Bose® ControlSpace® SP-24 Sound Processor Theory of Operation

The ControlSpace® SP-24 Sound Processor is a 1RU chassis with two XLR audio inputs, and four XLR audio outputs. It incorporates an LCD display on the front panel for setup. Setup and menu navigation are accessed by using four directional push buttons, and a Select/Load button. Signal present (green) and Clip (red) indicators are visible on the front panel. The SP-24 incorporates a universal switch-mode power supply and an IEC AC receptacle is on the rear panel. The rear I/O panel includes a USB port for connecting the controller to a PC running the SP-24 Editor software and to facilitate software upgrades.

The following is a brief functional description of the SP-24 PCB assemblies.

Main Power supply (switch-mode):

- Universal mains input, accepts 100-240VAC, 50/60Hz
- Generates +12VDC, -12VDC, +5V, and +3.3V
- Includes Standby mode that is controlled by the front panel Standby switch

Rear Panel PCB:

- Two analog XLR audio inputs
- Four analog XLR audio outputs
- USB port
- Output relays for On/Off pop control

Front Panel PCBs:

- LCD display module
- Navigation buttons
- Signal Present/Clip indicators
- Standby button

DSP PCB:

- DSP for audio processing with associated memory
- A/D and D/A conversion
- CPLD for miscellaneous logic, mute, LED drive, and transceiver functions
- Local voltage regulation for DSP Core
- Selectable analog gain circuitry

Switch-Mode Power Supply

Refer to the schematic sheet for the Switch Mode Power Supply PCB, part number 298155, for the following information. The information inside the brackets [ ] are the component's grid coordinates on the schematic sheet.

The power supply is a primary switch mode power supply (SMPS) that generates DC voltages for the other PCB's. It can be put into a standby mode using the on/off header XS2 [C6] on the SMPS.

Switch-Mode Power Supply (continued)

Digital circuits run on 5VDC and 3.3VDC to minimize power consumption. The DSP core voltage is 1.2V, and uses a separate regulator (U504) on the DSP PCB. All analog audio circuits are powered at +/- 12VDC to maintain a large dynamic range. Total power consumption is less than 15W. The power supply is non-repairable.

Input/Output PCB

Refer to the schematic sheet for the Input/Output PCB, part number 353803-001S, for the following information. The information inside the brackets [ ] are the component's grid coordinates on the schematic sheet.

The Input / Output PCB contains the input and output XLR connections, signal conditioning circuits, On/Off pop control circuits, and the USB connector and microcontroller. The two balanced inputs from J601 and J602 [A2 and A4] are passed to the DSP PCB for Gain Control and A/D conversion. The four output signals, DAC CH1 to CH4, come from the DSP PCB, and the differential drive buffers connect to the output XLR connectors J701 [D5], J702 [C5], J703 [D11] and J704 [C11] through output relays K1 [D4], K2 [D10], K3 [C4] and K4 [C10] that are controlled by anti-pop circuits at turn-on and turn-off.

A standard USB type B connector, J201 [A8] is on the rear panel. This connector is connected to a USB microcontroller, U202 [A10] that provides control and monitoring of the DSP state via a Windows PC running the SP-24 Editor software. This software is also used to update the firmware code and EQ presets in the SP-24. Refer to the firmware and loudspeaker EQ update procedures located in the service manual, reference number 352427-SM, for instructions.

Button and LED, Standby Switch and LCD Display PCBs

Refer to the schematic sheet for the Button and LED PCB and the Standby Switch PCB, part number 298160, for the following information. The information inside the brackets [ ] are the component's grid coordinates on the schematic sheet.

The front panel has three separate PCBs attached; the Button and LED PCB, the Standby Switch PCB and the LCD Display PCB.

The first is the Button and LED PCB, which contains the five push buttons for menu navigation, and the signal present/Clip LEDs. The navigation and Select/load button are scanned by the DSP (U501) [DSP schematic sheet, location A/B 5/6]. The signal present and clip LEDs are driven by the DSP through U507 [DSP schematic sheet, B3].

The second PCB located on the front panel is the LCD Display PCB. This is a separate PCB because it incorporates chip-on-board technology that is non-repairable. This PCB assembly is bought as a module from a third-party vendor. If the display fails, the entire PCB assembly must be replaced. The display is a blue backlit LCD module that is controlled through the CPLD IC U502 [DSP schematic sheet, A10]. The Display PCB is fed from J303 [Button and LED PCB schematic sheet, C/D1] located on the Button and LED PCB. The control and display signals for the Display PCB are fed to the Button and LED PCB at J302 [Button and LED PCB schematic sheet, A/B1] from the DSP PCB at CN500 [DSP schematic sheet, B2].

Button and LED, Standby Switch and LCD Display PCBs (continued)

The third PCB assembly located on the front panel is the standby switch PCB. This is a 2PST switch (SW106, [D4]) that controls the remote On/Off feature on the SMPS and is used to put the unit into Standby mode when not in use. The remote On/Off feature on the SMPS is also used by the anti-pop circuit on the Input/Output PCB. J105 [C2] connects to the I/O board, carrying the relay power enable/disable signal to control relays K1 – K4.

Digital Signal Processor PCB

Refer to the schematic sheet for the Digital Signal Processor PCB, part number 353804-001S, for the following information. The information inside the brackets [ ] are the component's grid coordinates on the schematic sheet.

The DSP board utilizes a Texas Instrument TMS320D708, U501 [C5/6] for audio processing, a Burr-Brown PCM1804 2 channel analog to digital converter U512 [B10] and Cirrus CS4392 2 channel digital to analog converters, U508 [C9] and U509 [B9]. An Altera EPM3032-10 CPLD, U502 [D10] performs glue logic functions between the different components on the DSP board.

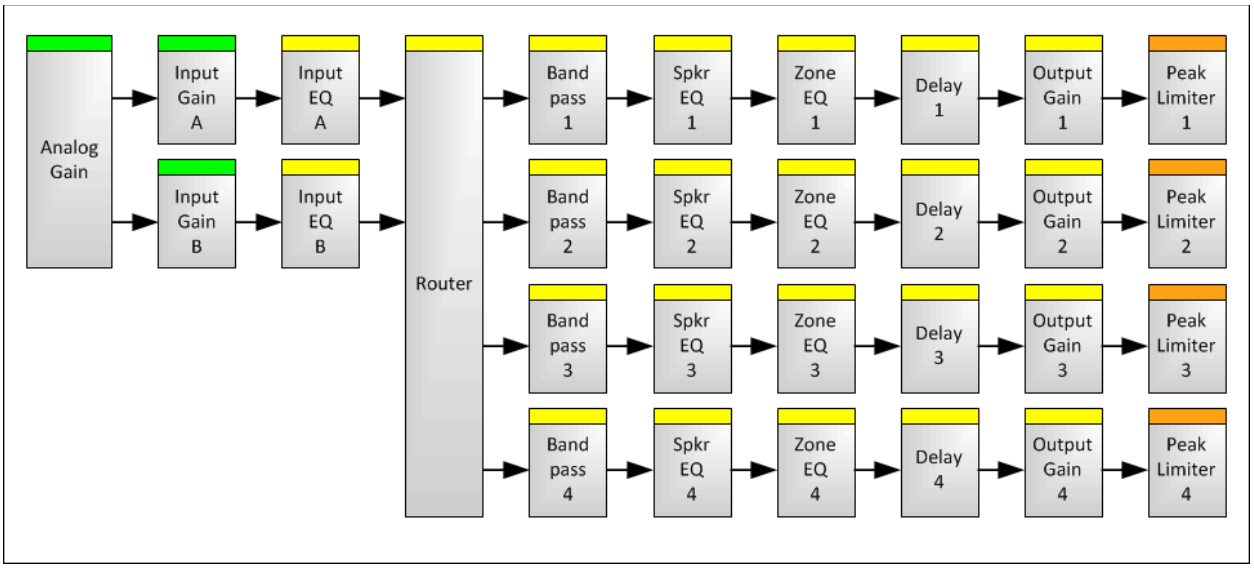

Figure 1 - DSP Signal Flow Diagram

The two differential audio inputs from J601 and J602 come from the Input/Output PCB, and travel through a software selectable differential gain circuit using the OPA1632 U516 [A3] and ADG452 U514 [A5]. From there, they enter U512 [B10] (the PCM1804 high performance differential A/D converter). Signal processing is done at 44.1 kHz, 24 Bit within the DSP subsystem. Once processed, the four output signals are sent to U508 [C9] and U509 [B9] (the differential D/A converters) and then over to the Input/Output PCB via CN502 [A/B11]. J501 [D8] accepts a JTAG header for interrogating the DSP chip. J500 [D9] is used to program the CPLD, U502, [D10] on the production line. The system uses a 4Mbit flash memory, U500 [D2]. All code (except the CPLD) is up-loadable over the serial port to facilitate field upgrades.

The main system oscillator is 22.5792MHZ Y500, [C9]. It is conditioned by the CPLD, and presented to the DSP which in-turn generates the necessary clocks for the system (A/D, D/A, LCD).

The DSP implements the signal flow diagram shown in Figure 1 and also performs the following functions:

1. All audio signal processing functions.
2. Sense key press inputs on the front panel board.
3. Display the menu structure on the LCD module.
4. Set gain levels on the analog input hardware.
5. Generate clocks for both the ADC and DAC's
6. Provide a serial interface for code updates.
7. Read flash memory for power-on code load and preset access.

ADC and DACs

The ADC converts the incoming analog signals from the line inputs into a digital serial data stream, which is connected, to the McASP on the DSP.

The DACs convert the serial data output of the DSP to analog signals that are in connected to the line level outputs. The DACs have internal gain controls that are not used in the SP-24.

Flash Memory
The AM29LV400BB flash memory part is used in byte mode (512 kbytes) and is configured with preset data and 3 discrete programs that serve different functions in the operation and maintenance of the SP-24.

CPLD
The Altera EPM3032 provides the glue logic functions such as chip select decoding.

Below is a system block diagram:

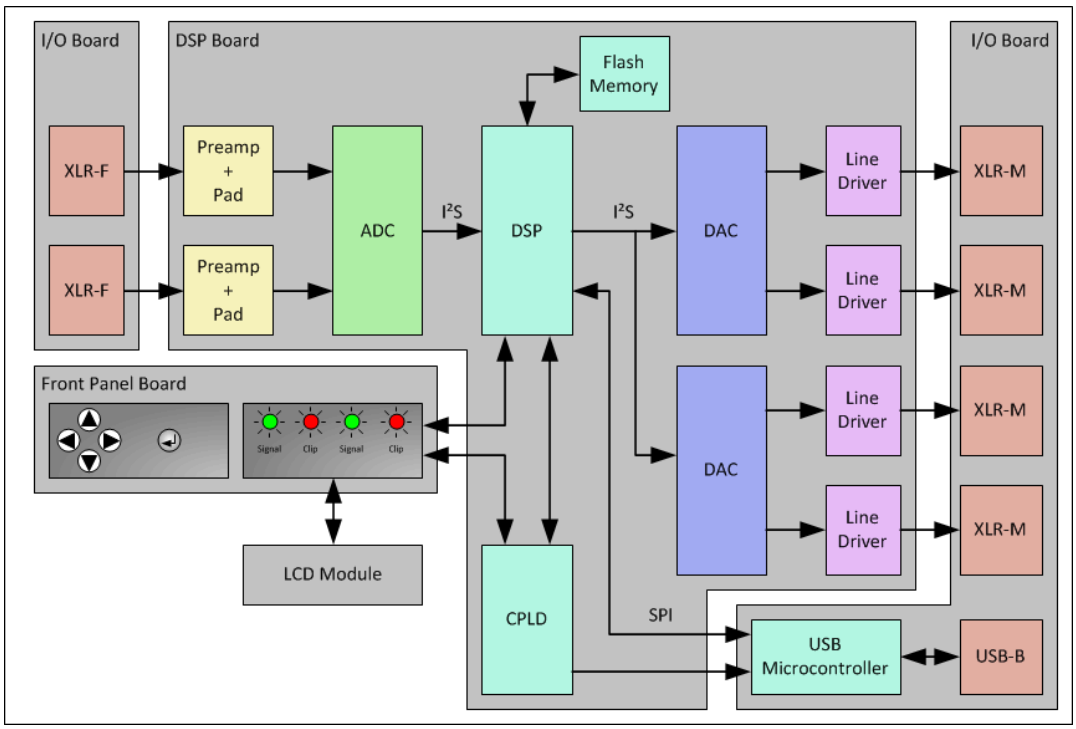

Figure 2 - SP-24 Hardware Block Diagram

Bose® ControlSpace® SP-24 Sound Processor Block Diagram

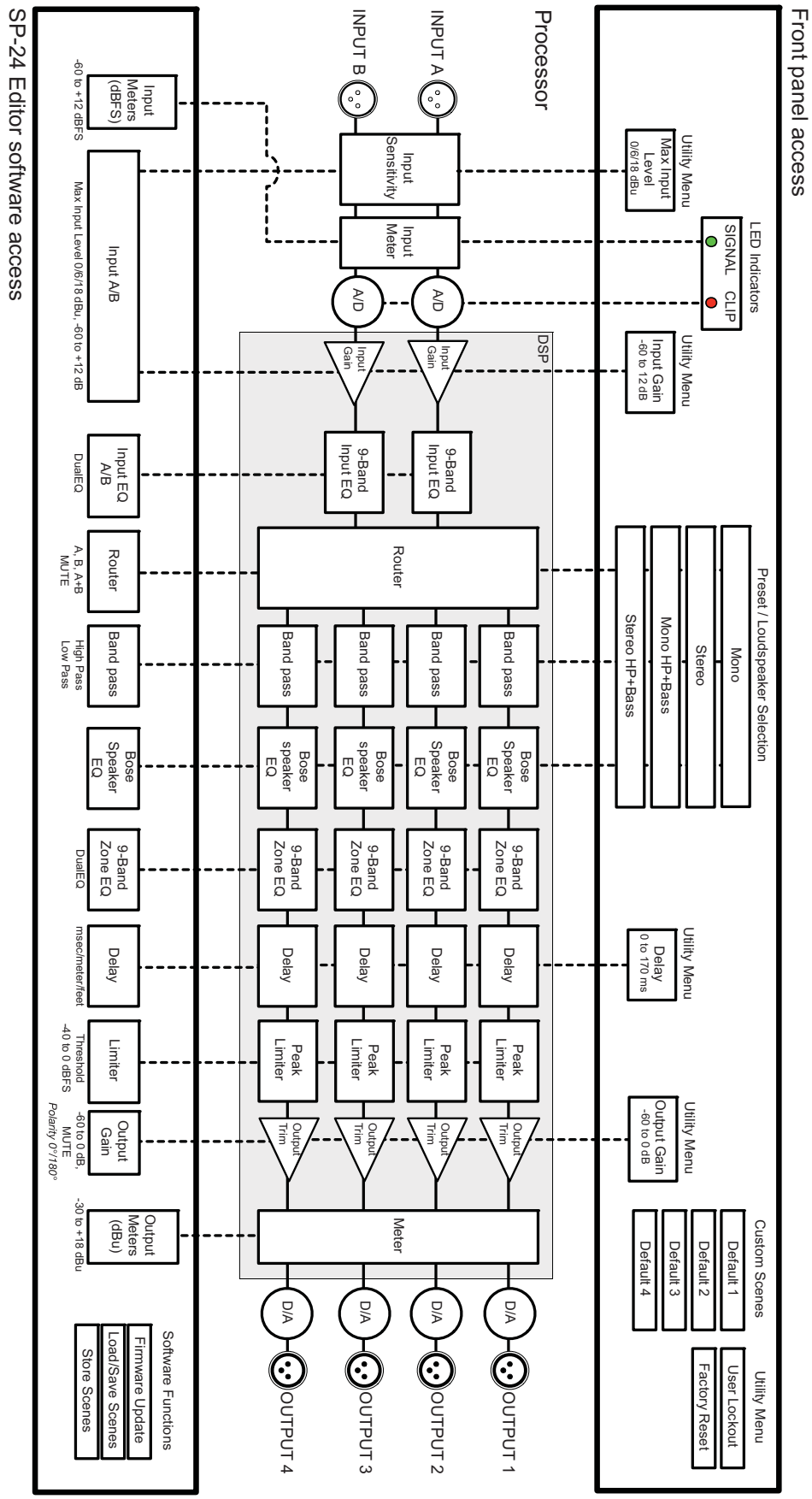

Figure 3 - SP-24 System Block Diagram