AcSense-Mini-4CH User Manual

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For Payload Configuration: 4CH hydrophone array, BAR30 pressure/temp, external switch, external console cable, eth streaming, RTC. Questions? Contact: efischell@acbotics.com

System Overview, Note, and Warnings

The *AcSense-Mini-4CH* streams over ethernet up to 4-channel hydrophone array at up to 96 kHz with RTC and underwater pressure/temperature for use in underwater sensing applications. Based on the AcSense-Digital-OEM board plus a 4-CH configurable front end. Additional sensors include internal IMU, RTC, and external pressure/temperature sensor.

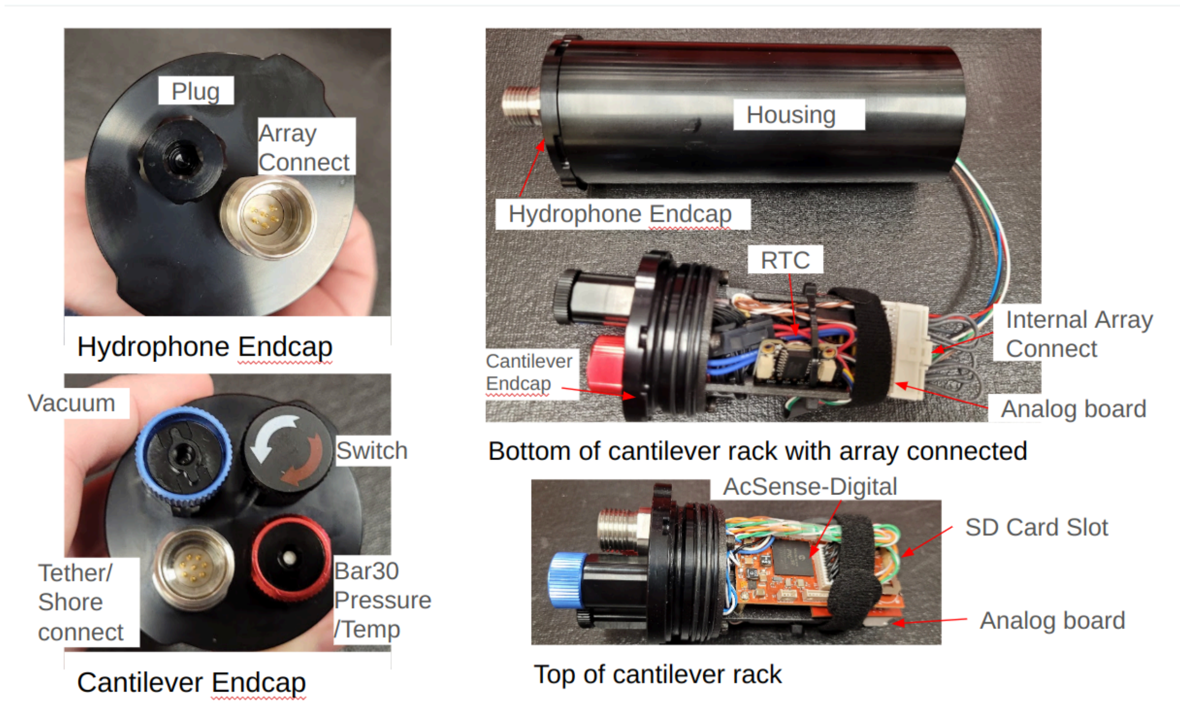


Figure 1: Electronics rack and payload components, including housing, cantilever endcap with electronics rack. Array connect is a Blue Trails Cobalt 6; Tether/shore connect is a Blue Trails Cobalt 8.

Hydrophone Array Shore Cable

Figure 2: Hydrophone array and shore cable

WARNINGS:

- ☐ **DO NOT grab or twist connectors when opening/closing the enclosure.**
- ☐ **Switch is only "ON" when entirely screwed in**
- ☐ **O-rings: whenever the system is opened/closed, inspect o-rings for damage or dirt. If dirty, remove, clean, and re-grease prior to re-assembly. If damaged, replace.**

Typical Use

Sealing

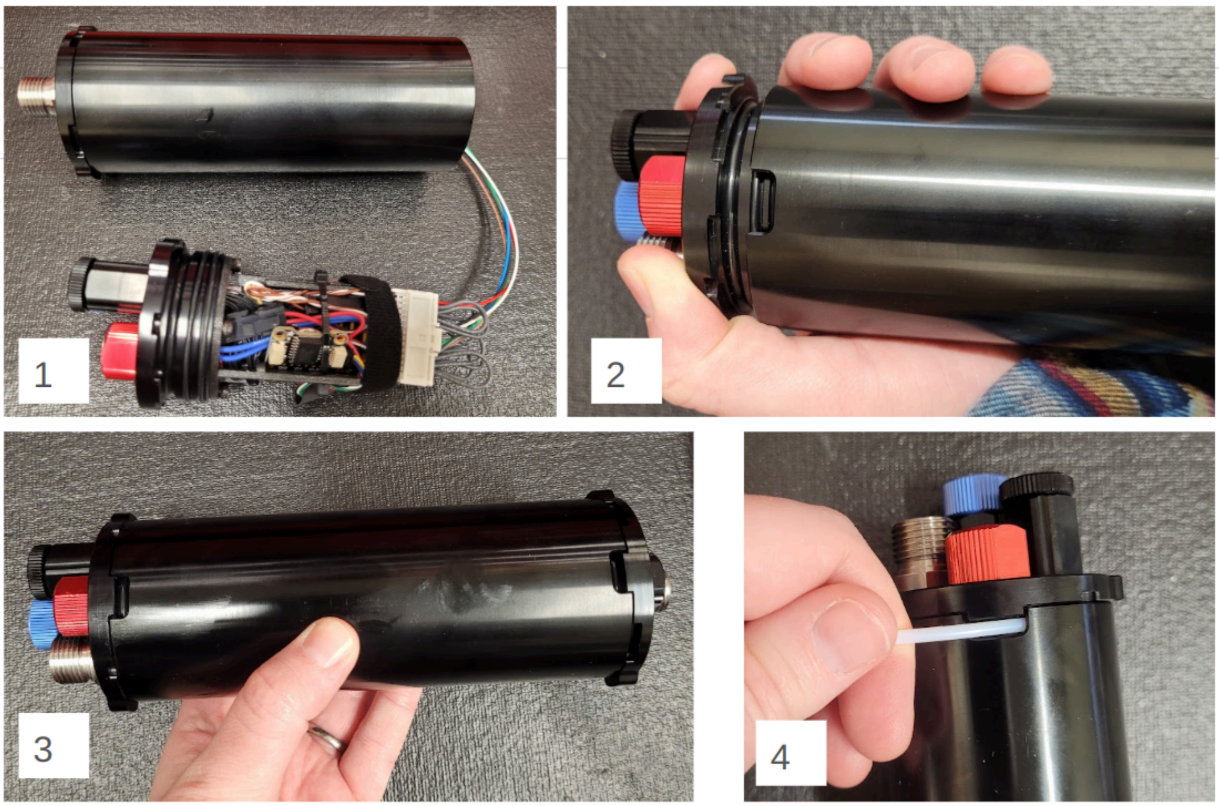


Figure 2: Steps for sealing the housing.

Inspect bore seal o-rings for damage; regrease using molykote, replace is needed. Ensure velcro battery straps are in place, SD card is in its slot, and switch is OFF. Test each connector in the cantilevered sensor payload endcap by lightly twisting; if it moves, re-tighten using a wrench.

1. Plug in internal array connector to analog board on cantilever endcap.
2. Insert cantilever endcap into bottle on array system; rotationally align key.
3. Push until entirely compressed.
4. Insert ortman key into slots on both ends.

Plugging in array, tether, or shore cable

1. Plug in cable to connector on endcap
2. Screw collar until completely engaged.

Powering On

1. Plug in shore cable to 8-pin connector on cantilever endcap; fully screw in black collar
2. Plug in wallwort to power outlet (note: the system runs off of 3.7-17 V; the wallwort provides 12V but you can run off of an adjustable power supply or USB power if desired)
3. Turn the On/OFF switch clockwise until fully engaged.
4. Observe console via e.g. minicom and/or ethernet via wireshark to confirm data is streaming.

Console

1. Connect shore cable to 8-pin connector
2. Connect USB to Serial converter to Serial port
3. Power ON using switch: Green LED should be lit
4. Log in via Minicom or other terminal (Baud rate 115200, flow control off):
   > minicom -D /dev/ttyUSB0
   (Navigate menus to adjust baud rate, flow control)

To Verify sensor values using serial console:

➔ ?

The system will begin giving you heartbeats. To enable internal pressure/temperature streamed logging:

➔ PTS+

To stop streaming PTS over serial or to get a single data entry:

➔ PTS

In general, a command and + will stream; a command without plus will give a single return and stop. The options for data queries for the default config are:

LOG STS CFG ADC EPT_30 GPS PTS IMU
SDCARD

Setting the RTC:

To manually set the RTC, in the serial console:

➔ > ?
➔ > CFG
➔ >> RTC
➔ >> RTC MM/DD/YY HH:MM:SS
➔ >> EXIT
➔ To confirm: (it may take a few seconds to update)
➔ > RTC

To enter FTP mode using serial console:

On boot, the console service provides an option to select alternate config files or to initiate file transfer:

```
Version: acsense_v2.1.1

ACBOTICS Initialization (RCON=0x40), enter '?' for Config
Press 1 to enter data offload mode
  2: 2_Hydrophone_Stream.cfg
  3: 3_Geophone_Stream.cfg
```

Multiple .cfg files may be loaded onto the SD card of the AcSense system; by default DefautConfig.cfg will run, but on boot or reset you can select a different config via the command line. To go into FTP mode for file transfer, press “1” (you can press it multiple times until it enables FTP mode. If you don’t press anything, it will use DefaultConfig.cfg as before.

See console service section in full software documentation package for full details.

Streamed Data: ROS Application

The ROS application for ethernet streaming is available open-source; for the most up to date public repo and use instructions, see:
https://github.com/Acbotics-Public/AcSense_ROS.git

Streamed Data: UDP Interface

Open source UDP interface code is available here:
https://github.com/Acbotics-Public/acbotics_interface.git

microSD Card Config

The provided microSD card should have a file called “DefaultConfig.cfg”. This file sets which data streams are turned on and off, what is logged, and what is used as the clock for the system. The default for your configuration (4 channel 12 bit ADC, 96 kHz sampling, ethernet streaming, Bar 30, RTC) is below.

```
ACBOTICS CONFIG ON.............................................
CONSCFG ON.....................................................
SDCFG ON.......................................................
CONS ON........................................................
SDCARD OFF.....................................................
ENET ON .......................................................
IMU ON  .......................................................
PTS ON ........................................................
PTS READINT=100................................................
ADC OFF                ........................................
ENET PORT=9760 IP=224.1.1.1 ACH=INTADC1........................
ENET SER_ON SER_IP=192.168.2.115...............................
ENET SEN_ON SEN_IP=224.1.1.1 SEN_PORT=9766 CH=PTS CH=EPT CH=RTC.
ENET SER_INV=1 SER_TX_PORT=9684 SER_RX_PORT=9685 SER_CON=J19....
ENET DAQ_IP=192.168.2.56 DAQ_SM=255.255.255.0..................
PING OFF.......................................................
INTADC ON CH=0 CH=1 CH=2 CH=3 DIFF=1 SIGNED=1 FS=96000     .....
INTADC RBELEMS=100                                    ..........
EPT_30 ON READINT=100 DNAME=J7.................................
RTC ON DNAME=J25...............................................
TIMEMGR SRC=RTC................................................
MAG OFF        ................................................
GPS OFF........................................................
```

See detailed software documentation package for full configuration options.

NOTE: We HIGHLY recommend using only Micron Technology Inc. microSD cards for multi-channel acoustic logging systems as many microSD cards we tried resulted in data write errors. Size your card based on expected data to be logged; e.g.
https://www.digikey.com/en/products/detail/micron-technology-inc/MTSD256ANC8MS-1WT/16983775

Beamformer

The AcBeamform module provides estimates of acoustic energy received in each elevation/bearing. Performance of the beamformer is contingent on array geometry, signal to noise ratio, power noise, and system mechanical noise.

See UDP protocols doc for a description of raw beamformed data that is returned by the AcBeamform module. Beamformed output is per frequency, elevation, and azimuth set by the beamformer config and represents the energy at the appropriate frequency, elevation, and azimuth.

Contact us if you have purchased a beamforming license, and we will walk you through the setup and configuration process.

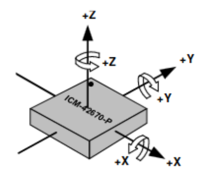
Pre-Deployment: Seal and get flat IMU orientation

1. Insert cantilever endcap into bottle on array system; rotationally align key. Insert ortman key into slot.
2. Turn on if still off, plug in shore cable.
3. Check RTC using the RTC command v. actual date, adjust if needed using commands.
4. Make a note of IMU values on a flat surface (IMU+ command to stream):
    a. Pitch =
    b. Roll =?
    c. Acc X =
    d. Acc Y =
    e. Acc Z =
5. Rotate the system on its side:
    a. Pitch =
    b. Roll =
    c. Acc X =
    d. Acc Y =
    e. Acc Z =
    (Accelerometer is on the bottom of the board)(x is across the short dimension, y is along the long dimension, z is through the rack)
6. If you want to pull a vacuum (optional):
    a. Screw red vacuum connector into vacuum port.
    b. Observe vacuum via PTS+ command via serial console; at atmospheric it should read about 1000.
    c. Pull vacuum, then quickly unscrew red vacuum connector; If you succeeded, the pressure will be below 1000 and will remain constant-ish (contingent on temperature).

Final Checks:

1. Vacuum port closed: Blue plug in place, fully screwed in.
2. Tether plugged into 8-pin connect.
3. Remove red cap on pressure sensor
4. Hydrophones placed as desired, locations measured
5. Hydrophone array connected to 6-pin connector
6. Powered on with switch
7. Ethernet stream functioning

(Accelerometer is on the bottom of the AcSense-Digital board)(x is across the short dimension, y is along the long dimension, z is through the rack)



Design information and additional details

Software/Software Documentation

Detailed software documentation on UDP, console service, and configuration is available here:
https://drive.google.com/drive/folders/1NAreHchK1WECrs49j4L7UmqwYeIl3E1I?usp=sharing

Git repos:

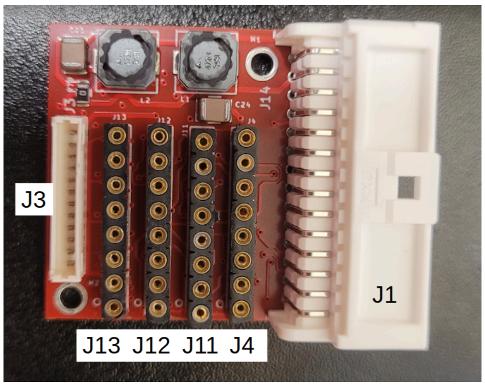
AcSense Utils: Parsing/plotting utilities for logging systems
https://github.com/Acbotics-Public/AcSense_utils.git
Acbotics_interface: open UDP interface
https://github.com/Acbotics-Public/acbotics_interface
ROS node for raw data streaming:
https://github.com/Acbotics-Public/AcSense_ROS
Parser GUI:
https://github.com/Acbotics-Public/AcSense-parser

Analog Board: 4-CH configurable front end

Part number: 100638

CAD Part: 100638_Configurable_Analog_Front_End

The 4-channel amp and filter board for the AcSense-Mini includes 4 generic input acoustic channels with customer-adjustable gain and filters. Filters and gains are set via resistor packs.



Connector	Suggested Mating Component	Description
J1	Microclasp 2x 14; PN 0513532800	Hydrophone connection; up to 4 channels
J3	Picoblade 12 cable; Digikey WM17207-ND	SPI/Power connection to AcSense-Digital; connects to J17 on AcSense-Digital
J14 (marked as J4 on pic)	Leave empty for default 4 Hz highpass; see table below	Highpass resistor pack; resistors in part will be in parallel w existing 80.6 kOhm resistors; F_highpass = 1/(2pi(R/2)*0.000001), R=1/(1/R_pack+1/80600)
J11/J12	33 Ohm: 4608X-102-330LF See table below for other example options	Lowpass Resistor packs; F_Lowpass = 1/(2**pi**R*(2C)) where R is the resistance of the packs. Must be populated, each handles 2 channels; use the same value for both. C =0.1uF
J13	2.7 kOhm: 4608X-102-272LF	Gain Resistor pack; see table below.

Values as shipped:

Connector	**Description**	**Resistor Value**	**Result**
J13	Gain stage	2.7kOhm	~20x gain
J14	Highpass filter	22 Ohm	~15 kHz highpass
J11/J12	Lowpass filter	10 Ohm	~79 kHz lowpass

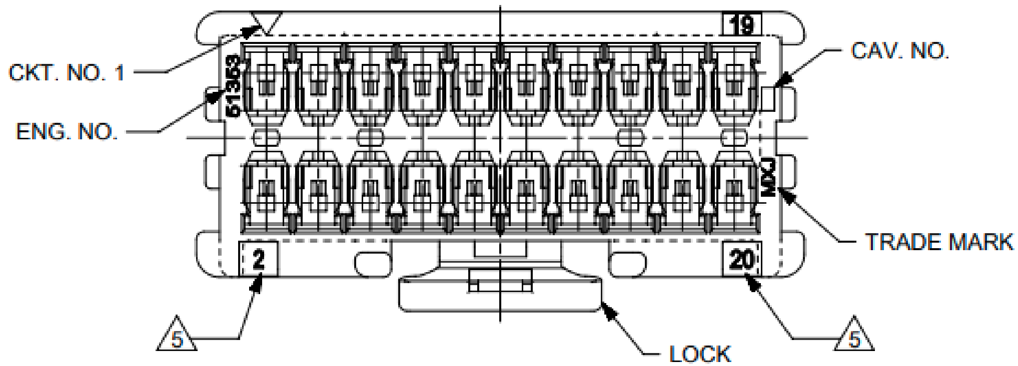
Hydrophone Connector: see hydrophone connect, below

Hydrophone Connect:

Hydrophones

4-5x HTI-96-MIN -167 dB re 1 V/uPa wired/soldered to cobalt connector

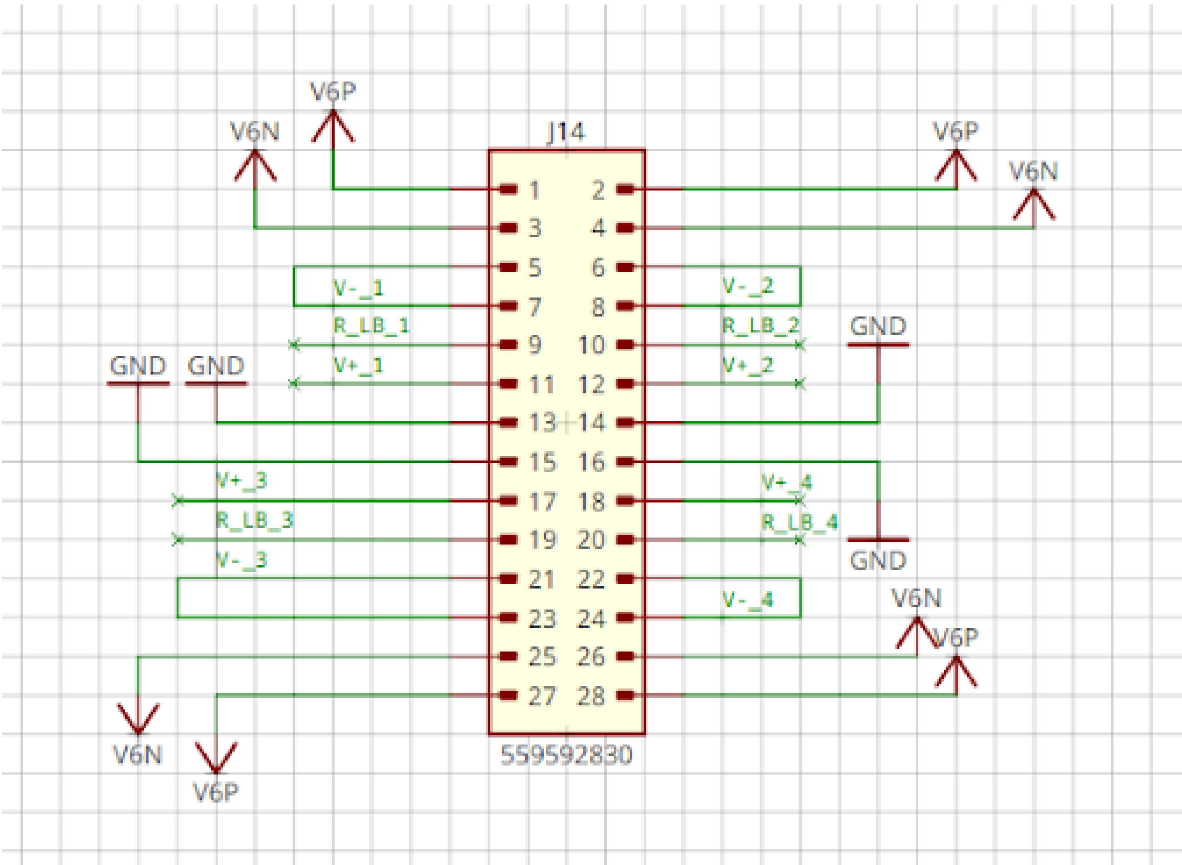
Bulkhead: Cobalt 10 mm 6 pin



J14 on amp board; for 1-channel, 1-> red hydrophone, 11->green hydrophone wire, loopback 5/9, loopback 7/3

Pin No	Descriptio n	Hydrophone	Bulkhead Subsea	Connect: INT J14 microclasp 2 x 14	INT J14 loopback microclasp 2 x 14
1	CH0	CH0 Green	Black	11 (CH0 in)	
2	POW	Red common	Red	1 (12 V)	
3	CH1	CH1 Green	White	12 (CH1 IN)	
4	CH2	CH2 green	Blue	17 (CH2 IN)	
5	CH3	CH3 green	Green	18 (CH3 IN)	
				Pin 5	*Pin 9*
				Pin 7	*Pin 3*
				Pin 6	*Pin 10*
				Pin 8	*Pin 4*
				Pin 21	*Pin 25*
				Pin 23	*Pin 19*

				Pin 24	*Pin 20*
				Pin 22	*Pin 26*



Tether Connect

Tether Cable

Blue robotics PUR 8 pin cable soldered/attached to Cobalt 8

Bulkhead: Cobalt 10 mm, 8 pin

Pin No	Description	Cable	Bulkhead Subsea	Internal crimp Subsea	Attach to subsea
1	GND	Brown/ white	Brown/white	Microfit 1x2, male shell female pin, pin 1	Connect microfit to frankencable that powers everything together
2	POW	Brown	Brown	Microfit 1x2, male	

				shell female pin, pin 2	
5	Ethernet Rx-	Green	Green	Picoblade 1x4 1 (to AcSense Digital J4 Rx-) If using cut botblox cable, green	AcSense Digital J4
6	Ethernet Rx +	Green/ white	Green/whit e	Picoblade 1x4 2 (to J4 Rx+) If using cut botblox cable, yellow	
7	Ethernet Tx-	Orange	Orange	Picoblade 1x4 3 (to J4 Tx-) If using cut botblox cable, red	
8	Ethernet Tx+	White/ orange	Orange/whi te	Picoblade 1x4 4 (to J4 Tx+) If using cut botblox cable, orange	
3	Serial Tx SL pin 5 (Blue)	Blue	Blue	Picoblade pin 2	NOTE: connect to ttl level shifter usb thingy for console on topside, AcSense digital J20 bottom
4	Serial Rx SL pin 4 (white)	Blue/wh ite	Blue/white	Picoblade pin 1	

Tether Pigtail

Pin No	Descripti on	Cable	Bulkhead Subsea	Pigtail crimp	

1	GND	Brown/ white	Brown/whit e		
2	POW	Brown	Brown		
5	Ethernet Rx-	Green	Green	RJ45 Rx- If using cut botblox cable, green	
6	Ethernet Rx +	Green/ white	Green/whit e	RJ45 Rx+ If using cut botblox cable, yellow	
7	Ethernet Tx-	Orange	Orange	RJ45 Tx- If using cut botblox cable, red	
8	Ethernet Tx+	White/ orange	Orange/whi te	RJ45 Tx+ If using cut botblox cable, orange	
3	Serial Tx	Blue	Blue	SL 5	
4	Serial RX	Blue/wh ite	Blue/white	SL 4	

Adjusting Gain and Filters

The adjustable front-end board means the user can adjust the filter/gain settings for the system by switching resistor packs. Part numbers and values are listed below for adjusting various settings on highpass, lowpass, and gain stages.

Standard Pack values & part numbers

Resistance (Ohm)	Manufacturer Part no	Acbotics Part no	In J11/J12 Lowpass Fc	In J4 Highpass Fc	In J13 Gain
82 Ohm 8-SIP	4608X-2-820LF-ND	100783	9714.451042	3881.831159	~500
150 Ohm 8-SIP	4608X-2-151LF-ND	100784	5315.042395	2122.0677	~400

300 Ohm 8-SIP	4608X-102-301LF-ND	100785	2662.457769	1061.03385	~150
2.7k Ohm 8-SIP	4608X-2-272LF-ND	100786	304.6047688	117.89265	~19
5.6k Ohm 8-SIP	4608X-2-562LF-ND	100787	151.9758916	56.84109912	~9.5
12k Ohm 8-SIP	4608X-102-123LF-ND	100788	76.1877594	26.52584625	~5
33 Ohm 8-SIP	4608X-2-330LF-ND	100789	24124.27883	9645.762274	~1000
22 ohm 8-sip			~40 kHz	14468	
10 ohm 8-sip			~79000Hz		

Highpass Filter

High pass is 1uF combined with R. Where R is 80.6kin parallel with the resistor pack. 3dB point for highpass is 1/(2**pi**(R/2)*C);

Lowpass Filter

Low pass is 0.1uF combined with resistor pack. 3dB point for lowpass is 1/(2**pi**R*(2C)). Must be populated; both J11/J12 should be the same. See https://www.ti.com/lit/an/slwa053b/slwa053b.pdf for more info about differential vs single ended if interested. default to 33 ohm

Gain

Table 7. Gains Achieved Using 1% Resistors

1% Standard Table Value of R_G (Ω)	Calculated Gain
49.9 k	1.990
12.4 k	4.984
5.49 k	9.998
2.61 k	19.93
1.00 k	50.40
499	100.0
249	199.4
100	495.0
49.9	991.0

Streaming config

Streamed Data: ROS Application

The ROS application for ethernet streaming is available open-source; for the most up to date public repo and use instructions, see:
https://github.com/Acbotics-Public/AcSense_ROS.git

Streamed Data: UDP Interface

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Logging config

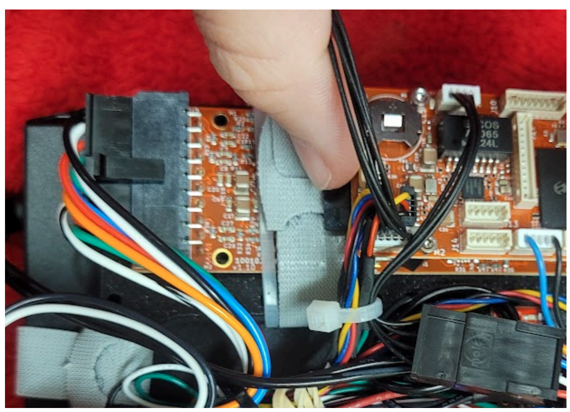
Offloading Data: Via FTP

Connect ethernet via shore cable; using console, select data offload mode. Once data offload is enable, you can use filezilla to connect to AcSense file system to copy files, modify configurations, etc.

For full details, see software documentation package.

Offloading Data: By Opening Bottle and Removing SD Card

The AcSense firmware creates a series of folders; every time the system turns on, it writes to the next sequential folder. The most recent folder with data in it contains the most recent run; occasionally a file system refresh is required to have the new files show up. Note that if files are initially created before the GPS RTC is set, the dates of creation on the folders will reflect that rather than the correct time.



SD Card location: to remove, push in and then gently extract. Tweezers can be helpful!

1. Open the housing as described above
2. Locate SD card on end of the electronics rack away from the sensor endcap under the Digital board.
3. Press the SD card to "pop" out, remove SD card
4. Put SD card into reader, connected to a computer, copy data to known location
5. Run parser as described below, in "Data Parsing".

NOTE: a pair of tweezers can be useful for inserting/removing the SD card if you are struggling with it.

Note: The last directory will contain the latest data; in general, data should be contained within a single directory but it sometimes gets split either due to too many files being created in a single directory or due to system reset due to an overflow state. A new directory is entered on longer runs every 5-6 hours. We suggest you use the timestamps and expected duration to check, and clear the SD card of D* directories prior to each use.

Logged data Parser and Plotter

Parsing and plotting is handled via an open-source GUI provided by Acbotics Research. For the most up to date public repo and use instructions, see:
https://github.com/Acbotics-Public/AcSense_utils.git