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ASTi ACU Technical User Guide

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Product Name: ACU

ASTi ACU Technical User Guide

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ASTi

500-A Huntmar Park Drive

Herndon, VA 20170

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1.0. ACU

Description

The ACENet Communication Unit (ACU) module is the remote interface of audio and input/output (I/O) unit for ASTi's Target platform. The hardware permits installation close to operator positions, and takes advantage of digital audio and I/O distribution to reduce noise and cross-talk susceptibility. All audio and I/O is digitally distributed between ACUs and Target platforms for maximum noise rejection and reliability. This unit may be connected directly to the Target platform. The hardware is available in a 1U (19 inch) two, four and six channel rackmount configurations.

The ACU has 48 kHz digital audio distribution and pro-audio style interfaces, providing high fidelity audio. The software configurable amp/preamp gains, mic power selection, accommodate a wide range of audio peripherals such as military and commercial headsets, audio amps, speakers, mics, recording equipment, and real radio/communications equipment.

The ACU offers multiple serial ports and configurable digital/analog I/O providing direct integration of PTT units, volume controls, simulated communications panels, Hand-Held Terminals, and live radio control, into the communications simulated environment.

Features

- Independent, software-configurable audio inputs and outputs (1 per channel)
- Control Inputs (3 per channel)
- Digital Outputs (1 per channel)
- RS-422 serial ports (1 per channel)



Figure 1: ACU Hardware Layout Diagram

2.0. Physical Specifications

Channel Options

The hardware is available in a 1U (19 inch) two, four and six channel configurations.



Figure 2: ACU Front Panel (2 Channel)

| CHANNEL A CHANNEL B CHANNEL C CHANNEL D THE CHANNEL A CHANNEL B CHANNEL C CHANNEL D CHANNEL A CHANNEL B C C CHANNEL D C C C C C C C C C C C C C C C C C C C | |
|---|--|
|---|--|

Figure 3: ACU Front Panel (4 Channel)



Figure 4: ACU Front Panel (6 Channel)



Figure 5: ACU Rear Panel

The number of serial ports on rear panel of the ACU will reflect the amount of ACU channels.

Dimensions

12" length x 16.9" width x 1.72" height

Width with the rackmount kit is 19"

Allow at least 2" or more of space to the front and rear of module for cable access and clearance.

Weight

Weight will vary depending on channel options. The maximum weight will not exceed 5.50 lbs. including attached mounting brackets.

| Input to PSL-UM-001 | 100-240 VAC, 50-60Hz, 1.5Arms (120VAC), 0.75Arms (240VAC) | | |
|---------------------|---|---|--|
| Power Connector | Inside Diameter 0.100", Outside Diameter 0.218", locking, center positive | | |
| | Connector Part # | Switchcraft 712RA supplied with P2439 Hex Nut (5/16-32) and P2441 Washer | |
| | Mating Connector Part # | Switchcraft 760k | |
| Power Consumption | 15 VDC, 3 A | | |

Power Requirements

The hardware is powered by an individual power supply included with ACU shipment. The power adapter inlet connector is an IEC320 type C14 or C8, requiring a matching cordset equipped with an IEC320 C13 or C7 connector (female line cord). Country-specific power connectors must be acquired separately for international use.

3.0. Installation

ACENet

The ACU connects to the ACENet network via the two ACENet ports on the back panel of the ACU. The right port is the primary and left port is the secondary port. Only one port is required for the ACU to function. The port names do not signify a specific order, either port can be used at any given time. The ACU connects to the ACENet network using category 5e or better cable.



Caution: Customer made cables are the number one reason for product failure. ASTi recommends using manufactured Cat 5e cables.

| Maximum Cable Length to ACENet Switch | | |
|---------------------------------------|-----------------------|--|
| ACU | 100 meters (328 feet) | |
| Target | 100 meters (328 feet) | |

Direct connection to the Target is supported and requires a cross over cable. ACUs do not support daisy chaining to additional units or internal switching across networks.

The ACENet network supports mixing both ACUs and ACE-RIUs on the same switch. All ASTi ACENet devices can interact on the same ACENet network.

Note: When powering up the ACUs there may be a 0-12 second delay to prevent an overload on the network.



Figure 6: ACENet Ports



Figure 7: RJ-45 Pinout Diagram

Serial Connection

The serial ports permit connection of user interface devices to the ACU.



Figure 8: RJ-12 Serial Connection

Indicator Lights

ACU Status

The ACU LED indicator lights display ACU status.

| LED Light | Status |
|----------------------|--|
| Red (top) | Indicates there is internal board failure. |
| Solid Green (bottom) | Indicates the ACU started up properly but the ACENet connection cannot be found. |
| Flashing Green | Indicates the ACU is working properly. |



Figure 9: ACU Status LED Lights

ACU Channels

The channel LED indicator lights display the channel status.

| LED Light | Status |
|----------------------|---|
| Red (top) | Indicates there are channel errors. |
| Solid Green (bottom) | Indicates the channels are properly recognized. |



Figure 10: ACU Channel LED Lights

ACENet Port

The ACENet LED indicator lights display the port status.

Note: Only one port, primary or secondary, can be in use at any given time.

| LED Li | ight | Status |
|---------------|--------------------|--|
| Green (left) | Solid | A solid light indicates a network link. |
| | Flashing | A flashing light indicates network activity. |
| Amber (right) | Solid/ Flashing | One ACENet device per network will function as the ACENet master, and will be identified with a flashing amber light. All other ACENet devices should report a solid amber light. |



Figure 11: ACENet Port LED Lights

4.0. Audio Input and Output

For information on setting the ACU Input/Output gains see section 7.0.

Audio Input

| Characteristic | Line Mode | Microphone Mode | |
|---|--|--|--|
| Input Impedance | 32 KOhms | 1.5 kOhms | |
| Input Level | +/- 2.25 Vp-p max. at 0 dB gain | +/- 2.2 Vp-p max. 0 dB gain | |
| Input Gain | -20 to +20 dB software configu- rable | 0 to +52 dB software configurable | |
| Microphone Power for Condenser Micro- phones | n/a | Selectable T-Power at 13.8 VDC, cur- rent limited with 3.24 kOhms. Soft- ware enabled/disabled | |
| Total Harmonic Distor- | 0.045696 from 20 Hz to 20 kHz | 0.064% from 20 Hz to 20 kHz | |
| tion (THD) + noise | input | Typical: -0.048% at 1 kHz | |
| | Typical: 0.040% at 1 kHz | | |
| Frequency Response | +/- 3 dBv from 20 Hz to 20 kHz | +/- 3.5 dBv from 20 Hz to 20 kHz | |
| | Typical = 0.4 dBv at 20 Hz, | Typical = $+/-$ 3.5 dBv from 20 Hz to | |
| | -2.7 dBv at 20 kHz | 20 kHz | |
| Common Mode Rejec- tion | -78 dBv at 60 Hz, -56.4 dBv at 20 kHz | -67 dBv | |
| | Typical = $+/- 3.5$ dBv from 20 Hz to 20 kHz | | |
| Noise at Unity Gain | 89 dBv | 60 dBv | |
| Working Signal to Noise ratio at 20 dB headroom | 89 dBv | 60 dBv | |

WARNING! Do not plug a microphone requiring phantom power into an ACU device, this will cause damage to the microphone! If you are unsure of the difference between mic-power and phantom power, please contact the microphone manufacturer or ASTi before connecting equipment. Note: Most military headsets use mic-power.

Electret Microphones



Figure 12: Mic-Power Circuit for Electret Microphones

Note: R1 and R2 connections are only active when power mode is enabled in the software.

Mic-Power is selectable in software (see warning on previous page). Input may be selected between line mode and microphone mode in software.



ACU Input Frequency Response

Figure 13: Input Frequency Response

Audio Output

| Audio Type | Output |
|---------------------------|-------------------------------|
| Output Impedance | 12 Ohms |
| Output Current | 0.2125 A at 8 Ohms |
| Output Level | 1.7 VAC rms into 8 Ohms |
| Output Power | 1 lead: 0.36 W |
| | 2 leads: 0.5 W |
| Frequency Response | +/- 3 dB from 20 Hz to 20 kHz |
| Total Harmonic Distortion | <0.07% |
| THD + Noise | |

Audio Isolation Characteristics

| Between | Isolation | Frequency |
|------------------------------|-----------|-----------------|
| Headphone output channels | 90 dBv | 20 Hz to 20 kHz |
| Line 1 input to Line 2 input | 99 dBv | 20 Hz to 20 kHz |
| Mic 1 input to Mic 2 input | 94 dBv | 20 Hz to 20 kHz |



ACU Output Frequency Response

Figure 14: Output Frequency Response

Audio Interface Pinout



Shell: Earth Ground

Figure 15: DB-15 (F) Connector Pinout Diagram

Headphone Output 1 is the same as Headphone Output 1, pins 5 and 6 are usually tied together as shown in the Typical Headset Connections figures.

5.0. Control Input and Digital Output

Control Input

The control inputs are contact sensing; no voltage is required. Simply connect the control input and control input ground lines together using a switch or other suitable device, such as a press-to-talk (PTT) device. The control input can logically function in one of two ways. The first is as a digital input and the second is as an analog input. In both cases, the ACU component in the model will be able to read the control input value and use this value as required for the application.



Figure 16: Control Input Circuitry

Control Input used as a Digital Input

To use the Control Input as a Digital Input simply short or open the required pins. For example, if you short pins 9 and 10 Control Input 1 will be True. If the pins are open Control Input 1 will be False. Here the control input acts like an on/off switch.

Control Input used as a Analog Input

The Control Input can be used as an Analog Input by inserting a resistance between the control input and control input ground pins. With this configuration the ACU component in the model will map the resistance to an uint8 value that can be used in modeling your application. The ASTi 4-Channel PTT for example contains a switch that is used to change the resistance between the control input and control input ground pins. The uint8 number read in the ACU component will vary by a given percentage based on the tolerances of all of the components involved.

Digital Output

The digital output circuitry consists of an opto-isolated, solid-state relay for switching power to external loads.

| Туре | Opto-isolated FET |
|--------------------------------------|--------------------------|
| Maximum Continuous Current Rating | 120 mA |
| Maximum Power Dissipation | 180 mW |
| Maximum Frequency Responses | 500 Hz |



Figure 17: Digital Output Circuitry

6.0. Additional Information

Grounding

Connect earth ground to the rear panel of the ACU. Earth ground should be as short as possible.



Note: Do not remove bolt #1 from the screw, removal will cause the screw to fall inside the ACU chassis.

- 1. Remove bolt #2.
- 2. Slip ring connector onto the threaded end of jackscrew.
- 3. Insert bolt #2 onto the threaded end of jackscrew. Caution: Do not cross-thread or overtighten bolt when reattaching.
- 4. The ground wire attached to the ring connector should be as short as possible.

Proper grounding and shielding are the keys to keeping unwanted signals separate from intended signals. The two most important factors of good shielding are conductivity and continuity/connectivity. By following a few basic guidelines, electro-mechanical (EMI) and radio frequency (RFI) interference can be minimized, especially over longer cable runs.

Conductivity of a shield is characterized by its ability to transfer signals which have been induced upon it. High conductivity, as found with copper shielding, allows for good transfer of unwanted signals to ground.

The second characteristic of good shielding is continuity/connectivity. In order to perform properly, a shield must completely enclose the signal carrying conductors. Compromises to the structural integrity of a shield can lead to holes or breaks which will allow interfering signals to reach the main conductors. Connectivity is also related to continuity; a cable's shield must make good contact with the chassis of the terminating equipment. A shield must make one continuous connection across all equipment and cables in order to provide a pathway to ground.

The D-Sub connectors on ASTi interface electronics have a dedicated pin, which is directly tied to the chassis ground. Cable connections (to headphones, power amplifiers, etc.) should have their shields tied directly to the chassis ground pin. By doing this, any extraneous signal, EMI and RFI, will be properly shunted to the ground.

Memory Devices

| Volatile | | | | |
|------------------------|-------|--------------------|--------------------------------------|--|
| Туре | Size | User Modifiable | Function | Process to Clear |
| MCU Internal SRAM | 4kb | No | Used as RAM for an inter- nal MCU | Remove Power Count to 30 Restore Power |
| Non-Volatile | | | | |
| Туре | Size | User Modifiable | Function | Process to Clear |
| MCU Internal EEPROM | 8kb | Yes | Used to store settings | None |
| MCU Internal Flash | 128kb | Yes | Used to store Firmware for the MCU | None |
| Flash | 4Mb | Yes | Used to store Firmware for the DSP | None |

The ACU memory devices are summarized in the table below.

Temperature & Humidity Ranges

| Type of Range | Suggested Range |
|-------------------------------------|--------------------------------|
| Operating Temperature Range | +10°C to +40°C (50°F to 104°F) |
| Operating Max. Temperature Gradient | 20°C (68°F) per hour |
| Operating Humidity Range | 10% to 90% non-condensing |
| Storage Temperature Range | -10°C to +70°C (14°F to 158°F) |
| Storage Max. Temperature Gradient | 30°C (86°F) per hour |
| Storage Humidity Range | 5% to 95% |

Reliability

The ASTi sound system has been designed to use the minimal complexity of electronic hardware, using the highest quality components.

| Typical System Mean Time Between Failure (MTBF) | | |
|---|---------------|--|
| COTS | 246,493 hours | |
| MIL | 122,999 hours | |

Dip Switch Positions



Figure 18: Dip Switch

| Position | Switch #1 | Switch #2 | Outcome/Result |
|----------|-----------|-----------|--|
| 12 | Up | Up | Used for normal operation (default position) |
| 12 | Down | Up | Allows for firmware updates |
| 12 | Up | Down | NOT SUPPORTED |
| | | | DO NOT USE |
| 12 | Down | Down | NOT SUPPORTED |
| н | | | DO NOT USE |

Mic-Power and Preamp

Please see the Telestra 4 Remote Management System 4 User Guide (DOC-01-TEL4-RMS4-UG-4) for instructions on setting the mic-power and preamp.

Updating Firmware

Please see the Telestra 4 Remote Management System 4 User Guide (DOC-01-TEL4-RMS4-UG-4) for instructions on updating ACU firmware.

7.0. ACU Gain Settings

This section provides the ACU gain settings for interfacing with different devices and varying signal levels.

While there are "recommended" RMS gain values for headset 'x', when it comes to interfacing with other devices that also have input and output gains, there is no right answer. The level will vary depending on the signal level in the model and the outboard hardware.

A full-scale signal (on the scope) in $ACE = 2.0_{pp} (\pm 1.0)$. It is possible to have larger signals inside of the model, but if you try to get those signals out of any audio distribution device (ACU, ACE-RIU, Crown® Amp, and ACU2) they will be clipped. This occurs because the signal has exceeded the ACENet maximum value (16 bit resolution). RMS gains are the relative gains in dB and are not an indication of the absolute signal level coming in or out of any ACENet device, they are only describing how much relative gain or attenuation is being applied to the source signal, irrespective of absolute level.

Note: As you will see below, Pro levels are about 12dB more (+4dBu verses -7.78dBu) than Domestic Consumer levels, which are 4x more signal (see V_{rms} figures below).

The smaller input signals will allow larger RMS gains. Note that if you are using a piece of pro gear, it doesn't necessarily mean that your signal is using the full voltage swing of the device.

There is the possibility of slightly different values due to electronic component tolerances.

ACU Output

 $2.0_{pp}(\pm 1.0)$, 1kHz sine wave in ACE

Maximum Output

The maximum unclipped signal you can achieve is $9.20V_{pp} = 3.19V_{rms}$ by using a +9dB output gain in RMS.

+4dBu International Studio/Pro Level

+4dBu = 1.78dBV = 1.228V_{rms} = \sim 3.47V_{pp} can be achieved by using an RMS output gain of +1dB. This is the largest signal a piece of pro gear can accept at its input.

-10dBV Domestic Consumer Level

-10dBV = -7.78dBu = 0.316V_{rms} = ~ 0.89 V_{pp} can be achieved by using an RMS output gain - 11dB. This is the largest signal a piece of domestic consumer gear can accept at its input. For example home theater receivers, VCRs, most gear with a "Line In", etc.

ACU Input (Differential or Single-ended)

Maximum Input

With the RMS gain set to -23, the largest unclipped signal you can input is $\sim 8.5 V_{pp} = 3 V_{rms} = 11.8 dBu = 9.58 dBV$. This shows up in the ACE scope as a 0.64_{pp} signal.

+4dBu International Studio/Pro Level

+4dBu = 1.228V_{rms} = ~ 3.47 V_{pp} can be input with the RMS input gain set to as high as -2dB without clipping. This shows up in the ACE scope as a 2.0_{pp} signal.

-10dBV Domestic Consumer Level

-10dBV = 0.316Vrms = ~ 0.89 V_{pp} can be input with the RMS input gain set to as high as +10dB without clipping. This shows up in the ACE scope as a 2.0_{pp} signal.

^{*} All of the ACU gain testing was done with ACU firmware v1.18.

8.0. Typical Headset Connections



Figure 19: Typical Mono Headset Connection



Figure 20: Typical Stereo Headset Connection

9.0. Mounting Options

There are two options to connect the mounting brackets to the chassis.



Figure 21: ACU Side View

Rackmount Option

The brackets can be connected to the front holes in the sides of the chassis for mounting in the standard 19" rack. To attach the brackets simply line up the holes and insert the screws as shown below. The long part of the bracket will attach to the hardware with four (4) screws. The short part of the bracket will extend in line with the front of the hardware mounting to the rack with two (2) screws.



Figure 22: Bracket Connected to ACU for Rackmount

Alternative Mounting Option

The brackets can also be connected to the middle holes in the sides of the ACU hardware for mounting (under-desk mount, etc.). To attach the brackets simply line up the holes and insert the screws as shown below. The short part of the bracket will attach to the hardware with two (2) screws. The longer part of the bracket will extend in line with the top of the hardware and mounts with four (4) screws.



Figure 23: Bracket Connected for Under-Desk Mount

10.0. Warranty Information

The equipment is warranted for a period of one (1) year following purchase. In the case of equipment upgrades, warranty applies to original date of shipment of individual components.

Other commercial equipment purchased or provided such as monitors, amplifiers, speakers, fiber optic links, etc. are also covered under the one year warranty unless otherwise stated.

The warranty does not cover improper equipment handling or improperly packaged returns. Extended warranties are available, contact ASTi for details (703) 471-2104.

Repairs and Returns

If it becomes necessary to return equipment to ASTi please observe the following instructions:

1. Request an RMA number through the form on the ASTi web site: www://www.astiusa.com/support/

The receiving department at ASTi will not receive a repair without an RMA number.

- 2. When packaging the equipment in question, make sure it is well protected. ALWAYS DOUBLE BOX the DACS/Telestra. The inner container should employ some semi-rigid, contour-fitting foam, while the exterior container should use a more pliant, shock-absorbing material such as styrofoam peanuts. The device should be properly enclosed in an anti-static bag to prevent possible ESD damage. Failure to properly package the equipment during shipping could void the warranty.
- 3. Do not send accessory pieces such as rack mount kits, power supplies or software. Only include items that do not work.
- 4. The shipping label must include the RMA number.
- 5. Include a description of the problem including the serial number for the unit in question. Include point of contact information including name, telephone number, and equipment return address. Failure to include this information could extensively delay the return of the equipment.
- 6. Evaluation of equipment is performed free of charge. No work will be done without prior customer approval.
- 7. Customer is responsible for shipping charges to ASTi for warranty and non-warranty repairs.
- 8. Note that if equipment is not under warranty, a purchase order will be required to cover any repairs. ASTi will provide a quote for all non-warranty items, including return shipping. Customer is responsible for return shipping charges on non-warranty equipment.
- 9. Equipment still under warranty will be shipped back via Federal Express, unless otherwise directed. ASTi is responsible for return shipping charges on domestic items under warranty.
- 10.If equipment is not received by ASTi within thirty (30) days of the RMA number issuing date, the request data and number issued will be closed and designated as unused.

- 11. Any items received from customers without RMA numbers or appropriate contact information included with shipment will not be tested. After sixty (60) days, ASTi reserves the right to scrap all hardware received in this condition.
- 12. **International customers** must include the correct product value on all shipping documents. Contact ASTi for proper harmonized tariff codes. The customer is responsible for duties, taxes and fees incurred in shipment of the equipment.

Disclaimer and Warnings

There are NO user serviceable components in this device. Opening the chassis will void the warranty.