LINEAR ACOUSTIC

LQ-1000

Loudness Quality Monitor

With Full-Color Loudness Speedometer™

Plus ITU-R BS.1770-1 and EBU R128 Support
and Optional Dolby® Digital/Plus/E Decoding

User Guide

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User Guide

Release Date: February, 2011
Software Version: 1.00.05 and later

Linear Acoustic Inc.
Phone: 717-735-3611
FAX: 717-735-3612
Web: www.LinearAcoustic.com

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Chapter 1: Introduction

The Linear Acoustic LQ-1000 Loudness Quality Monitor is an all-in-one unit that combines standard ITU-R BS.1770 loudness measurement with unique display techniques to simplify loudness measurement. Values are displayed graphically so that no interpretation is required better ensuring that all operators will have the same high quality result.

The LQ-1000 provides the following features:

- Triple ITU-R BS.1770 loudness meters with individual integration time adjustments (i.e. Slow, Medium and Fast) with numeric and logical color graphic indication of results: Blue=too quiet, Green-Yellow=good (spans 15dB comfort zone), Red=too loud
- **NEW:** Simultaneous EBU R128 metering with relative gating and Loudness Range (LRA)
- Quad meter engines for simultaneous measurement of 5.1+2 ITU and EBU
- **NEW:** Session and 7.5 day Weekly logging with results in graphable CSV format
- Oscilloscope and third/sixth octave real-time spectrum analyzer (RTA)
- Standard HD/SD-SDI I/O with access to all 16 audio channels and VANC metadata
- VGA output
- Headphone output with plenty of level for quiet content
- **NEW:** Scaling "Apply" function allows simple gain shifting of up to +/-24dB to be applied to input audio with safety limiter to prevent overload; automatic calculation of target vs. measured difference then manual apply
- Optional redundant power supplies
- Optional built-in dual Dolby Digital/Dolby Digital Plus/Dolby E decoding

1.1 Principles of Operation

Figure 1-1 shows the internal audio path of the LQ-1000. It should be noted that this diagram is a general representation of signal flow. Please consult the appropriate section of this manual for specific functionality.

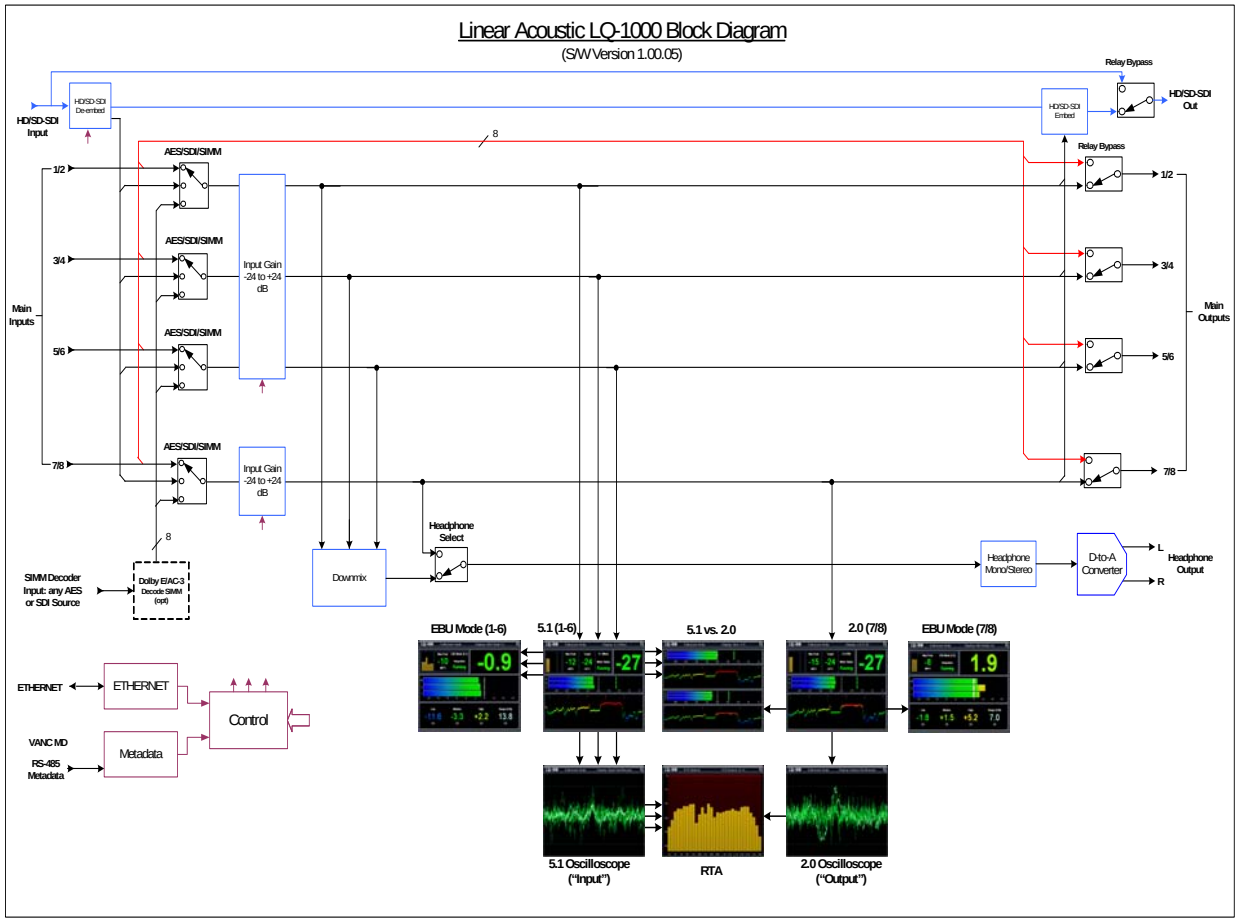

Figure 1-1 Audio Block Diagram

1.2 Reference Levels and Line Up Features

The LQ-1000 is designed to support a standard reference level of -20dBFS via its digital inputs. The LQ-1000 Plus contains a host of built in signal generation capabilities that are useful for both level calibration of downstream equipment, and for channel identification. Please see Chapter 4 for detailed information.

1.3 Powering Up and Shutting Down

With the unit plugged in to a valid AC power source, press the Left, Up, and Right buttons around the rotary encoder. The Linear Acoustic logo blue LEDs will illuminate first and the unit will then begin booting.

Shutting down is exactly the same: press the Left, Up, and Right buttons. The screen will show the shutdown sequence, then will then go blank. A few seconds later, the Linear

Acoustic logo backlight will go off and the unit is now powered off.

If there is a need to bypass the unit (LQ-1000 Plus), the best way is via Master Bypass in the System Settings menu.

1.4 Reset and Upgrades

To reset the unit, simply follow the power off procedure above, then power back on.

For software updates, the factory will provide instructions and an update file that must be copied to the USB device supplied with the unit.

WARNING: Do not connect any devices other than the supplied USB thumb drive to the USB connector on the rear panel without specific instructions from the factory!

1.5 Warranty and Feedback

Please take a moment to fill out and return the warranty card included with the unit and drop it in the mail. This will enable us to contact you if there are any software or documentation issues. Also, we are very interested in your feedback. This unit was designed based on input gathered from many broadcast and post production engineers and it will evolve further thanks to ongoing suggestions and comments from users. We look forward to hearing from you.

Chapter 2: Connections and Quick Setup

This chapter covers all required connections for the LQ-1000.

2.1 Unpacking and Inspection

Before unpacking the unit, inspect the outer carton for shipping damage. If the carton shows damage, inspect the unit in those areas. Please save the carefully designed shipping carton and packing materials. In the unlikely event that the unit needs to be returned to the factory, alternate cartons or packing materials may not be adequate and can cause damage not covered by warranty.

The following essential items are provided with the unit:

- Bag containing:
    - One or two IEC power cords (style matches country of order);
    - USB Thumb Drive for software updates
    - this manual, and a small piece of SWAG
- Warranty information: Please fill out and return the warranty card to Linear Acoustic to ensure your software and documentation are kept up to date.

2.2 Installation

LQ-1000 installation requires:

- two standard rack space units with ADEQUATE VENTILATION (the unit vents from the front side slots;
- standard 75-Ohm BNC cables for digital signal connections;

  To connect to digital equipment with 110-Ohm XLR connectors, use impedance-matching transformers (available from Canare, Neutrik and other manufacturers).
- Proper selection of reference. The unit will default to internal 48kHz, but for proper timing should be set to AES 1, AES Ref or SDI (AES Ref is only available on the LQ-1000 Plus and units shipped since February, 2011).

2.3 Rear Panel

The rear panel of the LQ-1000 contains its electrical I/O.

2.3.1 Connection Ports

All of the LQ-1000's connections are on the rear panel and are described in detail below. See Chapter 6: *Specifications* for specific pinouts.

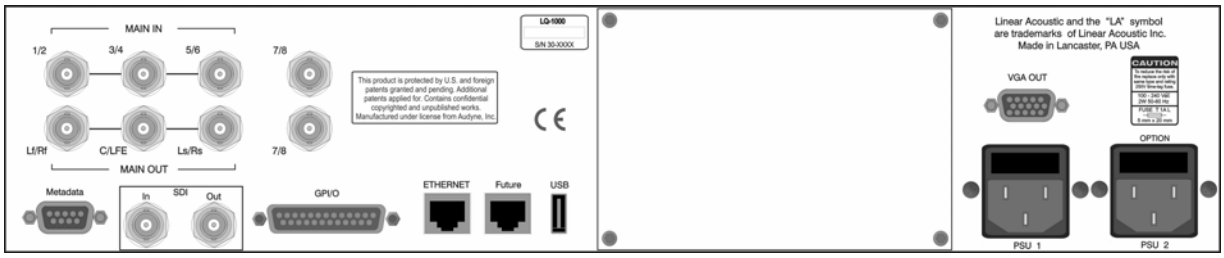

Figure 2-1 Rear Panel

- **Main In**: Connect the 48kHz PCM signals to these inputs. The input channels are arranged as follows: 1/2 = Left front/Right front, 3/4 = Center/LFE, 5/6 = Left surround/Right surround. 7/8 is for an additional +2 program, or can be left unconnected and an internal downmix can be created.

NOTE: *Appropriate reference must be selected for proper operation.*

- **Main Audio Output:** Main 48kHz processed digital audio outputs with same channel configuration as the inputs on 1-6. The output of the extra stereo +2 program is available on 7/8 or a compatible LtRt downmix of the main program can be selected.

- **Metadata I/O:** RS-485 connection accepts the metadata output of any Dolby equipment (DP572, DP570, etc...) or any Dolby-compatible metadata source. Metadata is currently only used for limited display in the "System Info" menu.

- **SDI Input:** Any of the 16 possible audio channel from an applied HD/SD-SDI signal can be de-embedded and used in place of or along with AES inputs. This can be selected in the System Options->I/O Options menu on a pair-by-pair basis.

- **SDI Output:** Up to 16 audio channels, including the Main outputs and audio channels present in the applied SDI signal can be re-embedded. Channels in the SDI stream can also be passed through in a bit-accurate manner, allowing pre-encoded Dolby E or AC-3 bitstreams to pass untouched. AES outputs remain active in parallel with embedded audio.

- **GPI/O:** Used to remotely control meter Start/Stop, Apply, Reset, and Next Screen. These inputs are in parallel with the front panel F1-F4 buttons.

- **ETHERNET:** Automatically senses 100 or 1000BASE-T Ethernet connectivity for NTP time service. The LQ-1000 has DHCP enabled and the unique MAC address is displayed in the System Info menu. Using the MAC address, a facilities network router can be programmed to assign a specific IP address to the LQ-1000.

- **Future:** Extra RJ-45 connector for future I/O use.

- **USB:** Used for software updates via factory instruction. Please Do Not connect any USB devices to this connector without factory guidance as this may affect the performance of the unit.

NOTE: *Please do not connect anything to the USB connector without specific instructions from the factory. Permanent damage can occur!*

2.4 Quick Setup Notes

The Linear Acoustic LQ-1000 is configured at the factory and is ready to go on the air after making the proper input and output connections and determining if upmixing is desired.

- Select appropriate reference from the System Options->I/O Options menu (AES Ref, AES 1, SDI, or Internal 48kHz) and make sure the selected reference is applied to the unit. If reference is missing, the "double L" signal in the upper right corner of the screen will flash red. For proper operation it should not be flashing.

- Apply audio sources to Main AES inputs and/or SDI Input.

- On a pair-by-pair basis, select the inputs to the processor in the System Options->I/O Options menu.

- You should see input audio on the top left thumbnail input meters, and you should also have audio output on the Main AES outputs.

- Pressing the "Prev." button will enter the Main Menu screen and will show Input and Output audio on larger scaled meters. Re-enter the full screen mode by highlighting the menu selection and pressing "Next".

- In Full Screen mode, press the right "Next" button to cycle through the available meters: 5.1, 2.0 (7/8), Mon +7/8 (5.1 vs. 2.0), Input Oscilloscope, Output Oscilloscope, RTA.

The best way to learn the unit is to explore the different settings with audio applied and a copy of the menu tree. There are many different ways to use this flexible unit and the menu system will quickly become familiar with just a bit of use.

2.5 Password Programming

After setup, users may wish to password-protect the LQ-1000. This will prevent unauthorized or accidental changes to the settings, however please do not forget the password!

Chapter 3: Applications and Use

The Linear Acoustic LQ-1000 Loudness Quality Meter was designed to provide all of the necessary metering tools to allow for proper loudness measurement and human-assisted control. To recap and expand on the features listed in Chapter 1:

- Loudness Speedometer™ for display of Target Loudness, Maximum Loudness, Maximum Peak, and four speeds of Current Loudness
- Triple ITU-R BS.1770 loudness bargraph meters with individual integration time adjustments (i.e. Slow, Medium and Fast) with numeric and logical color graphic indication of results:
    - Blue = too quiet
    - Green/Yellow = good (spans the ~15dB comfort zone)
    - Red = too loud
- **NEW:** EBU R128 metering with relative gating and Loudness Range (LRA)
- Quad meter engines for simultaneous measurement of 5.1+2 ITU and EBU
- **NEW:** Session and 7.5 day Weekly logging with results in graphable CSV format
- Front panel Start/Stop and Reset controls, also GPI controllable
- Headphone output with plenty of gain and drive capability
- VGA output for remote monitor
- Multichannel manually applied gain scaling of input audio +/-24dB with protection limiters to prevent overload
- Optional auto-sensing Dolby Digital/Plus/E decoding

There are myriad application for this flexible tool. The basic idea behind this meter is to enable better content creation and adjustment as early as possible in the production chain. Leaving it to even a smart transmission processor at the end will affect the original artistic intent of the program producer.

NOTE: *The golden rule is: "Get Loudness Right At Each Stage"*

3.1 Measuring Loudness

Loudness measurement is decidedly different than simply measuring audio levels. This is because loudness involves human perception and the measurement will therefore not be objective, like voltage or current, but will instead be subjective. While the mechanics of how humans hear are fundamentally the same for each person, what they perceive can vary significantly.

As hearing research has evolved from over many decades, a truly universal method for quantifying loudness in a repeatable manner was only formulated in the last few years. Until that point, the only methods available combined objective meters like VU and PPM with the "eyeball average" of an operator. Skilled operators got reasonable good results, but alas the world is running in short supply of skilled operators.

3.1.1 ITU-R BS.1770

The International Telecommunications Union (ITU) formed a study group to investigate a better and more universal answer to the question of how to objectively measure loudness. The result was published as ITU-R BS.1770 and essentially specifies a system that filters, weights, then power sums audio channels to create a repeatable numeric result. The basic block diagram for the resulting system is shown below:

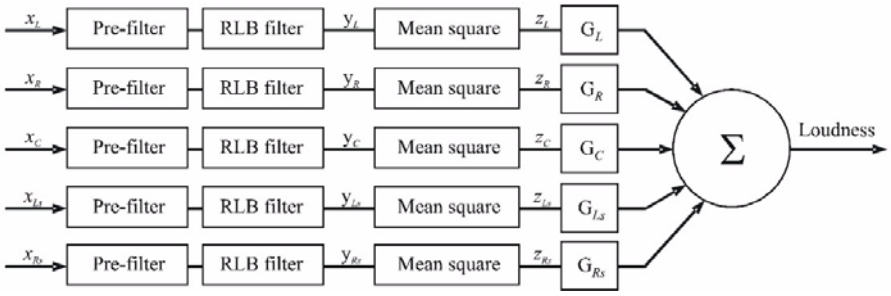

Figure 3-1 Block diagram of ITU-R BS.1770 multichannel loudness algorithm

It can be seen in the above drawing that applied multichannel audio is first filtered (by two separate stages of filtering to be explained below), then are integrated (mean square) to allow power summing, which among other things removes the effects of inter-channel phase difference causing cancellation. Note that the surround channels are boosted by approximately 1.5dB each before the sum and the LFE channel is not currently included in the measurement.

The two stages of filtering are used to remove very low frequency information that does not add to perceived loudness but will skew loudness results, and to apply a shelving high frequency boost to make up for frequency response changes due to the shape of the human head. The two filters are shown below:

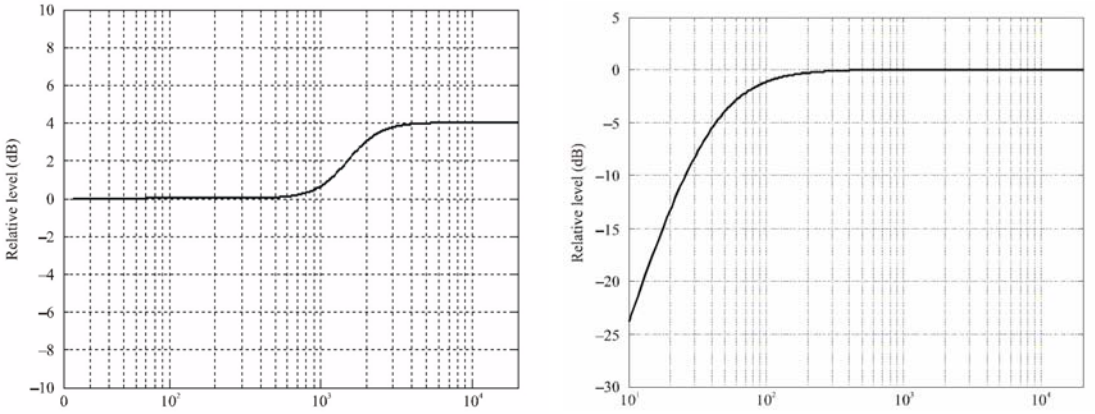

Figure 3-2 Responses of the pre-filter to account for acoustic effects of the head (left), and the RLB high-pass filter (right) combine to produce the so-called K-weighting filter.

The final output of this system is Loudness, K-weighted, with respect to Full Scale, or dBLKFS. If a 1kHz tone is applied to the L, C, or R inputs of this system, the output will indicate approximately -3 dBLKFS, and if applied to Ls or Rs will indicate approximately -1.5 dBLKFS.

The intention of the standard is to measure the loudness of a program over the entire length of the program. While this works nicely for pre-recorded content, it does not make for a useful tool for real-time use. One important part of this measurement that is not yet part of the standard is integration time. The current metering system will produce instantaneous results, but these are relatively useless because the resulting measurement varies too much and "eyeball interpretation" is once again required.

Longer integration times settle the measurement down and produce a value that correlates better with what a user actually hears and is steady enough to be useful. Scholarly research by Gilbert Soulodre of the Canadian Research Centre (CRC) and Jeffrey Riedmiller of Dolby Laboratories have suggested that a minimum useful integration time is 3 seconds and that for practical metering a 10 second average is useful. The recent work of the European Broadcasting Union (EBU) is suggesting that including an even faster value could be helpful.

3.1.2 EBU Recommendation R128

The LQ 1000 supports the new EBU R128 recommended practice for loudness metering. This new mode adds Relative Gating, display of Momentary, Slow, and Integrated loudness, and Loudness Range indication. These measurements are also captured in a Session log and an always-running 7.5-day Weekly log, all of which can be exported via USB. EBU mode runs simultaneously with standard ITU mode and all measurements are always available.

Note that while some of the readings can be useful for continuous live metering, our early experience has shown that the best use of EBU mode is on a segment-by-segment basis where the meter is Started, Stopped, then reset for the next measurement.

The following functions are supported:

- EBU Measurement gate:
    - Absolute gate below -70 LUFS (Loudness Units w.r.t. Full Scale) and a gate with a relative threshold -8 LU below absolute gated loudness level
- Numeric display of overall (integrated) loudness with respect to target to and accuracy of 1/10th LU (Loudness Unit), controlled by start/stop/reset
- Display of Loudness Range (LRA):
    - Measures the variation of loudness on a macroscopic time scale
    - Difference between low (10th) and high (95th) percentile loudness distribution
- Display of low (10th), High (95th) and Median loudness from which LRA is derived
- Simultaneous multi-speed bargraphs:
    - Momentary - 400msec integration for indicating very fast changes in loudness
    - Short Term - 3 second integration for useful indication of loudness changes
    - Integrated - Bargraph version of overall loudness (infinite)
- Color change centered on target to indicate loudness "Comfort Zone"
- Logging functions to save measurement data:
    - Timestamped (internal clock or configurable NTP connection) CSV files for direct import to external spreadsheet and graphing software
    - Session Log - All readings between Start/Stop, reset for new session
    - Weekly Log - All readings for 7.5 days, rolling capture

3.2 Measurement with the LQ-1000

After connecting signals to the LQ-1000 and ensuring that the clock is set appropriately (the "double-L" symbol should not be flashing red), measurements can begin. The most useful display is "Fullscreen Mode" where all measured details are displayed in one place. The included 11x17 print of the menu tree will be useful to have when first venturing through the menus of the LQ-1000, refer to

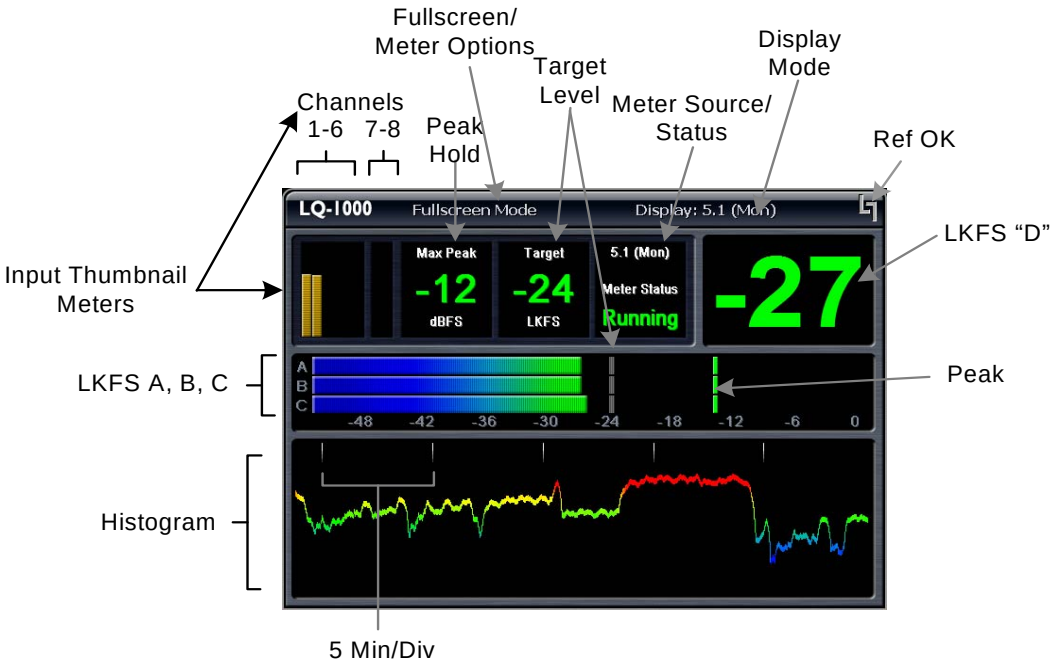

Figure 3-3 Fullscreen ITU mode display for channels 1-6

The first thing to note is signal presence on the small thumbnail meters in the upper right of the display. Next, make sure that "Fullscreen Mode" is showing on the top of the display. If it says "Meter Options" press the Left (Back) button, then press the Up button to return to the top which shows "Display: XXX". The menu tree is helpful here! Then, make sure that the desired meter is being displayed (Display: 5.1, 2.0, scope, RTA). The available meters can be cycled through by pressing the Right (Next) button.

There are three LKFS bargraph meters A, B, and C and they have been set at the factory to have integration times of 3 seconds, 10 seconds, and 30 seconds respectively. If having multiple meters is distracting, they can all be set to the same value and 10 seconds is the suggested setting.

The large numeric reading in the top right corner is LKFS meter D, and it is set to 10 second integration by default. The bottom histogram keeps a running graph of the output of LKFS meter D.

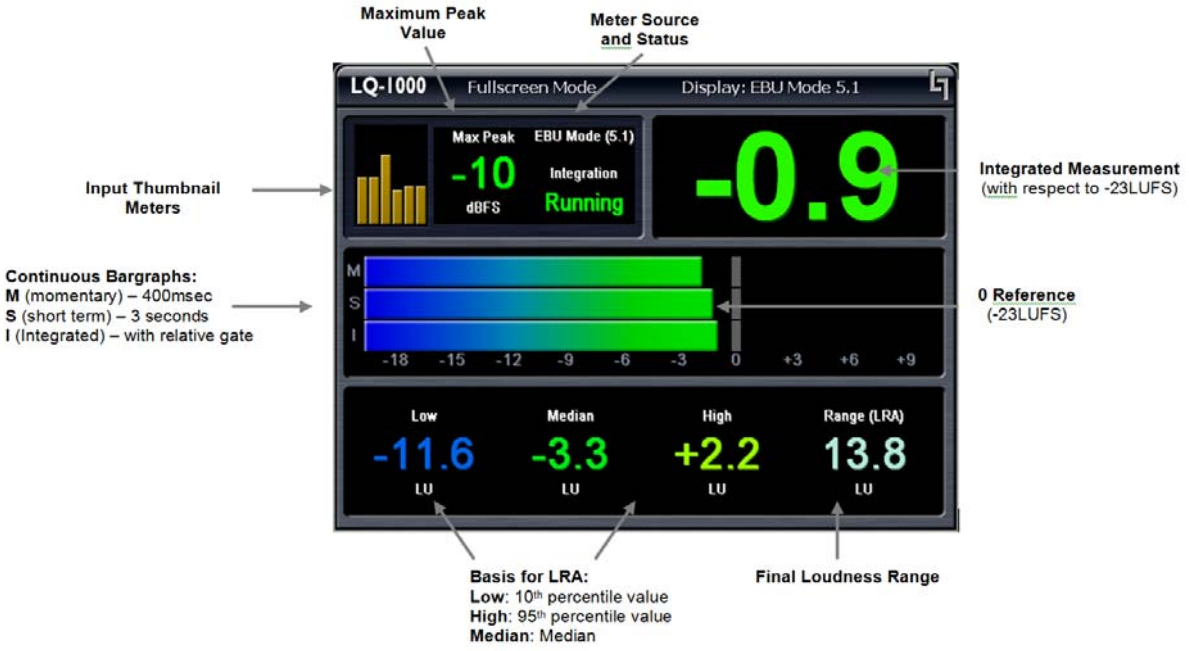

Figure 3-4 EBU Mode screen for channels 1-6

The input thumbnail meters are the same for EBU and ITU modes. The major difference is the large Integrated Measurement meter which shows loudness *relative* to -23LUFS (LKFS) and the scale is in Loudness Units (LU). A reading of 0 shows that the input audio matches the target.

The bargraphs show measurements with fixed integrations: the top is Momentary with a 400msec integration, the middle is Short term with a 3-second integration, and the bottom is Integrated with an infinite integration and the relative gate applied. This meter is simply a graphical indication of the large numerical readout in the top right.

3.2.1 Display Colors

You will notice that in all modes, the meters are very colorful. In addition to being nice to stare at while listening to some classic Pink Floyd, there is a method to the madness. The color gives a running indication of loudness with respect to the user-adjustable Target level, and the variation in color depicts the so-called loudness "Comfort Zone" which is about 15dB wide.

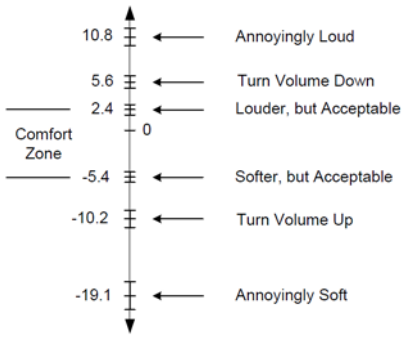

Figure 3-5 Comfort Zone (from Riedmiller, et. al.)

The Comfort Zone is asymmetrical, where audio can get about twice as quiet as it can get loud before a consumer will likely need to adjust the volume up or down. Likewise, the colors of the LQ-1000 vary from green through yellow to red (too loud) more quickly than they fall from green to blue (too quiet).

3.3 Scaling with the LQ-1000

A digital multichannel gain control is provided to scale content quickly and easily. Up to 24dB of cut or boost can be applied to the audio prior to metering and output. This can be done manually by watching the meter and adjusting the gain once content has been measured for a representative length of time (i.e. 20 seconds of a 30 second spot).

Automatic calculation of the gain correction value can be accomplished by selecting "Apply Loudness Measurement" under the "Meter Options" menu, then pressing the Right (Next) button. The difference between the Target value and the LKFS "D" measurement will be entered into the Input Gain field. To Reset the meter and the Input Gain filed, simply press the front panel F3 Reset button (with GPI enabled).

3.4 Application Examples

Below a few simple scenarios are shown in block diagram form to highlight some uses.

3.4.1 Discrete Baseband AES

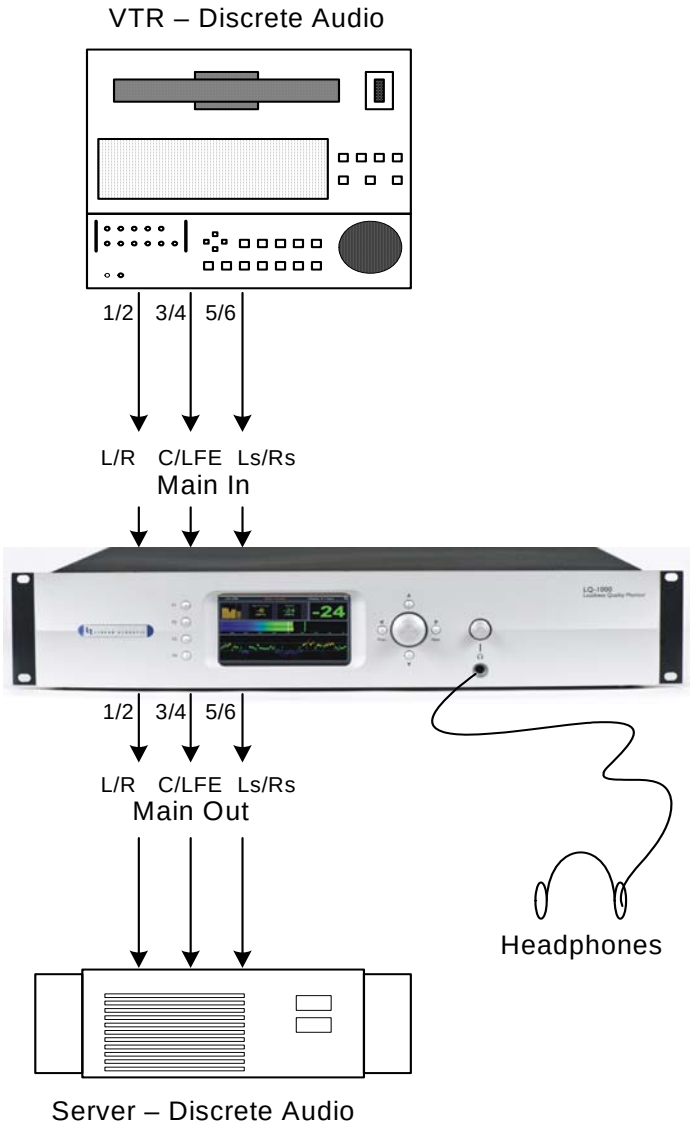

Figure 3-6 LQ-1000 Used for ingest of discrete audio channels

As shown above, discrete audio can be played back from tape, monitored for proper quality and loudness level, and manual adjustment of the content can be performed as it is captured by the server or another tape machine.

3.4.2 Discrete Baseband SDI

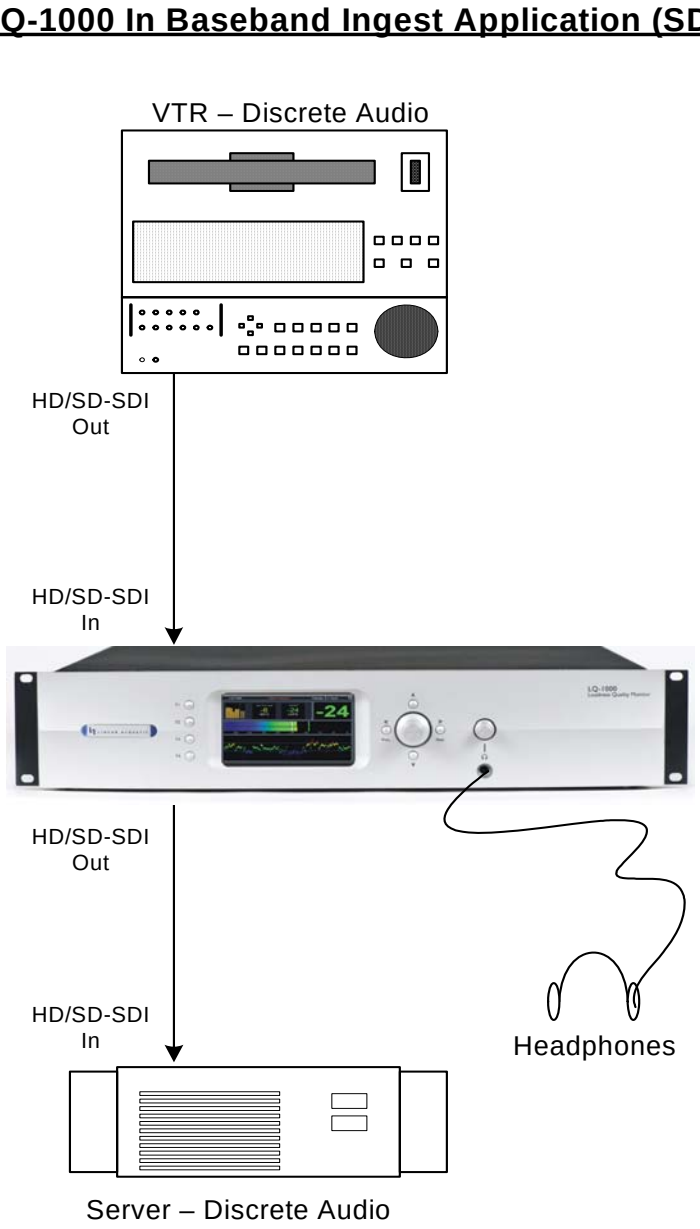

Figure 3-7 LQ-1000 Used for ingest of SDI embedded audio channels

Similar to Figure 3-5, SDI audio can be played back from tape, monitored for proper quality and loudness level, and manual adjustment of the content can be performed as it is captured by the server or another tape machine. The LQ-1000 also simultaneously outputs the audio via AES for other applications.

3.4.3 Dolby E Decode to Baseband

LQ-1000 In Dolby E to Baseband Ingest Application

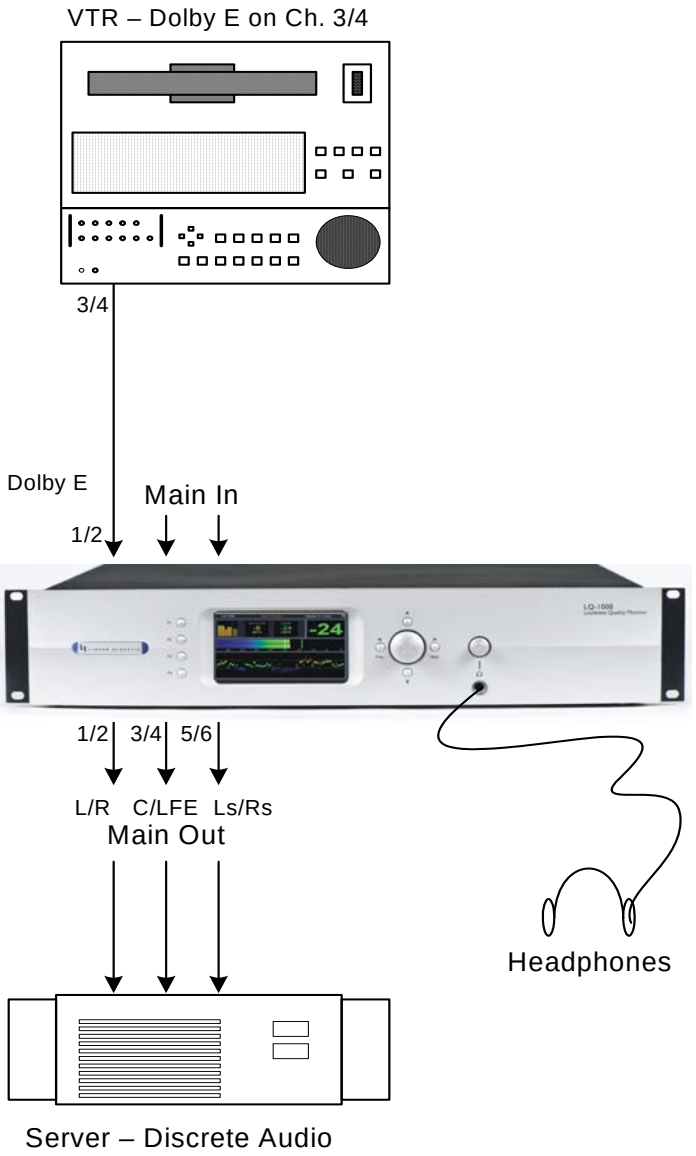

Figure 3-8 LQ-1000 used for decode of Dolby E audio and loudness measurement during ingest

The LQ-1000 can optionally contain a Dolby E/Dolby Digital decoder enabling it to replace several pieces of equipment normally used during ingest. Audio can be decoded, checked for proper loudness, adjusted if necessary, then output as discrete or embedded.

The auto-sensing capabilities of the unit allow it to easily handle either Dolby E or Dolby Digital with no re-patching or equipment changes.

3.4.4 Live Production

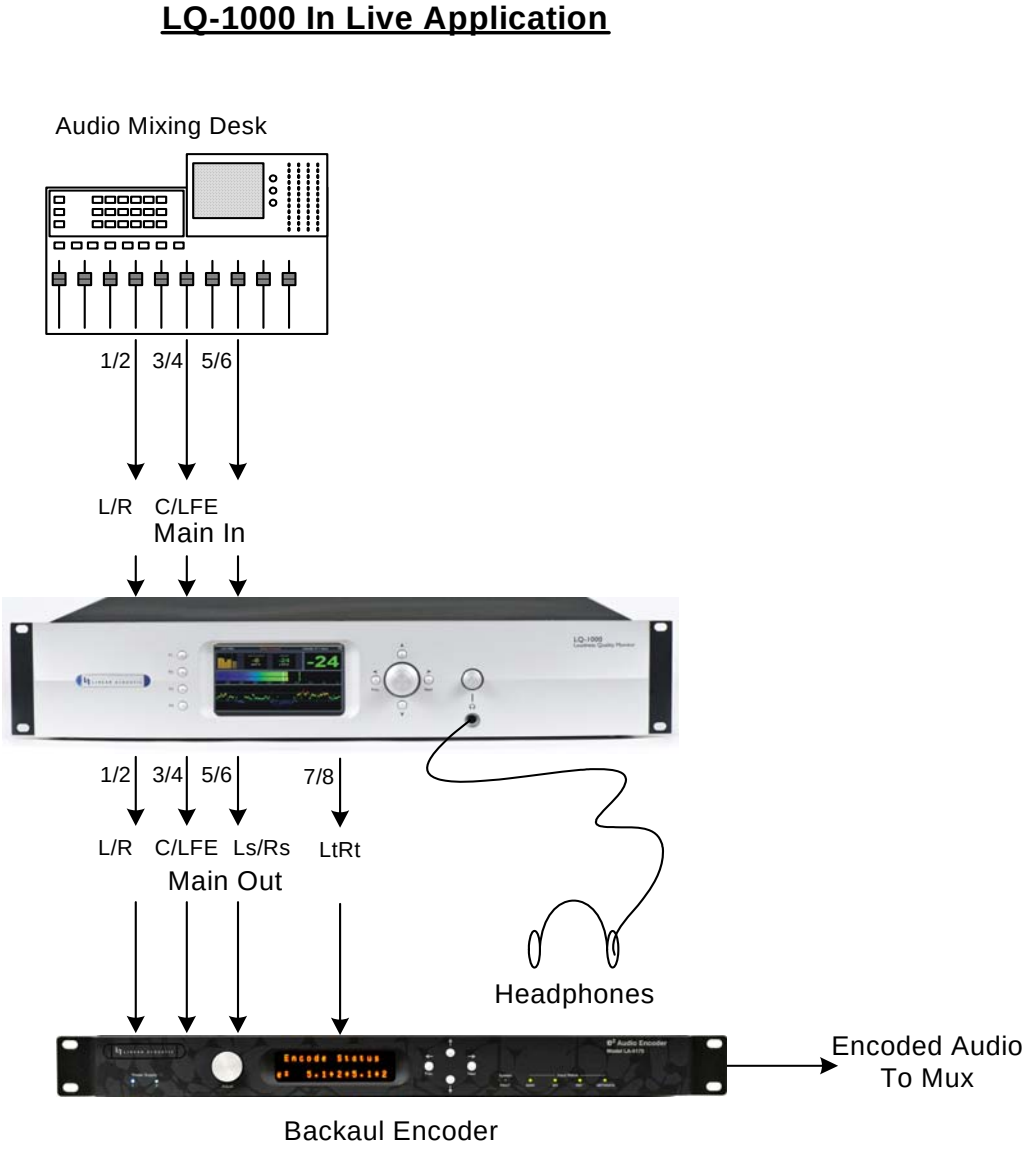

Figure 3-9 LQ-1000 used for live production

The LQ-1000 can be used during live production to provide metering, bus compression or peak limiting, and monitoring functions to enable verification of downmix. The unit can be used separately as an upmixer/loudness controller and monitor section since these two parts are separate functions.

Shown in Figure 3-8 is a greatly simplified live application. The LQ-1000 is used to measure the loudness of the live mix and feeds audio to a backhaul encoder (Linear Acoustic e-squared shown, but could be Dolby E). This setup allows a quick overall adjustment to be made if necessary. Dual power supplies and relay bypass make it ideal for live use.

Chapter 4: Detailed Operation

This chapter discusses in detail the structure of the Linear Acoustic LQ-1000, how to use the front panel LCD interface to access the menus, accessing and saving factory and user processing presets, GPI and Metadata setup, and information about test tone generation features of the unit. Definitions of the processing presets and individual adjustments are covered in detail in Chapter 7.

4.1 Main Menu Navigation

Most of it is rather obvious, and a bit of experimentation will quickly make you comfortable navigating through the submenus. If in doubt, use the Left Arrow to back out towards the Main menu. The menus and submenus are structured to access more complex functionality as you go deeper into the hierarchy. See page 31 for a menu tree.

The left side of Figure 4-1 shows the main screen in *Locked* mode. Once unlocked, the top level of the main screen looks like the right side of Figure 4-1. The meters show input, processing, and output activity for the Main Inputs. The submenus to the right of the meters are used to access the processor's functions, which are described in this chapter.

Figure 4-1 Locked Main Screen (left); Unlocked Main Screen (right)

4.1.1 System Info Menu

The **System Info** menu provides real-time statistics regarding the current state of the LQ-1000. It is a quick way to judge overall system function and status. Below is the system info screen and following are descriptions of the indicators.

:

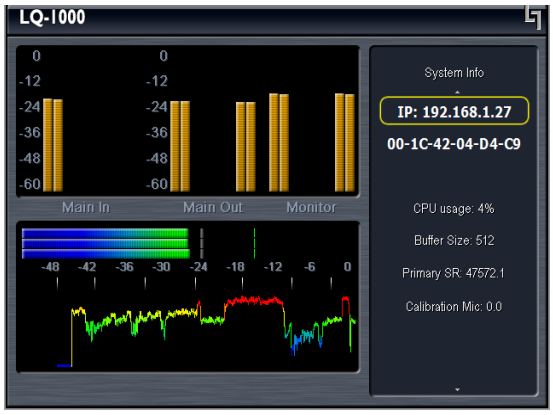

Figure 4-2 System Info menu

- **Firmware Version**
- **Host** – Unit name (normally LQ1KXXX where XXX are from the unit S/N)
- **IP Addr** – 127.0.0.1 (dynamically allocated, so this will change IF connected), directly beneath the IP address is the unique MAC address for the unit
- **CPU Usage** – Normally around 45%
- **Buffer Size –** The size of the audio buffer in samples.
- **Primary SR –** Average Sample Rate, nominally 48 kHz
- **LfRf Upmix** – Indicates whether upmixing is currently on or off (not used in LQ)
- **Metadata** – Indicates current status of incoming metadata
- **Options -** Displays installed options such as simm (Dolby decoder), SDI, etc...
-

4.1.2 System Options

The **System Options** menu provides the following functions:

- **Master Bypass** – Relay bypass of Metadata and SDI inputs to outputs; with LQ-1000 Plus, also bypasses Digital Inputs to Digital Outputs
- **Metadata Bypass** – Relay bypass of metadata input to metadata output
- **I/O Options** – General system audio and clock setup:

- **Audio Inputs** – Select the source for each of the ten processing core inputs:
  - **In 1/2 = AES In 1/2** (SDI 1/2 - 15/16)
  - **In 3/4 = AES In 3/4** (SDI 1/2 - 15/16)
  - **In 5/6 = AES In 5/6** (SDI 1/2 - 15/16)
  - **In 7/8 = AES In 7/8** (SDI 1/2 - 15/16)
  - **In 9/10 = AES In 9/10** (Not Used))
- **SDI Outputs** - Selects the source for each of the 16 possible audio channels for embedding (first and last shown, defaults in bold):
  - **Out 1/2 = AES 1/2** (AES 3-10, Enc A, Enc B, SDI 1/2 - 15/16, Mute)
  - **...**
  - **Out 15/16 = SDI 15/16** (AES 3-10, Enc A, Enc B, SDI 1/2 - 15/16, Mute)
- **SIMM Source** – Selects input for Dolby Digital/Dolby E decoder SIMM module. Allows selection of any AES or SDI input.
- **Test Tones** – See below
- **Clock Source** – Select between the following (must be 48kHz):
  - **External Reference (ONLY SUPPORTED BY LQ-1000 Plus)**
  - **AES Input 1**
  - **SDI**
  - **Internal 48kHz**
- **Metadata (status)** – Indicates presence or failure of input metadata (RS-485 or VANC). Presence will be shown as the audio coding mode of the applied program (i.e. 3/2 or 2/0).
- **Metadata Source (RS-485/VANC) -** Selects between RS-485 (serial 9-pin) metadata or metadata extracted from the vertical ancillary VANC) space of an applied HD-SDI signal.
- **VANC DID: -** Sets the Data ID for metadata extraction. Default is 0x45.
- **VANC SDID: -** Sets the secondary Data ID for metadata extraction. Default is 0x01.
- **VANC Extract Line -** Sets the video line for metadata extraction. Default is Auto.

    - **VANC Async -** Enable for SMPTE 2020M "B" mode (i.e. CBS Metadata)

- **Test Tones** – See Below (duplicated in this menu for convenience)

- **Record Audio to USB** – Allows Input, Output, or Input+Output to be recorded to a USB drive for troubleshooting purposes.

- **GPI Setup** – See Details Below

- **Time/Date Settings** – Set time, date, and NTP service for timestamping purposes. See below for setup details

- **Preferences:**

    - **Change Password** – The password is either entered here for the first time or changed. Use the rotary knob and the right arrow key to enter your password, then select **Save.** You will be prompted several times, and then you will be reminded not to lose the password. *Please heed the warning!* If you do happen to lose it, please call us to assist recovery without losing presets. If you wish to remove the password, simply enter the old password, then enter nothing for the new one and select **Save**. You will be prompted a few times, and then it will be removed.

    - **LCD Shutoff** – Permanently set to Never as unit uses OLED display.

- **Reinitialize** – Fast reset of the system software and audio drivers

- **Save Settings Immediately –** Changes to the system are automatically saved over a period of many minutes in order to minimize the chances of audible clicks and pops that may occur during a save process. However, it is sometimes useful to be able to save immediately. Selecting this function will do so, and will remind the user that it takes a few seconds even after the function has been performed.

- **Save Settings to USB –** Allows unit settings to be stored to a factory supplied or factory approved USB device connected to the rear panel USB connector. When this device is installed in an LQ-1000 unit and the system is power cycled, a startup message will prompt the user to allow restoring all settings of presets from USB.

- **Weekly Log to USB –** Saves rolling 7.5 day CSV loudness log file to USB

- **Update Software** – Allows software and firmware to be updated from the USB thumb drive included with the unit using factory supplied updater file. Selecting this option will force a system re-start, you will be prompted.

- **Power Cycle –** Slow reset of the entire system. Select this to perform a full system reboot and re-initialize; you are returned to the main menu.

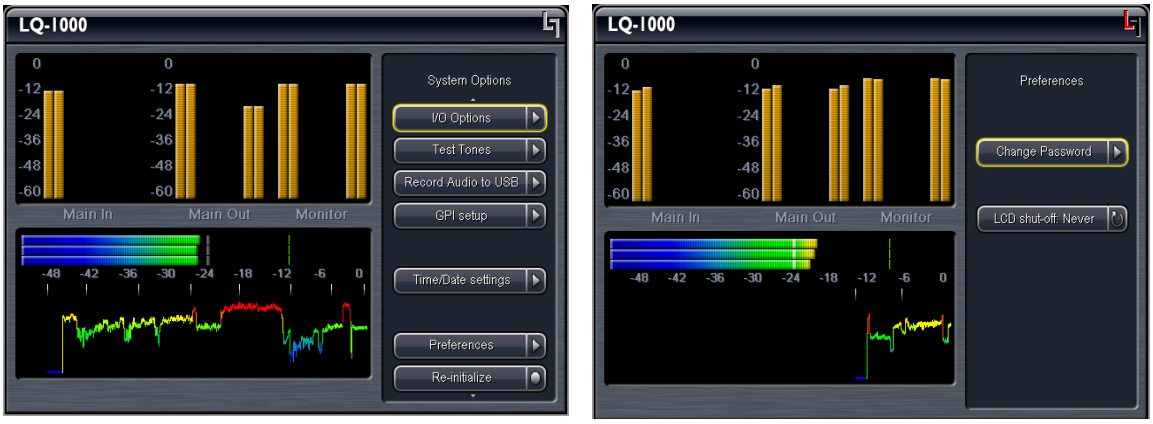

Figure 4-3 System Options menu (left) and Preferences menu (right).

4.1.3 Test Tones

Test Tones – Multiple setup tones are available to calibrate the LQ-1000 and other downstream equipment. The **Level** control is self-explanatory, and is set at the standard –20 dBFS reference level and adjusts the overall level of the test signals. **On/Off** turns the selected test signal on or off while **Cycle** determines which channels will reproduce the selected test signal. It can be adjusted to cycle through all channels, all channels of just the main program (default), and individual channels.The available test signals are:

- Sine – 1 kHz sine wave
- Voice – Voice ID of all selected channels
- Pink Noise – Equal energy-per-octave noise
- White Noise – Equal level-per-octave noise
- Brown Noise – Low-pass-filtered noise
- Brown Nose – Try it (because broadcast audio is a funny business)
- BLITS – Black and Lane Identification Test Signal (multichannel identification tones)

4.1.4 GPI Setup

The LQ-1000 supports four GPI inputs which can be controlled by contact closures via the rear-panel GPI/O connector or from the front panel F1-F4 keys which operate in parallel with external inputs. Once the GPI functions are set and GPI is enabled, additional changes are not allowed until GPI is disabled.

- GPI Input A-D - Disable, Run/Stop, Apply, Reset, Next Screen. Note that Monitor Preset selection is not currently in use.

The GPI settings are normalized to A=Run/Stop, B=Reset. C=Apply, and D=Next Screen.

NOTE: *GPI MUST be enabled for the front panel function keys (F1-F4) to operate.*

4.1.5 Record Audio to USB

Allows for capture of audio to an installed USB thumb drive. Note that this is currently intended for factory diagnosis of audio issues and requires a special player for proper reproduction. With instructions from the factory, 6 or 8 channels of input and/or output audio can be captured and emailed to us to assist with troubleshooting.

4.1.6 Time and Date Settings

Allows configuration of the LQ-1000 internal clock for correct time zone, date, and time. It also allows enabling a Network Time Piece (NTP) service which can automatically connect to a time server and keep time and date synchronized. Depending on the network to which the LQ-1000 is connected, configuration of the facilities Ethernet router may be necessary

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NOTE: *The LQ-1000 has DHCP enabled which means that it will automatically fetch an IP address from the network. To assign a static IP address, the units MAC address is provided and the local router can be configured to map the desired IP address to that unique MAC address.*

4.2 Fullscreen Menu Navigation

The Fullscreen metering menu is likely where the LQ-1000 will be set during typical use. Since the majority of the screen is devoted to providing a clear indication of a number of parameters simultaneously, there is not much room left for menus. Then again, most things will be set once per session (or once period), and anything requiring adjustment such as Start/Stop, Apply, and Reset can be controlled by the dedicated F1-F4 keys on the front panel.

The very top of the Fullscreen menu has two important sections. The left area (above the peak meter) is an indicator only and shows the current mode that will be adjusted by the right area (above the meter status) which allows selection and adjustment of parameters. Available adjustment modes are Fullscreen Mode, Meter Options, and RTA Options:

Figure 4-4 Top of Fullscreen Mode screen, showing current mode on the left (Fullscreen Mode) and parameter that will be adjusted on the right (Display: 5.1).

4.2.1 Fullscreen Mode Adjustments:

- Display - Top of the menu tree, allows selection of 5.1 (Main In 1-6), 2.0 (7/8 input or downmix selected in I/O Settings), 5.1 vs. 2.0, Input Oscilloscope (looks at 5.1), Output Oscilloscope (looks at 7/8), RTA
- Input Gain (LQ-1000 Plus only) - Provides +/-24dB of gain to input signals
- ITU Meter Options - Sub-menu for meter settings (see below)
- EBU Meter Options - Sub-menu for EBU meter settings (see below)
- RTA Options - Sub-menu for RTA settings (see below)
- Scope Channel - Adjusts the input channel that drives the oscilloscope
- Screenshot to USB - Copies the current screen to a timestamped file and stores it to an installed USB thumb drive.

4.2.2 ITU Meter Options:

- Target Loudness - Sets static display of target and target marks over bargraph meters. Default is 24.
- Input Gain - allows +/-24dB of gain to be applied to audio inputs
- Display Value: Allows top middle numeric reading to show Max Loudness, or the numeric value for meters A, B, or C.
- Integration Time (LKDFS) A-D - Adjust the integration time for each of the meters to 400ms, 3/10/30 seconds and Infinite. Default is 3 seconds, 10 seconds, 30 seconds, and 10 seconds for meters A-D.
- ITU Gating Level - Sets the threshold below which the meter automatically pauses. Default is -70dB. This is essentially a silence gate. Be careful not to adjust too low as it will remain ungated due to noise, and likewise setting too high may cause too much gating thus affecting the overall measurement.
- Infinite Integration: Run/Stop - Allows starting/stopping (pausing) meter. This can also be controlled via GPI.
- Peak Hold Time - Sets how long the peak meter will hold the last peak value. Default is 3 seconds.
- Scroll Interval - Sets how fast the histogram will scroll from left to right. Note that it acts like a "zoom" control and only on subsequent loudness values. The time between the horizontal ticks remains at 5 seconds.
- Apply Loudness Measurement - Apply the automatically calculated difference between the loudness measured by the "D" LKFS meter and the target value as an offset to Input Gain. Note that this can be done automatically by pressing the F3 front panel key when GPI is enabled.
- Save Log to USB - Saves a "session" log to USB which contains time-stamped CSV formatted loudness data. The data is started when the meter is started, and stops when the meter stops. Reset clears the data.

NOTE: *Resetting loudness measurement will clear the current data for session logging. If you want to keep this data, be sure to save to USB first!*

- Reset Loudness Measurement - Clears the integrator for all meters, does not reset Input Gain. Note that except for a setting of Infinite, all integrators are self-clearing once their time elapses (so about 30 seconds for an integration time of 30 seconds).

- Reset Peak Hold - Resets the value shown in the numeric Peak indicator.

- Screenshot to USB - Copies the current screen to a timestamped PNG file and stores it to an installed USB thumb drive.

4.2.3 EBU Meter Settings

- EBU Scale - +9 scale displays loudness from -18 to +9LU and +18 scale displays loudness from -36 to +18LU.

- Input Gain - allows +/-24dB of gain to be applied to audio inputs. For convenience, this is a duplicate of the adjustment in ITU Meter Settings, and adjusting it in either place will control the same attenuator.

- Integrated Measurement - Start/Stop the EBU integrated meter.

- Peak Hold Time - Sets how long the peak meter will hold the last peak value. Default is 3 seconds.

- Apply Loudness Measurement - Apply the automatically calculated difference between the loudness measured by the EBU Integrated meter and the target value as an offset to Input Gain (i.e. the same number shown by the top right numerical readout). Note that this can be done automatically by pressing the F3 front panel key when GPI is enabled.

- Save Log to USB - Saves a "session" log to USB which contains time-stamped CSV formatted loudness data. The data is started when the meter is started, and stops when the meter stops. Reset clears the data.

NOTE: *Resetting loudness measurement will clear the current data for session logging. If you want to keep this data, be sure to save to USB first!*

- Reset Loudness Measurement - Clears the integrator for all meters, does not reset Input Gain. Note that except for a setting of Infinite, all integrators are self-clearing once their time elapses (so about 30 seconds for an integration time of 30 seconds).

- Reset Peak Hold - Resets the value shown in the numeric Peak indicator.

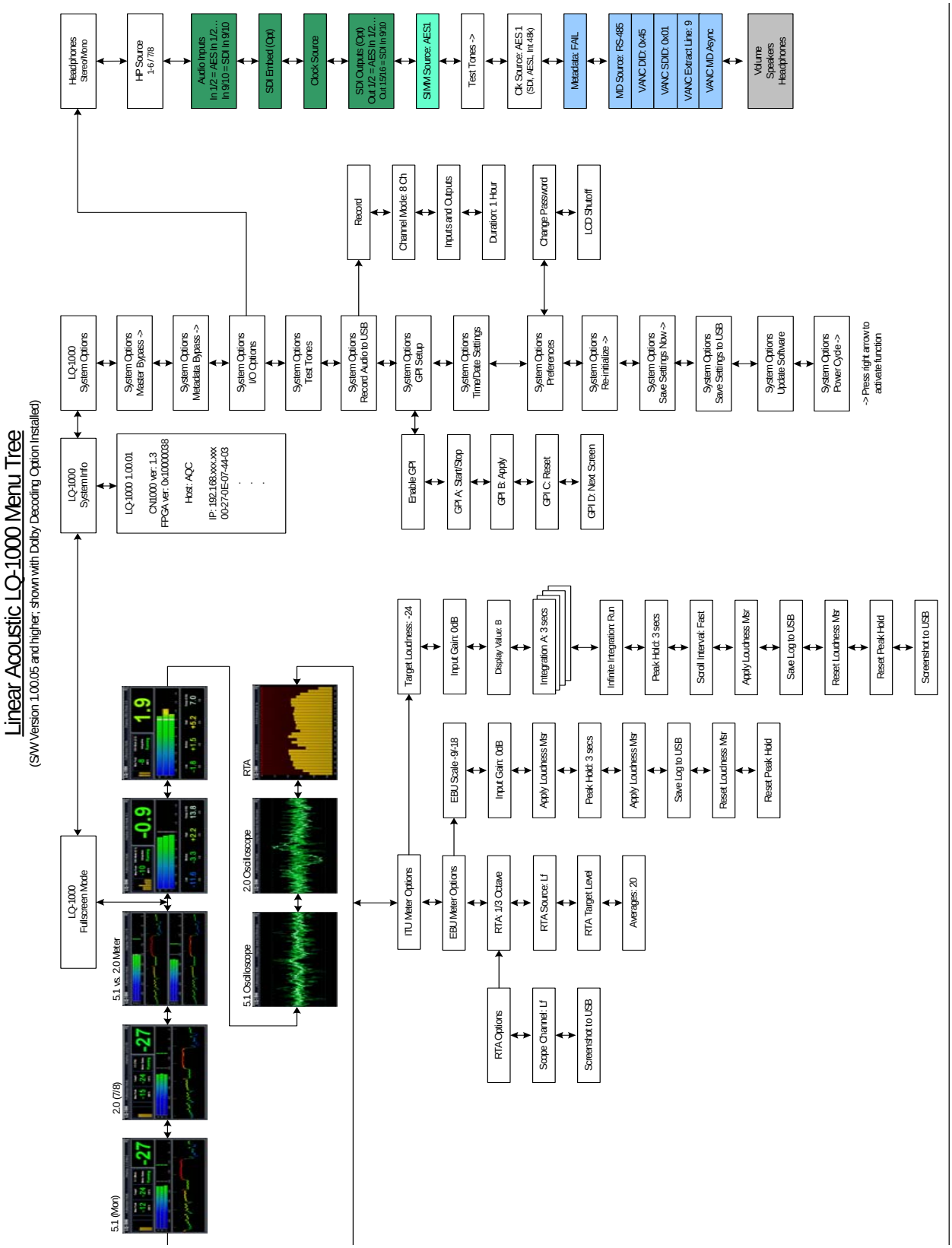
4.2.4 RTA Options:

- 1/3 octave/1/6 octave - sets the analyzer to 30 bands or 60 bands. Typical measurements require only 1/3 octave resolution.

- RTA Source - Select the input for the RTA

- Target Level - Adjusts a horizontal target line, used for display only

- Averages - Sets the averaging for the RTA. Lower averaging results in a faster display which is nice to look at but harder to use when calibrating low frequencies. A typical value in the 20-50 region is useful for analyzing the frequency response of an input signal, higher numbers for room calibration.


Linear Acoustic LQ-1000 Menu Tree
(SW Version 1.00.05 and higher; shown with Dolby Decoding Option Installed)
Headphones Stereo/Mono
HP Source 1-6 / 7/8
Audio Inputs In 1/2 = AES In 1/2... In 9/10 = SDI In 9/10
SDI Embed (Opt)
Clock Source
SDI Outputs (Opt) Out 1/2 = AES In 1/2... Out 15/16 = SDI In 9/10
SIMM Source: AES1
Test Tones ->
Clk Source: AES 1 (SDI, AES1, Int 48k)
Metadata: FAIL
MD Source: RS-485
VANC DID: 0x45
VANC SDID: 0x01
VANC Extract Line: 9
VANC MD Async
Volume Speakers Headphones
LQ-1000 System Options
System Options Master Bypass ->
System Options Metadata Bypass ->
System Options I/O Options
System Options Test Tones
System Options Record Audio to USB
System Options GPI Setup
System Options Time/Date Settings
System Options Preferences
System Options Re-initialize ->
System Options Save Settings Now ->
System Options Save Settings to USB
System Options Update Software
System Options Power Cycle ->
-> Press right arrow to activate function
Record
Channel Mode: 8 Ch
Inputs and Outputs
Duration: 1 Hour
Change Password
LCD Shutoff
LQ-1000 System Info
LQ-1000 1.00.01
CNU000 ver: 1.3
FPGA ver: 0x10000038
Host: AQC
IP: 192.168.xxx.xxx
00:27:0E:07:44:03
Enable GPI
GPI A: Start/Stop
GPI B: Apply
GPI C: Reset
GPI D: Next Screen
LQ-1000 Fullscreen Mode
5.1 (Mon)
2.0 (7/8)
5.1 vs. 2.0 Meter
5.1 Oscilloscope
2.0 Oscilloscope
RTA
ITU Meter Options
EBU Meter Options
RTA: 1/3 Octave
RTA Source: Lf
RTA Target Level
Averages: 20
RTA Options
Scope Channel: Lf
Screenshot to USB
Target Loudness: -24
Input Gain: 0dB
Display Value: B
Integration A: 3 secs
Infinite Integration: Run
Peak Hold: 3 secs
Scroll Interval: Fast
Apply Loudness Msr
Save Log to USB
Reset Loudness Msr
Reset Peak Hold
Screenshot to USB
EBU Scale -9/-18
Input Gain: 0dB
Apply Loudness Msr
Peak Hold: 3 secs
Apply Loudness Msr
Save Log to USB
Reset Loudness Msr
Reset Peak Hold

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Chapter 5: Troubleshooting

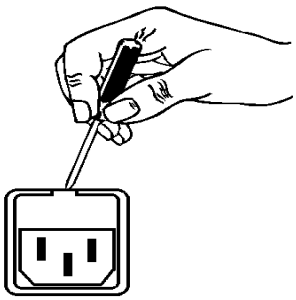
The Linear Acoustic LQ-1000 is a very stable and reliable unit, and most problems can be traced back to mis-wiring causing incorrect signals to be applied to the unit, or more than likely mis-configuration. As simple as the unit is to use once installed, it is very flexible and thus necessarily somewhat complex. In an effort to speed troubleshooting, some common problems and solutions are described below.

5.1 Problems and Possible Causes

One of the best troubleshooting features of the LQ-1000 is the hard-bypass of the audio signals. This is useful because it allows instant removal of the unit from the signal path. Hard-bypass can be accomplished two ways, the simplest being to remove AC power from the unit by turning the power switch off. A less dramatic way to accomplish the same result is to access the System Options menu and enable Master Bypass. If you are unsure of what is happening in a particular system, simplifying the signal path is a good start and will help isolate problems quickly.

5.1.1 Unit won't power on

Check to make sure that the unit is connected to a live outlet (it happens...). If proper AC voltage is being applied to the unit, remove power and check the fuse (the IEC inlet module has a fuse compartment that can be carefully opened with a small screwdriver). If the fuse is blown there is a spare in the holder. Install the replacement fuse, re-insert the fuse carrier, and re-apply power.



NOTE: *Replace fuses only with the same size and rating: 5mmx20mm T1AL (250V)*

With the unit plugged in to a valid AC power source, press the Left, Up, and Right positions surrounding the rotary encoder. The Linear Acoustic logo blue LEDs will illuminate first and the unit should then power on normally.

5.1.2 The "LA" symbol is flashing red

The small Linear Acoustic logo in the upper right corner of the display is used to indicate that the reference input is either missing or wildly incorrect. Check to make sure that an AES signal is connected to Main Input 1 or that there is an SDI signal present, then make sure the clock is set appropriately (see Chapter 4).

5.1.3 Output Audio Clicks and Pops

This could indicate that the chosen reference signal is missing or at the wrong sample rate (the unit expects to be locked to 48kHz). The unit is designed to default to an internal 48kHz reference in case the external reference is removed. This allows audio to continue, but due to the sample rate converters present on each input pair, the outputs will be asynchronous with the inputs. The solution is to make sure that the reference is connected.

It could also mean that audio applied to the unit is not properly referenced, or that the equipment that the LQ-1000 is feeding is not properly referenced. Using the master bypass function of the unit is a helpful way to troubleshoot this issue.

5.1.4 Audio Sounds Strange

Reports of audio that sounds like it is in a tunnel indicate timing issues between the channel pairs. Most often viewers watching in stereo will be the first to notice such problems. Offsets as small as a couple of milliseconds may quickly become audible under the right conditions.

5.1.5 Audio Fixed by Re-boot

This can be a very misleading situation. Experience has shown that re-booting can sometimes fix things by interrupting the AES signals thereby causing equipment downstream to re-lock to the incoming signals. This will sometimes mask the true problem. Careful and methodical troubleshooting is essential, clocking issues can be tricky.

5.1.6 Audio Has Artifacts

Sometimes described as "squirrels in the surrounds" this is almost always caused by source content that has been encoded at too low a rate. For example, some program delivery services or server systems may use MPEG 1, Layer 2 audio data reduction to save bandwidth. When operated at 256kbps or higher per stereo pair, there will be no issues. However, 128kbps or lower can result in coding artifacts that are present in the original stereo and may be unmasked by when isolating channels. Note that this content is inferior in quality and will have worse results if consumers matrix decode the signal (which is the default mode for most home theatre A/V receivers fed with stereo). Our best advice is to take this up with the program provider or server manufacturer. Today, bandwidth is cheap and there is no good reason to run lower than 256kbps per channel pair at a minimum.

Chapter 6: Specifications

Table 6-1 Electrical Specifications

Sampling Rate	32-96 kHz, 48kHz nominal (±0.1%)
Word Length	24-bits
Measurement Algorithm	ITU-R BS.1770-2 with EBU R128 support
Digital Audio In	Four unbalanced female BNC connectors, comply with AES-3ID-2001/SMPTE 276M. Internal 75-Ohm termination.
Digital Audio Out	Four unbalanced female BNC connectors that comply with AES-3ID-2001/SMPTE 276M specifications.
Metadata Input/Output	RS-485, 9-pin female D-connector on rear panel
GPIO Port	TTL level, 25-pin female D-connector
Ethernet	RJ-45 female jack connector 10-1000 BASE-T, supports logging and streaming audio (LeifWire(TM))
Analog Headphone Output	
Frequency Response	20 Hz–20 kHz, ±0.5 dB
Distortion	Less than 0.1% at 1 kHz Less than 0.2%, 20 Hz–20 kHz
Output Level	+12dBu maximum into 600 Ohms
SDI	
HD/SD-SDI I/O	Audio can be de-embedded (demuxed) from any of the four groups and re-embedded (muxed) into any of four the groups. Signals per SMPTE 299M-2004/292M-2004. Metadata can be extracted from VANC per SMPTE 2020 A or B. Supports 1080i/720P 50/59.94

Table 6-2 Mechanical Specifications

Dimensions	3.5 × 19 × 17 in (8.9 × 48.3 × 43.2 cm)
Net Weight	10 lb (4.5 kg) approx.
Shipping Weight	14 lb (6.4 kg) approx.
Power Requirements	90-240 VAC, auto-sensing, 50–60 Hz
Power Consumption	40 W maximum

Table 6-3 Environmental Specifications

Operating Temperature	0°C to 50°C, fan cooled
Non Operating Temperature (Storage)	–20°C to +70°C
Humidity	Up to 98% relative humidity, non-condensing
EMC Radiation Limits	FCC Part 15 Class A, ICES-003

Metadata Input Port

9-pin female D-connector with full-duplex RS-485 protocol running at 115 kbps. Pinout is compatible with SMPTE 207M. Pin-for-pin compatible with Dolby metadata sources (i.e. straight-through cable should be used.

Table 6-4 Metadata I/O Port Pinout

Pin	Connection
1	Shield
2	TX A asynchronous data out –
3	RX B asynchronous data in +
4	Ground
5	NC
6	Ground
7	TX B asynchronous data out +
8	RX A asynchronous data in –
9	Shield

Ethernet Port

Standard RJ-45 female connector that supports 10 to 1000BASE-T.

GPI/O Parallel Control Port

TTL level controls, active Low. GPI A and B are held low to activate their assigned function, while GPI 1-6 require momentary contact to ground to activate their functions. The 5-V output for external GPO indicators is limited by a self-resetting fuse.

Table 6-5 GPI/O Parallel Control Port Pinout

Pin	Function	Pin	Function
1	+ 5 V (150 mA)	14	+ 5 V (150 mA)
2	GPI A (Hold Low = On)	15	Ground
3	GPI B (Hold Low = On)	16	Ground
4	GPI C (Hold Low = On)	17	Ground
5	GPI D (Hold Low = On)	18	Ground
6	RESERVED	19	Ground
7	RESERVED	20	Ground
8	RESERVED	21	Ground
9	RESERVED	22	Ground
10	Unit Status (NC): Open = OK	23	Unit Status: Common
11	Unit Status (NO): Closed = OK	24	GPO 1
12	GPO 2	25	Ground
13	Ground		