

Technical Documentation

AC/DC Capacitive Sensor Unit
Model CSU-1011-PXI

User Manual



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AC/DC Capacitive Sensor Unit
Type CSU-1011-PXI

From Serial No. 103405

Rev 2.2 - December 2019



SERVICE WARNING

The AD/DC Capacitive Sensor Unit contains no user-serviceable parts. It should be opened and serviced by qualified personnel only.

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1. Getting Started

Principle of Operation

The CSU-1011-PXI AC/DC Capacitive Sensor Unit (CSU) is a fully integrated analog synchronous modulation/demodulation system that provides the ability to measure mean and fluctuating quantities of interest, e.g., wall shear stress or pressure, using a differential capacitive sensor. The CSU provides low-noise power to the sensor head and conditions the analog voltage signal received from the sensor head for output to a data acquisition system. Capacitive sensing at DC is achieved by shifting the sensor baseband frequencies to a modulated signal and demodulating the returned signal from the sensor, enabling simultaneous real-time measurement of both mean and dynamic components.



Figure 1-1: CSU-1011-PXI

Features and Benefits

- Ability to measure mean and fluctuating quantities using a variety of capacitive devices
- Compatible with 3U CompactPCI, PXI, and PXI Express Hybrid chassis
- PXI-compatible form factor uses low-noise power provided by chassis
- Multi-pin LEMO push-pull connector provides supply voltages and carrier signals to sensor

Additional Required Equipment

The following additional components and specifications are recommended for AC and DC testing/calibration with the capacitive sensor control unit:

- CSU-compatible capacitive sensor head and cable
- RG58 coaxial cable with BNC connectors
- Data acquisition system (DAQ) – AC/DC measurement
 - Sensing Range: ± 1 , ± 5 , ± 10 V – sensor dependent (see datasheet)
 - Resolution: 18+ bits
 - Sampling frequency:
 - Sensor dependent w/ analog filter between sensor output and analog-to-digital converter (ADC)
 - 100+ kS/s w/o analog filter
- Digital multimeter – DC measurement only
 - 6.5 digits with power line cycle (PLC) integration
 - DAQ or PC connection (e.g., GPIB)

Initial Setup

Unpacking

The CSU-1011-PXI is shipped in an antistatic package to prevent electrostatic damage to the module. Electrostatic discharge (ESD) can damage several components on the module.

CAUTION **Never touch the exposed pins of connectors.**

To avoid such damage in handling the module, take the following precautions:

- Ground yourself using a grounding strap or by touching a grounded object.
- Touch the antistatic package to a metal part of the computer chassis before removing the module from the package.

Remove the module from the package and inspect the module for loose components or any sign of damage. Notify IC2 if the module appears damaged in any way. Do not install a damaged module into the chassis.

Store the CSU-1011-PXI in the antistatic envelope when not in use.

Installing the Capacitive Sensor Unit PXI card

The following are general installation instructions for installing the CSU-1011-PXI in a 3U PXI chassis. Consult the chassis user manual or technical reference manual for specific instructions and warnings about installing new modules.

1. Power off and unplug the chassis.
2. Choose an available PXI or PXI Express Hybrid slot in the PXI chassis.
3. Remove the filler panel for the slot you chose in step 2.
4. Ground yourself using a grounding strap or by holding a grounded object.
5. Insert the CSU-1011-PXI into the slot. Use the injector/ejector handle to fully insert the module into the chassis.
6. Screw the front panel of the device to the front panel mounting rail of the chassis.
7. Visually verify the installation. Make sure the module is not touching other modules or components and is fully inserted into the slot.
8. Plug in and power on the chassis.

NOTE **The CSU-1011-PXI should be powered for a minimum of one hour prior to testing to avoid undesirable start-up transients during measurement. Please refer to the Device Operation section for additional details regarding proper system operation.**

2. Description

The CSU-1011-PXI AC/DC Capacitive Sensor Unit is an integrated analog synchronous modulation/demodulation system that provides the ability to measure mean and fluctuating quantities of interest using a capacitive sensor, e.g., wall shear stress or pressure. Capacitive sensing at DC is achieved by shifting the sensor baseband frequencies to a modulated signal and demodulating the returned signal from the sensor. The CSU provides low-noise power and carrier signals to the sensor head and conditions the returned analog voltage signal for output to a data acquisition system. The CSU-1011-PXI is compatible with CompactPCI, PXI, and PXI Express Hybrid chassis.

Signal Conditioning Electronics

The analog synchronous modulation/demodulation circuit provides two 180° phase-shifted 1 MHz carrier signals to the fixed sensor electrodes. Mean forces acting on the sensing element result in static changes in the nominal capacitance, thus changing the amplitude of the carrier wave. Demodulation of the amplitude-modulated sensor output voltage then provides baseband information in real time including both mean and dynamic components.

EMI Shielding & Cabling

The CSU provides the sensor bias voltages and supply voltages via a shielded, multi-pin, twisted-pair cable, providing a continuous shield from the CSU to the face of the sensor head. Internal shielding of the signal conditioning electronics provides added immunity to EMI when operating on line power.

Calibration

Each CSU is calibrated and paired via serial number with a specific sensor head and the pair should be used together for measurement. The results of each system calibration are presented in individual sensor calibration sheets.



Figure 2-1: CSU-1011-PXI

Front Panel at a Glance

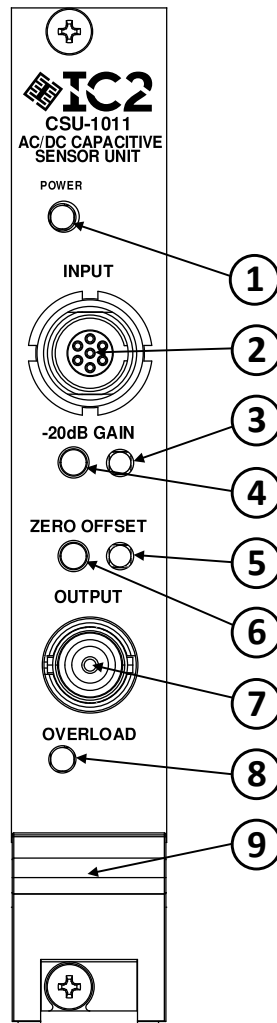


Figure 2-2: The CSU front panel.

Name	Description
1 Power LED	Indicates that the card is powered on
2 Sensor Input	Multi-pin LEMO push-pull connection to sensor
3 -20dB Gain LED	Indicates gain status (on = -20dB nominal gain)
4 -20dB Gain Button	Switches between -20dB gain and 0dB gain
5 Zero Offset LED	Indicates Zero Offset status (on = Zero Offset active)
6 Zero Offset Button	Switches between Zero Offset active and inactive
7 Sensor Output	BNC connection to DAQ
8 Overload LED	Indicates measured signal is clipped by signal conditioning circuit
9 Injector/Ejector Handle	Used for installation/removal of the CSU-1011-PXI

3. Device Operation

Powering the System

The CSU-1011-PXI is powered through the backplane of the chassis. Please refer to installation instructions in Initial Setup for connecting the module to the chassis.

System Warmup

The CSU should be powered on with the sensor head connected and allowed to warm up for at least one hour to reach thermal equilibrium and mitigate undesirable start-up transients in the system response. If the system has been powered on for one hour but needs to be relocated the second warm-up duration can be reduced to fifteen minutes.

System Connection

The capacitive sensor head should be connected to the paired CSU using the included shielded multi-pin cable. The pinout for the CSU front panel and sensor head connector is shown in Figure 3-1. A user-provided shielded BNC cable should be used to connect the DAQ to the CSU output. The serial number for the CSU is located on the injector/ejector handle and is listed on the data sheet for the accompanying calibrated sensor.

NOTE To ensure the calibration data is valid, the sensor must be connected to the corresponding CSU.

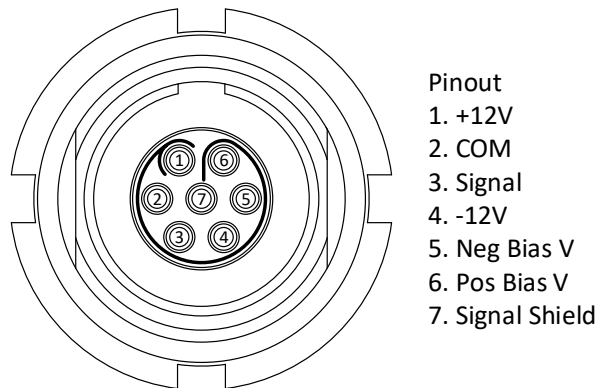


Figure 3-1: Pin configuration for the multi-pin Sensor Input connector on the CSU front panel.

Data Acquisition Settings

The output of the CSU should be connected to a data acquisition system via a BNC connection. The recommended minimum resolution is 100 nV. Typical AC-coupled signal outputs will not exceed 1 V in magnitude; however, mean output voltages can reach up to 6 V at full scale output without the Zero Offset engaged (see the DC Offset Measurement section for Zero Offset operation). The minimum bandwidth of the data acquisition system should be at least twice the measurement bandwidth of interest to avoid temporally aliasing the sensor signal. For fluctuating shear stress or pressure measurements, the input to the data acquisition system should be AC coupled.

The CSU is equipped with two different gain settings and an overload warning LED. The -20 dB Gain Button switches between the two gain settings and resets the overload circuit. When the Gain LED is off, the gain is set to 0 dB. When the Gain LED is on, the gain is set to -20 dB nominal (see the calibration datasheet for the actual gain of the system). To switch between gain settings, press the -20 dB Gain Button. The Overload LED turns on when the signal measured is too large for the signal conditioning electronics. The overload circuit can be reset by pressing the -20 dB Gain Button. If the Overload LED is on and does not turn off after resetting the overload circuit, use the lower gain setting.

DC Offset Measurement

Before and after data acquisition, the DC offset from the output of the circuit should be recorded. The DC offset provides information on whether sensor drift has occurred during operation. The DC offset of the sensor can be monitored at the CSU output by introducing a BNC tee to split off the signal. A digital multimeter with at least 6.5 digits should be set to maximize dynamic range for determining the DC offset of the sensor.

The Zero Offset correction brings the DC offset to nominally 0V. To engage the Zero Offset, press and hold the Zero Offset Button for 3-5 seconds. When the Zero Offset LED comes on, the DC offset will drop. To disengage the Zero Offset, press the Zero Offset Button for less than 3 seconds. The Zero Offset LED will turn off and the DC offset voltage will return to normal.

NOTE **Output drift can occur due to temperature and humidity fluctuations during the course of a test. Consult the sensor data sheet to determine the effect of changes in environmental conditions during testing.**

4. Specifications

Performance Specifications	MIN	TYP	MAX	UNIT
Carrier Signals @ 1 MHz			16	V _{pp}
Sensor Supply Voltages			±12	V
Pre-Demodulation Gain (factory preset)	20		40	dB
Operating Temperature Range	0 (32)		50 (120)	°C (°F)

Figure 4-1: Specifications Table

Mechanical Specifications	TYP		UNIT	
Weight	225	(0.5)	g	(lb.)
Width	20	(0.8)	mm	(in.)
Length	214	(8.4)	mm	(in.)
Height	131	(5.2)	mm	(in.)
Cable Length (standard)	2	(6.6)	m	(ft.)

Figure 4-2: Mechanical Specifications Table

5. Service and Repair

The CSU-1011-PXI AC/DC Capacitive Sensor Unit has been designed to operate correctly for many years. However, if a fault occurs which prevents it from operating correctly, disconnect the AC power cord and any cables connected to the front panel Input and Output connectors to prevent the risk of further damage. Contact a service representative to schedule an appointment for service and recalibration.



The sensor unit contains no user-serviceable parts. It should be opened and serviced by qualified personnel only.

6. WARRANTY

Interdisciplinary Consulting Corp. (IC2) warrants this product free from defects in material and workmanship for a period of one (1) year from date of shipment.

Interdisciplinary Consulting Corp. warrants the following items for 90 days from the date of shipment: cables, rechargeable batteries, and documentation.

During the warranty period, IC2 will, at its option, either repair or replace any product that proves to be defective. To exercise this warranty, please contact IC2 headquarters in Gainesville, FL. You will be given prompt assistance and return instructions. Send the product, transportation prepaid, to the indicated service facility. Repairs will be made and the product returned transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or a minimum of 90 days.

LIMITATION OF WARRANTY

This warranty does not apply to defects resulting from product modification without IC2's express written consent, or misuse of any product or part. This warranty also does not apply to problems arising from normal wear or failure to follow instructions.

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