

402 DUAL OUTPUT DELAY

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402

The Symetrix 402 is a single-input, dual-output digital delay intended for use in sound systems, video production, and other applications requiring a high-quality digital signal delay. The 402 uses oversampling 20-bit A/D and D/A converters to achieve recording-studio signal quality in an affordable package.

Each of the two outputs may be delayed from the input in 1-millisecond steps, up to a maximum delay of 885 milliseconds (999 feet, 304 meters, or 29 frames). The delay time settings are stored in nonvolatile memory. A rear-panel switch defeats the front panel delay time switches to prevent tampering. Each input and output has a level control.

In bypass mode (via the BYPASS switch or during power-off conditions) the inputs and outputs are hard-wired together.

A 12 segment LED display shows peak input level and is calibrated to assist the user in making the right trade-off between dynamic range and headroom.

All inputs and outputs are available via XLR connectors, TRS phone jacks, and screw terminals.

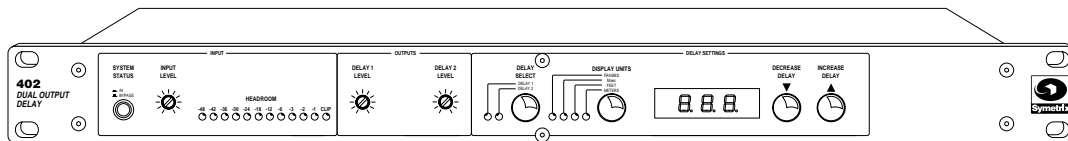
We recommend that you read this manual from cover to cover. Somewhere between the confines of the two covers you should find the answers to most (98%) of your questions, both technical as well as musical. Should you have any comments or questions, please do not hesitate to contact us at the numbers/addresses below. Your calls are always welcome.

Phone: (425)787-3222

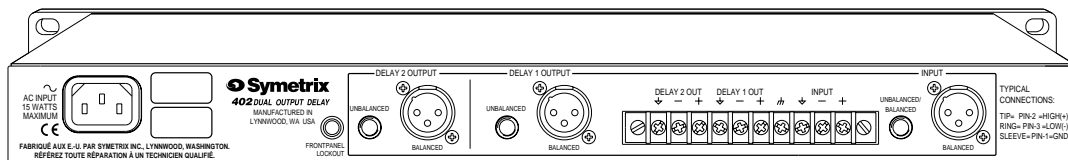
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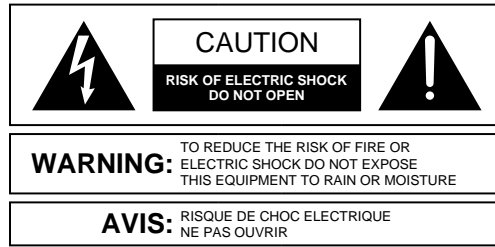
Front Panel



Rear Panel

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Equipment Markings



SEE OWNERS MANUAL. VOIR CAHIER D'INSTRUCTIONS.
 No user serviceable parts inside. Refer servicing to qualified service personnel.
 Il ne se trouve à l'intérieur aucune pièce pouvant être réparée l'utilisateur.
 S'adresser à un réparateur compétent.

The lightning flash with arrowhead symbol within an equilateral triangle is intended to alert the user of the presence of uninsulated “dangerous voltage” within the product’s enclosure that may be of sufficient magnitude to constitute a risk of electric shock to persons. The exclamation point within an equilateral triangle is intended to alert the user of the presence of important operating and maintenance (servicing) instructions in the literature accompanying the product (i.e. this manual).

Caution *To prevent electric shock, do not use the polarized plug supplied with the unit with any extension cord, receptacle, or other outlet unless the blades can be fully inserted.*

Terms

Several notational conventions are used in this manual. Some paragraphs may use **Note**, **Caution**, or **Warning** as a heading. Certain typefaces and capitalization are used to identify certain words. These are:

- Note** Identifies information that needs extra emphasis. A **Note** generally supplies extra information to help you to better use the 402.
- Caution** *Identifies information that, if not heeded, may cause damage to the 402 or other equipment in your system.*
- Warning** **Identifies information that, if ignored, may be hazardous to your health or that of others.**
- CAPITALS** Controls, switches or other markings on the 402’s chassis.
- Boldface** Strong emphasis.

Important Safety Instructions

Please read and keep these instructions. Heed and follow all warnings and instructions. Install in accordance with the manufacturer’s instructions.

Power Source This product is intended to operate from a power source that does not apply more than 250V rms between the power supply conductors or between either power supply conductor and ground. A protective ground

connection, by way of the grounding conductor in the power cord, is essential for safe operation.

Grounding The chassis of this product is grounded through the grounding conductor of the power cord. To avoid electric shock, plug the power cord into a properly wired receptacle before making any connections to the product. A protective ground connection, by way of the grounding conductor in the power cord, is essential for safe operation. **Do not defeat the safety purpose of the grounding plug.** The grounding plug has two blades and a third grounding prong. The third prong is provided for your safety. When the provided plug does not fit your outlet, consult an electrician for replacement of the obsolete outlet.

Danger from Loss of Ground If the protective ground connection is lost, all accessible conductive parts, including knobs and controls that may appear to be insulated, can render an electric shock.

Proper Power Cord Use only the power cord and connector specified for the product and your operating locale. Use only a cord that is in good condition. **Protect the power cord** from being walked on or pinched, particularly at plugs, convenience receptacles, and the point where they exit from the apparatus.

Proper Fuse The user accessible fuse is a part of the IEC AC inlet connector. The fuseholder accepts 5 x 20mm diameter fuses. For 117VAC operation, the correct value is 0.2A, 250VAC, slow blowing. For 230VAC operation, the correct value is 0.1A, 250VAC, slow blowing.

Operating Location **Do not operate this equipment under any of the following conditions:** explosive atmospheres, in wet locations, in inclement weather, improper or unknown AC mains voltage, or if improperly fused. Do not install near any heat source such as radiators, heat registers, stoves, or other apparatus (including amplifiers) that produce heat. Unplug this apparatus during lightning storms or when unused for long periods of time.

Stay Out of the Box To avoid personal injury (or worse), do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed. Only use accessories specified by the manufacturer. Clean only with a damp cloth.

User-serviceable parts There are no user serviceable parts inside the 402. In case of failure, refer all servicing to the factory. Servicing is required when the 402 has been damaged in any way, such as when a power supply cord or plug is damaged, liquid has been spilled or objects have fallen into the apparatus, the apparatus has been exposed to rain or moisture, does not operate normally, or has been dropped.

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Follow these instructions to get your 402 up-and-running as quickly as possible.

Connections

Connect your input source to either the XLR, TRS, or barrier strip connections. Connect the 402's output to your sound system's power amplifier inputs using either the XLR, TRS, or barrier strip connections.

Connect the AC input to an AC power source of the proper voltage and frequency, as marked on the rear of the unit.

Caution: *Failure to connect the 402 to the proper AC mains voltage may cause fire and/or internal damage. There are no user serviceable parts inside the chassis. Refer all service to qualified service personnel or to the factory.*

Warning: **Lethal voltages are present inside the chassis. There are no user serviceable parts inside the chassis. Refer all service to qualified service personnel or to the factory.**

Settings

Set the controls and switches on the front panel as follows:

IN/BYPASS - IN

INPUT LEVEL - Adjust for signal peaks at -1 dB maximum, as indicated on the Headroom display for maximum dynamic range. For +4 dBu systems, the correct setting is maximum CCW rotation. For -10 dBu systems, the correct setting is full CW rotation.

DELAY 1 LEVEL - Adjusts Delay 1 output level. For -10 dBu systems, the correct setting is full CCW rotation. For +4 dBu systems, the correct setting is full CW rotation.

DELAY 2 LEVEL - Adjusts Delay 2 output level. For -10 dBu systems, the correct setting is full CCW rotation. For +4 dBu systems, the correct setting is full CW rotation.

DELAY SELECT - Your choice.

DISPLAY UNITS - Your choice.

On the rear panel, ensure that the FRONT PANEL LOCKOUT switch is in the OUT position.

Initial Setup

The 402's controls and switches are now set according to the preceding section. All connections listed in the "Connections" section are now made. The 402 should now pass signal. The LED display should be illuminated.

Set the input level by increasing the setting of the input level control until the amber LEDs in the HEADROOM display illuminate. Ideally, the highest signal level should illuminate the -1 dB LED, and the CLIPPING LED should never illuminate (the CLIPPING LED operates at clipping. If the CLIPPING LED illuminates, rest assured that clipping actually occurred).

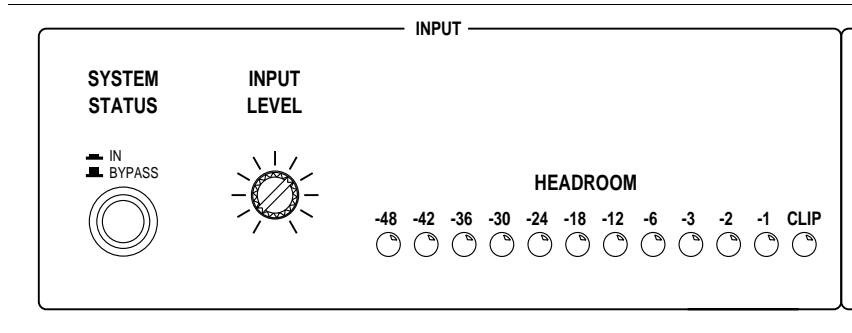
Set the DELAY 1 and DELAY 2 LEVEL controls by comparing the signal levels between BYPASS and IN and adjusting the control(s) for equal levels. Set the delay time for each output as follows:

1. Depress the DELAY SELECT switch until the delay select LEDs indicate the desired delay.
2. Depress the DISPLAY UNITS switch until the delay units LEDs indicate the desired display units (milliseconds, feet or meters).
3. Depress the INCREASE or DECREASE switches until the numeric display indicates the desired amount of delay.
4. Repeat this procedure for the remaining delay output.

Ensure that the output signals are delayed from the input signal (since the 402 will pass signal, albeit without any delay, even without AC power applied). You can check this by setting the IN/BYPASS switch to BYPASS. Unless you have selected a very short delay, you should hear a "time-shift" in the program when you do this. Remember to set the IN/BYPASS switch back to IN. The 402 is ready for use.

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Input Controls

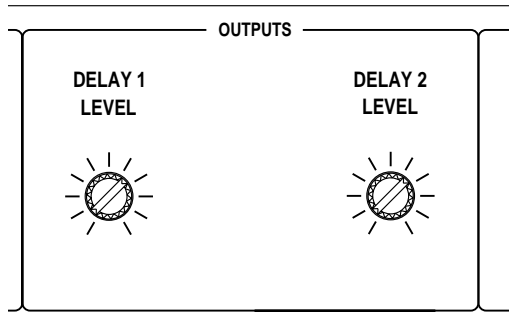


IN/BYPASS - Enables the 402 when depressed; hard wire bypass when out or during power-off condition

INPUT LEVEL - Adjusts input level for maximum dynamic range

INPUT METER - Indicates the input signal level and headroom of the 402. During operation, you should **never** see the red (CLIP) LED illuminate.

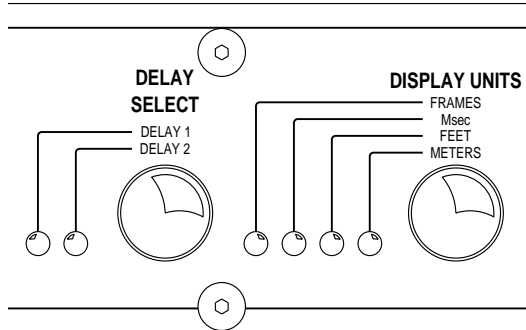
Output Controls



DELAY 1 LEVEL - Adjusts output level for Delay 1.

DELAY 2 LEVEL - Adjusts output level for Delay 2.

Mode Controls



DELAY SELECT - Selects delay line whose delay time is displayed in the numeric LED display.

DELAY SELECT LEDs - Indicates which delay's parameters are being displayed.

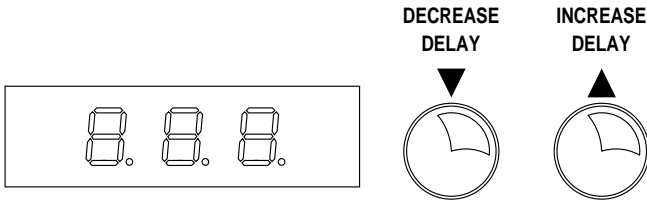
DISPLAY UNITS LEDs - These LEDs indicate which delay increment unit is being used for the numeric LED display.

DISPLAY UNITS - Pressing this button changes the units displayed in the numeric LED display from time to distance units.

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Display Controls

DELAY SETTINGS

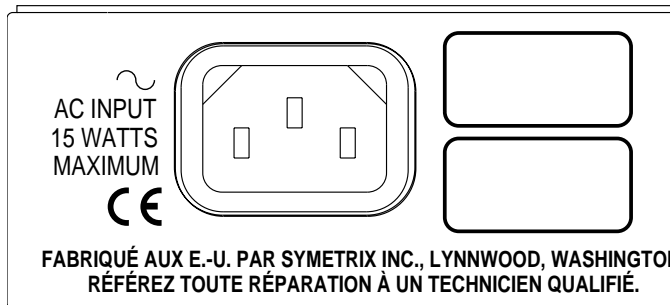


LED DISPLAY - Three-digit display indicates delay time for the currently selected delay.

INCREASE - Pressing this button increases the delay time for the current output in 1 ms, 1 foot, 1 meter, or 1 frame steps.

DECREASE - Pressing this button decreases the delay time for the current output in 1 ms, 1 foot, 1 meter, or 1 frame steps.

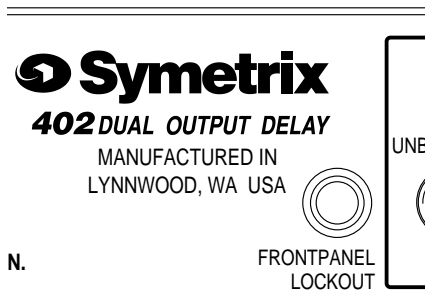
Power & Serial



AC POWER INPUT - IEC-power connector. Connect only to appropriate AC power source. Refer to rear-panel sticker for correct AC source value.

SERIAL NUMBER - Do yourself a favor and write this number down somewhere safe, and while you're at it, would you please send us the completed warranty card?

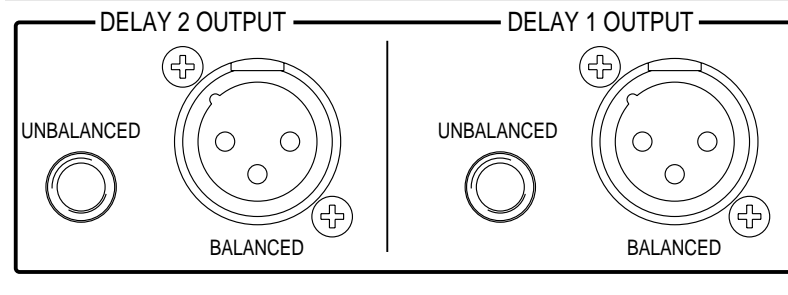
Front Panel Lockout



FRONT PANEL LOCKOUT switch - Push-push switch disables all front panel switches. The input and output level controls are not affected.

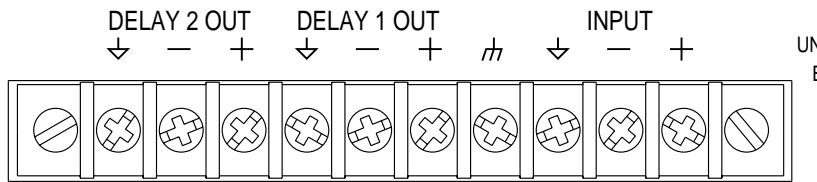
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Output Connectors



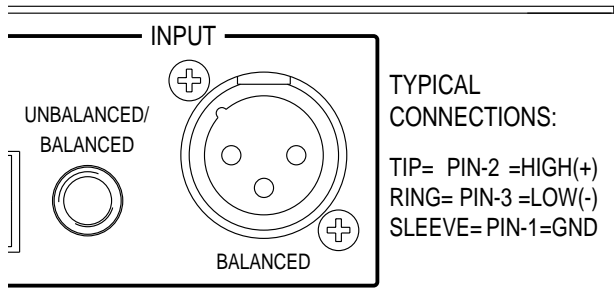
OUTPUTS - XLR-male, balanced; TRS phone, unbalanced. The barrier strip output and the XLR output are wired in parallel. The TRS output jacks may be strapped for balanced operation.

Terminal Strip



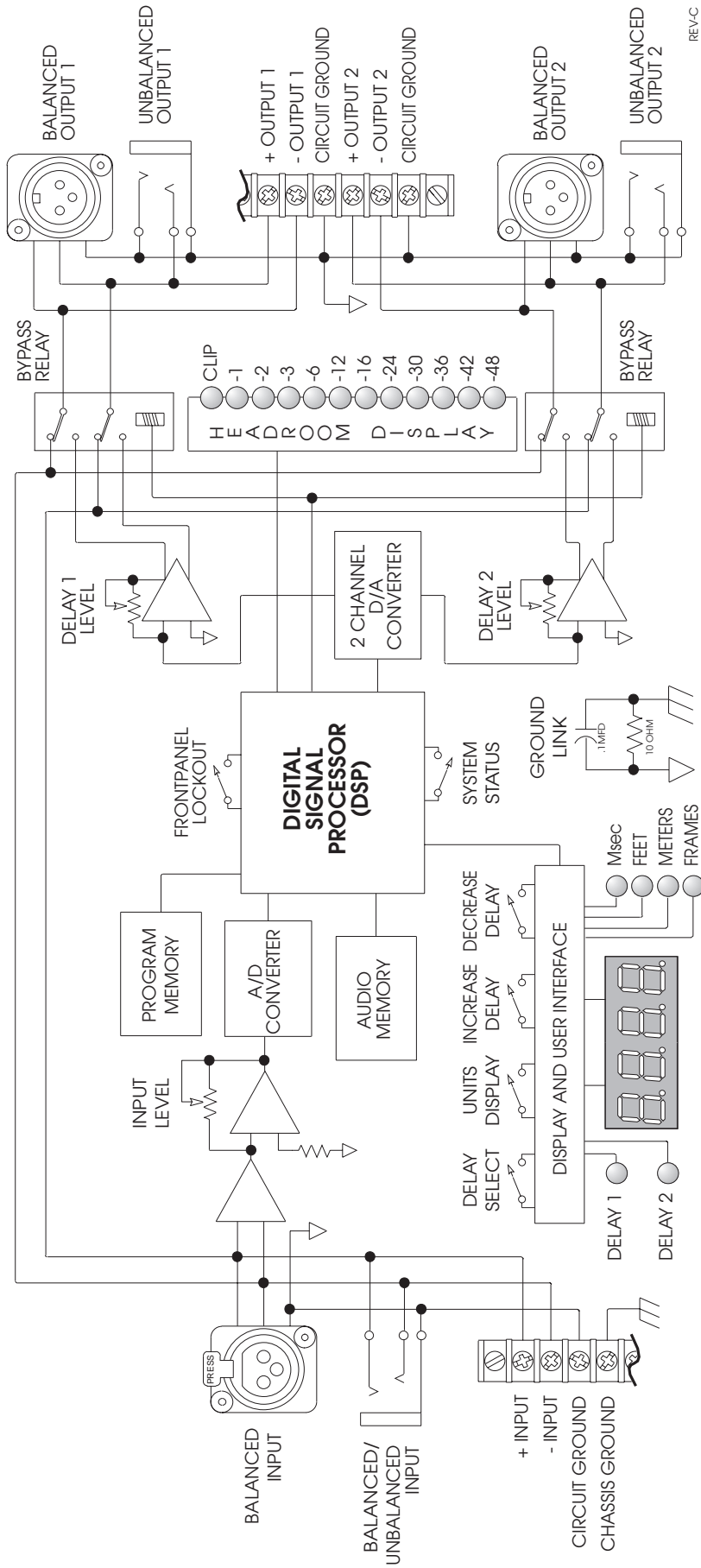
TERMINAL STRIP - Barrier strip with #6 screw terminals. Contains connections for all outputs and inputs (wired in parallel with their respective connectors), circuit ground and chassis ground.

Inputs



INPUTS - TRS (1/4-inch tip-ring-sleeve) phone, XLR-female. All of the inputs are wired in parallel.

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This section is intended for more advanced users. If you are a first-time 402 user, we recommend that you start out by using the procedure found in “First Time Setup” (Chapter 3).

Block Diagram

On the preceding page you can find the block diagram for the 402. Please take a moment and make note of the following:

- Bypass mode is a hard-wire bypass for each channel.
- The TRS, XLR and screw input terminals are all paralleled.
- The XLR and screw output terminals are paralleled.
- The TRS output jack is wired for unbalanced operation (tip = positive (+), ring and sleeve grounded).

Installation

The 402 may be installed freestanding or rack mounted. No special ventilation requirements are necessary.

- Mechanical One rack space (1.75 inches) required, 10 inches depth (including connector allowance). Rear chassis support recommended for road applications.
- Electrical 105-125 VAC, 12.5 watts.
- Connectors XLR-3 female for inputs, XLR-3 male for outputs, Pin 2 of the XLR connectors is “Hot.” TRS female and barrier strip connectors are also provided.

Level Setting, Headroom, and Noise

The 402 uses a novel approach to maximizing the overall signal-to-noise ratio at both the inputs and outputs. If you follow our recommendations, then each block of the 402’s circuitry operates at its optimum signal level. This is especially important for the digital portions of the 402.

The following table illustrates the concept:

Nominal Signal Level	Input Level Control	Delay 1 or Delay 2 Level
+4dBu(1.23V)	Full CCW	Full CW
-10dBv(.245V)	Full CW	FullCCW

If you set the controls as suggested in the table, the 402 will have 18dB of headroom above either of the nominal signal levels. For optimum signal to noise performance in nominal +4 dBu systems, you may want to reduce the amount of headroom somewhat. Do this by turning the INPUT LEVEL control up (clockwise) until you see the desired signal level on the HEADROOM DISPLAY. Then, turn the OUTPUT LEVEL control down (counterclockwise) by the same amount that you turned the INPUT LEVEL control up.

Please Note: **These control settings represent a starting point.** You can fine-tune the input level by using the 402’s LED level display by adjusting the mixer’s output for a 0 VU level signal (or other suitable reference). Then adjust the INPUT LEVEL control on the front panel so that the display indicates peaks up to the -1 dB LED. You may want to disconnect the output connections from the unit when setting the input level.

If you use the output level controls to balance the ratio between your main speaker cluster and the fill speakers, it is important that you set the gain of the portion of the sound system that follows the 402 as if the 402 wasn’t there. This ensures that the 402 operates at or near unity gain, which ensures the best overall signal-to-noise ratio through the 402. You can quickly establish the unity gain setting by using the bypass switch as a way to compare signal levels.



Using the Delay Units Mode

The 402 can display its delay time in either units of time (milliseconds) or units of distance (feet or meters). The 402 converts any settings into an internally used value (the number of samples); thus the display may appear to be inconsistent (due to internal rounding of fractional values) when switching back and forth between time units and distance units. The display indicates the time or distance represented by the internal delay setting, rounded to the nearest whole unit.

Since one foot represents 0.886 milliseconds of delay, this also represents the maximum resolution of the 402's delay time setting.

Fine Tuning the Delay Time

Once you've established the proper delay setting, it may be necessary to make small adjustments in the setting. This can actually vary on a day-to-day basis, however most system operators ignore the day-to-day variation.

The factors that can actually influence the delay time are temperature, humidity, and wind. The delay time is influenced by temperature and humidity because the speed of sound is temperature dependent, and the relative humidity affects the density of the air, which affects the speed of sound. Finally prevailing winds may affect the delay time by causing refraction; effectively lengthening the path to the listener's ears.

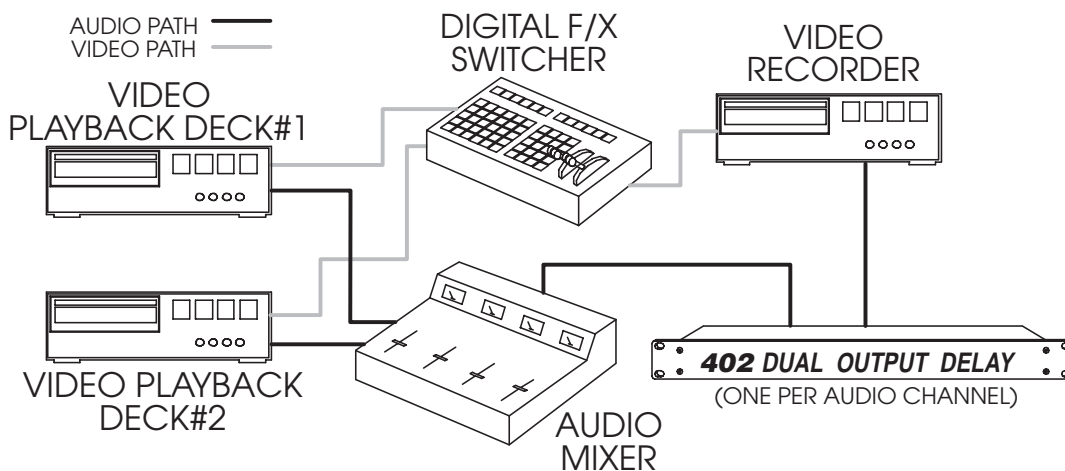
For the most part, you can ignore the effects of temperature and humidity, except perhaps, in situations where both occur in the extreme (like inside an ice rink). Remember that the dominant variable is the distance, and that the listeners sit within a zone, rather than all in the same seat.

Video Post Applications

Insert the 402 in the audio signal path before the recorder. (See diagram below for a typical hookup.) Use the DISPLAY UNIT button on the front panel to select FRAME delay increments. Adjust the delay time to account for the amount of frame delay from passes through frame synchronizers, digital signal processors, time base correctors, or satellite transmission.

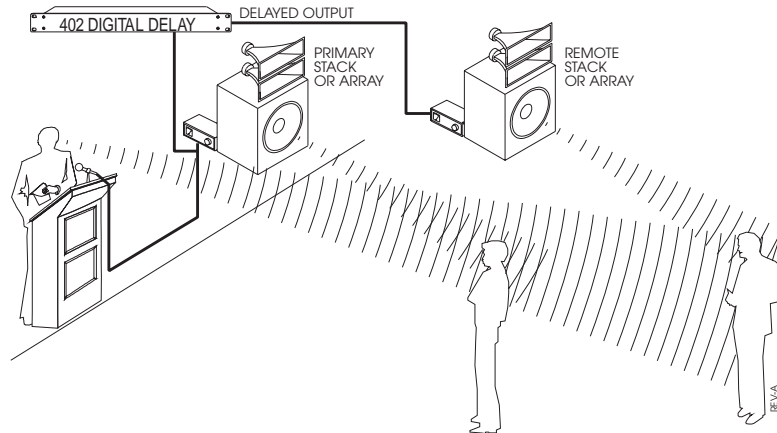
This is also a very useful technique in cases where the source tape already has some video delay due to previous passes through frames synchronizers etc.

Note: The 402's frame delay feature is based on the NTSC standard 29.97 frames per second. It will also work for the HDTV standard 30 frames/sec. However, if you are using PAL (25 frames/sec), set the DISPLAY UNITS to milliseconds and calculate the delay needed based on 40 milliseconds per frame.



Providing even coverage under balconies and other architectural features is a common problem in many auditoriums. At first glance, simply adding fill loudspeakers under the obstruction, directly connected to the sound system, seems like a reasonable solution. It is, but it works at the expense of the virtual image of the sound source since the sound from the fill speakers reaches the listener's ears much sooner than that emanating from the stage or the stage-mounted loudspeakers.

A further refinement of the solution adds a time delay to the signal sent to the fill loudspeakers. This delays the arrival of the sound from the fill speakers by an amount of time slightly greater than that required to travel the distance through air. The figure below illustrates this point. A psychoacoustical effect restores the illusion of the sound emanating from the source.



Using time delay to equalize arrival time difference due to different acoustical path lengths.

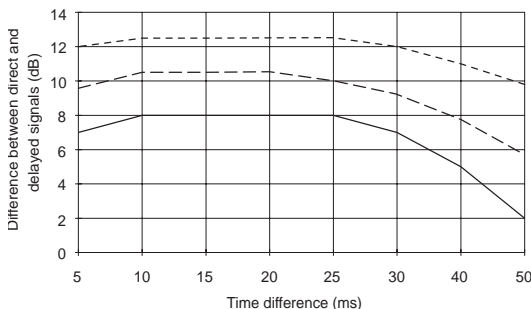
The Haas Precedence Effect

In the late 1940's, Helmut Haas, a German physicist, published a paper titled, "The Influence of a Single Echo on the Audibility of Speech."¹ The paper explores how our hearing perceives delayed sound delivered simultaneously with non-delayed sound and how it affects intelligibility. Dr. Haas describes a variety of tests, taken in a variety of surroundings.

Although Dr. Haas widely receives credit for the precedence effect, examination of the literature shows that other researchers were studying this phenomenon as early as 1849².

Dr. Haas' paper states that if two sounds arrive at our ears, within a specific period, the later of the two sounds may be louder without destroying the localization of the source. What does this mean for a sound system using fill loudspeakers? If the signal sent to the fill system is delayed sufficiently such that the sound arriving at the listener's ears is 10-30 milliseconds longer than the acoustical path delay (distance times the speed of sound) the Haas effect causes the source of the earlier signal to localize as the apparent source. This is true even if the later (delayed) signal is

significantly (up to about 10 dB) louder than the early signal. The figure to the left shows the relationship between the delay and the level of the secondary source.



Level difference versus delay for speech

1 "The Influence of a Single Echo on the Audibility of Speech.", Helmut Haas, *Journal of the Audio Engineering Society*, March 1972. Also reprinted in the JAES anthology: "Sound Reinforcement." This paper was originally titled, "ber den Einfluss des Einfachechos auf die Horsamkeit von Sprache." It was submitted as a dissertation toward a doctor's degree and was later translated into English and published in the United States by the AES.

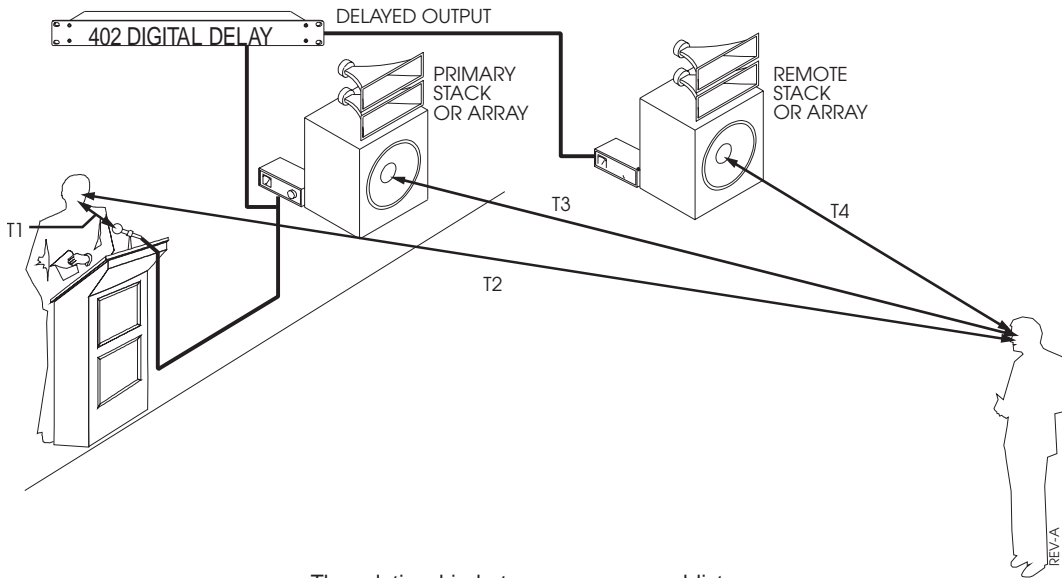
2 See bibliography at the end of this chapter.

Details

When applying a digital delay such as the 402 in an actual sound system, we must consider the following acoustical sources of time delay:

1. The source to microphone distance.
2. The source to listener distance.
3. The primary sound system to listener distance.
4. The fill system to listener distance.

In an application where microphones are always close talked (like a rock and roll PA), we can ignore item 1. In applications where the listener is sufficiently distant or where the acoustical contribution of the source to the listener is minimal, we can ignore item 2. The figure below illustrates the relationship between the various sources and the listener.



The relationship between sources and listener.

To calculate the delay needed, you'll need the following distances:

- t1. The source to microphone distance.
- t2. The source to listener distance.
- t3. The primary sound system to listener distance.
- t4. The fill system to listener distance.

Next convert the distances into delay times:

$$t = \frac{d}{c} \quad \text{where:} \quad t = \text{delay (sec)} \quad d = \text{distance (ft or m)}$$

$$c = \text{velocity of sound (1129ft/sec or 344.1m/sec at 71.5F)}$$

The approximate delay needed for the fill speakers will be:

$$t = t1 + t3 - t4 + th \quad \text{where:}$$

t = approximate delay required

t1 = source to mic delay

t3 = main system to listener delay

t4 = fill system to listener delay

th = Haas delay, 10-30 ms

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Although the formula given is quite precise, in practice the actual delay time is not. The actual path taken by the sound waves varies according to temperature and relative humidity. The dominant variable in **any** installation is the distance difference, and although temperature and humidity are factors, their effect on the overall delay are small compared to the effect of changing the distance. Thus it will always be necessary to fine-tune the final adjustment either by ear or by using test equipment.

The 402 makes setting the delay time easy. Start out by selecting the mode corresponding to the distance units that you use (feet or meters). Select the delay, based on distance, required. Then switch to time units and add the Haas delay and any additional correction needed. There is more adjustment resolution when using feet or time mode than when using meters mode.

Additional Delay Zones

Some installations require additional delay zones (coverage zones provided by delayed fill loudspeakers). Begin by establishing the delay required for each zone. Next examine the signals between adjacent zones and ensure (by varying the delay times) that the arrival times for signals from overlapping zones fall within the Haas zone. If it is not possible to manipulate the delay times to guarantee arrival times within 20-30 milliseconds, it may be necessary to alter the coverage of the adjacent speakers, or to reduce their level slightly. Of course, this is easier to do when you are working on paper, rather than on the premises.

Other Uses for Delay

Of course, the 402 can also be used where a single or double semi-fixed delay might be needed, for instance, to provide fixed slapback at two different rates for an effect, or for satellite uplink transit time compensation.

Digital delays are also used for speaker cluster alignment, however the 1 ms/1 ft minimum delay adjustment of the 402 is too coarse for this application.

Related Reading

If you are interested in conducting further research into the precedence effect or the applications of time delay in audio systems design, the following list of articles and papers is a good starting point.

“The Influence of a Single Echo on the Audibility of Speech.”, Helmut Haas, *Journal of the Audio Engineering Society*, March 1972. Also reprinted in the *JAES* anthology: “Sound Reinforcement.”

“The Precedence Effect in Sound Localization.” Hans Wallach, Edwin B Newman, Mark R. Rosenzweig, *The American Journal of Psychology*, July 1949. Reprinted in *JAES*, December 1973.

“*Sound Reinforcement*,” an anthology of articles from the pages of the *Journal of the Audio Engineering Society*. Copyright 1978, Audio Engineering Society Inc, New York, NY.

“*Sound System Engineering*”, second edition, Don and Carolyn Davis, Copyright 1987, Howard W. Sams & Co., Indianapolis IN.

“*The Master Handbook of Acoustics*,” second edition, F. Alton Everest, Copyright 1989, Tab Books Inc., Blue Ridge Summit PA.

“Some Single- and Multiple-Source Localization Effects,” Mark B. Gardner, *Journal of the Audio Engineering Society*, July/August 1973. Contains extensive bibliography.

“Designing an Auditorium Sound Reinforcement System,” Peter D. Hisocks, *Journal of the Audio Engineering Society*, December 1973.

“*Scientific Writings of Joseph Henry*,” Joseph Henry, Smithsonian Institute, Washington, D.C. 1886. For details of the 1849 date, see footnote at bottom of p. 295.

402

This section discusses a multitude of things, all related to getting signals in and out of the 402.

Matching Levels versus Matching Impedances

In any audio equipment application, the question of “matching” inevitably comes up. Without digging a hole any deeper than absolutely necessary, we offer the following discussion to (hopefully) clarify your understanding of the subject.

Over the years, we have all had impedance matching pounded into our heads. This is important only for ancient audio systems, power amplifiers, and RF. Technically speaking, the reason is power transfer, which reaches a maximum when source and load are matched. Modern audio systems are voltage transmission systems and source and load matching is not only unnecessary, but undesirable as well.

- ❑ Ancient audio systems operate at 600 ohms (or some other impedance value), and must be matched, both at their inputs and at their outputs. Generally speaking, if you are dealing with equipment that uses vacuum tubes, or was designed prior to 1970, you should be concerned about matching. These units were designed when audio systems were based on maximum power transfer, hence the need for input/output matching.
- ❑ Power amplifiers are fussy because an abnormally low load impedance generally means a visit to the amp hospital. Thus, it’s important to know what the total impedance of the pile of speakers connected to the amplifier really is.
- ❑ RF systems are matched because we really are concerned with maximum power transfer and with matching the impedance of the transmission line (keeps nasty things from happening). Video signals (composite, baseband, or otherwise) should be treated like RF.

Some folks seem to believe that balanced/unbalanced lines and impedances are related; or even worse that they are associated with a particular type of connector. Not so. Unbalanced signals are not necessarily high-impedance and balanced signals/lines are not necessarily low-impedance. Similarly, although 1/4 inch jacks are typically used for things like guitars (which are high-impedance and unbalanced), this does not predispose them to only this usage. After all, 1/4 inch jacks are sometimes used for loudspeakers, which are anything but high-impedance. Therefore, the presence of 3-pin XLR connectors should not be construed to mean that the input or output is low-impedance (or high-impedance). The same applies to 1/4 inch jacks.

So, what is really important? Signal level, and (to a much lesser degree), the impedance relation between an output (signal source) and the input that it connects to (signal receiver).

Signal level is very important. Mismatch causes either loss of headroom or loss of signal-to-noise ratio. Thus, microphone inputs should only see signals originating from a microphone, a direct (DI) box, or an output designated microphone-level output. Electrically, this is in the range of approximately -70 to -20 dBm. Line inputs should only see signals in the -10 to +24 dBm/dBu range. Guitars, high-impedance microphones, and many electronic keyboards do not qualify as line-level sources.

The impedance relation between outputs and inputs needs to be considered, but only in the following way:

Always make sure that a device’s input impedance is higher than the output source impedance of the device that drives it.

Some manufacturers state a relatively high-impedance figure as the output impedance of their equipment. What they really mean is that this is the minimum load impedance that they would like their gear to see. In most cases, seeing a output impedance figure of 10,000 (10K) ohms or higher from modern equipment that requires power (batteries or AC) is an instance of this type of rating. If so, then the input impedance of the succeeding input must be equal to or greater than the output impedance of the driving device.

Symetrix equipment inputs are designed to bridge (be greater than 10 times the actual source impedance) the output of whatever device drives the input. Symetrix equipment outputs are

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designed to drive 600 ohm or higher loads (600 ohm loads are an archaic practice that won't go away). You don't need to terminate the output with a 600 ohm resistor if you aren't driving a 600 ohm load. If you don't understand the concept of termination, you probably don't need to anyway.

The two facts that you need to derive from this discussion are:

1. Match signal levels for best headroom and signal-to-noise ratio.
2. For audio, impedance matching is only needed for antique equipment and power amplifier outputs. In all other cases, ensure that your inputs bridge (are in the range of 2 to 200 times the output source impedance) your outputs.

Signal Levels

The 402 is designed around studio/professional line levels: +4 dBu or 1.23 volts. The unit is quiet enough to operate at lower signal levels such as those found in semipro or musical-instrument (MI) equipment (-10 dBu or 300 millivolts).

I/O Impedances

The 402 is designed to interface into almost any recording studio or sound reinforcement application. This includes:

- 600 ohm systems where input and output impedances are matched.
- Unbalanced semiprofessional equipment applications.
- Modern bridging systems where inputs bridge and outputs are low source impedances (voltage transmission systems).

The 402's input impedance is 9400 ohms balanced, and 4700 ohms unbalanced. The inputs may be driven from any source (balanced or unbalanced) capable of delivering at least -10 dBu into the aforementioned impedances.

The 402's output impedance is 100 ohms balanced, 50 ohms unbalanced. The output line driver delivers +22 dBu into an open-circuit balanced load, or +17 dBm into 600 ohm unbalanced loads, unbalanced.

Polarity Convention

The 402 uses the international standard polarity convention of pin 2 hot. Therefore:

XLR	Tip-Ring-Sleeve	Signal
1	Sleeve	Ground
2	Tip	High
3	Ring	Low

If your system uses balanced inputs and outputs, and uses the 402 this way, then the polarity convention is unimportant. If your system is both balanced and unbalanced, then you must pay attention to this, especially when going in and coming out through different connector types (like input on an XLR, output on a phone jack).

Input and Output Connections

The figure on the next page illustrates how to connect the 402 to balanced and unbalanced sources and loads.

To operate the 402 from unbalanced sources, run a 2-conductor shielded cable (that's two conductors plus the shield) from the source to the 402. At the source, connect the low/minus side to the shield, these connect to the source's ground; connect the high/plus side to the source's signal connection. At the 402, the high/plus wire connects to pin 2, the low/minus wire connects to pin 3,

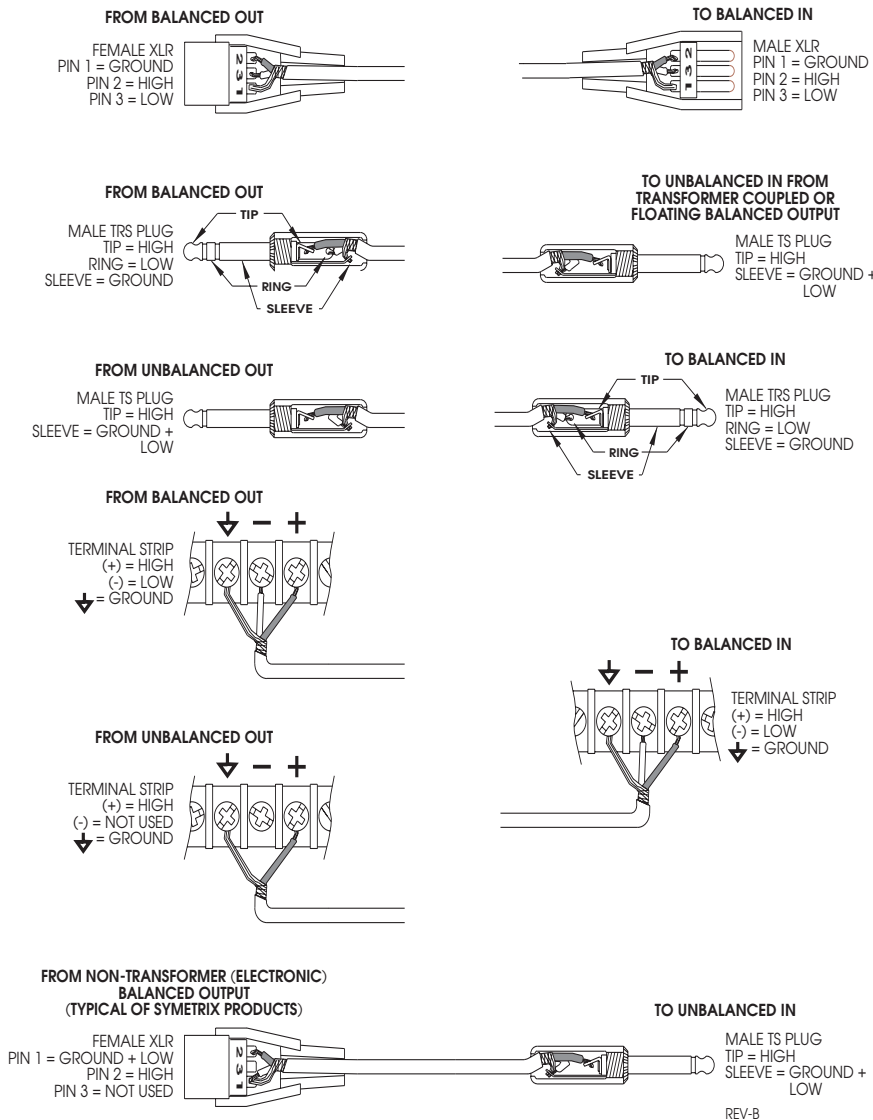
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and the shield (always) connects to pin 1. This is the preferred method as it makes best use of the 402's balanced input (even though the source is unbalanced). The other alternative shown converts the 402's balanced input into an unbalanced input at the input connector. This works, but is more susceptible to hum and buzz than the preferred method. There is no level difference between either method.

You can drive unbalanced loads with the 402's outputs by using the XLR connector with pin 3 left open. In an emergency (the show must go on), you can ground pin 3, but if you have the choice...leave it open. If you must ground pin 3, it is must be grounded at the 402, rather than at the other end of the cable. The price, regardless of whether or not pin 3 is grounded is 6 dB less output level. This can be easily made up via the output gain controls.

The 1/4-inch input jack is paralleled with the XLR-input and the screw terminals. In a large installation, it is permissible to use one of the connectors as the input connection and to use either or both of the remaining connections for paralleling other inputs with the 402.

The 1/4 inch output jack is a TRS (tip-ring-sleeve) jack wired for unbalanced operations, in parallel with the terminal strip and XLR output connections. When the 402's output is unbalanced, it's level will drop by 6dB.



Input and output connector wiring. These diagrams represent the majority of connectors used in modern audio equipment. Locate the source connector in the left column and match it up with the destination connector in the right column. Wire your cable according to the diagrams.

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Here are a few applications that the 402 lends itself to.

Distributed Sound Systems

This is probably the primary use for the 402. As described in the “Sound System Basics” chapter (Chapter 7), the 402 delays its input signal so that the direct sound from the source and the amplified sound from the sound system’s fill speakers arrive at the listener’s ears at approximately the same time (approximately because the sound from the fill system should arrive a bit later than the direct sound to preserve the illusion of the source). If the primary sound system must be mounted forward of the stage opening, then the 402 can also be used to delay this system slightly so that the direct sound from the stage and the amplified sound from the primary sound system arrive simultaneously.

Recording Applications

When recording a live performance, the primary pickup microphone is located some distance away from the orchestra or group. If you use accent microphones to “sweeten” the sound of a particular instrument, or if you add the vocal mix for a pop group, often there is enough acoustical delay between the accent mics and the primary pickup to cause comb filtering or a lack of presence. The 402 can be used to delay the signals from the accent microphone(s) to force them into time coherence with the primary microphone(s).

Satellite Transit Time Compensation

Sometimes a simultaneous audio-video feed arrives from the source via two completely different paths. The visuals may travel via a satellite uplink and downlink while the audio may take a terrestrial path. When this occurs, the sound and pictures will be out of sync by the difference in length of the two paths. A geostationary satellite orbits the earth at an altitude of 22,500 miles which results in an overall transit time of 242 milliseconds ($22500 \times 2 / 186000$).

To compensate for this delay, the 402 can be used to delay the audio signal by an amount equal to the difference in their paths.

Effects

Although the 402 makes no claim at being a be-all effects box, it can be used to generate two distinct delays, which might be used for slapback effects. If you return the 402’s outputs via a pair of input modules on your board, you can also create repeating echo effects by simply sending some of the 402’s output back to its input. The 402 might be a bit difficult to use in this application because the user interface wasn’t designed for rapid changes in the delay time. On the other hand, if you can live with relatively preset delay times and superb audio quality, the 402 will work just fine, thank you.

Video Post Applications

There are several sources of video frame delay in the video editing process. Whenever you send a video signal through a frame synchronizer, digital signal processor, or time base corrector, the video signal will be delayed by one frame. Satellite video transmission can also cause delay problems if the audio is transmitted separately via land line. In order to keep the video and audio locked together, one must delay the *audio* by the same amount that the video has been delayed. Hence the need for the 402 Dual output delay, which can display its delay time in milliseconds or NTSC frames.

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<u>Symptom</u>	<u>Probable Cause</u>
No output	<p>Check cables and connections.</p> <p>Are inputs driven by outputs, and outputs driving inputs?</p> <p>Verify cables, source and load by patching input and output connections together, at the unit.</p> <p>Check output by plugging headphones into output TRS jacks. Is the HEADROOM display operating?</p> <p>Check for AC power presence. Power LED on?</p>
Hum or buzz in output	<p>Check input connector wiring.</p> <p>Ground loop. Check related system equipment grounding. Are all system components on the same AC ground?</p> <p>Check grounding options.</p>
Distortion	<p>Check input signal. Is it too hot, or is it already distorted?</p> <p>Is the HEADROOM display indicating clipping?</p> <p>Check output loading. It should be above 600 ohms.</p> <p>Are the power amplifier(s) clipping?</p> <p>Is something else clipping?</p>
Noise (hiss)	<p>Check input signal levels, and level control settings.</p> <p>The HEADROOM display should indicate the presence of signal, up to but not including the CLIP led.</p> <p>Check gain settings on downstream equipment. The system gain structure should be such that the 402 operates at or near unity gain.</p> <p>Is the input signal already noisy?</p>
No LED display	<p>Is the unit plugged in, and turned on?</p> <p>Is the AC outlet OK?.</p>
No delay	<p>Is the unit in BYPASS mode?</p> <p>Is the unit plugged in? (The unit reverts to BYPASS when power is disconnected!)</p>
No nothing	<p>Is the unit turned on?</p>



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402 Specifications

Input/Output

Input One, 4700 ohms balanced bridging. XLR-female, TRS and screw terminals.

Outputs Two, 150 ohms source impedance, balanced. XLR-male, TRS and screw terminals.

Maximum input level +25 dBu

Maximum output level +22 dBu into an open-circuit balanced load, +18.5 dBm into 600 ohm balanced loads

Performance Data

Frequency Response 12 Hz-20 kHz +/- 1.5 dB

Distortion (THD+noise) < .015% @ 1 kHz, 1V RMS

Maximum Delay Time 885 milliseconds, 999 feet, 304 meters, 26 NTSC frames

Headroom Display 12-LED bargraph, 8 green LEDs @ 6dB/step, 3 yellow LEDs @ 1dB/step, 1 red LED @ true clipping

Dynamic Range >104 dB. This represents the difference between the largest and smallest signals that will pass through the 402. Measured using 8192 point FFT with Blackman-Harris windowing function.

Signal-to-Noise 93 dBfs measured with RMS voltmeter using 20 kHz "Brickwall" filter.

Sample Rate 48kHz

Converter Type Sigma-Delta, 20-bit Linear

Parameter Storage EEPROM nonvolatile memory. Backup battery NOT required. 10,000 parameter changes minimum.

Security

Recessed rear panel lockout switch disables delay increment switches. Optional security cover Symetrix SC-1.

Physical

Size (hwd), in & cm 1.75 x 19 x 7 in, 4.44 x 48.26 x 17.78 cm

Weight, lbs & kg 7.5 lbs, 3.4 kg (shipping wt.), 6 lbs, 2.7kg (net)

Electrical

Power 117V AC nominal, 105-125VAC, 50-60 Hz

230VAC nominal, 205-253VAC, 50Hz

Power consumption 12.5 Watts

Note: The maximum operating ambient temperature is 25 degrees C.

In the interest of continuous product improvement, Symetrix Inc. reserves the right to alter, change, or modify these specifications without prior notice.

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402 Architects and Engineers Specifications

The Digital Delay (DDL) shall be a single input, dual output model that delays its input signal by a precise period before delivering the delayed signal to its output. There shall be two independent delays provided, each sharing a common input, and a common chassis. All signal processing shall occur within the digital domain. Delays utilizing bucket brigade delays, or other analog means shall not be acceptable within the letter of this specification. The DDL shall occupy one rack space (1U).

The DDL shall be capable of delaying an audio signal by up to 885 milliseconds. The delay time shall be adjustable in one millisecond, one foot, one meter, or one frame increments. The delay time shall be displayable in milliseconds, feet, meters or frames and shall be selectable from the front panel at any time during operation. Each channel's delay time shall be stored in nonvolatile memory. Provision shall be made to disable the front-panel delay-time adjustment.

The DDL shall indicate its peak input signal level via a multistep LED ladder having the following indication points: -48, -42, -36, -30, -24, -18, -12, -6, -3, -2, -1VU, and clip.

The frequency response shall be 12-20000 Hz +/- 1.5 dB. The dynamic range shall be 104 dB minimum. The dynamic range shall be defined as the difference between the largest output signal possible and the smallest output signal possible. The total harmonic distortion shall be no more than .015 %, measured at 1 kHz, 1V RMS.

The inputs shall be active balanced bridging designs terminated with 3-pin XLR (AES/IEC standard wiring), 1/4" TRS female, and screw terminals. The input circuitry shall incorporate RFI filters. The outputs shall be active balanced designs having equal source impedances and terminated with 3-pin XLR (AES/IEC standard wiring), screw terminals and 1/4" TRS jacks.

The DDL shall accept input signals ranging from -10 to +4 dBu. The balanced inputs shall accommodate +20 dBu signals without distortion, and the balanced outputs shall be capable of delivering +22 dBu into an open-circuit balanced load, and +20 dBm into 600 ohm balanced loads without distortion. The output level of each output shall be adjustable over the range of -10 to +4 dBu.

When the unit is inoperative (either by loss of power, or via the BYPASS switch), the inputs and outputs shall be wired together. There shall be no transients transmitted to the output terminals during either turn-on, turnoff, or bypass operation.

The Dual Output Delay shall be capable of operating by means of its own built-in power supply connected to 117V nominal AC (105-130V) 50/60Hz (230V nominal AC, 207-253V, 50Hz where applicable). Power consumption shall be 12.5 Watts. The DDL shall be Listed by Underwriters Laboratories Inc. (UL) or other equivalent nationally recognized safety testing agency.

The unit shall be a Symetrix Incorporated model 402 Dual Output Delay.

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402 Limited Warranty

Symetrix, Inc. expressly warrants that the product will be free from defects in material and workmanship for one (1) year. Symetrix's obligations under this warranty will be limited to repairing or replacing, at Symetrix's option, the part or parts of the product which prove defective in material or workmanship within one (1) year from date of purchase, provided that the Buyer gives Symetrix prompt notice of any defect or failure and satisfactory proof thereof. Products may be returned by Buyer only after a Return Authorization number (RA) has been obtained from Symetrix. Buyer will prepay all freight charges to return the product to the Symetrix factory. Symetrix reserves the right to inspect any products which may be the subject of any warranty claim before repair or replacement is carried out. Symetrix may, at its option, require proof of the original date of purchase (dated copy of original retail dealer's invoice). Final determination of warranty coverage lies solely with Symetrix. Products repaired under warranty will be returned freight prepaid by Symetrix via United Parcel Service (surface), to any location within the Continental United States. At Buyer's request the shipment may be returned via airfreight at Buyer's expense. Outside the Continental United States, products will be returned freight collect.

The foregoing warranties are in lieu of all other warranties, whether oral, written, express, implied or statutory. Symetrix, Inc. expressly disclaims any IMPLIED warranties, including fitness for a particular purpose or merchantability. Symetrix's warranty obligation and buyer's remedies hereunder are SOLELY and exclusively as stated herein.

This Symetrix product is designed and manufactured for use in professional and studio audio systems and is not intended for other usage. With respect to products purchased by consumers for personal, family, or household use, Symetrix **expressly disclaims all implied warranties, including but not limited to warranties of merchantability and fitness for a particular purpose.**

This limited warranty, with all terms, conditions and disclaimers set forth herein, shall extend to the original purchaser and anyone who purchases the product within the specified warranty period.

Warranty Registration must be completed and mailed to Symetrix within thirty (30) days of the date of purchase.

Symetrix does not authorize any third party, including any dealer or sales representative, to assume any liability or make any additional warranties or representation regarding this product information on behalf of Symetrix.

This limited warranty gives the buyer certain rights. You may have additional rights provided by applicable law.

Limitation of Liability

The total liability of Symetrix on any claim, whether in contract, tort (including negligence) or otherwise arising out of, connected with, or resulting from the manufacture, sale, delivery, resale, repair, replacement or use of any product will not exceed the price allocable to the product or any part thereof which gives rise to the claim. In no event will Symetrix be liable for any incidental or consequential damages including but not limited to damage for loss of revenue, cost of capital, claims of customers for service interruptions or failure to supply, and costs and expenses incurred in connection with labor, overhead, transportation, installation or removal of products or substitute facilities or supply houses.

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Servicing the 402

If you have determined that your 402 requires repair services and you live *outside* of the United States please contact your local Symetrix dealer or distributor for instructions on how to obtain service. If you reside in the U.S. then proceed as follows:

At the Symetrix factory, Symetrix will perform in-warranty or out-of-warranty service on any product it has manufactured for a period of five years from date of manufacture.

Before sending anything to Symetrix, contact our Customer Service Department for a return authorization (RA) number. The telephone number is (425) 787-3222, Monday through Friday, 8AM (800 hours) though 4:30 PM (1630 hours), Pacific Time.

In-Warranty Repairs

To get your 402 repaired under the terms of the warranty:

1. Call us for an RA number.
2. Pack the unit in its original packaging materials.
3. Include your name, address, daytime telephone number, and a brief statement of the problem.
4. Write the RA number on the outside of the box.
5. Ship the unit to Symetrix, freight prepaid.

We do *not* accept freight collect shipments.

Just do these five things, and repairs made in-warranty will cost you only one-way freight charges. We'll prepay the return (surface) freight.

If you choose to send us your product in some sort of flimsy packaging, we'll have to charge you for proper shipping materials. If you don't have the factory packaging materials, then do yourself a favor by using an oversize carton, wrap the unit in a plastic bag, and surround it with bubble-wrap. Pack the box full of Styrofoam peanuts. Be sure there is enough clearance in the carton to protect the rack ears (you wouldn't believe how many units are returned with bent ears). We won't return the unit in anything but Symetrix packaging for which we will have to charge you. Of course, if the problem turns out to be operator inflicted, you'll have to pay for both parts and labor. In any event, if there are charges for the repair costs, you will pay for the return freight. All charges will be COD unless you have made other arrangements (prepaid, Visa or Mastercard).

Out-of-Warranty Repairs

If the warranty period has passed, you'll be billed for all necessary parts, labor, packaging materials, and freight charges. Please remember, you must call for an RA number before sending the unit to Symetrix.

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Declaration of Conformity

We, **Symetrix Incorporated**, 14926 35th Ave. West, Lynnwood, Washington, USA,
declare under our sole responsibility that the product:

402 DUAL OUTPUT DELAY

to which this declaration relates, is in conformity with the following standards:

EN 60065
Safety requirements for mains operated electronic and related
apparatus for household and similar general use.

EN 50081-1
Electromagnetic compatibility - Generic emission standard
Part 1: Residential, commercial, and light industry.

EN 50082-1
Electromagnetic compatibility - Generic immunity standard
Part 1: Residential, commercial, and light industry.

The technical construction file is maintained at:

Symetrix, Inc.
14926 35th Ave. West
Lynnwood, WA, 98037-2303
USA

The authorized representative located within the European Community is:

World Marketing Associates
P.O. Box 100
St. Austell, Cornwall, PL26 6YU, U.K.

Date of issue: 1 November 1995

Place of issue: Lynnwood, Washington, USA

Authorized signature:



Dane Butcher, President, **Symetrix Incorporated**.

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 **Symetrix**



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