KSC-2 HIGH PERFORMANCE SIGNAL CONDITIONER FOR KULITE SENSOR PRODUCTS

KULITE KSC-2 FEATURES

- Two channels per system
- 0.1% overall DC accuracy
- 6-pole low-pass filters with programmable flat/pulse characteristics
- Cutoff frequencies programmable from 500 Hz to 127.5 kHz
- Patent pending REZCOMP® transducer resonance compensation to extend useable bandwidth of resonant sensors (Option C3)
- Precise digital calibration of gain, excitation and DC offset
- Bipolar Constant Voltage Excitation with Remote Sense
- Unipolar Excitation Mode to power internally regulated transducers
- Automatic or manual bridge balance/suppress
- Balanced Differential Input
- Programmable AC/DC input coupling
- 7 nV/ $\sqrt{Hz}$ maximum input noise
- Pre-Filter Gain: x1 to x128 in binary steps
- Post-Filter Gain: x1/16 to x16 with 0.025% minimum resolution
- Input and output overload detection with programmable threshold
- Front-panel auto-balance and overload reset with fault LED indicators
- Calibration/Zero Input
- USB control interface with field upgradable firmware
- GUI interface for control of up to 8 KSC-2 units
- Compact stackable chassis design with link kit to lock units together
- Side-by-side rack-mount option

KSC-2 DESCRIPTION

The KSC-2 is a compact, rugged dual-channel high precision amplifier/filter 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 while a unipolar excitation mode is supplied to condition sensors having internal regulation. Automatic or manual balance modes are supported.

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 that 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 that can cause non-linearities due to clipping of the amplifier. Overload detectors alert the user to output overloads as well as pre-filter overloads that may be masked by the low-pass filter.

The KSC-2 features an optional patent pending REZCOMP® transducer resonant compensation technology that extends the useable 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 is available to control the KSC-2 via USB 2.0. A spreadsheet style graphical user interface is supplied to control up to eight KSC-2 units as a single system. Configurations may be saved/recalled from the host computer. Settings may be saved to non-volatile memory for field deployment without a host computer. Front panel LED indicators alert the user to overloads, excitation and autobalance status. In addition, autobalance can be initiated via a momentary front panel switch. 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.

KSC-2 INPUT WIRING

Input Connector:

9-Pin female D-Sub at front panel of card (2 ea.)

Channel Input Wires:

±SIG (2); ±EXC (2); ±SEN (2); SHLD (1); GND; 5th Wire Sensor Temperature Output (1)

KSC-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: ±0.1% of setting ±5 mV

Current: 30 mA, short circuit protected

Noise: 100 µVrms, 3 Hz to 100 kHz

Drift: ±0.0025%/ºC of setting or ±50 µV/ºC

Stability: ±0.005% or ±250 µV for 8 hours

Load Regulation:

±0.03% or ±200 µV, whichever is greater, no load to full load

Sense:

Programmable Local or Remote. Sense boost limited to 3 V above programmed setting.

Auto-Balance (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):

Pre-Filter Gain ≥16: ±32 mV/V with 1 µV/V resolution

Pre-Filter Gain <16: ±512 mV/V with 16 µV/V resolution

KSC-2 CONSTANT VOLTAGE EXCITATION SUPPLY (CONTINUED)

Unipolar Mode:

Level: 14 Vdc ±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.

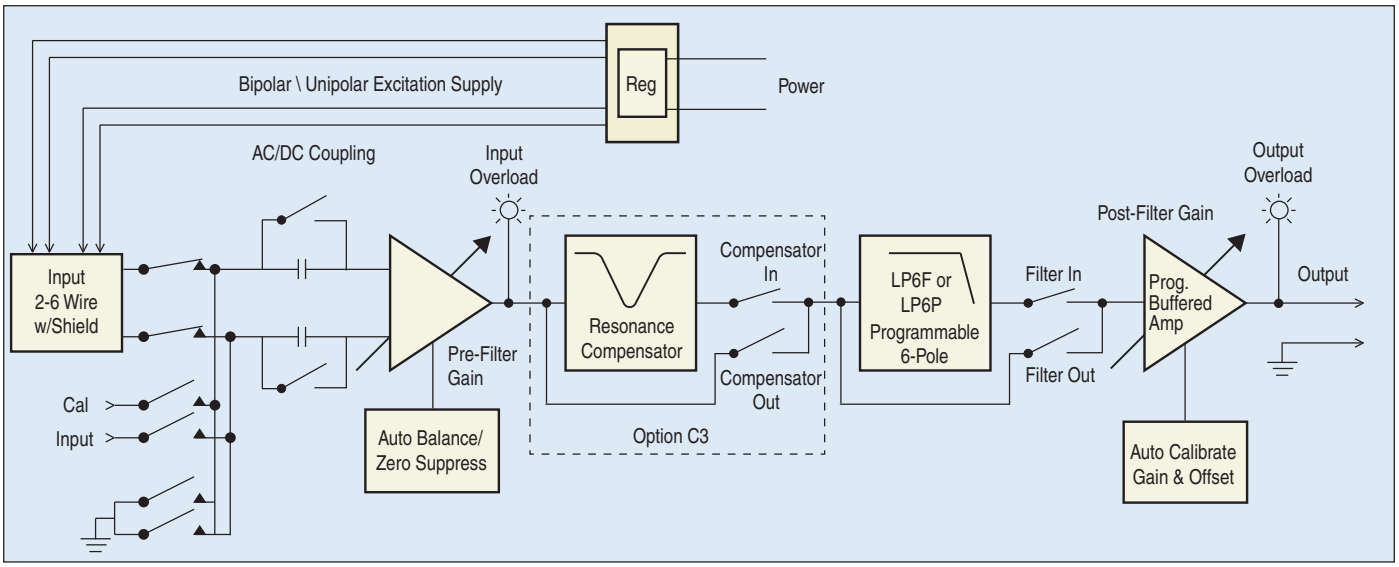
Modes: Automatic or Manual Entry

Range (RTI):

Pre-Filter Gain ≥16: ±320 mV with 10 µV resolution

Pre-Filter Gain <16: ±5.12 V with 160 µV resolution

KSC-2 CHANNEL BLOCK DIAGRAM



KSC-2 INPUT CHARACTERISTICS

Type:

Balanced differential input with programmable AC/DC coupling

Maximum Input Level:

±10 Vpk (common mode and normal mode signals)

Level vs Frequency:

±10 Vpk for f ≤ 127.5 kHz; ±10 Vpk x (127.5 kHz/f) for f >127.5 kHz

Input Impedance: 10 MΩ per side

Drift: 1 µV/°C, RTI

CMRR (input gain >x16): 110 dB, DC to 1000 Hz

Spectral Noise:

7 nV/ $\sqrt{Hz}$ at 1 kHz and pre-filter gain >64

Prog. AC Coupling Freq: 0.25 Hz (3.01 dB), 2-pole

Input Protection: 24 V continuous

KSC-2 AMPLIFIER CHARACTERISTICS

Pre-Filter Gain:

x1 to x128 in x2 steps with overload detection (10 Vpk threshold)

Post-Filter Gain: x1/16 to x16

Post-Filter Gain Resolution:

0.025% min for POG ≥1; 0.025%/POG for POG <1

Output Overload Detector:

Level programmable from 0.1 to 10.2 V in 0.1 V steps

Overall DC Accuracy:

±0.1 % after auto-adjust at any gain setting. Includes filter and compensator.

Temperature Coefficient: ±0.004% / C

DC Linearity:

0.005% re: full scale output, best-fit straight line

Frequency Response:

DC to 127.5 kHz: 0 dB ±0.1 dB; –3 dB typical at 500 kHz

KSC-2 TEST MODES

Amplifier Short:

A switch at the amplifier input is utilized to ground the input stage for measurement of noise and DC offset.

Cal Input:

Switch disconnects signal from input connector and injects signal on Cal Input BNC at the amplifier input.

Operate: Normal operating mode

KSC-2 FILTER CHARACTERISTICS

Type:

Programmable Flat/Pulse Low-Pass 6-pole, 6-zero low-pass filter. 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: ±0.2 dB maximum to 0.8 Fc

Amplitude Match: ±0.2 dB maximum to 0.8 Fc

Phase Match: ±2° maximum to 0.8 Fc

Wideband Mode:

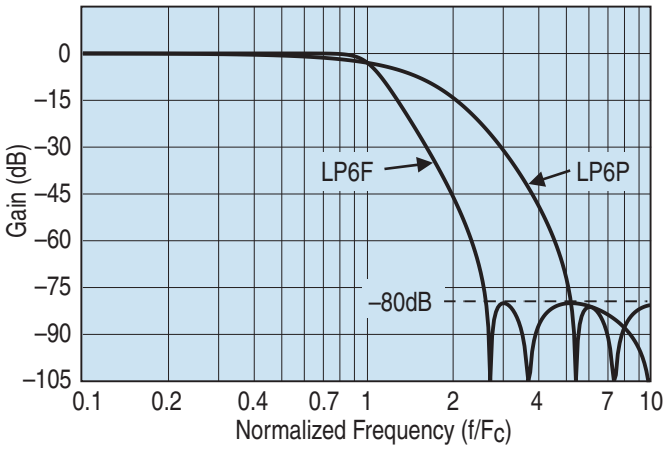
Filter may be removed from the signal path resulting in 3-pole Butterworth wideband amplifier frequency response with nominal –3 dB frequency at 500 kHz.

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 Fc	5.1923 Fc
Cutoff Frequency Phase	–270.0 deg	–140.3 deg
Phase Distortion (DC to Fc)	<60 deg	<1.45 deg
Zero Frequency Group Delay	0.5834/Fc	0.3924/Fc
Percent Overshoot	15.8%	1.1%
1% Settling Time	2.80/Fc	0.84/Fc
0.1 % Settling Time	4.36/Fc	1.02/Fc
–0.1 dB Frequency	0.766 Fc	0.193 Fc
–1 dB Frequency	0.9080 Fc	0.5983 Fc
–2 dB Frequency	0.9624 Fc	0.8293 Fc
–3.01 dB Frequency	1.0000 Fc	1.0000 Fc
–20 dB Frequency	1.3822 Fc	2.3616 Fc
–40 dB Frequency	1.8546 Fc	3.5115 Fc
–60 dB Frequency	2.3206 Fc	4.5462 Fc
–80 dB Frequency	2.6113 Fc	5.1923 Fc

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.

LP6F and LP6P Amplitude Response

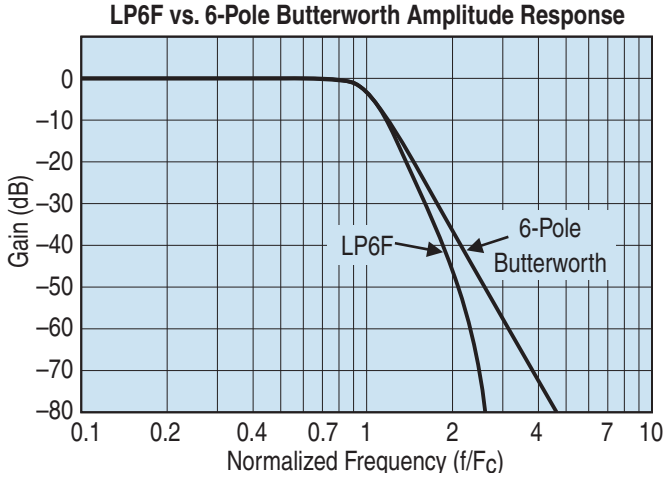


The LP6F and LP6P 6-pole low-pass filters have the versatility to address applications in either the time or frequency domain. Simply program the filter characteristic to match your measurement requirements.

FLAT MODE LOW-PASS FILTERS

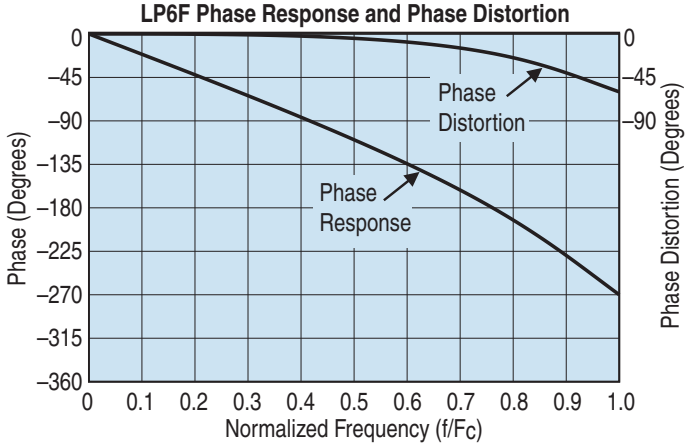
The LP6F FLAT mode characteristic has a pass-band amplitude response nearly identical to the 6-pole Butterworth yet has much sharper roll-off characteristics. This makes the LP6F a good choice for spectral analysis or for anti-aliasing applications.

LP6F vs. 6-Pole Butterworth Amplitude Response



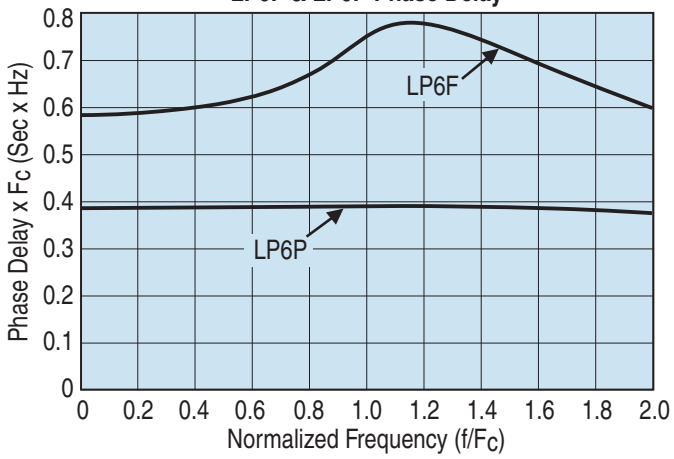
Like the Butterworth low-pass filter, the LP6F has a non-linear phase response with 60 degrees of phase distortion at the cutoff frequency.

LP6F Phase Response and Phase Distortion



The non-linear 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.

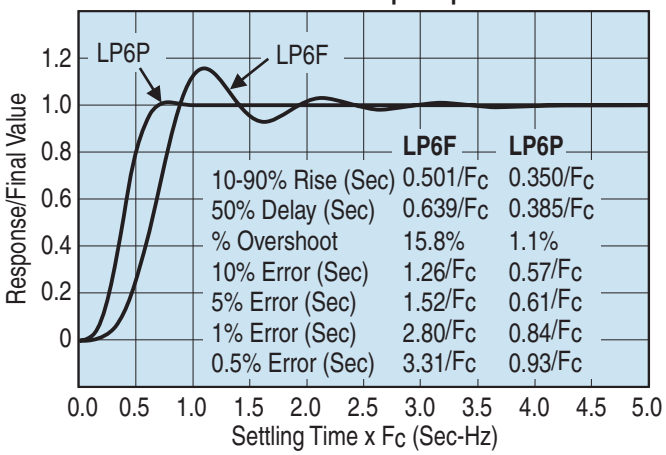
LP6F & LP6P Phase Delay



PULSE MODE LOW-PASS FILTERS

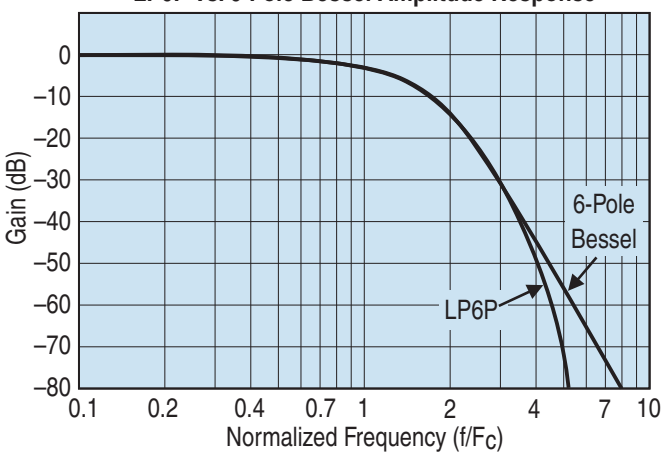
For the time domain, the LP6P PULSE mode low-pass filter has excellent transient response and phase linearity required for time domain applications such as transient (shock) measurements and time domain waveform analysis.

LP6F & LP6P Step Response



When compared to a 6-pole Bessel filter, the LP6P has similar pass-band characteristics yet has much sharper transition slope from pass-band to stop-band.

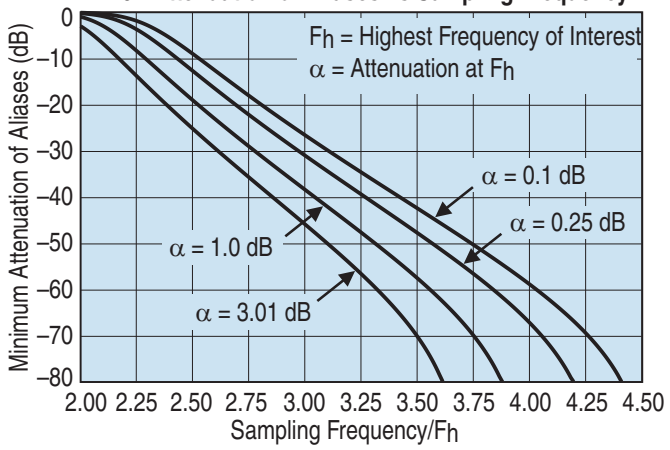
LP6P vs. 6-Pole Bessel Amplitude Response



ANTI-ALIASING APPLICATIONS

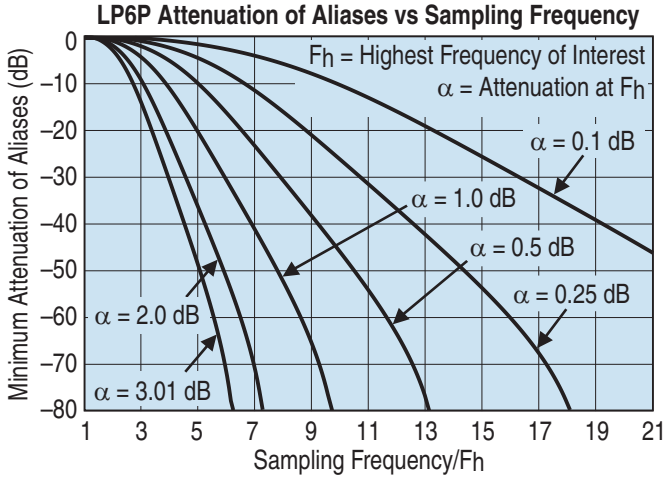
When used for anti-aliasing applications, the LP6F provides more useable bandwidth for a given sampling frequency.

LP6F Attenuation of Aliases vs 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.

LP6P Attenuation of Aliases vs Sampling Frequency



The chart below provides a comparison of attenuation of aliases versus sampling frequency for the LP6P, 6-pole Bessel (BE6), LP6F and the 6-pole Butterworth (BU6). It is clear that much lower sampling frequencies are required for the KSC-2 LP6P and LP6F when compared to traditional filter characteristics.

	Sampling Frequency for –3.01 dB Attenuation @ Fh			
Alias Attn.	**BE6**	**LP6P**	**BU6**	**LP6F**
20	$3.4F_c$	$3.4F_c$	$2.5F_c$	$2.4F_c$
40	$4.6F_c$	$4.5F_c$	$3.2F_c$	$2.9F_c$
60	$6.4F_c$	$5.5F_c$	$4.2F_c$	$3.3F_c$
80	$9.0F_c$	$6.2F_c$	$5.6F_c$	$3.6F_c$

KSC-2 TRANSDUCER COMPENSATOR (OPTION 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:

±0.1 dB DC to 0.8 Fr; 1.25 Fr ≤ f ≤ 10 kHz

Q ≤ 10: ±0.2 dB; 0.8 Fr < f < 1.25 Fr
Q > 10: ±0.02 dB * Q; 0.8 Fr < f < 1.25 Fr

Mid-Range:

±0.15 dB DC to 0.8 Fr; 1.25 Fr ≤ f ≤ 100 kHz

Q ≤ 10: ±0.25 dB; 0.8 Fr < f < 1.25 Fr
Q > 10: ±0.025 dB * Q; 0.8 Fr < f < 1.25 Fr

High-Range:

±0.2 dB; DC to 0.6 Fr;
±0.5 dB; 1.7 Fr ≤ f ≤ 255 kHz

Q ≤ 10: ±1.25 dB; 0.6 Fr < f < 1.7 Fr or 255 kHz whichever is less
Q > 10: ±0.125 dB * Q; 0.6 Fr < f < 1.7 Fr or 255 kHz whichever is less

Phase Match:

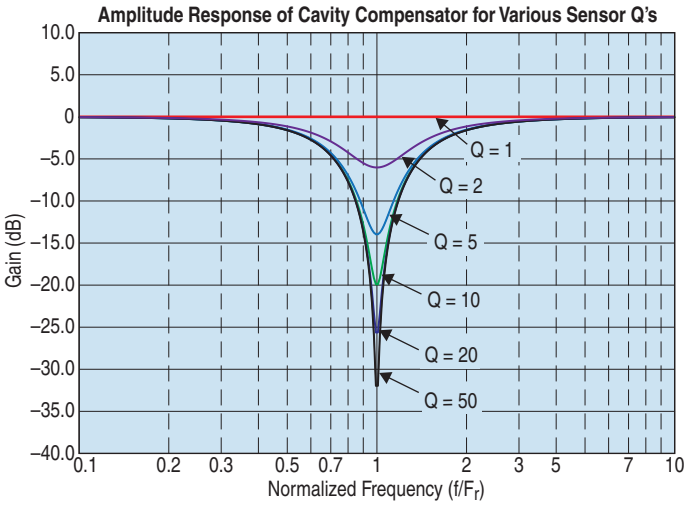
±2°, DC to 0.8 Fr Low and Mid-Ranges;
DC to 0.6 Fr High-Range

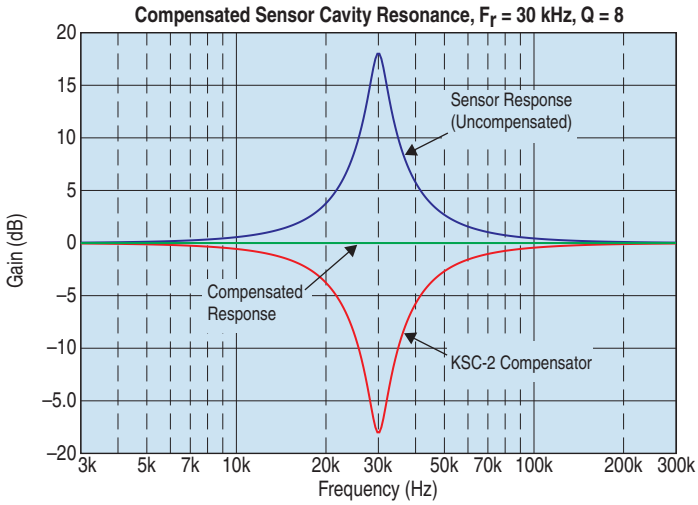
Amplitude Match:

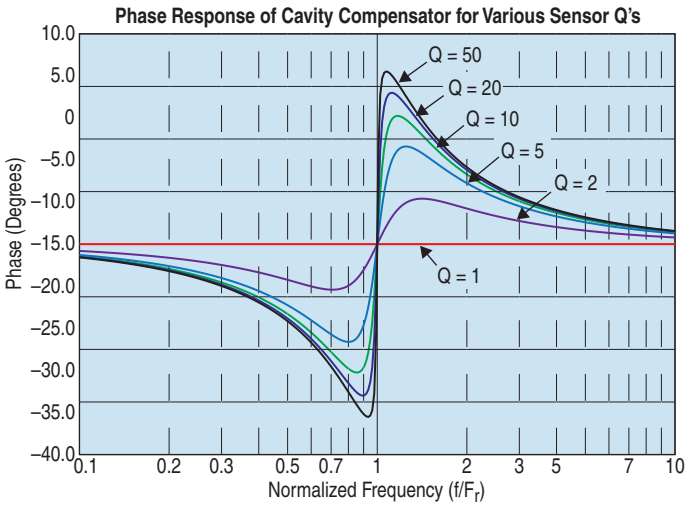
±0.2 dB, DC to 0.8 Fr Low and Mid-Ranges;
DC to 0.6 Fr High-Range

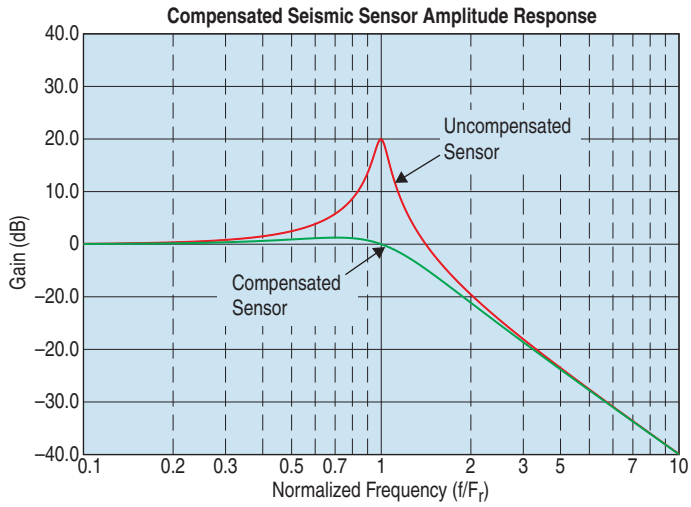
Compensator Off:

Compensator may be removed from the signal path.









KSC-2 OUTPUT CHARACTERISTICS

Type:

DC coupled, single-ended output, short circuit protected

Impedance: 10 Ω

Max Output: ±10 Vpk, ±25 mA pk

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

Offset Drift: 1 µV/°C, RTI + 150 µV /°C RTO, typical

Noise: 2.8 µV rms RTI + 60 µV rms RTO, 3 Hz to 100 kHz

Crosstalk: –80 dB, DC to 100 kHz

KSC-2 CONTROL

REMOTE INTERFACE:

USB 2.0 Type B using high-level command set protocol

NON-VOLATILE MEMORY:

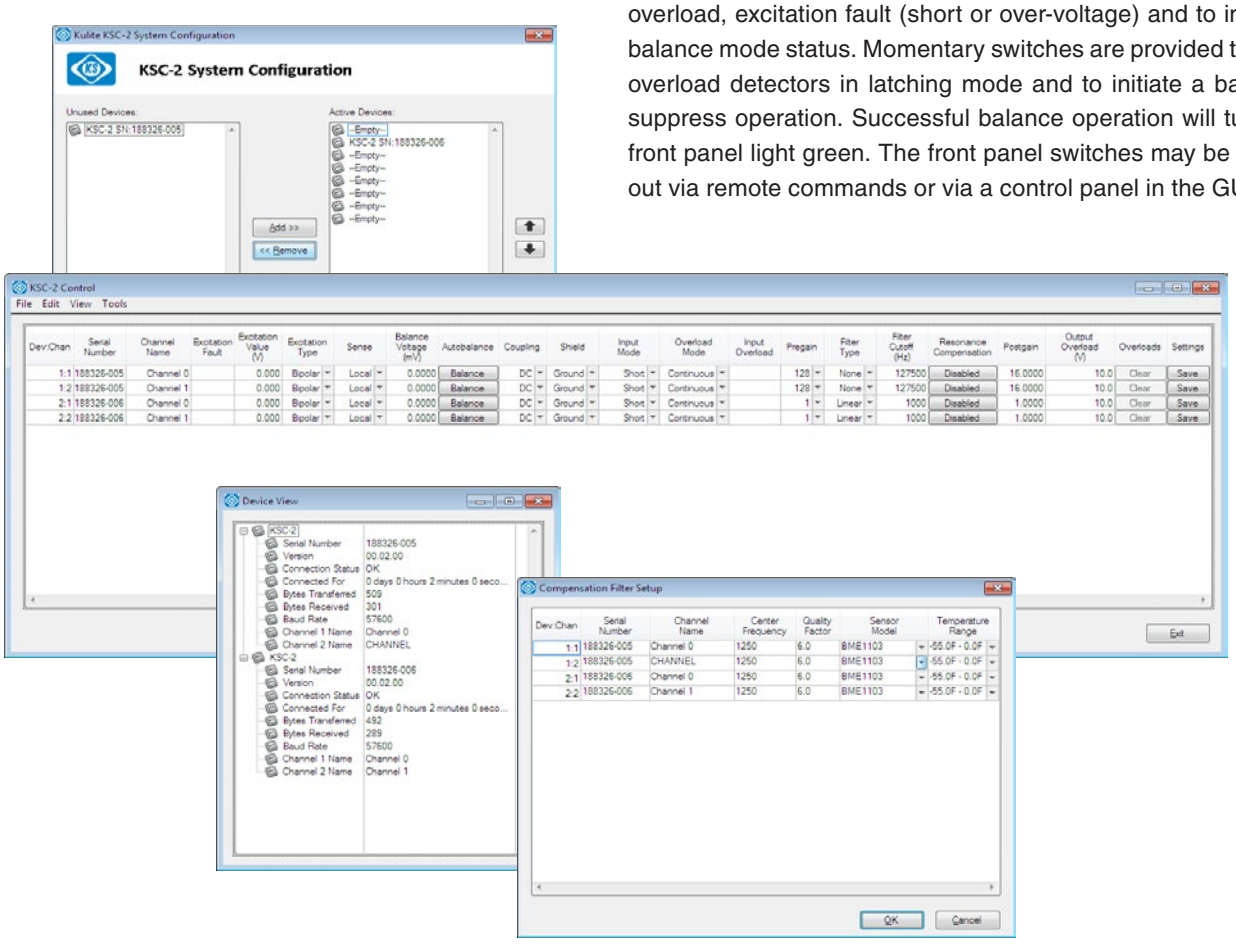
KSC-2 programmed state may be saved to non-volatile memory for retention of settings through power cycle or for field deployment without an attached control computer.

GRAPHICAL USER INTERFACE:

Spreadsheet style software executable on Windows OS provided with each unit. Up to eight KSC-2 units may be controlled as a system via the GUI. Provisions for save/recall of configurations are supported.

FRONT PANEL CONTROLS AND INDICATORS:

LED's are provided for each channel to indicate input or output overload, excitation fault (short or over-voltage) and to indicate balance mode status. Momentary switches are provided to clear overload detectors in latching mode and to initiate a balance/suppress operation. Successful balance operation will turn the front panel light green. The front panel switches may be locked out via remote commands or via a control panel in the GUI.



KSC-2 Signal Conditioner Front View

KSC-2 Signal Conditioner Rear View

KSC-2 GENERAL CHARACTERISTICS

Size: 12.5 x 8.6 x 1.75 inches (LxWxH)

Weight: 3.5 lb. net

Temperature:

0°C to 55°C (operating); –20°C to 85°C (storage)

Humidity:

10 to 90% noncondensing

Input Connectors:

2 ea. 9-pin D-Sub on Front Panel

Output Connectors:

2 ea. 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

ACCESSORIES

KSC-2-LINK Link Kit for Joining Two KSC-2 Units

KSC-2-RM Rack Mount Ear Kit

KSC-2-ACPS

Spare External AC/DC Power Supply
(one included with KSC-2 unit)

KPPX-4P-30 Mating Power Entry Connector for KSC-2

CONN-IN-9D

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

CONN-IN-9D-SC

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

CONN-IN-9D-SCT

9-Pin mating Input Connector with metal backshell and screw terminal connections

USB-A/B-6

Locking USB Cable Accessory (72”). Standard (non-locking) Type A USB connector for host computer to locking Type B USB connector for KSC-2.

THE KSC-2 CONFORMS TO THE FOLLOWING ISO/IEC STANDARDS:

Product category:

Electrical equipment for measurement, control and laboratory use conforms to the following directives and standards:

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.

ORDERING INFORMATION

KSC-2-<Options>

- C3 Transducer Resonance Compensator
- KSC-2 Dual Channel Filter/Amp

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