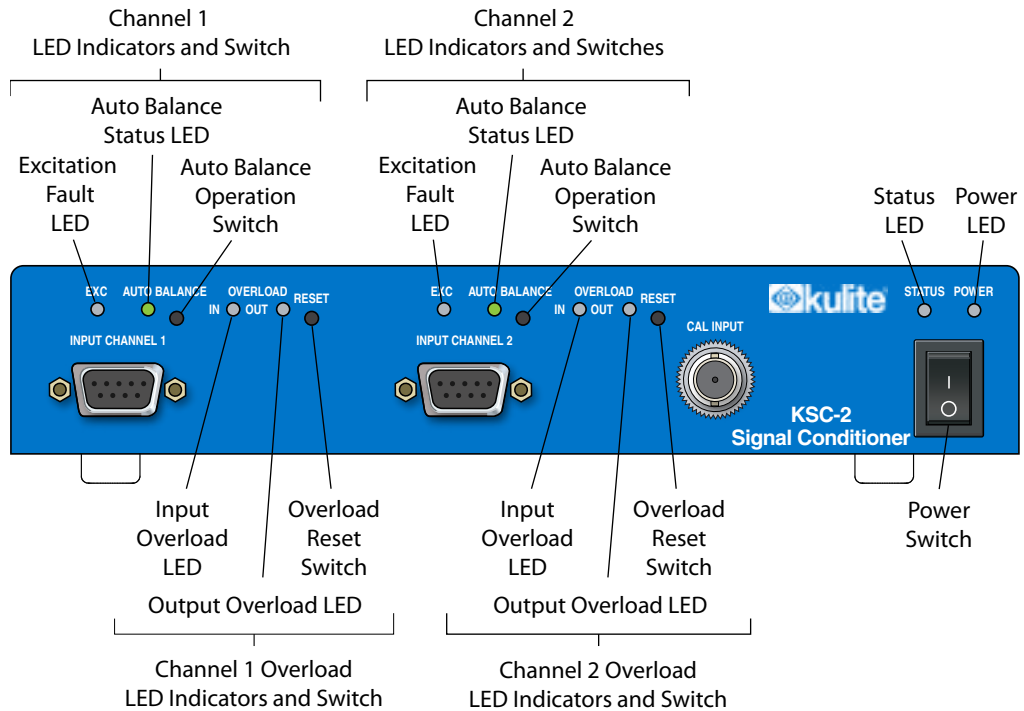


Figure 24 KSC-2 Front Panel Switches and Indicators

### 2.7.1 Applying Power

To apply power, be sure that the external power supply is connected to the rear panel and plugged in. On the front panel, move the right-hand power switch to the On position (I). The upper-right POWER light turns green. The green STATUS light indicates that the KSC-2 unit has initialized.

## 2.7.2 Autobalance Indicators and Reset Button

The KSC-2's autobalance function measures any imbalance inherent in the bridge and provides appropriate compensation to the circuit. Front-panel LEDs for each channel indicate the channel's balance mode status: in progress (yellow), successful (green), or failed (red).

To initiate a balance/suppress operation for a channel, press the momentary switch to the right of the channel's AUTO BALANCE LED. You can also initiate an auto-balance from the KSC-2 Control GUI (see Section 4.5.9) or via remote commands (see Section 5.4.7).

**Note:** Autobalance is disabled when the KSC-2 unit is AC coupled.

The front-panel switches may be locked out using the Options panel in the GUI (see *Tools* in Section 4) or remote commands (see *Device Control and Information* in Section 5).

## 2.7.3 Overload Indicators and Reset Button

For each channel, front-panel LEDs indicate input or output overload and excitation faults (short or overvoltage). Overload indicators, labeled IN and OUT to show input and output overloads, respectively, turn red in an overload condition:

- The IN overload detection circuit is located following the prefilter gain stage and prior to the filter stage.
- The OUT overload detection circuit is located following the postfilter gain stage.

To clear the overload detectors while in Latching mode, press the RESET switch for the desired channel. For more information about Latching and Continuous modes, see Section 4.5.13.

When an excitation fault is detected, the EXC indicator turns red. The LED remains lit until the excitation fault is corrected.

The front-panel switches may be locked out via a control panel in the GUI (see *Tools in Section 4*) or remote commands (see *Device Control and Information* in Section 5).

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## 3 KSC-2 Control Software Programming Instructions

### 3.1 Introduction

The KSC-2 Control Graphical User Interface (GUI) provides an easy-to-use spreadsheet-style interface for control and configuration of the KSC-2 signal conditioner. The GUI can control up to eight KSC-2 units as a system. This section describes how to install the GUI on a Windows OS computer and use it to operate KSC-2 units.

### 3.2 GUI Installation

This section contains instructions for installing the KSC-2 Control GUI software on a Windows-based host computer.

#### 3.2.1 Antivirus Software

All software is routinely scanned for computer viruses using the latest antivirus software and has been found to be free of viruses and malicious software.

If your antivirus program is reporting a problem and blocking the installation of the KSC-2 Control GUI software, disable the antivirus program and retry the installation.

#### 3.2.2 Installing the KSC-2 Control GUI Software

The KSC-2 Control GUI software is distributed on the KSC-2 Signal Conditioner Software Distribution CD. Install and run the GUI program as described in this section.

**Note:** It is strongly recommended that you exit all programs before you run the KSC-2 Control installer. Applications that run in the background, such as virus-scanning utilities, could lengthen the amount of time required for the installation.

**Step 1** Insert the CD into a Windows-compatible computer, open the *KSC-2 GUI* folder and then open the *Installer* folder.

Double-click the *setup.exe* file to start the GUI software installer.

The start-up panel briefly displays while the installer initializes.

**Step 2** In the Destination Directory panel, shown in Figure 25, select the destination folder for the software program.

The default destination for the KSC-2 GUI is *C:\Program Files\KSC-2\*.

Click Next to continue.

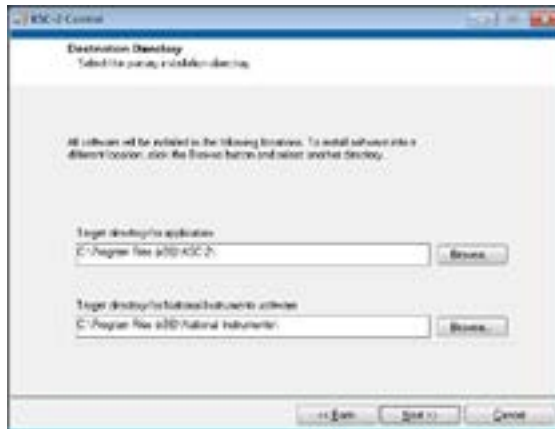


Figure 25 Destination Directory Panel

**Step 3** Review the License Agreement in the License Agreement pane. Select “I accept the License Agreement” and click Next.

**Step 4** Review the Start Installation summary panel and click Next.

The Progress panel displays, showing the installation’s progress.

**Step 5** When you see the Installation Complete panel (Figure 26), click Finish.

**Step 6** You must restart your computer to finish the installation. Click the Restart button on the Restart panel.



Figure 26 Installation Complete Panel

### 3.2.3 Uninstalling the KSC-2 Control GUI Software

Uninstall the KSC-2 Control GUI software through the Windows Control Panel.

Click the Start button and select Control Panel. In the Control Panel's list of programs, find and select *KSC-2 Control*. Click Uninstall/Change. Confirm that you want to remove the program from the host computer by clicking Yes in the confirmation panel, and Windows uninstalls the software.

### 3.2.4 Starting the KSC-2 Control GUI Software

Follow the steps below to open the KSC-2 Control GUI software:

- Step 1** Ensure the KSC-2 unit is properly connected to the host computer and powered up.
- Step 2** From the Windows Start, All Programs menu, click the KSC-2 icon to start the GUI program. Figure 27 shows what the start-up screen looks like the first time you open the program.

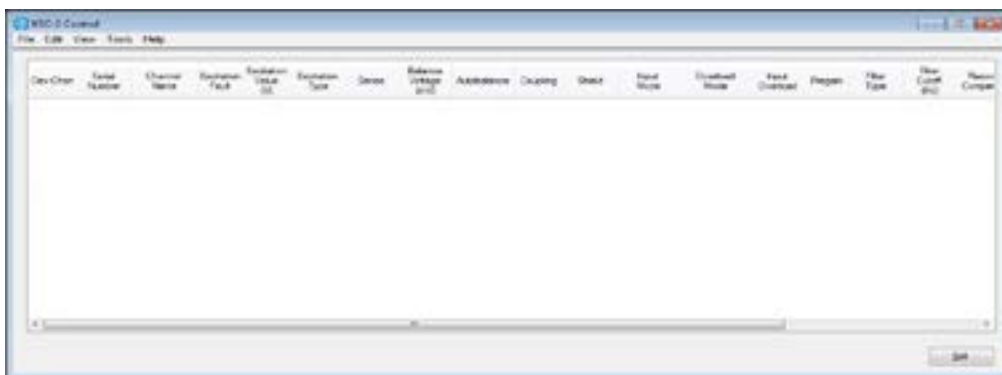


Figure 27 Initial KSC-2 Control Screen (Partial)

### 3.2.5 Connecting Multiple KSC-2 Units to the Control GUI

To connect one or more KSC-2 units to the GUI, connect each unit's USB cable to a USB hub and connect the USB hub to your host computer. In the KSC-2 Control GUI select Edit, System Configuration. See Section 3.4.2 for information about working with the System Configuration panel.



## 3.4 Main Menu

The main menu is located in the menu bar at the top of the KSC-2 Control GUI screen. This section describes the main menu commands.

### 3.4.1 File

The File menu contains commands related to the handling of files: Open, Save, and Save As. It also contains the Exit command for closing the KSC-2 Control GUI program. To select one of these commands, click File and then choose the command you want from the drop-down menu.

**Note:** The KSC-2 Control GUI stores system configuration files and sensor database files in .csv format. This file format, which holds tabular data in plain-text form, consists of sequences of records in which each record contains an identical list of fields. The .csv file can be opened in a spreadsheet program such as Microsoft Excel.

#### Open

To open a saved file, select File, Open, and choose one of these options:

- **System Configuration**

If you want to apply the saved settings for a specific saved system configuration, select this option.

- **Sensor Database**

The sensor database contains information about various Kulite sensors and, for each, helps you to determine the Q factor for various resonance frequencies.

Navigate to the folder that holds the file you want to open. Choose the file and click the Select button to open it.

#### Save

The active configuration can be saved at any time by selecting File, Save on the menu bar. The GUI provides a confirmation prompt before overwriting the current configuration file.

#### Save As

Select File, Save As to save the existing system configuration in a new file. The GUI provides a prompt where you specify the location and name of the configuration file to be saved.

## Exit

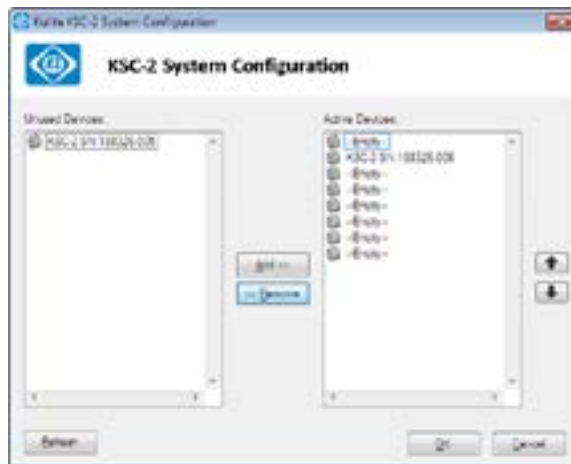
To close the KSC-2 Control GUI program, select File, Exit from the menu bar. Alternatively, you can close the program by clicking the upper-right Close symbol (X) or the lower-right Exit button.

**Note:** When the KSC-2 unit is field deployed without a host computer, exit the GUI first and then power off the KSC-2.

## 3.4.2 Edit

### System Configuration

The KSC-2 System Configuration panel, shown in Figure 29, is where you add or remove devices from the system or change their order. To open the panel, select Edit, System Configuration. This panel lists unused devices on the left and active devices on the right.



**Figure 29** KSC-2 System Configuration Panel

- To activate a device, select it in the Unused Devices list and click Add. The device moves to the Active Devices list.
- To deactivate a device, select it in the Active Devices list and click Remove. The device moves to the Unused Devices list.
- To change the order of the devices in the Active Devices list, select the device you want to move. Use the right-hand up and down arrows to move the device to its new position.
- If you do not see a connected KSC-2 unit in the System Configuration panel, click the Refresh button. The program searches for and displays all connected KSC-2 units.

When you have finished editing the system configuration, click OK to apply your changes and close the panel.

## Compensation Filters

The KSC-2's optional, patent-pending REZCOMP transducer resonance compensation can extend the usable bandwidth of resonant sensors to as much as 80% of the sensor resonant frequency (or in some cases, beyond the sensor resonant frequency).

If your KSC-2 is equipped with REZCOMP option C3, select Edit, Compensation Filters to open the Compensation Filter Setup panel (Figure 30) to get information about, program, and configure the compensation filters.



Figure 30 Compensation Filter Setup Panel

The Compensation Filter Setup panel contains these fields:

- **Dev:Chan**

The Dev:Chan column shows each device number and channel number. 1:1 is device 1, channel 1; 1:2 is device 1, channel 2; 2:1 is device 2, channel 1; and so on.

- **Serial Number**

This column displays the serial number of each connected device.

- **Channel Name**

This column shows the name of each channel.

- **Compensator Model**

This column displays C3, the model name of the detected compensation filter.

- **Resonant Frequency**

Resonant frequency depends on the sensor being used. Enter the desired resonant frequency here.

Resonant compensation frequencies are programmable as shown in Table 4.

Table 4 Compensation Frequencies	
Low Range	10 Hz to 2.55 kHz in 10 Hz steps
Mid Range	2.6 kHz to 51 kHz in 200 Hz steps
High Range	52 kHz to 255 kHz in 1 kHz steps

- **Quality Factor**

The compensation quality factor (Q) is programmable from 1 to 20 in 0.1 steps, and from 20 to 50 in 0.5 steps. For low-, mid-, and high-range frequency response accuracy for different quality factors, see Section 1.4.4, “Optional KSC-2 Transducer Compensator (C3) Characteristics.”

- **Sensor Model**

This field shows the sensor model connected to the channel.

- **Temperature (F)**

This column displays the temperature. The default units are °F.

**Note:** To change the units in the Temperature display, select Tools, Options. In the Options panel’s Units section, click the Temperature Scale drop-down arrow and select Fahrenheit or Celsius.



### 3.4.3 View

#### Device

Selecting View, Devices opens the Device View panel (Figure 31), which gives information about the KSC-2 units connected to the Control GUI. For each unit, Device view supplies the following information:

- Serial number
- Firmware version
- Connection status
- Connected for (length of time the device has been connected)
- Bytes transferred
- Bytes received
- Baud rate
- Channel 1 name
- Channel 2 name

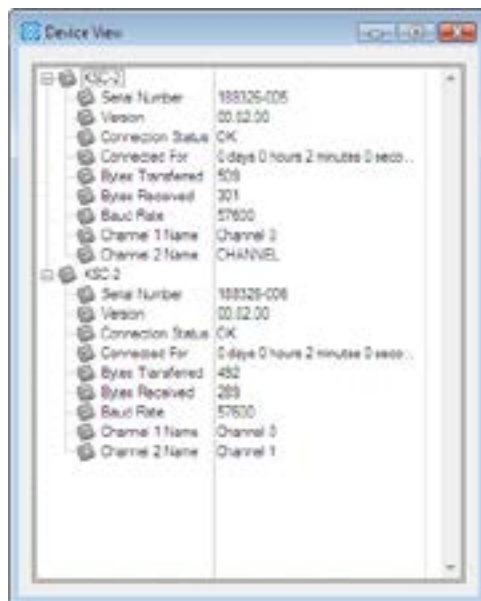


Figure 31 Device View Panel

## 5th-Wire Readings

The Kulite 5th wire transducer was developed to allow customers to obtain data about the bridge temperature of the pressure transducer in order to compensate the sensor for thermal errors. Using this temperature signal correctly can result in a very accurate pressure measurement—even over a wide temperature range.

The Kulite 5th wire voltage is proportional to the temperature of the silicon die. The output is approximately 5 V at room temperature and increases by 2 mV/°F nominal. Refer to Kulite application note *Kulite 5th Wire Combination Pressure and Temperature Transducers* for more details.

To open the 5th Wire Readings panel (Figure 32), select View, 5th Wire Readings. Here you can see each channel's voltage reading on the transducer's fifth wire in volts.



Dev Chan	Serial Number	Channel Name	Reading
11	188326 006	TEST	5.0000
12	188326 006	544	0.0000

Figure 32 5th Wire Readings Panel

### 3.4.4 Tools

#### Commands

Select Tools, Commands and choose an option from the flyout menu to execute one of the following commands:

- **Balance All**

The autobalance function measures any bridge imbalance inherent in the bridge and provides appropriate compensation to the circuit. This command initiates an autobalance cycle on the bridge sensor for all channels.

- **Clear All Overloads**

This command clears the both the input and the output overload detectors for all channels.

- **Save All**

This command saves all channels' configurations to the device's nonvolatile memory so that settings can be retained through power cycle or for field deployment without an attached control computer.

- **Calibrate All Offsets**

The auto offset procedure assures DC accuracy of the amplifier/filter channel by eliminating all sources of internal error throughout the channel circuit. This command initiates an offset correction routine for all channels. When you select Tools, Commands, Calibrate All Offsets, a Confirm panel appears, warning you that offset adjustment can take some time and asking whether you want to proceed. Click Yes to perform the offset adjustment.

**Note:** Offsets drift with temperature. Ensure the system is warmed up for at least 30 minutes before running the routine.

- **Reset All to Default Values**

This command changes all settings for the selected channel back to their original, factory-set values, as follows:

- Excitation Type: Bipolar
- Excitation Value: 0
- Balance Voltage: 0
- Coupling: DC
- Pregain: 1
- Postgain: 1
- Sense: Remote
- Shield: GND
- Input Mode: Operate
- Compensation Filter: Off
- Compensation Filter Cutoff: 10 KHz
- Compensation Quality Factor: 1
- Filter Cutoff: 10 KHz
- Filter: None
- Output Overload Limit: 10
- Overload Mode: Continuous

## Options

When you select Tools, Options, the Options panel (Figure 33) offers the following selections:

- **Configuration**

This section of the Options panel gives you two choices:

- Whether to load the last used configuration when the GUI starts
- Whether to automatically save the current system configuration when you close the program

- **Hardware Control**

This section of the panel contains four options:

- Tell the system to always check devices for their settings, which is helpful after field tests to see whether those settings have changed
- Lock local operation when the program connects, disabling the front-panel autobalance and overload reset buttons
- Set the baud rate to 9600, 19200, or 57600 (the default)

- **Set the status update rate in steps of 0.25 second (the default rate is 1.00)  
Units**

In this section of the Options panel, select Fahrenheit or Celsius as the system's temperature scale.

After you've made your selections, click OK to apply them and exit the Options panel.



Figure 33 Options Panel

### **Re-sync Device Communications**

When a device becomes out of sync with the Control GUI, the control's background turns yellow. To get the device and the software back in sync, select Tools, Re-sync Device Communications.

### **3.4.5 Help**

#### **About**

Select Help, About to view the version number of the installed software.

## 3.5 KSC-2 Settings

### 3.5.1 Device:Channel

The Dev:Chan column shows the device number and channel number. 1:1 is device 1, channel 1; 1:2 is device 1, channel 2; 2:1 is device 2, channel 1; and so on.

### 3.5.2 Serial Number

This column displays the serial number of each KSC-2 unit.

### 3.5.3 Channel Name

This column shows the name of each channel. To give a channel a unique name, click in this field and type the name you want to assign.

### 3.5.4 Excitation Fault

If there is an excitation fault in one or more channels, this field turns red. The EXC LED on the unit's front panel also turns red for the affected channel. The field and the LED remain red until the excitation fault is corrected.

### 3.5.5 Excitation Value (V)

This column shows the constant voltage excitation value, in volts, for each channel. In bipolar mode, excitation value is programmable from 0 to 12.5 V in 1.25 mV steps. To program the excitation value, click inside the field and type the desired value.

### 3.5.6 Excitation Type

The KSC-2 supports both bipolar and unipolar excitation modes. (See Section 1.3.1 for more information about these modes.)

This column displays each channel's excitation type. To change the excitation type, click the drop-down arrow and select Bipolar or Unipolar.

**Note:** In unipolar excitation mode, up to 5 V of zero suppress is available. Zero suppress allows the use of more gain to emphasize small gage fluctuations and provides an accurate means to balance a full bridge.

### 3.5.7 Sense

This column shows whether a channel's sense is local or remote. To change the Sense setting, click a field's drop-down arrow and choose Local or Remote.

**Note:** Sense lines are relevant only to bipolar excitation. Do not use sense lines with unipolar excitation. In unipolar mode, sense is automatically set to local.

### 3.5.8 Balance Voltage (mV)

This column displays the bridge balance voltage in mV. To set the bridge balance voltage, click in this field and type the desired number of millivolts.

### 3.5.9 Autobalance

Channels can be autobalanced when the system is in bipolar excitation mode. Click the Balance button in this column to automatically balance the bridge DC output using voltage insertion at the amplifier input.

During an autobalance operation, the front-panel LED for the channel being balanced is yellow. When the operation completes successfully, the LED turns green. If the autobalance is unsuccessful, the LED turns red.

**Note:** An alternative method to initiate an autobalance is to press the front-panel Auto Balance button to the right of the LED Auto Balance indicator on the channel(s) you want to balance. If you press more than one Auto Balance button, the channels balance one at a time in the order in which you pressed the buttons.

**Note:** To autobalance all channels, go to the GUI's menu bar and select Tools, Commands, Balance All.

**Note:** Autobalance is disabled when the KSC-2 unit is AC coupled.

### 3.5.10 Coupling

This column shows each channel's input coupling as either DC or AC. To change the input coupling, click the drop-down arrow and select AC or DC.

**Note:** AC coupling is useful for dynamic applications where the DC bias on the transducer, which can limit dynamic range, can be coupled out of the signal.

### 3.5.11 Shield

This column shows the channel's shield configuration. The shield can be set to ground at the conditioner, open (floating) at the conditioner, or driven by the common mode signal on the channel.

- If Shield is set to Ground, the shield line must not be grounded at the gage.
- If Shield is set to Float, the shield line should be grounded at the gage.
- If Shield is set to Drive, the shield line should not be grounded at the gage.

To change the shield configuration, click the drop-down arrow and choose Ground, Float, or Drive.

### 3.5.12 Input Mode

The KSC-2 amplifier stage input is software configurable to facilitate *in situ* calibration or diagnostics. Three input modes are available:

- OPERATE is the normal operating mode. It connects the sensor signal input pins to the amplifier input.
- SHORT mode disconnects the sensor and internally shorts the amplifier inputs to signal ground. This is a useful diagnostic test mode to measure and document the DC offset and noise contribution of the KSC-2 internal circuitry.

**Note:** Any DC voltage injected to execute an automatic or manual bridge balance is temporarily removed while in SHORT mode.

- CAL mode disconnects the sensor input and internally connects the KSC-2 amplifier to the CAL INPUT on the KSC-2 front panel. CAL mode is a useful feature to accurately measure the AC or DC gain of the KSC-2 amplifier.

**Note:** The signal on the KSC-2 CAL input can be distorted if the prefilter gain stage is driven into heavy saturation by the test signal. This could corrupt a calibration reading on a second channel connected to the same CAL signal. To prevent false calibrations, the KSC-2 GUI allows multiple channels to be in CAL mode only if all channels have the same prefilter gain setting. To further safeguard against false calibrations, the KSC-2 GUI does not allow changes to prefilter gain while in CAL input mode.

Choose the mode you want from the drop-down list in this field.

### 3.5.13 Overload Mode

The KSC-2 has two overload modes: latching and continuous. In Latching mode, the overload detector holds an overload condition until reset by the operator. In Continuous mode, the overload indicator LED lights only while an overload condition is present in the channel. Overload latching does not latch the amplifier output. That is, latching does not change the output of the amplifier; it simply notes a condition, which may be temporary.

To change the Overload mode for a channel, click a field's drop-down arrow and select Latching or Continuous.

### 3.5.14 Pregain

This column displays each channel's prefilter gain. You can program prefilter gain from  $\times 1$  to  $\times 128$  in  $\times 2$  steps. To change a channel's prefilter gain, click the field's drop-down arrow and choose the desired gain.



### 3.5.15 Filter Type

This column shows each channel's filter type:

- None: To bypass the filter completely
- Pulse: For time-domain measurements
- Flat: For frequency-domain measurements

Click a field's drop-down arrow to choose a filter type. Section 1.3.5 explains more about flat vs. pulse mode.

### 3.5.16 Filter Cutoff (Hz)

This column shows the filter's cutoff frequency in Hz, with a range from 500 Hz to 127,500 Hz in 500 Hz steps. To configure the filter cutoff frequency, click in a field and type the desired frequency.

### 3.5.17 Resonance Compensation

The KSC-2's optional REZCOMP transducer resonance compensation technology extends the usable frequency of sensors with recess mounting, device packaging, or seismic resonances. This column shows whether resonance compensation is enabled or disabled. Click the button to toggle resonance compensation on or off.

**Note:** REZCOMP is available only for KSC-2 units with the C3 option.

### 3.5.18 Postgain

This column shows each channel's vernier postfilter gain value. Postfilter gain ranges from  $\times 1/16$  to  $\times 16$ . To configure a channel's postfilter gain, click in this field and type the desired value.

### 3.5.19 Output Overload (V)

This column shows the output overload detector level in volts. You can set this level between 0.1 V and 10 V, in 0.1 V steps. To change the output overload detector level for a channel, click in this field and type the desired voltage.

### 3.5.20 Overloads

If an overload condition is detected in a channel's input or output, an LED indicator for the affected channel glows red on the front panel of the KSC-2 unit. If the unit is in Latching mode, reset the indicator by clicking the Clear button in the Overloads column of the GUI or pressing the channel's front-panel RESET button. See Section 3.5.13 for information about Latching and Continuous modes.

**Note:** To clear multiple overloads simultaneously while in Latching mode, select Tools, Commands, Clear All Overloads from the menu bar.

### 3.5.21 Settings

To save a channel's current configuration to the KSC-2 unit's nonvolatile memory, click the Save button in this column for the desired channel(s).

## 4 KSC-2 High-Level Command Set

### 4.1 Introduction

This section describes the high-level command set for the KSC-2 signal conditioner. The format of the commands is a channel number and colon followed by the command to be executed. Each command returns the actual setting of the hardware. An unrecognized command returns **UNKNOWN COMMAND**.

### 4.2 Communication Configuration

The KSC-2 system operates as a single-connection server. Only one client can exercise control of the system at any point. The active connection precludes any other. This is done to protect the system from multiple origin control.

Open a terminal emulator communication program, such as Tera Term Pro, that can support terminal operations. Tera Term Pro is a free software terminal emulator (communication program) for MS Windows. It supports Telnet connection, serial port connection, and VT100 emulation.

The terminal emulator program will provide a panel similar to the one shown in Figure 34. Select Serial and then, from the drop-down list, choose the COM port for your USB serial port. Click OK.



Figure 34 Tera Term New Connection Panel

**Note:** You can find the COM port for your USB serial port using Windows Device Manager. Click the Start button and then select Control Panel, System, Device Manager.

The terminal emulator program provides a terminal setup panel (in Tera Term select Setup, Terminal) similar to the one shown in Figure 35. Choose CR+LF from the Transmit drop-down menu. Select Local Echo to have commands reflected on the control display.



Figure 35 Tera Term Terminal Setup

**Note:** If you're having trouble connecting to the terminal emulator, check the baud rate. (In Tera Term, select Setup, Serial port and click the Baud rate drop-down list.) This rate should be 57600.

### 4.3 Command Format

Commands to the KSC-2 system are sequences of ASCII characters. Each command consists of a channel number followed by a colon, a keyword, and optional parameters. To process the command, press the Enter key.

The ASCII codes for delete and other process type codes are ignored.

Commands are not case sensitive: Commands and operators may be entered with mixed upper- and lower-case alphabetic characters.

Numeric command values are automatically rounded to the nearest correct setting.

Commands are followed by a response, which reports the system response to the command and verifies that the command was processed.

The command specifications in this manual use specific symbols to define the command syntax and semantics. The symbol "... " is the "and so on" or range operator, and the symbol "|" is the logical OR operator.

The format of a command is a channel number followed by a colon and the command to be executed. For example, the command below sets the excitation value of channel 1 to 10 V:

**1:EXC=10**

A command that is not recognized by the system returns **UNKNOWN COMMAND**.

### **4.3.1 Command to Return Current Value**

A command immediately followed by a question mark (?) returns the current value for the specified channel and setting. For example, the command below returns the current voltage excitation value for channel 1:

**1:EXC?**

## **4.4 Command Set**

### **4.4.1 Excitation Commands**

The **EXC** command, shown below, sets the constant voltage excitation for the desired channel. Levels are specified in volts. The system returns the hardware coerced value.

**CHAN:EXC=0, 0.00125, 0.0025, ..., 12.5**

The following command returns the current voltage excitation value for the specified channel:

**CHAN:EXC?**

To configure a channel's excitation to operate in bipolar or unipolar mode, use the **EXCTYPE** command:

**CHAN:EXCTYPE=BIPOLAR | UNIPOLAR**

The following command returns the excitation mode (bipolar or unipolar) to which a channel is currently set:

**CHAN: EXCTYPE?**

The **SENSE** command sets the excitation supply to use either local or remote sense:

**CHAN:SENSE=LOCAL | REMOTE**

The following command returns a channel's current sense setting:

**CHAN:SENSE?**

**Note:** Sense lines are relevant only to bipolar excitation. Do not use sense lines with unipolar excitation. In unipolar mode, sense is automatically set to local.

To check for an excitation fault in a channel, use the **EXCFAULT** command:

**CHAN:EXCFAULT?**

This command returns **1** if the excitation supply is in a fault condition, **0** if not.

#### 4.4.2 Input Commands

To set the specified channel's input coupling as either DC or AC, use the **COUPLING** command as shown below:

**CHAN:COUPLING=DC | AC**

The following command returns the value to which input coupling is currently set:

**CHAN:COUPLING?**

The **SHIELD** command lets you configure the specified channel's shield. The shield can be set to ground at the conditioner, open (floating) at the conditioner, or driven by the common mode signal on the channel.

- If **SHIELD** is set to "ground", the shield line should not be grounded at the gage.
- If **SHIELD** is set to "float", the line should be grounded at the gage end.
- If **SHIELD** is set to "drive", do not connect the shield line to ground at the gage.

**CHAN:SHIELD=GROUND | FLOAT | DRIVE**

The following command returns the shield's current setting:

**CHAN:SHIELD?**

Use the **PREGAIN** command to configure the channel's prefilter gain to a fixed step:

**CHAN:PREGAIN=1 | 2 | 4 | 8 | 16 | 32 | 64 | 128**

The following command returns the current prefilter gain value for the channel:

**CHAN:PREGAIN?**

To set the channel to operate in one of three prescribed modes (operate, short, or calibrate), use the **MODE** setting:

- **OPERATE** is the normal operating mode.
- **SHORT** grounds the amplifier input stage to measure noise and DC offset.
- **CAL** disconnects the signal from the input connector and injects the signal on the CAL INPUT BNC at the amplifier input.

**CHAN:MODE=OPERATE | SHORT | CAL**

The following command returns the current **MODE** setting:

**CHAN:MODE?**

#### 4.4.3 Filter Commands

The **FILTER** command sets the channel's filter type to either flat mode (for frequency-domain measurements) or pulse mode (for time-domain measurements). A setting of **NONE** bypasses the filter completely.

**CHAN:FILTER=FLAT | PULSE | NONE**

The following command returns the channel's **FILTER** setting:

**CHAN:FILTER?**

To configure the 6-pole LP filter's cutoff frequency from 500 Hz to 127.5 KHz in 500 Hz steps, use the **FC** command. The system returns the hardware coerced value.

**CHAN:FC=500 | 1000 | ... | 127500**

The following command returns the current filter cutoff frequency value:

**CHAN:FC?**

The **COMPFLT** command enables or disables the cavity compensation filter for the specified channel. Use **ON** to enable the filter or **OFF** to disable it:

**CHAN:COMPFLT=ON | OFF**

The following command tells you whether the cavity compensation filter is currently on or off:

**CHAN:COMPFLT?**

You can set the cavity compensation filter's center frequency from 10 Hz to 2.55 kHz in 10 Hz steps, from 2.6 kHz to 51 kHz in 200 Hz steps, and from 52 kHz to 255 kHz in 1 kHz steps with the **COMPFLTFC** command. The system returns the hardware coerced value.

**CHAN:COMPFLTFC=10 | 20 | ... | 255000**

The following command returns the current center frequency of the cavity compensation filter:

**CHAN:COMPFLTFC?**

The **COMPFLTQ** command sets the cavity compensation filter's quality factor from 1 to 20 in 0.1 steps and from 20 to 50 in 0.5 steps. The system returns the hardware coerced value.

**CHAN:COMPFLTQ=1 | 1.1 | ... | 50**

The following command returns the current value for the cavity compensation filter's quality factor:

**CHAN:COMPFLTQ?**

#### 4.4.4 Output Commands

To configure the specified channel's vernier postfilter gain to a supplied value, use the **POSTGAIN** command. The system returns the hardware coerced value.

**CHAN:POSTGAIN=0.0625 | ... | 16**

The following command returns the current vernier postfilter gain value for a channel:

**CHAN:POSTGAIN?**

#### 4.4.5 Offset Commands

The auto offset procedure assures DC accuracy of the amplifier/filter channel by eliminating all sources of internal error throughout the channel circuit.

Offsets drift with temperature. Ensure the system is warmed up before you run the



routine.

Use the **OFFSETADJ** command to initiate an offset correction routine for the specified channel. This command returns **PASSED** if all of the offsets were adjusted correctly and **FAILED** otherwise.

**CHAN:OFFSETADJ**

#### 4.4.6 Overload Detector Commands

Overload detectors alert the user to overvoltage conditions. To learn the status of the input overload detector, use the following command:

**CHAN:INOVLD?**

The system returns **1** if an overload condition exists and **0** if not.

The **OUTOVLDLIM** command sets the output overload detector level from 0.1 V to 10 V in 0.1 V steps. The system returns the hardware coerced value.

**CHAN:OUTOVLDLIM=0.1 | 0.2 | ... | 10**

The following command returns the output overload detector's current level:

**CHAN:OUTOVLDLIM?**

The following command returns the status of the output overload detector: **1** if the channel is overloaded and **0** otherwise.

**CHAN:OUTOVLD?**

In latching mode, the overload detector holds an overload condition until it is reset by the user. In continuous mode, the system autoresets after an overload condition. The **OVLDMODE** command turns latching mode on or off for the specified channel's input and output overload detectors:

**CHAN:OVLDMODE=LATCHING | CONTINUOUS**

The following command tells you whether or not a channel is in latching mode:

**CHAN:OVLDMODE?**

The **OVLDCLEAR** command clears the both the input and the output overload detectors for the specified channel:

**CHAN:OVLDCLEAR**

#### **4.4.7 Bridge Commands**

The autobalance function measures any bridge imbalance inherent in the bridge and provides appropriate compensation to the circuit.

To initiate an autobalance cycle on the bridge sensor, use the **AUTOBAL** command. The system returns **PASSED** if the balance was successful and **FAILED** otherwise. It may take several minutes for the autobalance to complete.

**CHAN:AUTOBAL**

**Note:** The KSC-2 unit's front-panel Autobalance LED indicators respond to the **AUTOBAL** command: yellow while the balance operation is in progress, green if the balance was successful, and red if the balance operation failed.

**Note:** Autobalance is disabled when the KSC-2 unit is AC coupled.

The **AUTOBALSTAT?** command returns the status of the bridge balance for the channel. The system returns **BALANCED** (if the bridge is balanced), **UNBALANCED** (if the bridge is unbalanced), or **INVALID** (if the state of the bridge balance is unknown):

**CHAN:AUTOBALSTAT?**

To set the balance level as a ratio of bridge offset to excitation in mV/V, use the **BALRATIO** command. The system returns the hardware coerced value.

**CHAN:BALRATIO=X**

The following command returns the balance level in terms of a ratio of bridge offset to excitation in mV/V:

**CHAN:BALRATIO?**

**BALVOLT** sets the bridge balance voltage in mV. The system returns the hardware coerced value.

**CHAN:BALVOLT=X**

The following command returns the current balance voltage in mV:

**CHAN:BALVOLT?**

To see the voltage read on the fifth wire of the transducer in volts, use the following command:

**CHAN:5THWIRE?**

## **Device Control and Information**

The **SAVE** command saves the current device configuration to nonvolatile memory. When the action is complete, the system returns **DONE**.

**SAVE**

**LOCK** locks or unlocks user control of the front panel switches. Individual switches can be specified in the order of channel 2 overload clear, channel 2 autobalance, channel 1 overload clear, channel 1 autobalance. **1** locks the switch, and **0** unlocks it.

**LOCK=XXXX**

For example, the command **LOCK=1100** locks the overload clear and autobalance for channel 2, while leaving these switches unlocked for channel 1.

The following command returns the current locked status of the front panel switches:

**LOCK?**

To see the device's serial number (in the format XXXXXX-XXX), use the **SN** command:

**SN?**

The **VER** command returns the device's firmware version number (in the format XX.XX.XX):

**VER?**

The **IDN** command returns the model (KSC-2) associated with the device:

**IDN?**

**STATUS?** returns the status of the overload and excitation fault monitors for both channels of the device.

**STATUS?**

The following table shows the meaning of each number that may be returned by the system in response to the **STATUS** command.

<b>System Response</b>	<b>Ch. 2 Excitation</b>	<b>Ch. 2 Output Overload</b>	<b>Ch. 2 Input Overload</b>	<b>Ch. 1 Excitation</b>	<b>Ch. 1 Output Overload</b>	<b>Ch. 1 Input Overload</b>
0	N	N	N	N	N	N
1	N	N	N	N	N	Y
2	N	N	N	N	Y	N
3	N	N	N	N	Y	Y
4	N	N	N	Y	N	N
5	N	N	N	Y	N	Y
6	N	N	N	Y	Y	N
7	N	N	N	Y	Y	Y
8	N	N	Y	N	N	N
9	N	N	Y	N	N	Y
10	N	N	Y	N	Y	N
11	N	N	Y	N	Y	Y
12	N	N	Y	Y	N	N
13	N	N	Y	Y	N	Y
14	N	N	Y	Y	Y	N
15	N	N	Y	Y	Y	Y
16	N	Y	N	N	N	N
17	N	Y	N	N	N	Y
18	N	Y	N	N	Y	N
19	N	Y	N	N	Y	Y
20	N	Y	N	Y	N	N
21	N	Y	N	Y	N	Y
22	N	Y	N	Y	Y	N
23	N	Y	N	Y	Y	Y
24	N	Y	Y	N	N	N
25	N	Y	Y	N	N	Y
26	N	Y	Y	N	Y	N
27	N	Y	Y	N	Y	Y
28	N	Y	Y	Y	N	N
29	N	Y	Y	Y	N	Y
30	N	Y	Y	Y	Y	N
31	N	Y	Y	Y	Y	Y
32	Y	N	N	N	N	N
33	Y	N	N	N	N	Y
34	Y	N	N	N	Y	N

Y = yes (a fault/overload condition exists); N = no (no fault/overload condition detected).

System Response	Ch. 2 Excitation	Ch. 2 Output Overload	Ch. 2 Input Overload	Ch. 1 Excitation	Ch. 1 Output Overload	Ch. 1 Input Overload
35	Y	N	N	N	Y	Y
36	Y	N	N	Y	N	N
37	Y	N	N	Y	N	Y
38	Y	N	N	Y	Y	N
39	Y	N	N	Y	Y	Y
40	Y	N	Y	N	N	N
41	Y	N	Y	N	N	Y
42	Y	N	Y	N	Y	N
43	Y	N	Y	N	Y	Y
44	Y	N	Y	Y	N	N
45	Y	N	Y	Y	N	Y
46	Y	N	Y	Y	Y	N
47	Y	N	Y	Y	Y	Y
48	Y	Y	N	N	N	N
49	Y	Y	N	N	N	Y
50	Y	Y	N	N	Y	N
51	Y	Y	N	N	Y	Y
52	Y	Y	N	Y	N	N
53	Y	Y	N	Y	N	Y
54	Y	Y	N	Y	Y	N
55	Y	Y	N	Y	Y	Y
56	Y	Y	Y	N	N	N
57	Y	Y	Y	N	N	Y
58	Y	Y	Y	N	Y	N
59	Y	Y	Y	N	Y	Y
60	Y	Y	Y	Y	N	N
61	Y	Y	Y	Y	N	Y
62	Y	Y	Y	Y	Y	N
63	Y	Y	Y	Y	Y	Y

Y = yes (a fault/overload condition exists); N = no (no fault/overload condition detected).

The **BLINKLEDS** command, which is useful for identifying individual devices, causes all of the front-panel LEDs to blink three times. This command returns **DONE** when the action is complete:

**BLINKLEDS**

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## 5 KSC-2 Troubleshooting

### 5.1 Introduction

This section contains troubleshooting tips for issues commonly encountered when using a KSC-2 unit.

### 5.2 KSC-2 Does Not Turn On

When power is applied to a KSC-2 unit, the POWER indicator light turns green. If the unit does not turn on when you move the Power switch to the On (I) position, check to make sure that the power cable is:

- Connected to the POWER IN connector on the left side of the unit's rear panel
- Plugged into an electrical outlet

### 5.3 KSC-2 GUI Does Not Recognize the System

If the installed KSC-2 Control GUI software does not recognize the system, use this checklist:

- Ensure that the power cable is connected and the unit is turned on.
- Check that the USB cable connects the unit to the host computer.
- Ensure that no terminal emulator program (such as Tera Term) is already running and connected to the KSC-2 unit.
- Open Windows Device Manger to make sure the KSC-2 software is installed. To open Device Manager, click the Start button and select Control Panel, System, Device Manager.
- Make sure the device driver for the KSC-2 unit is installed. Look for it in the Windows Device Manager (Start, Control Panel, System, Device Manager). If the driver does not appear in Device Manager, try the following:
  - Run the installation program on the KSC-2 Signal Conditioner Software Distribution CD that came with your unit (see Section 4.2.2).
  - Restart your computer.
  - Disconnect the USB cable from your computer and then plug it into a different USB port. Windows will detect the device and install its driver. If the driver fails to install properly, Windows shows a notification panel.

- Check your computer's COM port settings. Open Device Manager (Start, Control Panel, System, Device Manager). In the Device Manager list, click the arrow to the left of Ports to expand that section. Right-click the COM port you want and select Properties. In the Properties panel (Figure 36), click the Port Settings tab. In the Properties panel (Figure 36), click the Port Settings tab.



Figure 36 Device Manager COM Port Properties Panel

Make sure the COM port is configured with the following settings:

- **Bits per second:** 57600
- **Data bits:** 8
- **Parity:** None
- **Stop bits:** 1
- **Flow control:** XON/XOFF

## 5.4 Overload Indicators Are Red

The front panel of the KSC-2 unit has input and output overload indicators for each channel. See Section 2.6.3, *Overload Indicators and Reset Button*, for more information about overload indicators.

## 5.5 KSC-2 Unit LEDs Are Out of Sync with the GUI

If you are in the process of entering data in a GUI field, you may notice that the LEDs on the front panel of the KSC-2 unit do not match those in the GUI. This is a temporary condition that happens while data is being entered in the GUI.

To resync the KSC-2 unit and the GUI, finish data entry and press the Enter key.



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## 6 Support and Service

### 6.1 Technical Support

Kulite provides full technical support from installing a new system to troubleshooting existing set-ups before or during a measurement test.

Technical support is available by phone, E-mail or by fax.

**Technical Support Phone:**

(201) 461-0900

**Customer Service E-Mail:**

KSCsupport@kulite.com

**Fax:**

(201) 461-0990

### 6.2 Service and Repair

If equipment is being returned to Kulite for service or repair, contact the factory for a Return Authorization Number.

To obtain a Return Authorization Number contact Kulite by one of these methods:

**Phone:**

(201) 461-0900

**E-mail:**

KSCsupport@kulite.com

**Fax:**

(201) 461-0990

Include the following information with the equipment:

- Owner's name, company, address and telephone number.
- A detailed description of the service or repair.
- The instrument model and serial numbers.
- The Return Authorization Number issued by Kulite clearly marked on the outside of the shipping container.

Equipment should be shipped in the best available packing materials. Factory packaging is available. Contact Kulite for more information.

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