

StudioComm for Surround

Model 780-02 Central Controller and Model 790 Control Console

User Guide

Issue 4, December 2020

**This User Guide is applicable for systems consisting of:
Model 780-02: serial number M780-02-00151 and later with
software version 1.00 and higher and FPGA version 4.15 and higher;
Model 790: serial number M790-00151 and later with software version 1.00 and higher**

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Revision History

Issue 4, December 2020:

- Revised how dim values are stated. Now are four positive dB values. Operation does not change. For clarification only.

Issue 3, October 2016:

- Revised text for error codes Err1, Err2, and Err3; added text for error code Err4.

Issue 2, April 2015:

- Revised specifications to reflect final audio performance measurements.
- Text clarifications.

Issue 1, January 2015:

- Initial release.

Introduction

What This User Guide Covers

This User Guide is designed to assist you when installing and using the Model 780-02 Central Controller and one or more associated Model 790 or Model 71 Control Consoles.

Overview

Creating and distributing eight channel (7.1) surround audio material has become common for entertainment, cinema, and allied applications. As such, the ability to simply and effectively monitor these sources is imperative during the recording and post-production process. Studio Technologies has addressed these needs with the StudioComm for Surround Model 780-02 Central Controller and the Model 790 and Model 71 Control Consoles. With digital audio inputs, analog monitor output, support for multiple user control surfaces, and an extensive set of resources it's a simple task to integrate a monitoring system into virtually any facility. The carefully selected group of features, including two surround (7.1) and one stereo input, configurable input-source time delay, LFE low-pass filter, analog surround (7.1) monitor output, configurable downmix and mute/solo functions, and bass management, along with a multi-format sync input, make the system powerful yet simple to operate. And by using the best of contemporary technology, as well as following rigorous design practices, the system's audio quality is excellent.

A StudioComm for Surround system starts with the Model 790 Control Console. It's the system's "command center" and is designed to reside at a user's location, allowing fingertip selection of all monitoring

functions. Numerous LEDs provide complete status information. A 4-digit numeric display indicates the level of the monitor output. A major strength of the Model 790 is its ability to configure, under software control, many important operating parameters. Intended for secondary monitoring locations that don't require all of the Model 790's features, the Model 71 Control Console is a compact user control surface. It provides three of the most basic functions: a rotary level control, dim on/off button, and reference level on/off button.

Most installations will use only one Model 790 Control Console. However, up to three additional Model 790 or Model 71 Control Consoles can also be connected. This provides multiple users with control over a facility's monitor system. And to make installation simple, the Model 780-02 provides power for all connected Model 790 or Model 71 units.

The core of this StudioComm for Surround system is the Model 780-02 Central Controller. The one-rack-space unit contains circuitry that supports balanced digital audio inputs, a balanced analog monitor output, digital audio and control processing, and interfacing for the user control surface(s). The Model 780-02 provides two surround (7.1) and one stereo digital audio inputs. These balanced digital inputs are AES3-compliant; sources of this type are ubiquitous in many post-production and audio facility environments. The inputs allow a sample rate of 44.1, 48, 88.2 or 96 kHz and a bit depth of up to 24 to be supported. Circuitry associated with the stereo input provides sample rate conversion (SRC) capability, allowing a wide range of digital audio sources to be monitored. To compensate with processing

delays (latency) associated with associated video displays up to 340 milliseconds of input delay can be selected. For flexibility, two delay values can be configured, allowing real-time selection as desired. A number of different signals can serve as the Model 780-02's digital audio timing reference. For synchronization with a master timing reference a dedicated source of word clock, DARS (AES11), bi-level video, or tri-level video can be connected. Alternately, the L/R connection of the actively selected surround or stereo input source can serve as the timing reference.

One analog surround (7.1) monitor outputs is provided. It's intended for connection to analog inputs on a monitor loudspeaker system. Electrically balanced, the monitor output signals provide low-noise, low-distortion, and high-headroom performance.

A sophisticated bass management function is integral to the Model 780-02's design and can be enabled if desired. The overall

goal of bass management is very simple: ensure that the entire audio bandwidth of all channels can be accurately monitored. Many loudspeaker systems have inherent low-frequency limitations, preventing a true sonic "picture" of the source material from being presented. To overcome this, the low-frequency energy from the seven channels associated with the surround inputs and the two channels associated with the stereo input can be separated and routed to the subwoofer (SUB) channel of the monitor output. Several of the bass management functions can be configured to match the requirements of specific installations.

Great care was taken in designing the system's architecture, ensuring that the character of the audio input signals was preserved. All audio processing, including bass management, is performed in 32-bit logic using a high-speed field-programmable gate array (FPGA) integrated circuit. High-performance integrated circuits are used to perform input, output, and clocking tasks.

Figure 1. Model 780-02 Central Controller Front Panel

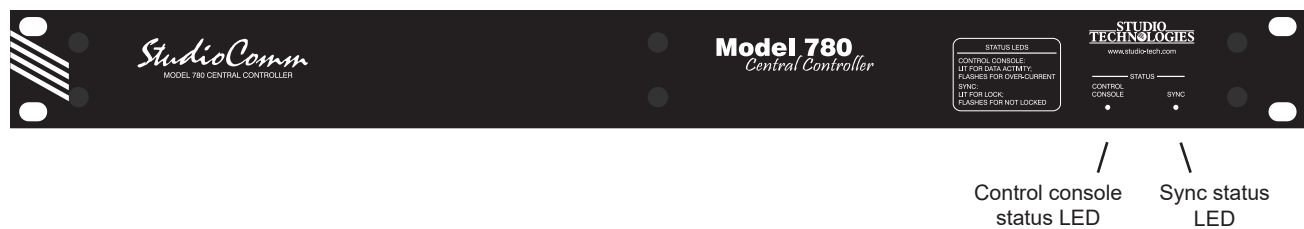
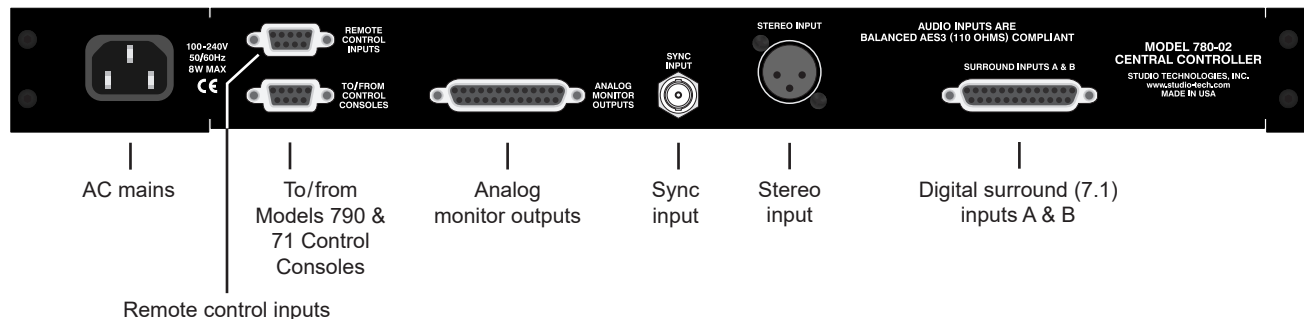


Figure 2. Model 780-02 Central Controller Back Panel



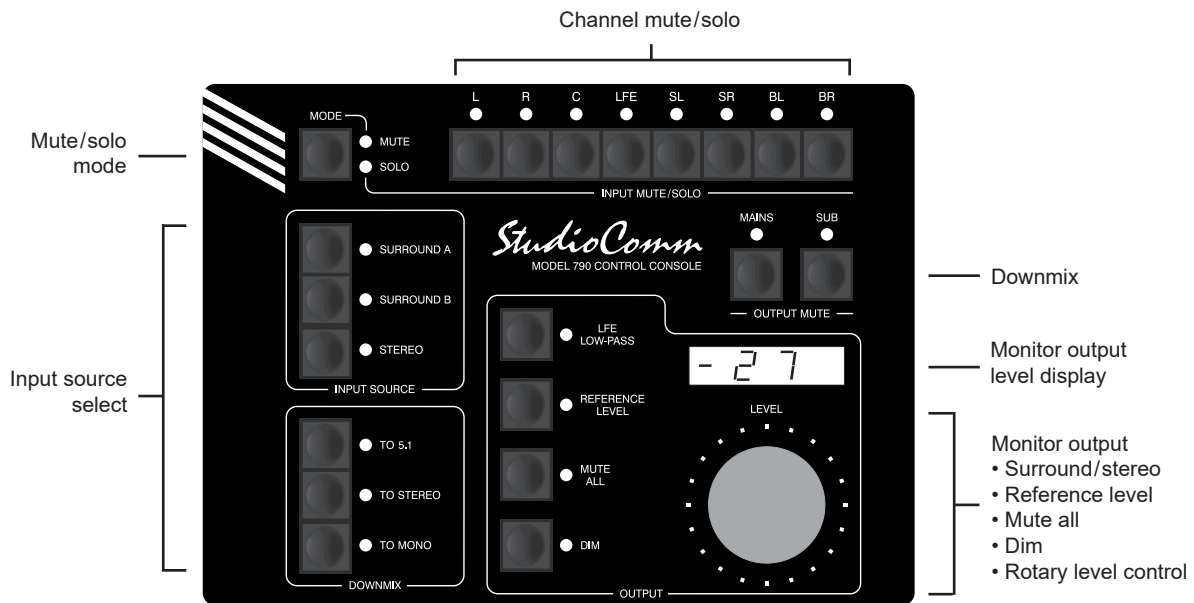


Figure 3. Model 790 Control Console Front Panel

The Model 780-02 occupies one space (1U) in a standard 19-inch rack. Digital audio sources are interfaced with the Model 780-02 using one 25-pin female D-subminiature connector and one 3-pin female XLR connector. A BNC connector is used to interface with an external sync source. Analog monitor output signal connections are made using a 25-pin female D-subminiature connector. One 9-pin female D-subminiature connector is used to connect the Model 780-02 with a maximum of four Model 790 or Model 71 Control Consoles. A second 9-pin “D-sub” connector is used to interface with remote control signals. AC mains power is connected directly to the Model 780-02, with an acceptable range of 100 to 240 V, 50/60 Hz.

Additional Details

The Model 790 provides three buttons and associated LEDs for selection of the source to be monitored. The choices are the two surround inputs and the stereo input; only one source can be monitored

at a time. It’s interesting to note that while the surround inputs have an LFE channel associated with them, the corresponding monitor output channel is designated as subwoofer (SUB), rather than LFE. This terminology was selected to highlight the fact that this output channel may include more than just LFE content. The bass management function, if enabled, will re-direct low-frequency energy from the main channels, combine it with the contents from the LFE input channel, and route the combination to the monitor output’s subwoofer (SUB) channel.

An LFE low-pass filter function is provided as a means of checking the audio content in the LFE channel of a selected surround input. The user can enable and disable the function as required, helping to ensure that the proper signals are being mixed to the LFE channel. Having the correct audio content in the LFE channel can be critical as the LFE channel is typically band-restricted during distribution.

The level of the channels associated with the monitor output can be controlled by way of a large, easy-to-use rotary control. The control, actually a digital encoder, allows level selection in precise 0.5-dB steps. The auto mute all function causes the monitor output channels to automatically mute whenever the output level control reaches maximum attenuation. Using the reference level function, the monitor output level can be set to a pre-configured value. This is provided for audio-with-picture applications that require a specific monitor output level. The reference level is easily configured by taking an electronic “snapshot” of the desired monitor output level. For user confirmation, the 4-digit LED display will show the level of the monitor output channels. To match the needs of a facility, the display can be configured to show either the attenuation level or the sound pressure level (SPL).

The dim function allows the monitor output level to be reduced by a fixed dB amount. The dim level is configured from among four available values. A mute all function allows the monitor output channels to be simultaneously muted. The input mute/solo section allows an input channel to be muted or monitored as desired. Multiple channels can also be simultaneously selected for muting or “soloing.”

Two output mute functions are also provided. One button allows the seven main channels of the monitor output to be muted. A second button allows the subwoofer (SUB) channel of the monitor output to be muted. The output mute functions, along with the input mute/solo function, allow a user complete flexibility when checking an input source and its path to the loudspeaker system. These mute and solo resources

are crucial in a multichannel environment, especially when signals are passing through the bass management function.

Three downmix functions allow the selected input source to be checked for compatibility with common audio channel formats. This can help ensure that surround and stereo mixes correctly “fold down” into formats that utilize less channels than the original. Errors can be quickly identified and then corrected. The downmix functions, To 5.1 and To Stereo, apply only to the two surround (7.1) sources. The To Mono downmix function applies to the surround and stereo inputs. Several of the downmix parameters can be configured to best meet the needs of an application.

For flexibility, the StudioComm for Surround system is designed to easily integrate with equipment such as production intercom systems, on-air or recording tally signals, and audio consoles. Two remote-control inputs provide access to the mute all and dim functions. By providing access to these functions, talkback or slate activity from an audio console or other communications system can control the level of the monitor outputs.

Installation

In this section you will be installing the Model 780-02 Central Controller in an equipment rack. Connections to the surround and stereo audio inputs and the surround monitor output will be made. A dedicated digital audio timing reference signal can be connected to the sync input. If desired, external equipment will be interfaced to the remote control inputs. A location will be selected for the first Model 790 Control Console and it will be connected to the Model 780-02. AC mains power

will be connected to the Model 780-02. For advanced applications up to three additional Model 790 or Model 71 Control Console units can be connected to the Model 780-02.

System Components

The main shipping carton contains one each of the following: Model 780-02 Central Controller, Model 790 Control Console, 9-pin D-subminiature interconnecting cable (approximately 20 feet (6 meters) in length), and a user guide. Also included in the shipping carton is a North-American-standard AC mains cord. Your dealer or distributor should provide an AC mains cord appropriate for destinations outside of North America. Any additional Model 790 or Model 71 Control Consoles will be shipped in separate cartons.

Mounting the Model 780-02

The Model 780-02 Central Controller requires one space (1U) in a standard 19-inch (48.3 cm) equipment rack. Secure the Model 780-02 into the equipment rack using two mounting screws per side. Select a location that is convenient for making connections to the audio signals as well as interfacing with the first (or only) Model 790 Control Console. A cable is supplied to connect the Model 780-02 to the Model 790. If the needs of a specific installation dictate, an alternate-length interconnecting cable can be fabricated and used.

Audio Connections

Digital audio input connections are made by way of one 25-pin female D-subminiature connector and one 3-pin female XLR connector. Analog monitor output connections are made by way of one 25-pin female D-subminiature connector. The connectors are located on the Model 780-02's back panel.

Refer to Figure 2 for a detailed view of these connectors.

Audio Inputs

Two balanced digital surround (7.1) and one balanced digital stereo audio source can be connected. Users will be able to monitor them, one at a time, using the analog monitor output. A one-to-one relationship is maintained between the input and output channels, i.e., left input to left monitor output, right input to right monitor output, center input to center monitor output, etc. (Of course this won't be true in the case where the user has enabled one of the three downmix functions.)

The audio inputs support digital audio signals with sample rates of 44.1, 48, 88.2 and 96 kHz and a depth (word length) of up to 24 bits. It's recommended that the connected signal sources maintain a common sample rate and timing reference. Having all signals "locked" together helps to ensure proper handling by the Model 780-02's all-digital signal path.

There is, however, an exception worth noting. Circuitry associated with the stereo input has sample rate conversion (SRC) capability, allowing virtually any stereo digital audio signal to be connected. A signal connected to the stereo input can have an independent sample rate and timing reference while still being monitored correctly. Refer to the Technical Notes section of this user guide for a detailed review of the SRC capability.

The Model 780-02's audio inputs are intended for connection with balanced digital audio sources that are compatible with the AES3 standard. This type of signal has a nominal impedance of 110 ohms and a nominal signal level of 5 Vpp.

One 25-pin female D-subminiature connector (DB-25F) is used to interface with the 16 channels associated with surround input A and surround input B. Each of the eight connections supports two audio channels. A wiring assembly prepared for these digital audio inputs would be identical to that of a TASCAM®-type (AES59-compliant) input assembly. A typical assembly of this type will often have eight 3-pin female XLR connectors on one end and a 25-pin male D-subminiature connector (DB-25M) on the other. Refer to Figure 4 or Appendix A for details on connecting with the 25-pin female D-subminiature connector.

Connections	Channel	Signal High (+)	Signal Low (–)	Shield
Surround Input A L/R	1	24	12	25
Surround Input A C/LFE	2	10	23	11
Surround Input A SL/SR	3	21	9	22
Surround Input A BL/BR	4	7	20	8
Surround Input B L/R	5	18	6	19
Surround Input B C/LFE	6	4	17	5
Surround Input B SL/SR	7	15	3	16
Surround Input B BL/BR	8	1	14	2

Notes: 1) All signals transformer-coupled digital audio; balanced AES3 (110 ohms, 5 Vpp) compatible.
2) Connector type on Model 780-02 is 25-pin female D-subminiature (DB-25F). Installer must provide male (DB-25M). Connector uses 4-40 threaded inserts for locking with mating plug.
3) Wiring scheme follows AES59-2012 convention. Standard TASCAM-type wiring harnesses are directly compatible, with the possible exception of 4-40 screw threads being required.

Figure 4. Connections for Surround A and Surround B Digital Inputs

Note that unlike a TASCAM-type assembly, the two threaded fasteners associated with the Model 780-02's D-subminiature connector use 4-40 threads. This complies with the original design standard for D-sub connectors.

On the Model 780-02 the stereo input uses a 3-pin female XLR connector for interfacing with a digital audio source. The mating cable should have a 3-pin male XLR connector wired such that the + signal goes to pin 2, the – signal to pin 3, and shield to pin 1.

Unbalanced AES3 digital audio signals can also be used with the Model 780-02's inputs if external coupling transformers ("baluns") are utilized. These impedance-matching (75 ohms to 110 ohms) and level step-up transformer assemblies typically provide a BNC connector on their input and a 3-pin male XLR connector on their output.

Monitor Output

The 25-pin female D-subminiature connector on the back panel labeled Analog Monitor Outputs provides access to the Model 780-02's surround (7.1) monitor output. The eight output channels are intended for connection with inputs on a loudspeaker system that provides seven main channels and one subwoofer channel.

The monitor output channels are designed for connection to audio amplifiers associated with monitor loudspeakers or to the inputs of loudspeakers that contain integrated amplifiers. The outputs are analog, electronically balanced and will perform optimally when driving loads of 2000 (2 k) ohms or greater. In most applications 3-pin male XLR connectors will be used to interface with the inputs on the associated amplifiers or amplified speakers. In this case the + terminal would go to pin 2 of the XLR, the – terminal to XLR pin 3, and the shield terminal to XLR pin 1.

Balanced operation of the monitor outputs is the preferred connection method but unbalanced operation does not pose a problem. To connect to an unbalanced load connect the + terminal as signal high, and only the Model 780-02's shield terminal as the signal low/shield. Leave the – terminal unconnected. For correct unbalanced operation, it is important not to connect – and shield together

A wiring assembly prepared for the Model 780-02's monitor outputs would typically be identical to that of a TASCAM-type output assembly. An assembly of this type would have a 25-pin male D-subminiature connector (DB-25M) on one end and eight 3-pin male XLR connectors on the other. Please refer to Figure 5 for the exact connection details. Again note that unlike a TASCAM-type assembly, the Model 780-02's D-sub connectors use 4-40 threads.

Connections	Channel	Signal High (+)	Signal Low (–)	Shield
Left (L)	1	24	12	25
Right (R)	2	10	23	11
Center (C)	3	21	9	22
Subwoofer (SUB)	4	7	20	8
Surround Left (SL)	5	18	6	19
Surround Right (SR)	6	4	17	5
Back Left (BL)	7	15	3	16
Back Right (BR)	8	1	14	2

Notes: 1) Connector type on Model 780-02 is 25-pin female D-subminiature (DB-25F). Installer must provide male (DB-25M). Connector uses 4-40 threaded inserts for locking with mating plug.

2) Wiring scheme follows AES59-2012 convention. Standard TASCAM-type wiring harnesses are directly compatible, with the possible exception of 4-40 screw threads being required.

Figure 5. Connections for Analog Monitor Outputs

Sync Input

The Model 780-02 requires a timing reference (sync) source so that the audio input signals will be interpreted correctly. A configuration setting allows the source of sync to be selected. The default setting uses the L/R input of the currently selected input source which can be either of the surround inputs or the stereo input. While this is acceptable, audio artifacts (clicks or noise) will typically occur when switching between input sources. A better method is to connect a dedicated timing reference signal to the Model 780-02's sync input connector. The connected sync source must maintain a stable relationship between itself and the connected audio sources. The actual sync source can be in one of several formats: word clock, DARS (AES11), bi-level video, or tri-level video.

An overview of the various compatible timing reference signals might prove worthwhile. Word clock is a digital signal that is locked in phase and frequency to the sample rate of the associated audio sources. DARS (digital audio reference source) is a timing signal compliant with the AES11 standard. It's sometimes referred to as "AES3-black." Technically it is similar to an AES3 signal but is generated specifically as a timing reference signal. Bi-level video sync signals were originally provided to support NTSC (United States) and PAL (European) analog broadcast applications, although they continue to be used by contemporary digital video equipment. Tri-level sync signals were primarily associated with facilities that upgraded to support high-definition (HD) video signals, however the need for this type of sync signal seems to be waning. The Model 780-02 supports both bi-level and tri-level signals at numerous rate combinations, allowing for compatibility with various worldwide video formats.

With the wide range of allowable sync sources proper Model 780-02 operation should be easy to obtain. Extensive testing has been done using many different sync source types and rates. Interested users can refer to Appendix B of this user guide for details.

An external sync reference source should be connected to the sync input BNC connector located on the Model 780-02's back panel. For flexibility the Model 780-02's sync input can be configured to be terminated with an impedance of 75 ohms or be high-impedance ("floating") so as to not load the source. A sync source that is dedicated for use by the Model 780-02's sync input would typically want to have the input termination enabled. If the sync signal connected to the Model 780-02 is being connected ("multed") to other inputs it may be desirable that the termination be disabled. (A general "rule of thumb" is that termination should be applied only at the location of the last physical device using a specific sync signal.)

Remote Control Inputs

Support is provided for two remote control input functions: remote mute all and remote dim. The Model 780-02's remote control inputs use logic circuitry, "pulled up" to 3.3 Vdc by way of resistors, which are active whenever they are brought to their logic low state. Inputs of this type are commonly referred to as GPI inputs. While the input circuitry is protected from over-current and static discharge (ESD), care should be taken to prevent nasty signals from reaching them. The inputs are active only when held in the low state; they can't be configured to change state ("latch") in response to a logic pulse.

A 9-pin D-subminiature connector (DE-9F) is used for the remote control inputs. Refer to Figure 6 or Appendix A for connection details. Note that pin 4 (remote common) connects to the Model 780-02's internal circuit common connection as well as to the Model 780-02's chassis and mains earth connections. Figure 6 also shows two spare remote control inputs (pins 8 and 9). These are provided for future applications and should remain unconnected.

Signal	Pin	Direction
Data Shield	1	Shield
Remote Mute All	5	Input
Remote Dim	6	Input
Remote Spare 1	8	Input
Remote Spare 2	9	Input
Remote Common	4	Common

Note: Connector type on Model 780-02 is 9-pin female D-subminiature (DE-9F). Connector uses 4-40 threaded inserts for locking with mating plug.

Figure 6. Connections for Remote Control Inputs

Connecting the Model 780-02 to the Model 790

A 9-pin female D-subminiature connector (DE-9F), labeled To/From Control Consoles, is provided on the back panel of the Model 780-02 Central Controller. This is used to interface the unit with Model 790 Control Consoles. Refer to Figure 7 or Appendix A for details. A 9-pin female D-sub connector (DE-9F) labeled To/From Central Controller, is provided on the back panel of each Model 790 Control Console. A cable with 9-pin male D-sub (DE-9M) connectors on each end is used to interconnect the Model 780-02 with the Model 790 units. A cable, approximately 20 feet (6 meters) in length, is included in the ship-

Signal	Pin	Direction
Data + (RS-485)	1	To/From Models 790/71
Data – (RS-485)	6	To/From Models 790/71
Data Shield	2	To/From Models 790/71
DC + (12 V)	4	To Models 790/71
DC – (12 V Return)	9	To Models 790/71
DC Power Shield	5	To/From Models 790/71

Note: Connector type on Model 780-02 is 9-pin female D-subminiature (DE-9F). Connector uses 4-40 threaded inserts for locking with mating plug.

Figure 7. Connections between Model 780-02 and Model 790 and Model 71

ping carton. The cable implements all nine connector pins in a one-to-one manner.

Should an interconnecting cable of a different length be required there's no problem for one to be fabricated and used. While it can be wired in a one-to-one fashion supporting all nine pins, only four connections are actually required: pin 1 (data +), pin 6 (data –), pin 4 (DC +), and pin 9 (DC –). The Model 780-02's connector pin-out scheme was designed to allow creation of an interconnecting cable which uses commonly available 2-pair audio cable. This cable, consisting of two twisted pairs each with an individual shield, is typically small in diameter, flexible, and available in many colors. One pair and shield can be used for the data connection (pins 1 and 6) while the other pair and shield can be used for the DC connections (pins 4 and 9). This implementation has the advantages of providing a shield for the data path and a more robust common (return path) connection (two conductors including the shield) for the DC power circuit.

A few simple calculations are required to determine the maximum cable length when fabricating a cable to be used when connecting a Model 780-02 to a Model 790. The differential transmission scheme used

by the system's RS-485 interface makes an interconnection in excess of 1000 feet (>300 meters) easily possible. The limiting factor is typically the ability of the wiring to pass the DC power supplied by the Model 780-02 to a Model 790. The Model 780-02 supplies 12 Vdc, 500 milliamperes (mA) maximum.

The Model 790 requires a minimum of 9 Vdc, 100 mA maximum, for operation. (The voltage must be measured directly at the Model 790's 9-pin D-subminiature connector.) So the maximum interconnecting cable length is directly related to the resistive voltage losses associated with the two DC-carrying conductors (supporting pins 4 and 9). As the Model 780-02 supplies 12 V and the Model 790 requires 9 V minimum, this leads to a 3 Vdc maximum drop due to the interconnecting cable. Using Ohm's law it's quite easy to determine if a desired cable length can be supported. Calculate the voltage drop by multiplying the total resistance (in ohms) of the proposed cable by 0.1 (the Model 790's required current in amperes). Remember to include the resistance in both conductors (DC + and DC –) when calculating the voltage drop. If the voltage drop in the cable is 3 V or less it should function correctly. If it's greater than 3 V the cable is too long or the wire gauge is too small.

Additional Control Consoles

Some installations may benefit from the Model 780-02's ability to be controlled by additional control consoles. At least one Model 790 Control Console must be connected to the Model 780-02 Central Controller. After this requirement has been met a combination of up to three additional Model 790 or Model 71 Control Consoles can also be connected to and powered by the Model 780-02.

When connecting multiple control consoles to a Model 780-02 all nine pins of each interconnecting cable can be connected in parallel (“multed”). Using this arrangement the data and 12 Vdc power signals between all the units will be connected in parallel. A custom cable implementation requires just four pins to be connected: pin 1 (data +), pin 6 (data –), pin 4 (DC +), and pin 9 (DC –).

To make installation simple, a “bus” cable assembly can be created using a short length of ribbon cable with one 9-pin male and multiple 9-pin female D-subminiature insulation-displacement connectors attached. Then standard 9-pin cables can link the control consoles with the connectors on the bus cable.

Refer to the previous paragraphs of this user guide where the issues involving Model 780-02 to Model 790 cable length are discussed. Note the required current for a Model 790 is 100 mA while a Model 71 requires only 35 mA. It’s important to review this information prior to selecting or fabricating the interconnection cables that will be used when installing multiple Model 790 or Model 71 units.

AC Mains Power

The Model 780-02 operates directly from AC mains power over a range of 100 to 240 V, 50/60 Hz. Being a “universal input” device, there are no switches to set or jumpers to install to match a location’s mains voltage. The unit uses a 3-pin IEC 320 C14-type inlet connector to mate with a detachable mains cord. All units are supplied with a mains cord that has a North-American-standard plug (NEMA 5-15L) on one end and an IEC 320 C13 socket on the other. Units bound for other

destinations will require that the appropriate cord be used. The wire colors in the mains cord must conform to the internationally recognized color code and should be terminated accordingly:

<u>Connection</u>	<u>Wire Color</u>
Neutral (N)	Light Blue
Line (L)	Brown
Protective Earth (E)	Green/Yellow

Safety Warning: The Model 780-02 does not contain an AC mains disconnect switch; the AC mains cord plug serves as the disconnection device. Safety considerations require that the plug and associated outlet be easily accessible to allow rapid disconnection of AC mains power should it prove necessary.

As soon as mains power is applied the Model 780-02 will perform a power-up sequence. The two LEDs on the right side of the front panel will momentarily light in a test sequence. Then the two LEDs will flash in cadence while the firmware loads into the Model 780-02’s main logic device. After a few seconds initial system operation will commence and the two LEDs will perform their intended functions. Once operating data is being interchanged with the one or more connected Model 790 or Model 71 Control Consoles the control console status LED will light. The sync status LED will light if a valid sync source has been recognized. The sync status LED will flash if a valid sync source is not recognized.

Also upon application of mains power, all connected Model 790 units will go through a power-up sequence, lighting each of its LEDs in succession. Using its

4-digit display, each Model 790 will then momentarily display its address, its software version, and the main and logic device software versions of the associated Model 780-02.

All connected Model 71 units will also go through a power-up sequence after mains power is applied to the Model 780-02. Each of the Model 71's three LEDs will light momentarily. After these LEDs have lit, the device address will be shown briefly using the dim and reference level LEDs, as shown in Figure 8 in the Configuration section. When this is complete the Model 71 will begin normal operation. Its status LED will light if communication is established with the Model 780-02. If the Model 71's status LED does not light check to see if there is a device address conflict among all connected control consoles and that all cables are implemented properly. Refer to the Configuration section of this user guide for details on selecting the device address.

Should an error be detected during the start-up process the two LEDs located on the right side of the Model 780-02's front panel will remain flashing in cadence. On the Model 790 units a diagnostic code may be displayed. Refer to the Technical Notes section of this user guide for details.

Only after the Model 780-02 and all connected Model 790 and Model 71 units have correctly powered up will full system operation begin.

Configuration

After the physical installation has been completed it's important that the system's configuration options be carefully reviewed. In most cases one or more of the operating parameters will be revised to

meet the needs of the specific installation. Many of the configuration parameters will impact the signal flow in to and out of the Model 780-02 Central Controller. Other parameters affect how the one or more Model 790 Control Consoles will display status conditions and respond to user commands. Most of the configuration choices will be made using a Model 790 Control Console. However, two configuration choices are available for any connected Model 71 Control Consoles.

Configurable Parameters

Many StudioComm functions can be configured to meet the exact needs of an installation. A Model 790 Control Console is used to display and select the desired system configuration. Here's an overview of what can be configured:

- Model 790 Device Address (must be unique for each unit!)
- Stereo Input Sample Rate Converter
- Bass Management
- Sync Source
- Sync Input Termination
- Audio-Synced-to-Video Sample Rate
- Reference Level
- Overall Display Mode
- Reference Level in dB SPL
- Auto Reference Level Off
- Dim Level
- Remote Inputs
- LFE Downmix Level
- Input Delay Settings
- Monitor Output Channel Level Offsets

The configuration diagrams, located later in this section, give details on setting each parameter. An overview of each configurable parameter is provided in the following paragraphs.

Entering and Exiting the Configuration Mode

A small button is located on the back of each Model 790 Control Console, adjacent to its 9-pin female D-subminiature connector. On any connected Model 790 unit pressing and holding its configure button for two seconds places both this specific unit and the Model 780-02 into their configuration modes. Other connected Model 790 and Model 71 units will enter a standby mode. When the Model 780-02 enters its configuration mode it will immediately mute the monitor outputs, providing an equipment and speaker protection measure. When a specific Model 790 has entered the configuration mode its array of buttons and LEDs will no longer perform their normal functions, instead being used to display the configuration settings and reflect changes as they are being made.

As a user aid, a Model 790 that has entered the configuration mode will have its mode mute and mode solo LEDs (associated with the input mute/solo section) light in an alternating manner. Other connected Model 790 units will indicate that they have entered the standby mode by simultaneously flashing their mode mute and mode solo LEDs.

To leave the configuration mode and return the system to normal operation requires a final action to be made. On the Model 790 unit that's in its configuration mode press and hold its configure button for two seconds. At this time any configuration changes will be stored in nonvolatile memory and

normal operation, using the stored configuration settings, will resume.

Our apologies to those of you who find the configure button a pain to use, but it's supposed to be that way! Seriously, the top of the button is slightly recessed from the back panel, making accidental activation unlikely. We didn't want normal operation to cease because someone pushed a Model 790 into a "rats nest" of schedules, memos from management, and empty coffee cups! But a firm press with the fleshy part of an index finger should do the trick.

There is no problem frequently "tweaking" the StudioComm system's operating parameters to achieve the desired performance. The configuration data is stored in nonvolatile memory, which is rated for many thousands of read and write cycles and a retention time in tens of years. Note that memory integrated circuits are located in the Model 780-02 Central Controller as well as the Model 790 and Model 71 Control Consoles. Only the individual device addresses are stored in each Model 790 and Model 71. All other configuration parameters are stored in the Model 780-02.

Model 790 Device Address

A unique device address must be assigned to each Model 790 Control Console that is connected to a Model 780-02. The address choices are A1, A2, A3, or A4, with the default address being A1. As most installations will utilize only one Model 790 its default setting is appropriate. For installations that use two, three, or four Model 790 units it's important that each be configured with a unique device address. Problems will occur if more than one unit has the same address. It's important to highlight the fact that the device address is the only

setting that must be done on each individual Model 790 unit. All other settings can be made on any one of the connected Model 790 units. Be sure that any selected address does not conflict with addresses that are, or will be, assigned to Model 71 units.

Stereo Input Sample Rate Converter

Circuitry associated with the stereo input can provide sample rate conversion (SRC) for digital audio signals connected to that input. The acceptable input range for sample rate conversion is very wide, but is dependent upon the output sample rate. With an output sample rate of 48 kHz any signal with a sample rate over a range of 8 to 216 kHz can be properly monitored by the system. This capability can be especially useful with signals that are not synchronized with respect to the other signals that are connected to the Model 780-02, even if their sample rates are identical. The only compromise is that the SRC process adds a fixed input-to-output (group) delay of approximately 1 millisecond, a value that shouldn't impact most applications. By default SRC is enabled and it's recommended that it remains that way. However there might be cases where this resource isn't desired and it can be disabled.

Bass Management

The Model 780-02 incorporates flexible and sonically excellent bass management capabilities. One configuration parameter is used to enable or disable bass management while three others are used to select the characteristics of the associated audio filters. While the settings are simple to make, great care must be taken to first review the entire monitor system. Only after obtaining a full understanding of the

performance of the associated loudspeaker system can a plan for the bass management functions be selected.

The bass management function impacts the analog monitor output channels and by default is disabled. The crossover point of the seven main channels' bass management filters can be selected from among four choices: 40, 50, 60, or 80 Hz. The default value is 80 Hz. The slope of the low-pass and high-pass filters associated with the seven main channels' bass management filters can be, as a group, selected. The choices are 12 dB-per-octave or 24 dB-per-octave with the latter being the default value. Setting the slopes to different values (asymmetrical filtering on the seven main channels) can be appropriate for some loudspeaker systems.

Sync Source

The Model 780-02 requires that a designated external timing reference (sync) signal be defined. Three of the choices—video, DARS, and word clock—are associated with a signal that is connected to the sync input BNC connector. The fourth choice allows the L/R input of the currently selected surround or stereo input to also serve as the system's sync source. This fourth choice is the default value.

Sync Input Termination

The sync input circuitry can be configured to provide a 75 ohm termination impedance to a connected source. When the sync input is not terminated the input impedance is very high, essentially applying no load to the source. If the sync source is connected only to the Model 780-02's BNC input connector then enabling termination is typically appropriate. However, if the sync source is being "shared" by multiple inputs then care

must be taken so that the signal is only terminated by one device. By default sync termination is enabled.

Audio-Synced-to-Video Sample Rate

If a video sync signal is connected to the sync input and video is selected as the Model 780-02's timing reference the sample rate of the connected digital audio signals must be explicitly specified. In most cases the default value of 48 kHz will be appropriate. But alternately 44.1, 88.2, or 96 kHz can also be selected. This setting enables the internal clock and timing circuitry to correctly interpret the video sync signal's relationship to the connected audio sources.

Reference Level

For consistent monitoring of audio signals it's often beneficial for users to be able to easily set the monitor output level to a known value. This is sometimes referred to as "mixing to 85 dB on the monitors," but the exact value will depend on the application. The StudioComm system allows a precise monitor output level to be stored and then enabled by pressing the Model 790 button labeled Reference Level. Setting the reference level is very simple but care is required:

1. Set up a precision sound pressure level (SPL) measuring device at the desired listening location.
2. Ensure that the StudioComm system is in its normal operating mode, not the configuration mode. Be certain that the dim, mute all, reference level, downmix, input mute/solo, and output mute functions are not active. The remote mute all and remote dim functions must also not be active.

3. Use the Model 790 Control Console to select the input source that contains the desired reference signal source, e.g., pink noise. This would typically be one of the surround inputs rather than the stereo input.
4. Observing the SPL meter, adjust the Model 790's rotary level control until the desired loudspeaker system reference level has been reached.
5. Being careful not to disturb the position of the rotary level control, enter the configuration mode by pressing and holding the configuration button for two seconds. Once the configuration mode has been entered the monitor output will mute.
6. Press and hold the reference level button; its associated LED will begin to flash. After five seconds the LED will light steadily to indicate that a "snapshot" of the new reference level has been taken. The Model 790's numeric display will then show the value of the new reference level. The value shown will always be a negative number as it's always a value less than the maximum output level. The reference level button can now be released.
7. To complete the process the configuration mode must be exited. This is performed by again pressing and holding the configuration button for two seconds. The new reference level is now stored in the Model 780-02's nonvolatile memory. Only by repeating the entire procedure can the value be changed.

Once the configuration mode has been exited, the monitor outputs will again become active. Confirm that the correct level

has been stored by pressing the reference level button. The SPL meter should display the desired level. If not, repeat the calibration procedure to achieve the desired goal.

You might wonder why you have to press and hold the reference level button for five seconds before the selected value is recognized. This is provided specifically so that unauthorized users won't accidentally change the reference level while they experiment with the configuration mode. Only if you know the "secret" will you be able to store a new value.

Overall Display Mode

The Model 790's 4-digit numeric display can be configured to display the monitor output level in either an attenuation mode or an SPL mode. In the attenuation mode (the default), the output level is shown as a reduction in level, in dB, relative to the maximum output level. When the rotary control is used to set the output level to its maximum the display will show **0.0**. As the rotary control is turned in the counter-clockwise direction the display will show negative values, reaching **-70.0** before the full mute function automatically mutes the monitor output.

In the SPL mode the display can be configured to allow the output level to be presented to users in terms of an actual sound pressure level (SPL). It is used in conjunction with the reference level in dB SPL configuration and the stored reference level. The SPL mode allows a user to see a visual representation of the SPL level that is present in the listening environment. While it takes a little more care to correctly implement the SPL display mode, it can offer an enhanced experience for StudioComm users.

Reference Level in dB SPL

The reference level in dB SPL configuration allows a specific SPL value to be associated with the stored reference level value. In this way whenever the monitor output channels are at their reference level, either through activating the reference level function or manually adjusting the rotary level control, the Model 790's display will show the configured SPL level. Whenever the monitor output is not at the reference value the display will show the current value, in dB, relative to the reference level. The reference level in dB SPL can be configured over a range of 70.0 to 100.0 dB in 1.0-dB steps. In many applications using the default value of 85 would be appropriate, reflecting the widely used audio-for-picture 85 dB monitoring reference level. (Typically this 85 dB is really 85 dBC, indicating that a C-weighting filter has been applied to the measurement.) Other common reference SPL values, such as 82 dB and 87 dB, are well within the allowable range.

Auto Reference Level Off

When auto reference level off is enabled, the function automatically turns the reference level function off if a change is made to the rotary level control while the reference level function is active. This is provided strictly as a user convenience that may, or may not, be desired. The default configuration is for the auto reference level off function to be disabled.

Dim Level

The dim function is used to reduce the monitor output level by a preset amount. The reduction is in dB relative to the monitor outputs' current level. There are four dim level values available: 10, 15, 20, and 25 dB. The default value is 20 dB.

Remote Mute All

Two configuration choices are associated with the remote mute all function: disabled and enabled. The default setting has the function enabled.

Remote Dim

Two configuration choices are associated with the remote dim function: disabled and enabled. The default setting has the function enabled.

LFE Downmix Level

By default, when the To Stereo or the To Mono downmix functions are active the LFE channel associated with the selected surround input is fully attenuated (muted). This removes LFE content from the “down-mixed” signal. In most applications this is appropriate. However, for special situations a configuration mode allows the LFE channel to be included. In this scenario, when the To Stereo downmix function is active, LFE is reduced in level by 6 dB and routed to both the left (L) and right (R) monitor output channels. When in this mode and the To Mono downmix function is active the level of the LFE channel is reduced by 6 dB and routed to the center (C) monitor output channel.

Input Delay

A time delay can be added to the input signals, allowing compensation for delays that may be present on associated video signals. The time delay applies to all input sources and associated channels and cannot be applied selectively. A configured delay time is referenced to a sample rate of 48 kHz. In the case of input signals with a sample rate of 48 kHz the delay range is 0 to 340 milliseconds in 1-millisecond steps.

For other sample rates the time must be linearly scaled. For example, for a sample rate of 96 kHz the actual time range is 0 to 170 milliseconds. In this case selecting a delay of 120 on the Model 790 will result in an actual time delay of 60 milliseconds.

For operating flexibility two different input delay values can be selected and stored during the configuration process. These can then be enabled as required by the user during normal system operation. The default value for both delay A and delay B is 0 milliseconds. Typical applications would require only one input delay to be configured. But in other cases two different, both non-zero, input delay values can be selected. This could be appropriate in applications where multiple video display systems are being used in the same control room or monitoring facility. Each video display may exhibit its own processing latency and audio would need to be “lined up” accordingly. During normal StudioComm operation a user can select the appropriate input delay for the display system currently being utilized.

Monitor Output Level Offsets

To provide assistance during room calibration, the relative output levels of the monitor output channels can be adjusted over a limited range. The eight channels can be adjusted in 0.5-dB steps over a ± 12 -dB range. The default, of course, is 0 dB for all channels. During configuration the displayed value represents the dB level difference as compared to the nominal output level. In most cases one channel should serve as the overall reference level and not be changed. This is typically the center channel.

This feature is provided primarily for use when the monitor output channels are connected to loudspeaker systems that don't offer a means of "trimming" the input sensitivity of individual channels. Without this capability, minor adjustments to the output level of specific loudspeakers to account for room acoustics wouldn't be possible.

It's also possible to use the StudioComm's output level offset capability to adjust the overall monitor output level to allow matching to the input sensitivity of loudspeaker systems. In this case all of the output channels would be configured to have the same output level offset setting. For example, the eight channels could all be configured to have a -3.5 dB output level offset. However, great care must be taken when configuring a system in this manner. The dynamic range or noise floor of the audio signals will be impacted and settings of greater than a few dB could lead to poor monitor system performance.

Restore Factory Defaults

The restore factory defaults function is provided primarily for factory use. In this way a system can be quickly set so that its default settings are selected. While you are welcome to use this function, be careful so that your configuration efforts aren't wasted. Specifically, be aware that the reference level is reset to minimum level. All the other parameters are fairly easy to set up, but resetting the reference level would require getting out an SPL meter and a calibrated signal source. This is a hassle you may not need!

Model 71 Control Console Configuration

Two configuration choices are available on each Model 71. One is its device address and the other is the button disable mode. A configure button is located on the back of each Model 71 Control Console, adjacent to the 9-pin female D-subminiature connector. Pressing and holding this button for two seconds places this specific unit in its configuration mode; normal operation of the Model 780-02 and other connected Model 71 and Model 790 units will continue. When a Model 71 enters its configuration mode its three LEDs will no longer perform their usual functions. Instead the status LED will blink to indicate that configuration mode is active. Refer to Figure 8 for details.

Device Address

The dim and reference level LEDs will display the Model 71's device address. The rotary level control is used to select the desired device address; the LEDs will respond accordingly. The device address must be selected so as not to conflict with the device address of any other connected Model 71 or Model 790 Control Console. The choices are A1, A2, A3, and A4. All Model 71 units have a default device address of A4; Model 790's units have a default device address of A1. This ensures that, in most cases, no change will have to be made. Refer to Figure 9 for details.

Button Disable

To disable the Model 71's two buttons, simultaneously press and hold both the dim and reference buttons for two seconds. When the disable request has been recognized the LEDs above both buttons will flash rapidly. Release the buttons and they will no longer enable or disable their normal

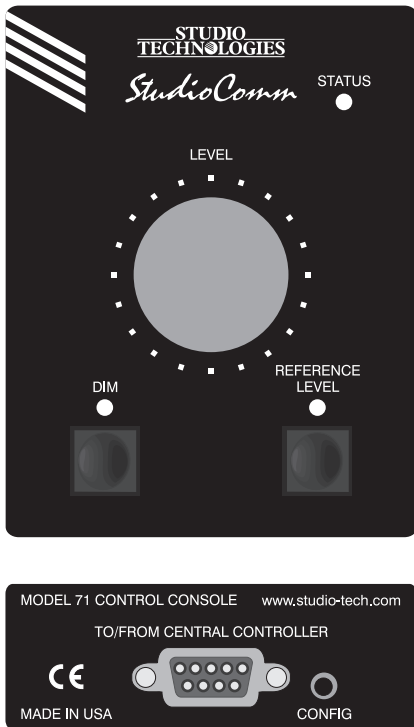


Figure 8. Model 71 Control Console Front and Back Panels


Address	Dim LED	Reference Level LED
A1	OFF	OFF
A2	OFF	ON
A3	ON	OFF
A4	ON	ON

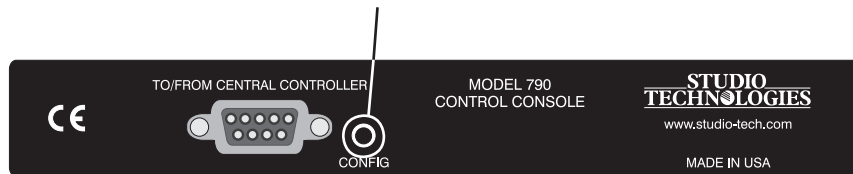
Figure 9. Model 71 Device Address Chart

functions. To return the buttons to normal operation simultaneously press and hold both buttons for two seconds at which time the two LEDs will flash rapidly.

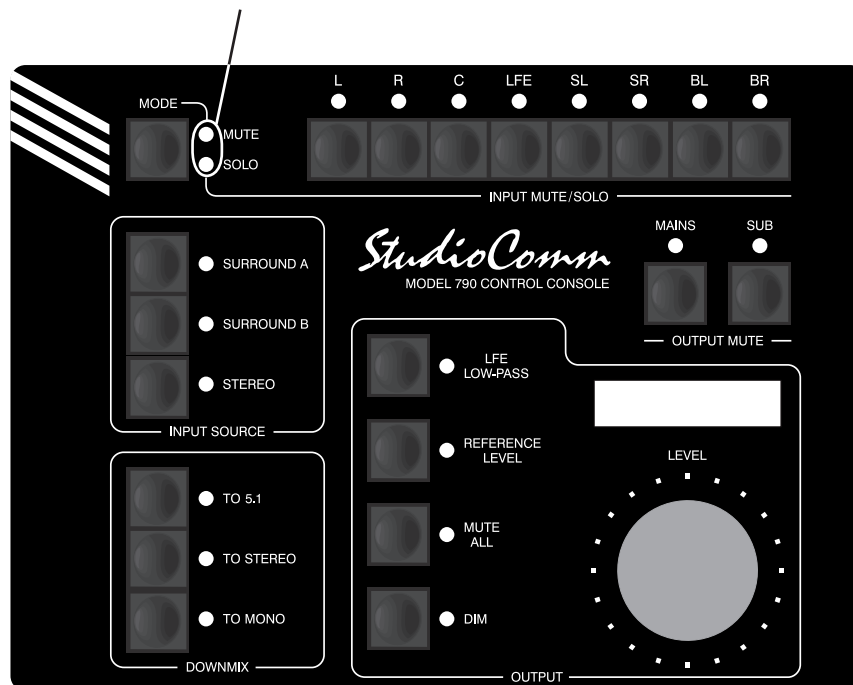
To leave the configuration mode and return a Model 71 to normal operation requires one last action: again press and hold its configuration button for two seconds. The selected configuration parameters will be stored in a nonvolatile memory device that is located inside this specific Model 71.

Configuration—Entering and Exiting Configuration Mode

 Press and hold the configuration button for 2 seconds to enter or exit the configuration mode.



These LEDs will light alternately when configuration mode is ac-

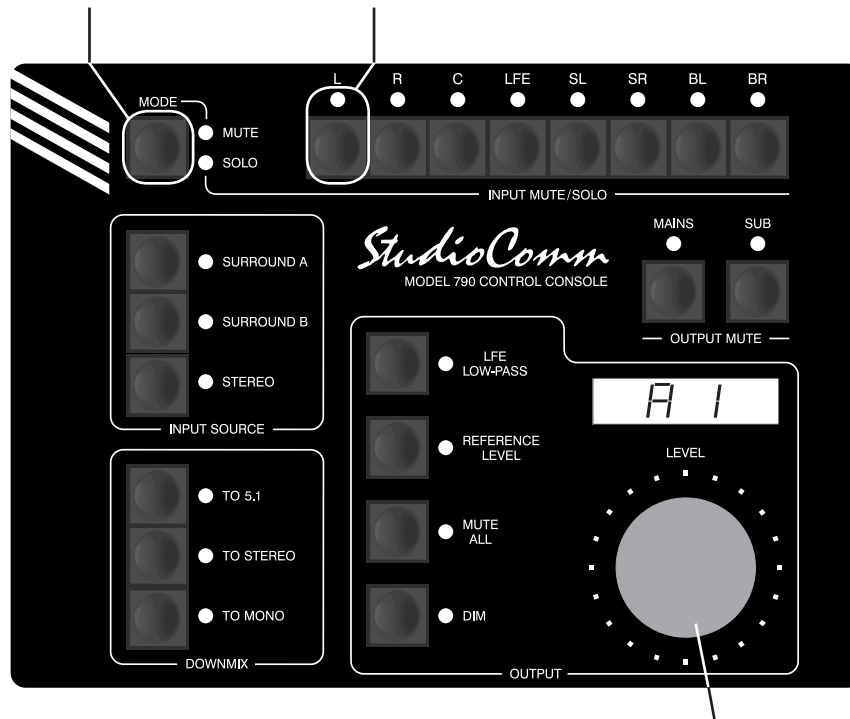


Configuration—Model 790 Device Address and Stereo Input Sample Rate Converter



Press and hold the Mute/Solo button to display and configure the Model 790's device address and stereo input sample rate converter.

This LED displays the configuration of the stereo input sample rate converter (SRC). LED L not lit means SRC is disabled; LED L lit means SRC enabled. Use the button to change the configuration.

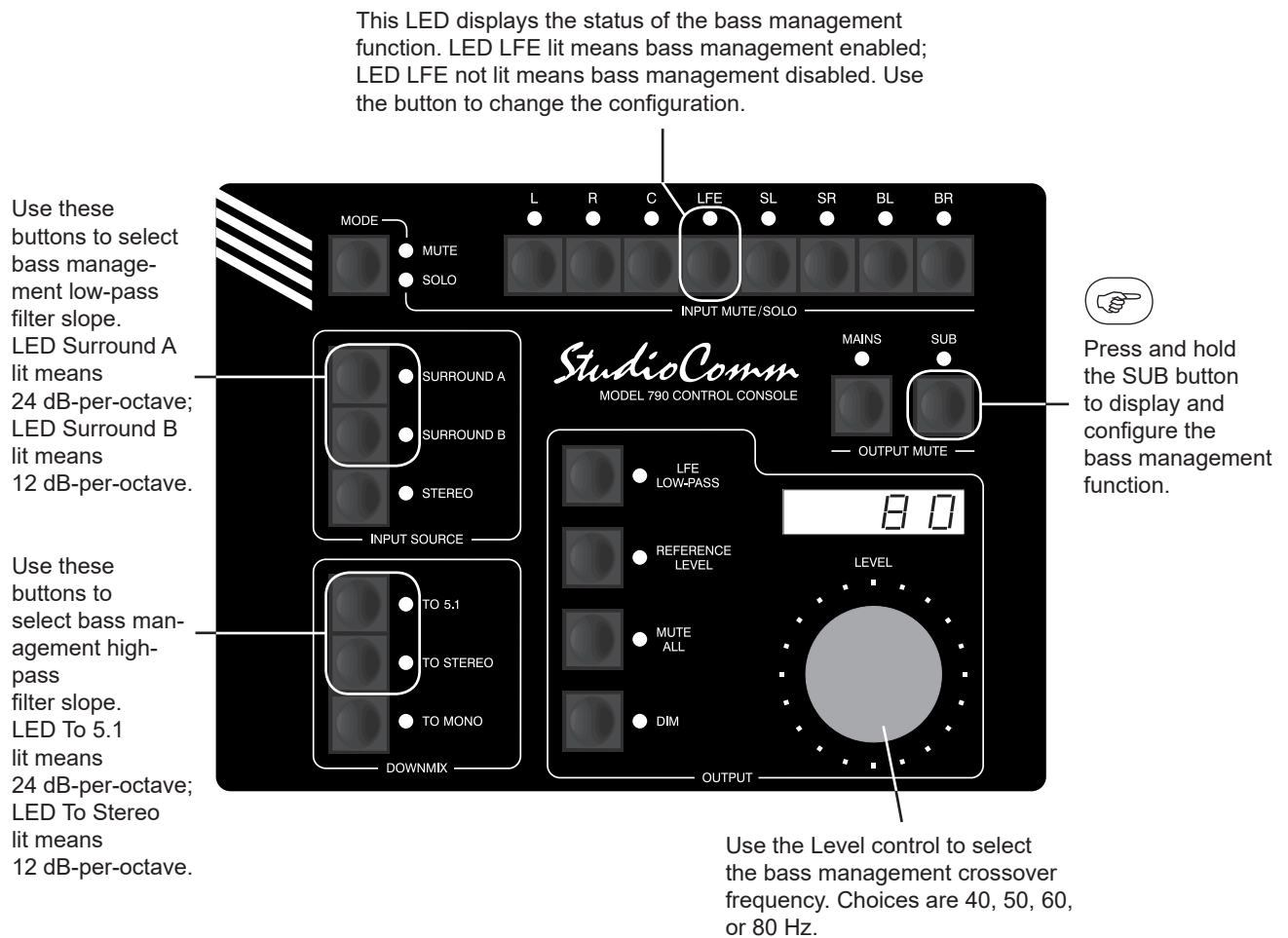


Use the Level control to change this specific Model 790's device address. Address can be either A1, A2, A3, or A4. See Note below.

Default: Device address A1.
Stereo input sample rate converter enabled.

Note: The Model 790's device address is the only parameter stored in the Model 790. All other parameters are stored in the Model 780-02.

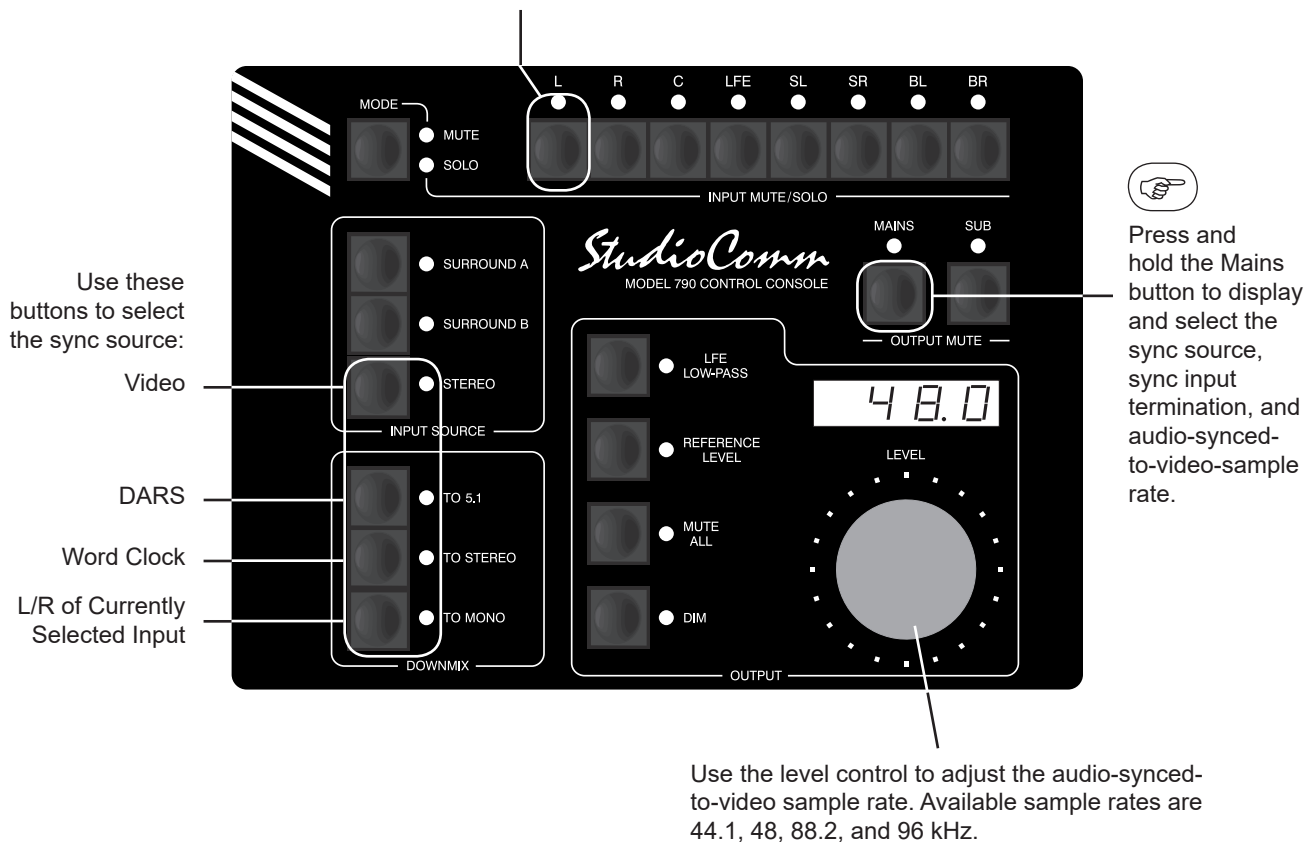
Configuration—Bass Management



Default: Bass management disabled.
 Bass management low-pass filter slope 24 dB-per-octave.
 Bass management high-pass filter slope 24 dB-per-octave.
 Bass management crossover frequency 80 Hz.


Configuration—Sync Source, Sync Input Termination, and Audio-Synced-to-Video Sample Rate

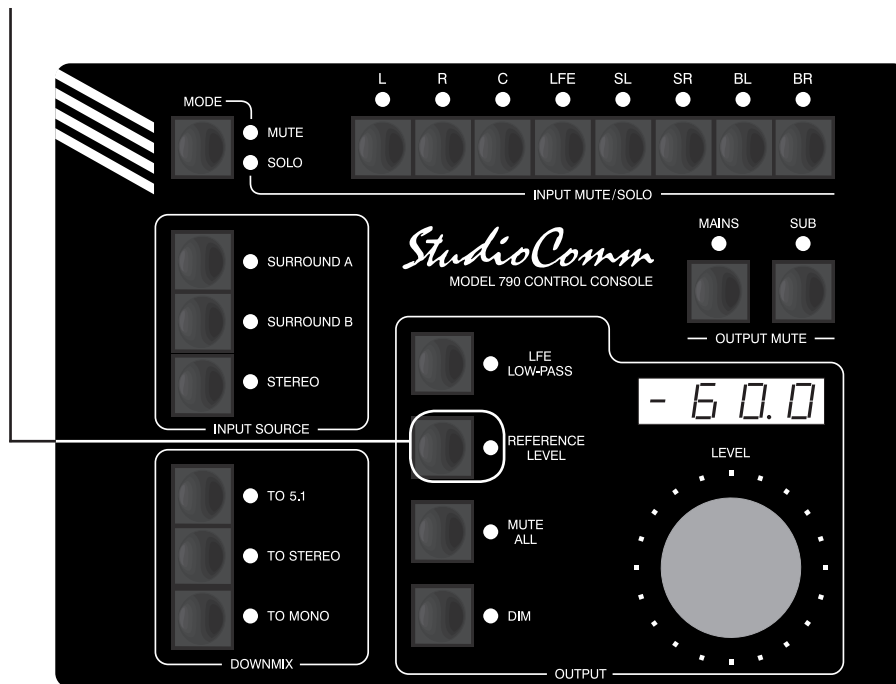
This LED displays the configuration of the sync input termination. LED L not lit means sync input is not terminated; LED L lit means terminated with 75 ohms. Use the button to change the configuration.



Default: Sync source is L/R of currently selected input.
Sync input terminated.
Audio-synched-to-video sample rate 48 kHz.

Configuration—Reference Level

-  Press and hold the Reference Level button for 5 seconds to take a “snapshot” of the level control’s setting at the time configuration mode was entered. The Reference Level LED will flash when the button is initially pressed and then light steadily when the “snapshot” has been taken. See Note below.



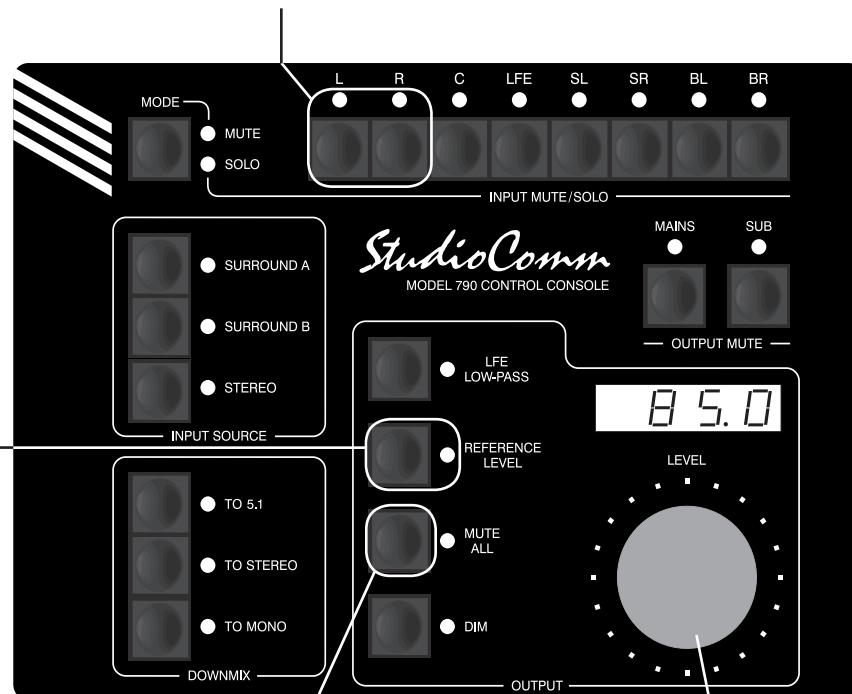
Default: Reference level set for –60.0 dB monitor output level.

Note: The 5-second button-press delay is a safety feature ensuring that the reference level will not be accidentally changed. To permanently store the new value, you must still exit the configuration mode.

Configuration—Overall Display Mode, Reference Level in dB SPL, and Auto Reference Level Off

When the Mute All button is pressed, use the Channel Mute/Solo L and R buttons to select the overall display mode. LED L lit means attenuation mode is selected; LED R lit means SPL mode is selected. Use the buttons to change the configuration.

When the Mute All button is pressed, use the Reference Level button to enable or disable auto reference level off. When the Reference Level LED is lit auto reference level off is enabled.



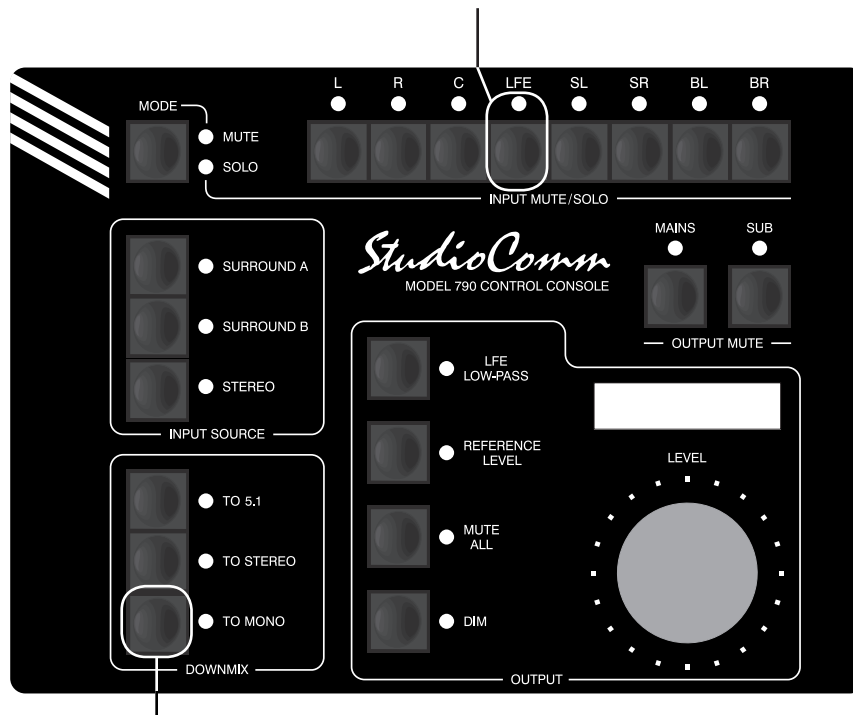
Press and hold the Mute All button to display and set the overall display mode, the reference level in dB SPL, and auto reference level off.

When the Mute All button is pressed, use the Level control to adjust the reference level in dB SPL.

Default: Attenuation display mode selected.
85.0 dB SPL reference level.
Auto ref level off disabled.

Configuration—LFE Downmix Level

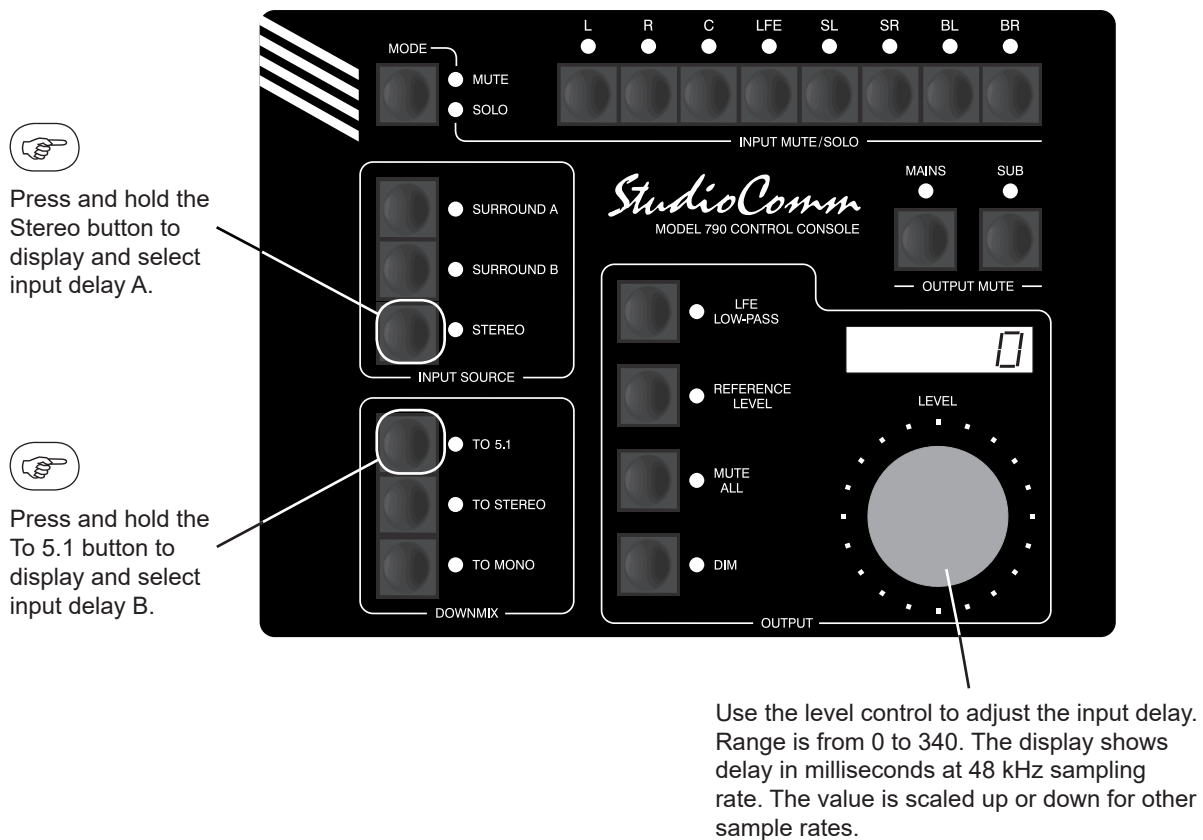
Use this button to select the LFE downmix level when the To Stereo or To Mono downmix functions are active. LED LFE not lit means full attenuation; LED LFE lit means -6 dB.



Press and hold the To Mono button to display and confirm the LFE downmix level.

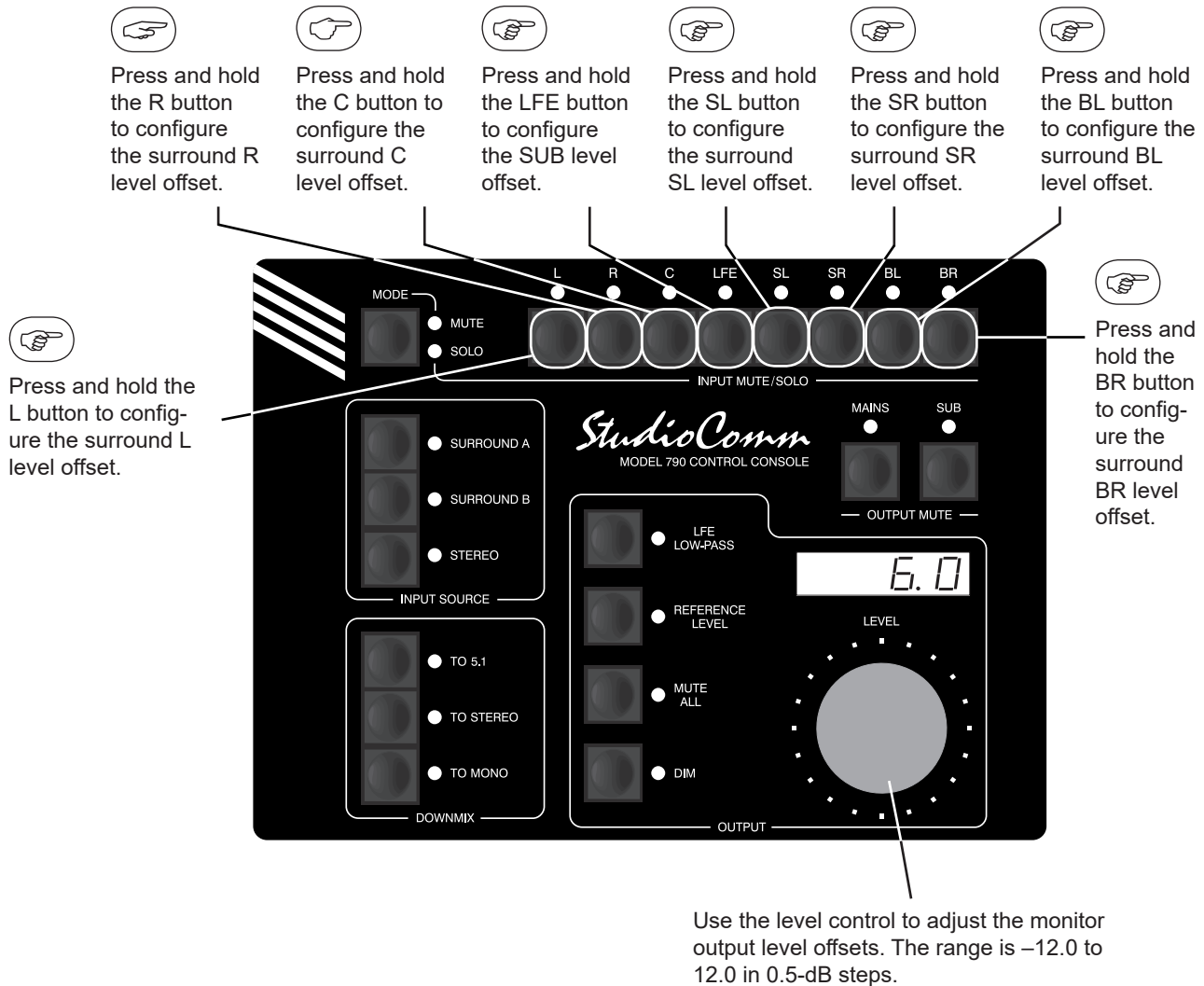
Default: LFE downmix level full attenuation when To Stereo or To Mono downmix functions active.

Configuration—Input Delay Settings



Default: Input delay 0 milliseconds for both A and B.

Configuration—Monitor Output Level Offsets

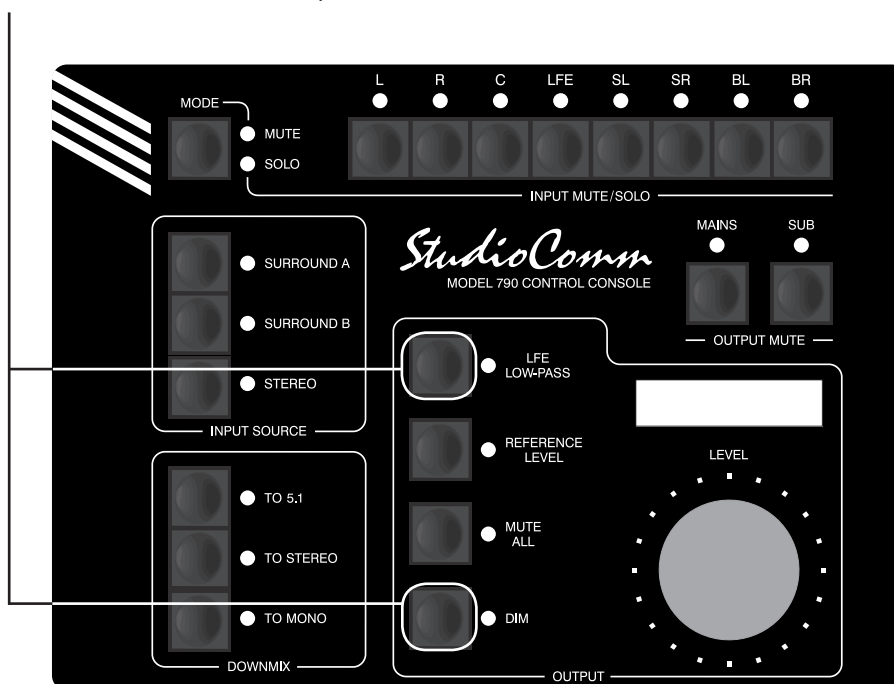


Default: 0.0 dB monitor output level offsets.

Configuration—Restore Factory Defaults



Press and hold both the LFE Low-Pass and Dim buttons for 5 seconds to restore Model 780-02 and Model 790 factory defaults. Once defaults have been restored, the associated LEDs will light. After the buttons are released, configuration mode will be exited and normal operation will resume. See Note below.



Factory Defaults:

Device address A1.	Attenuation display mode selected.
Stereo input sample rate converter enabled.	85.0 dB SPL reference level.
Bass management disabled.	Auto reference level off disabled.
Bass management low-pass filter slope 24 dB-per-octave.	20 dB dim level.
Bass management high-pass filter slope 24 dB-per-octave.	Remote mute all enabled.
Bass management crossover frequency 80 Hz.	Remote dim enabled.
Sync source is L/R of currently selected input.	LFE downmix level full attenuation when To Stereo or
Sync input terminated.	To Mono downmix functions active.
Audio-synced-to-video sample rate 48 kHz.	Input delay 0 milliseconds for both A and B.
Reference level set for -60.0 dB monitor output level.	0.0 dB monitor output level offsets.

Warning: Each Model 790 unit must have a unique address. Restoring factory defaults will reset only this specific Model 790 to device address A1. If another connected unit is already configured for address A1, normal system operation will stop.

Note: The 5-second button-press delay is a safety feature ensuring that the factory defaults will not be accidentally restored.

Operation

Now that you've installed and configured the StudioComm system you're ready to go. You should find operation very easy. However, taking time to review and understand this section of the user guide may prove valuable.

Upon AC mains power up the system will return to the last operating condition, including the selected source, downmix mode, etc. As a precaution, however, the monitor output level will always return to its minimum value. The rotary level control or the reference level button must then be used to set the level of the monitor output to the desired level.

Model 780-02 Central Controller

The Model 780-02's front panel contains two LEDs. The control console status LED will light whenever the Model 780-02 is communicating with the one or more connected Model 790 or Model 71 units. If the control console status LED is flashing it indicates that the 12 volt DC output provided to support the connected control consoles is in its short-circuit or over-current condition. The control console status LED will not light when a Model 790 is in the configuration mode or when the Model 790 is going through its power-up sequence.

The sync status LED will light whenever a valid timing reference signal is being received by the Model 780-02. A flashing sync status LED indicates that a valid sync signal is not being received. The timing reference can be, depending on how the system is configured, an externally supplied timing (sync) reference or the L/R input of the selected input source.

Control Consoles

StudioComm for Surround operation is controlled using a combination of up to four Model 790 or Model 71 Control Consoles that have been connected. Two system functions can also be controlled by means of the remote control inputs.

Model 790 Control Console

To make things easy to describe, the Model 790's operator functions are divided into six main groups: input source selection, downmix, monitor output general functions, input mute/solo, display and display mode, and remote control inputs.

Any change made to any one Model 790 unit will be reflected in the LEDs and displays on all the connected units. Note that all control consoles function simultaneously—there is no priority of one unit over the others.

Input Source Selection

To select an input source press one of the three input source buttons. The corresponding LED will light to indicate that the input has been selected. Only one source can be selected for monitoring at any one time.

Downmix

Three downmix functions allow users to perform "real-world" audio format compatibility checks. The To 5.1 function allows a 7.1 surround source to be checked for compatibility with 5.1 surround playback systems. When the function is active a 7.1 surround source is reproduced on the left (L), right (R), center (C), surround left (SL), surround right (SR), and subwoofer (SUB) monitor output channels. The To Stereo downmix function allows

a 7.1 surround source to be “folded down” (mixed) to stereo. The resulting signal is reproduced on the left (L) and right (R) monitor output channels. The To Mono function allows a 7.1 surround or stereo source to be converted to a single monaural channel. The resulting signal is reproduced on the center (C) monitor output channel.

Using the downmix functions simply requires pressing the desired button. Each button will always “latch” the function on and off. An LED, located adjacent to each button, will light whenever its respective function is active. For details on the exact actions performed by the three downmix functions refer to Appendix C at the end of this user guide.

Monitor Output General Functions

Four buttons and one rotary control are associated with the monitor output. The buttons control operation of the reference level, mute all, dim, and LFE low-pass filter functions. In addition the LFE low-pass filter button can be used to enable the display of the current sample rate. The rotary level control is used to manually set the monitor output level.

Reference Level

The reference level button sets the monitor output level to a preset value. Technical personnel, using a sound-pressure-level (SPL) meter and precision signal source, should have set this level to meet the requirements of the specific monitoring environment. The LED associated with the reference level button will light whenever the function is active. The 4-digit display will indicate the reference output level.

The StudioComm’s default reference level is -60.0 dB so “out of the box” the Model 790 will display **-60.0** when reference level mode is enabled.

How the rotary level control functions whenever the reference level mode is active depends on a configuration setting. If the auto reference level off function is disabled turning the rotary level control will have no impact on the reference level function; it will remain active. If the auto reference level off function has been enabled turning the rotary level control will cause the reference level function to automatically turn off.

The LED associated with the reference level button can also serve as a calibration aid. If the reference level mode is not active, whenever the monitor output level is selected to be the same as that stored for the reference value the reference level LED will flash. This exact level can be reached through the use of the rotary level control, either by itself or through the setting of the rotary level control in conjunction with the dim function. Whatever path the monitor output takes to reach the reference level value, it will cause the reference level LED to flash!

Mute All

Pressing the mute all button causes the monitor output to fully mute. The 4-digit display indicates the mute condition by showing four dashes (**----**). The mute all button is always set to “latch” the function on and off. The LED associated with the mute all button will light whenever mute all is active. Note that if mute all is enabled via the remote mute all function, the mute all LED will flash.

Dim

The dim function is provided for user convenience, allowing the monitor output level to be reduced by a fixed amount. The Model 790's configuration mode allows the dim level to be selected from among four choices: 10, 15, 20, or 25 dB. Pressing the dim button will enable the function. The dim button is always set to "latch" the function on and off. The 4-digit display, when selected for output level mode, will indicate the revised monitor output level. When dim is active the monitor output level reduction will apply no matter whether the level is being set by the rotary level control or by the reference level button. The LED associated with the dim button will light whenever dim is active. If dim mode is enabled via the remote dim function the dim LED will flash.

It's worth using a few sentences to discuss the auto dim off function. Whenever dim is enabled due to the dim button being pressed, and the rotary level control is active (reference level mode is not active), changing the setting of the rotary level control will automatically turn off dim. The auto dim off function is a unique attempt at protecting the aural health of users. No longer will there be a heart-stopping blast of audio when the dim button is pressed, supposedly to enable dim, but actually turning dim off because it was already enabled. It's hard to explain unless you've experienced this in person—trust us, this situation can and does happen!

Note that the auto dim off function is not active whenever dim is enabled due to the remote dim function being active. This allows remote control equipment, such as a talkback system, to reliably dim the monitor outputs.

LFE Low-Pass Filter

The LFE low-pass filter function is provided to emulate the processing done by some distribution formats to the signal present on an LFE channel. Unlike the seven main surround channels, an LFE channel is typically bandwidth restricted to save digital "bits." It's important that an audio mix maintains its integrity when such LFE bandwidth restrictions are in place. When enabled the LFE low-pass filter function applies a filter with a -6 dB cutoff frequency of 120 Hz and a slope of 48 dB-per-octave to the selected surround input source. To enable the LFE low-pass filter function simply press the LFE low-pass button. The associated LED will light when the filter is active in the LFE audio path.

Philosophy dictates how the filter function should be used. The function can be used as a final "double check" to ensure that material will maintain overall integrity when digitally processed. Enabling the filter during a final listening session should find the spectral content remaining constant. If the mix is impacted, content has been incorrectly routed to the LFE channel! It's also acceptable to leave the filter enabled at all times. This will ensure that an audio mix will "hold up" when processed. However, this may mask content remaining in the LFE channel which, although it won't be present after processing, may be confusing to mastering engineers or other personnel who monitor the original source material.

Displaying the Current Sample Rate

The LFE low-pass filter button is also used to display the system's current sample rate value. Pressing and holding the LFE low-pass button will cause the current sample rate value to be shown on the 4-digit

display. The possible values displayed will be **44.1**, **48.0**, **88.2**, or **96.0**. This can be useful during troubleshooting or just for general interest. Once the button is released normal display operation will resume.

Rotary Level Control

The rotary level control is used to manually adjust the monitor output level. The level control provides the ability to adjust the monitor output level over a 70-dB range. Technically, the rotary level control is a 24-step-per-revolution mechanical encoder. The amount of level change in dB per step (per “click”) will depend on how quickly the control is turned. When rotated slowly, each step represents a 0.5-dB change in level. In this case, to traverse the entire level range would require rotating the control more than five full turns. But the Model 790’s software detects when the control is rotated more quickly and increases the amount of level change in dB per step. A little experimentation will allow the user to acquire a good “feel” for how best to use the control.

The reference level LED will flash when the rotary level control sets the output level to be the same as the stored reference level. Whenever the rotary level control attempts to set the output level to be less than -70.0 dB, the monitor output channels will automatically mute. As previously discussed, the 4-digit display indicates the mute condition by showing four dashes (— — — —).

If the mute all function is active the rotary level control won’t have an impact on the monitor output level. It’s also not active whenever the reference level function is active, except if the auto reference level off function has been enabled. If the dim function is active, turning the rotary control will automatically disable the dim function.

Input Mute/Solo

The input mute/solo functions allow specific input channels to be selected for individual or group mute or “solo” monitoring. The functions take place electrically “after” the input source selection and input delay functions but “before” the LFE low-pass filter, downmix, output level, and output mute functions.

The input mute/solo mode and input mute/solo channel buttons, along with associated LEDs, work together to provide excellent operating flexibility. The input mute/solo mode button allows the user to select between the mute and solo functions. Going from mute mode to solo mode, or vice-versa, clears all active mutes or solos. Pressing the mode button twice is a legitimate means of quickly clearing muted or soloed channels. To mute or solo a channel simply requires pressing one of the eight input mute/solo buttons. The buttons function in a press-to-enable/press-to-disable “latching” mode. Multiple channels can be muted or soloed at the same time. LEDs associated with a muted or soloed channel will light to indicate that the function is active.

Output Mute

The two buttons associated with the output mute function provide a means of directly muting the monitor output channels. These serve as an aid in observing the performance of the loudspeaker system. The output mute function organizes the monitor output channels into two groups: the main channels (mains) and the subwoofer (SUB). The mains group consists of the seven main output channels: left (L), right (R), center (C), surround left (SL), surround right (SR), back left (BL), and back right (BR). The SUB group consists of only

the subwoofer (SUB) output channel. Two buttons and associated LEDs are used to control the output mute function. Both buttons function in a push-on/push-off manner.

It may be confusing at first to imagine why the output mute buttons are important. The reason, like the input mute/solo function, is bass management. The input mute/solo function allows observation of the channels associated with the surround and stereo inputs. But soloing a single channel, such as the left input of surround A, may result in audio content coming out of the system and being reproduced by both the left (L) and subwoofer (SUB) loudspeakers. By maintaining the left channel in the input solo mode, a user can activate the output mute function to independently mute the left (L) and subwoofer (SUB) output channels as desired.

Input Delay

Two input delay settings, A and B, can be selected and saved during system configuration. These are provided for aligning the audio input signals with latencies (delays) associated with video processing and display systems. During normal operation a user can select to have either input delay A or input delay B active. The input mute/solo mode button, the output mute SUB button, and the 4-digit display are used to select and display the input delay. When the mute/solo button is pressed and held the LED associated with the output mute SUB button indicates whether input delay A or input delay B is active. The LED will be lit when input delay B is active. The 4-digit display will show the active delay time in milliseconds referenced to a 48 kHz sample rate. The delay time will “scale” depending on the actual sample rate at

which the Model 780-02 is operating. While pressing and holding the mute/solo button the output mute SUB button can be pressed to change the selected input delay. Refer to Figure 10 for details. The selected input delay will be stored in non-volatile memory such that a power-down/power-up cycle will not change the active selection.

Display and Display Mode


The Model 790's 4-digit LED display shows the monitor output level as either the amount of attenuation or the sound pressure level (SPL). Both will indicate level in dB. What the digits actually represent will depend upon how the Model 790 has been configured.

Display in dB of Attenuation

If configured for the attenuation mode the display will show the monitor output level as an attenuation value in reference to the maximum output. This is in the form of 0.5-dB steps less than the maximum of 0.0 dB. So a display of -40.5 would indicate that the monitor output is set to be 40.5 dB below the maximum level. As the rotary level control is moved counterclockwise the output level will go down and the indicated value will get more negative.

Display in dB SPL

If the Model 790 is configured to display the monitor output level in dB SPL, the 4-digit display will always show the output level in positive numbers. These numbers are intended to represent the sound pressure level in dB SPL, a figure that should directly relate to the actual sound pressure level that the loudspeaker system is presenting to users. (Typically, the level value would actually be in dBC, the C-weighted

 During normal operation, press and hold the Mute/Solo button to view and change the input delay setting.

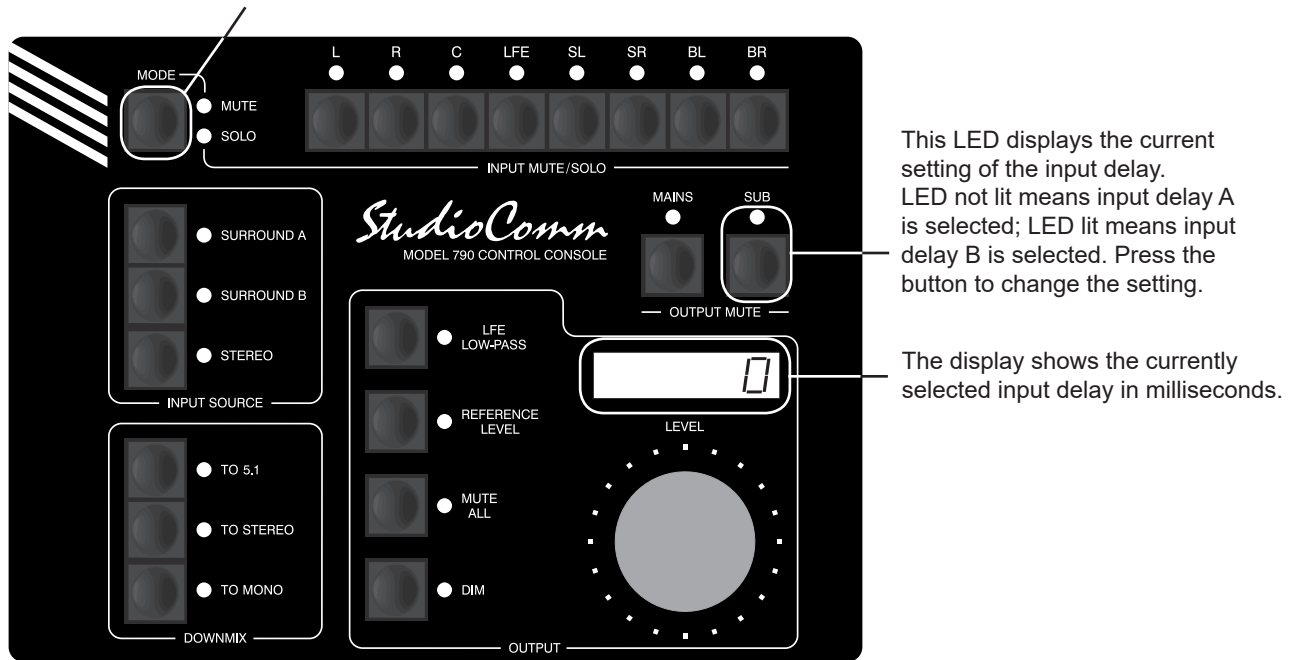


Figure 10. Selecting the input delay

sound pressure level.) When the reference level button is enabled, or the rotary level control is set so that the reference level has been reached, the display will typically show something in the range of 82 to 87 dB. Assuming that the monitoring environment has been correctly calibrated, this would indicate that an average listening level of 85 dB, for example, had been achieved.

Remote Control Inputs

As previously discussed in the Installation section of this user guide, two remote control signals can be connected to the Model 780-02. The functions are remote mute all and remote dim. When an external signal activates remote mute all the LED on the Model 790 associated with the mute all button will flash. If mute all was already active when the remote mute all function is

activated, the LED will change from being steadily lit to flashing.

When an external signal activates remote dim the LED on the Model 790 associated with the dim button will flash. If dim was already active when remote dim is activated, the LED will change from being steadily lit to flashing.

Model 71 Control Console

The Model 71 Control Console provides a rotary level control, two pushbutton switches, and three LEDs for control and status display. The rotary level control allows adjustment of the monitor output level. Two buttons, along with associated LEDs, provide access to the dim and reference level functions. A status LED lights steadily whenever normal Model 71 operation is taking place.

Any changes made using the Model 71's rotary level control and buttons will be reflected in the appropriate LEDs and displays on all the connected Model 790 and Model 71 units. And, as expected, changes made using a Model 790 will be reflected in the Model 71's LEDs.

In some applications it may be desirable to disable operation of a Model 71's dim and reference buttons. An example could be where non-technical personnel are allowed only to use the rotary level control. A configuration parameter, previously described in the Model 71 Control Console Configuration section of this user guide, allows button operation to be disabled.

Rotary Level Control

The rotary level control is used to manually adjust the monitor output level. Its operating characteristics are identical to the rotary control in the Model 790 Control Console, discussed earlier in this section.

Dim

The dim function allows the monitor output level to be reduced by a fixed amount. Its operating characteristics are identical to those of the Model 790 Control Console, discussed earlier in this section.

An indication is provided should the dim button be pressed when button operation has been disabled. Its associated LED will flash briefly but no operating change will occur. The LED will continue to display the status of the dim function as selected by other Model 790 and Model 71 units.

Reference Level

The reference level button sets the monitor output level to the preset value. The operating characteristics are identical to

those of the Model 790 Control Console, discussed earlier in this section.

An indication is provided should the reference button be pressed when button operation has been disabled. The associated LED will flash briefly but no operating change will occur. The LED will continue to display the status of the reference level function as selected by other Model 790 and Model 71 units.

Technical Notes

Loss of Sync

The Model 780-02 relies on an external timing reference (sync) source for proper operation. This can be in the form of an AES3, word clock, DARS (AES11), bi-level video, or tri-level video reference signal. In many cases the sync signal will be connected to the sync input BNC connector located on the Model 780-02's back panel. Alternately, a configuration choice allows the L/R input of the currently selected input source to also serve as the system's timing reference. Whenever a valid sync signal has been connected to the Model 780-02 the sync status LED, located on the unit's front panel, will light.

If a valid sync signal is not present several visual indications are provided. On the Model 780-02 the sync status LED will flash. On all connected Model 790 Control Consoles the 4-digit LED display will cease normal operation, instead alternating between the words no and sync. When a valid sync signal is again connected the Model 780-02's sync status LED will light steadily. On the Model 790 units the word sync will momentarily be displayed followed by a brief display of the active sample rate. The sample rate will display

as **44.1**, **48.0**, **88.2**, or **96.0**, reflecting the impact of the sync source rate and the Model 780-02's configuration.

If during normal operation the sync source changes from one valid rate to another a visual indication is provided. On the Model 790 units the new sample rate—**44.1**, **48.0**, **88.2**, or **96.0**—will momentarily be displayed.

Power Down

Care was taken in the Model 780-02's design to minimize the chance that objectionable clicks, pops, or other obnoxious audio signals will be present on the monitor outputs. A power-down circuit supplies the main microcontroller integrated circuit with an indication that a power loss is imminent. When this condition is detected the monitor outputs will automatically mute.

Power-Up Messages

Upon mains power being applied to the Model 780-02 all connected Model 790 units will go through a power-up sequence. The sequence starts by each of the individual LEDs lighting in a "walk-through" sequence. Then the 4-digit display tests all its LED segments. Finally, a set of messages provide details on the specific Model 790 and connected Model 780-02 software versions:

1. Displays **790**
2. Displays Model 790's software version
3. Displays Model 790's unit address (**A1**, **A2**, **A3**, or **A4**)
4. Displays **780**
5. Displays Model 780-02's main software version

6. Displays **FPgA**

7. Displays Model 780-02's logic device (FPGA) software version

After a successful system power-up sequence normal operation will then commence.

Error Codes

Should a problem be encountered during power up one of four error codes may show on the Model 790's 4-digit display.

Error Code Err1

Err1 indicates that communication is not taking place between the Model 790 and the Model 780-02. The most likely cause would be incorrect wiring of the data pair linking the two units.

Error Code Err2

Err2 indicates that the Model 780-02 is having problems with its internal logic device. (A high-speed field-programmable gate array (FPGA) serves as the digital "heart" of the Model 780-02 and without it no audio activity can occur.) The only way to remedy this condition is to first try removing and reconnecting mains power. (And that's a long-shot as to whether it would accomplish anything.) If **Err2** continues to be displayed the Model 780-02 must be returned to the factory for service.

Error Code Err3

If a digital audio source with a sample rate of other than 44.1, 48, 88.2, or 96 kHz is connected **Err3** will display and the mute all function will be automatically enabled. In this scenario, selecting a different source that has a sample rate of 44.1, 48, 88.2, or 96 kHz will return the system to normal operation.

Error Code Err4

Err4 will display if communications with a central controller has been established but that specific central controller is not compatible with the Model 790. For example, **Err4** will display if a Model 790 has been connected with a Model 760-Series central controller.

Sample Rate Conversion (SRC)

Circuitry associated with the stereo input can provide sample rate conversion (SRC) capability. A digital audio signal connected to that input can have its sample rate and timing re-synchronized to match the Model 780-02's internal timing. While it would be nice to proclaim that the engineers at Studio Technologies came up with a unique and exotic circuit to perform this function it's really not the case. Several semiconductor companies provide "single-chip" SRC solutions and an excellent one from AKM was selected for the Model 780-02. The technical capabilities of the Model 780-02's SRC function is stated in this way: the sample rate of an input signal can range from 1/6 to six times the Model 780-02's output sample rate, with the additional restriction that it must be no less than 8 kHz and no more than 216 kHz. The Model 780-02's monitor output sample rate is determined by the selected timing reference (sync) signal and, if required, a configured value. If a word clock, DARS (AES11), or AES3 signal is the designated sync source its rate will be the Model 780-02's output sample rate. If a video sync signal is connected, the Model 780-02's sample rate is selected as part of the configuration process.

So in practice what can the SRC function accomplish? If the Model 780-02's sample

rate is 48 kHz a signal connected to the stereo input can have a sample rate from 8 to 216 kHz. Or, as another example, if the Model 780-02's sample rate is 96 kHz a signal connected to the stereo input can have its sample rate range from 16 to 216 kHz.

As useful as allowing one sample rate to be converted to another, it may be the ability of the Model 780-02's SRC function to re-synchronize a signal that proves most valuable. For example, in typical post-production and broadcast applications all signals will have a sample rate of 48 kHz. A Model 780-02 and all of its normally connected input signals will be "locked" to a main timing reference signal that supports the 48 kHz sampling rate. But, as an example, a signal associated with a portable device, while at a 48 kHz sampling rate, may not be synchronized ("genlocked") to the "house" reference. Connecting this signal to the stereo input will cause the SRC function to "lock" it to the Model 780-02's rate, thus allowing it to be monitored over the loudspeaker system.

Model 780-02 to Control Console Connections

Figure 7 gives a detailed description of the signals that connect the Model 780-02 Central Controller to the one or more Model 790 or Model 71 Control Consoles. The Model 780-02 provides 12 volts DC for use by the control console's circuitry. The output current is limited to 100 mA, minimizing the chance that a short-circuit condition will damage the Model 780-02's circuitry. An asynchronous, bi-directional data interface links the connected units. The RS-485 hardware connection scheme operates at a rate of 115.2 kbit/s and uses an 8-N-1 data format. The Model 780-02 communicates

with each Model 790 and Model 71 unit 20 times per second, receiving button and rotary level control information and sending LED and 4-digit display status data.

“Hot” Disconnection of Control Consoles

There's no problem relocating one or more Model 790 or Model 71 Control Consoles while the StudioComm system is operating. You can disconnect the 9-pin interconnecting cable, move the unit (or units), and then reconnect without issue. Upon disconnection of all control consoles the Model 780-02 Central Controller will mute the internal digital audio channels as well as saving the current operating parameters. No clicks, pops, or other noises will occur when the Model 790 or Model 71 units are again connected. The control consoles will go through their standard power-up sequence and then normal operation will resume.

Specifications

Model 780-02 Central Controller

General Audio:

Supported Sample Rates: 44.1, 48, 88.2, and 96 kHz

Word Length: 24 bits maximum

Internal Processing: 32 bits

Input-to-Output Latency: two samples (e.g., 0.042 milliseconds @ 48 kHz sample rate)

Digital Audio Inputs: 3 (18 audio channels total)

Configuration: two surround (7.1) and one stereo

Type: balanced AES3 (110 ohms, 5 Vpp)

Connector—Surround Inputs: 25-pin female D-subminiature (DB-25F), AES59-2012-compliant

Connector—Stereo Input: 3-pin female XLR

Sample Rate Conversion (SRC):

Application: available on the stereo input

Input Sample Rate Range: 8 to 216 kHz, limited to 1/6 to 6 times the output sample rate

Latency: 1 millisecond, nominal

LFE Input Channel Low-Pass Filter: -6 dB @ 120 Hz, 48 dB-per-octave, on/off selectable

Configurable Input Delay: 0 to 340 milliseconds @ 48 kHz sample rate (scales up or down depending on actual sample rate)

Sync Source: configured to follow L/R of currently selected input or signal connected to sync input

Sync Input:

Compatible Sources: word clock, DARS (AES11), bi-level video, tri-level video

Jitter: 4 ns pp maximum

Connector: BNC (per IEC 60169-8 Amendment 2)

Termination: 75 ohms, selectable on/off

Analog Monitor Outputs: 8

Configuration: organized as one surround (7.1)

Type: electronically balanced, source impedance 200 ohms

Nominal Level: +4 dBu @ -20 dBFS input source and level control at maximum setting

Maximum Level: +24 dBu into 2000 (2 k) ohms or greater

Frequency Response:

20-20 kHz, ± 0.1 dB @ 48 kHz sample rate;
10-40 kHz, ± 0.4 dB @ 96 kHz sample rate

Dynamic Range: 119 dB, A-weighted

Distortion (THD+N): < 0.001%, 20-22 kHz, level control at full, 22 kHz bandwidth

Crosstalk: -110 dB, ref -1 dBFS, 20 kHz

Connector: 25-pin female D-subminiature (DB-25F), AES59-2012-compliant

Monitor Output Level Offsets: each channel independently adjustable in 0.5-dB steps over a ± 12 -dB range

Bass Management:

Crossover Frequency and Type: -6 dB @ 40, 50, 60, or 80 Hz, symmetrical for low-pass and high-pass filters, maximally flat

Filter Slope: 12 dB-per-octave or 24 dB-per-octave

Overall Operation: on/off selectable

Downmix Functions: To 5.1, To Stereo, and To Mono

Control Console Interface:

Type: RS-485, 115.2 kbit/s, 8-1-N

Polling Interval: 80 milliseconds, nominal

Power: 12 Vdc, 500 mA maximum

Connector: 9-pin female D-subminiature (DE-9F)

Remote Control Inputs: 2

Functions: remote mute all, remote dim

Type: 3.3 Vdc logic, activates on closure to system common

Connector: 9-pin female D-subminiature (DE-9F)

AC Mains:

Requirement: 100 to 240 V, +10/-15%, 50/60 Hz, 15 W maximum

Connector: 3-blade, IEC 320 C14-compatible (mates with IEC 320 C13)

Dimensions:

19.00 inches wide (48.3 cm)

1.72 inches high (4.4 cm)

7.00 inches deep (17.8 cm)

Mounting: one space (1U) in a standard 19-inch rack

Weight: 3.6 pounds (1.6 kg)

Model 790 Control Console

Application: up to four Model 790 Control Consoles can be connected to a Model 780-02 Central Controller

Power: 12 Vdc nominal (9 Vdc minimum), maximum current 100 mA, provided by Model 780-02 Central Controller

Control Data:

Type: RS-485

Data Rate/Format: 115.2 kbit/s, 8-N-1

Connector: 9-pin female D-subminiature (DE-9F)

Dimensions (Overall):

7.20 inches wide (18.3 cm)

2.20 inches high (5.6 cm)

5.40 inches deep (13.7 cm)

Weight: 1.7 pounds (0.8 kg)

Model 71 Control Console

Application: up to three Model 71 Control Consoles can be connected to a Model 780-02 Central Controller

Power: 12 Vdc nominal (9 Vdc minimum), maximum current 35 mA, provided by Model 780-02 Central Controller

Control Data:

Type: RS-485

Data Rate/Format: 115.2 kbit/s, 8-N-1

Connector: 9-pin female D-subminiature (DE-9F)

Dimensions (Overall):

3.20 inches wide (8.1 cm)

2.20 inches high (5.6 cm)

4.10 inches deep (10.4 cm)

Weight: 0.8 pounds (0.4 kg)

Specifications and information contained in this User Guide subject to change without notice.

Appendix A—Connection Pin-Out Charts

Connections	Channel	Signal High (+)	Signal Low (–)	Shield
Surround Input A L/R	1	24	12	25
Surround Input A C/LFE	2	10	23	11
Surround Input A SL/SR	3	21	9	22
Surround Input A BL/BR	4	7	20	8
Surround Input B L/R	5	18	6	19
Surround Input B C/LFE	6	4	17	5
Surround Input B SL/SR	7	15	3	16
Surround Input B BL/BR	8	1	14	2

Notes: 1) All signals transformer-coupled digital audio; balanced AES3 (110 ohms, 5 Vpp) compatible.
2) Connector type on Model 780-02 is 25-pin female D-subminiature (DB-25F). Installer must provide male (DB-25M). Connector uses 4-40 threaded inserts for locking with mating plug.
3) Wiring scheme follows AES59-2012 convention. Standard TASCAM-type wiring harnesses are directly compatible, with the possible exception of 4-40 screw threads being required.

Connections for Surround A and Surround B Digital Inputs

Signal	Pin	Direction
Data Shield	1	Shield
Remote Mute All	5	Input
Remote Dim	6	Input
Remote Spare 1	8	Input
Remote Spare 2	9	Input
Remote Input Common	4	Common

Note: Connector type on Model 780-02 is 9-pin female D-subminiature (DE-9F). Connector uses 4-40 threaded inserts for locking with mating plug.

Connections for Remote Control Inputs

Connections	Channel	Signal High (+)	Signal Low (–)	Shield
Left (L)	1	24	12	25
Right (R)	2	10	23	11
Center (C)	3	21	9	22
Subwoofer (SUB)	4	7	20	8
Surround Left (SL)	5	18	6	19
Surround Right (SR)	6	4	17	5
Back Left (BL)	7	15	3	16
Back Right (BR)	8	1	14	2

Notes: 1) Connector type on Model 780-02 is 25-pin female D-subminiature (DB-25F). Installer must provide male (DB-25M). Connector uses 4-40 threaded inserts for locking with mating plug.
2) Wiring scheme follows AES59-2012 convention. Standard TASCAM-type wiring harnesses are directly compatible, with the possible exception of 4-40 screw threads being required.

Connections for Analog Monitor Outputs

Signal	Pin	Direction
Data + (RS-485)	1	To/From Models 790/71
Data – (RS-485)	6	To/From Models 790/71
Data Shield	2	To/From Models 790/71
DC + (12 V)	4	To Models 790/71
DC – (12 V Return)	9	To Models 790/71
DC Power Shield	5	To/From Models 790/71

Note: Connector type on Model 780-02 is 9-pin female D-subminiature (DE-9F). Connector uses 4-40 threaded inserts for locking with mating plug.

Connections between Model 780-02 and Model 790 and Model 71

Appendix B—Sync Input Sources

The Model 780-02's sync input has been tested and confirmed for correct operation with the following sync signals:

Word Clock: Square wave signal with rate of 44.1, 48, 88.2, or 96 kHz.

DARS (AES11) or AES3: Signal with sample rate of 44.1, 48, 88.2, or 96 kHz.

Bi-Level and Tri-Level Video: See table below.

Video Format	Video Format, continued
NTSC ("Black Burst")	1035i/59.98 Hz
PAL ("Black Burst")	1035i/60 Hz
525i/59.94 Hz	1080i/50 Hz
525p/59.94 Hz	1080i/59.94 Hz
625i/50 Hz	1080i/60 Hz
625p/50 Hz	1080p/23.98 Hz
720p/23.98 Hz	1080p/24 Hz
720p/24 Hz	1080p/25 Hz
720p/25 Hz	1080p/29.97 Hz
720p/29.97 Hz	1080p/30 Hz
720p/30 Hz	1080psf/24 Hz
720p/50 Hz	1080psf/23.98 Hz
720p/59.94 Hz	
720p/60 Hz	

Appendix C—Downmix Formulas

The following provides a summary of the action performed when the downmix modes are active. Signals at unity gain unless noted. 0.707 = -3 dB; 0.5 = -6 dB; 0 = full attenuation.

To 5.1

$SL = SL + BL$

$SR = SR + BR$

BL and BR mute

To Stereo

$L = L + 0.707C + 0.707SL + 0.707BL + (0 \text{ or } 0.5)LFE$

$R = R + 0.707C + 0.707SR + 0.707BR + (0 \text{ or } 0.5)LFE$

C, LFE, SL, SR, BL, and BR mute

To Mono

For Surround Input A, Surround Input B

$C = .707L + .707R + C + 0.5SL + 0.5SR + 0.5BL + 0.5BR + (0 \text{ or } 0.5)LFE$

L, R, LFE, SL, SR, BL, and BR mute

For Stereo Input

$C = 0.707L + 0.707R$

L and R mute (LFE, SL, SR, BL, and BR already muted)

