

## Q Xpander Processors

# Monolithic IC MM1326, 1354, 1369

### Outline

These ICs are analog stereo enhancement processors. They use patented Q Xpander technology to create a stereo image with depth in three dimensions from ordinary left and right input channels.

There is no need for any special playback equipment; the enhanced audio effect can be experienced using standard stereo audio equipment.

This IC, produced by Mitsumi, faithfully incorporates algorithms developed by Q Sound Labs, Inc., the world leader in sound enhancement.

### Features

1. Sound spreading sensation can be varied at will using an external VR (MM1354, MM1369)
2. Pseudo-stereo effects can be obtained from monaural audio signals (MM1369)
3. Sound spreading sensation can also be varied with a VR for pseudo-stereo from monaural input (MM1369)
4. Q Xpander on/off and pseudo-stereo on/off switching at TTL level
5. Internal filter circuit for few external components (MM1369)
6. No need for input signal encoding or special external equipment; playback possible using ordinary stereo equipment
7. Low-noise design:     55  $\mu$ Vrms with Q Xpander on (MM1326)  
                               60  $\mu$ Vrms with Q Xpander on (MM1354)

### Package

SSOP-20A (MM1326AJ)  
 SDIP-22A (MM1326AD, MM1354AD, MM1354BD)  
 SSOP-24A (MM1354AJ)  
 SDIP-24A (MM1369AD, MM1369BD)

### Applications

1. Computer sound boards
2. Active speaker systems
3. TV game equipment and other amusement devices
4. TVs, monitors, audio equipment

### Line-Up

|                                  | MM1326       | MM1354       | MM1369                      |
|----------------------------------|--------------|--------------|-----------------------------|
| Variable sound spreading feature | Fixed        | Variable     | Variable                    |
| Pseudo-stereo function           | No           | No           | Yes<br>(spreading variable) |
| Operating power supply voltage   | 4.5~10.0 (V) | 4.5~12.0 (V) | 8.0~10.0 (V)                |

# [MM1326]

## Absolute Maximum Ratings

| Item                  | Symbol               | Ratings                                 | Units |
|-----------------------|----------------------|---|-------|
| Storage temperature   | T <sub>STG</sub>     | -40~+125                                | °C    |
| Operating temperature | T <sub>OPR</sub>     | -20~+75                                 | °C    |
| Power supply voltage  | V <sub>CC</sub> max. | 12                                      | V     |
| Input voltage         | V <sub>IN</sub> max. | GND ≤ V <sub>IN</sub> ≤ V <sub>CC</sub> | V     |
| Output voltage        | I <sub>O</sub> max.  | 10                                      | mA    |
| Allowable loss        | P <sub>d</sub>       | 500                                     | mW    |

## Recommended Operating Conditions

| Item                  | Symbol           | Ratings  | Units |
|-----------------------|------------------|----------|-------|
| Operating temperature | T <sub>OPR</sub> | -20~+75  | °C    |
| Operating voltage     | V <sub>OP</sub>  | 4.5~10.0 | V     |

## Electrical Characteristics

| Item                                      | Measurement conditions  | Min. | Typ. | Max. | Units             |
|---|---|------|------|------|-------------------|
| Consumption current                       |   |      | 15   | 20   | mA                |
| Output voltage                            | ★1  | 2    | 2.8  |      | V <sub>rms</sub>  |
| Voltage gain Q Xpander 1                  | SG1: 1V <sub>rms</sub> , 1kHz, SG2: no signal                                 | 5    | 6    | 7    | dB                |
| Voltage gain Q Xpander 2                  | SG1: 1V <sub>rms</sub> , 1kHz, SG2: no signal                                 | -1   | 0.5  | 2    | dB                |
| Voltage gain Q Xpander 3                  | SG1: no signal, SG2: 1V <sub>rms</sub> , 1kHz                                 | 5    | 6    | 7    | dB                |
| Voltage gain Q Xpander 4                  | SG1: no signal, SG2: 1V <sub>rms</sub> , 1kHz                                 | -1   | 0.5  | 2    | dB                |
| Voltage gain bypass 1                     | SG1: 1V <sub>rms</sub> , 1kHz, SG2: no signal                                 | -0.5 | 0    | 0.5  | dB                |
| Voltage gain bypass 2                     | SG1: no signal, SG2: 1V <sub>rms</sub> , 1kHz                                 | -0.5 | 0    | 0.5  | dB                |
| Input resistance                          |   | 21   | 30   | 39   | kΩ                |
| Power supply voltage rejection ratio      | V <sub>CC</sub> =9V+200mV <sub>rms</sub> , f=1kHz                             | 44   | 50   |      | dB                |
| Total harmonic distortion ratio Q Xpander | Lch=1V <sub>rms</sub> , Rch=no signal<br>Lch=no signal, Rch=1V <sub>rms</sub> |      | 0.3  | 0.7  | %                 |
| Total harmonic distortion ratio bypass    | Lch=1V <sub>rms</sub> , Rch=no signal<br>Lch=no signal, Rch=1V <sub>rms</sub> |      | 0.03 | 0.3  | %                 |
| Output noise voltage Q Xpander            | L, R channels=no signal, BW=20Hz to 20kHz, A curve                            |      | 55   | 100  | μV <sub>rms</sub> |
| Output noise voltage bypass               | L, R channels=no signal, BW=20Hz to 20kHz, A curve                            |      | 15   | 32   | μV <sub>rms</sub> |
| SN ratio Q Xpander                        | L, R channels=1V <sub>rms</sub> , 1kHz, BW=20Hz to 20kHz, A curve             | 80   | 85   |      | dB                |
| SN ratio bypass                           | L, R channels=1V <sub>rms</sub> , 1 kHz, BW=20Hz to 20 kHz, A curve           | 90   | 95   |      | dB                |
| L-R channel balance                       | L, R channels=1V <sub>rms</sub> , 1kHz, Bypass=0V                             | -1   | 0    | 1    | dB                |
| Bypass pin voltage (H)                    | ★2  | 2.1  |      |      | V                 |
| Bypass pin voltage (L)                    | ★3  |      |      | 0.7  | V                 |
| Bypass pin voltage (H)                    | ★4  |      |      | 350  | μA                |
| Bypass pin voltage (L)                    | ★5  | -10  |      |      | μA                |

★1: Output voltage amplitude at f=1 kHz such that total output harmonic distortion is 1%

★2: Voltage at which bypass pin (pin 2) is regarded as H (Q Sound mode)

★3: Voltage at which bypass pin (pin 2) is regarded as L (bypass mode)

★4: When V<sub>byp</sub>=5 V, current flowing into bypass pin (pin 2)

★5: When V<sub>byp</sub>=0 V, current flowing from bypass pin (pin 2)

## [MM1354]

### Absolute Maximum Ratings

| Item                  | Ratings                       | Units |
|-----------------------|-------------------------------|-------|
| Storage temperature   | -40~+125                      | °C    |
| Operating temperature | -20~+75                       | °C    |
| Power supply voltage  | 15                            | V     |
| Input voltage         | $GND \leq V_{IN} \leq V_{CC}$ | V     |
| Output voltage        | 10                            | mA    |
| Allowable loss        | 650                           | mA    |

### Recommended Operating Conditions

| Item                  | Ratings  | Units |
|-----------------------|----------|-------|
| Operating temperature | -20~+75  | °C    |
| Operating voltage     | 4.5~12.0 | V     |

### Electrical Characteristics

| Item                                      | Measurement conditions                             | Min. | Typ. | Max. | Units |
|---|--|------|------|------|-------|
| Consumption current                       |  |      | 16   | 21   | mA    |
| Voltage gain Q Xpander 1                  | SG1:1Vrms, 1kHz, SG2: no signal                    | 3    | 4    | 5    | dB    |
| Voltage gain Q Xpander 2                  | SG1:1Vrms, 1kHz, SG2: no signal                    | -1   | 0.5  | 2    | dB    |
| Voltage gain Q Xpander 3                  | SG1: no signal, SG2: 1Vrms, 1kHz                   | 3    | 4    | 5    | dB    |
| Voltage gain Q Xpander 4                  | SG1: no signal, SG2: 1Vrms, 1kHz                   | -1   | 0.5  | 2    | dB    |
| Voltage gain bypass 1                     | SG1:1Vrms, 1kHz, SG2: no signal                    | -5.6 | -5.1 | -4.6 | dB    |
| Voltage gain bypass 2                     | SG1: no signal, SG2: 1Vrms, 1kHz                   | -5.6 | -5.1 | -4.6 | dB    |
| Input resistance                          |  | 21   | 30   | 39   | kΩ    |
| Input voltage amplitude (1)               | *1   | 1    | 1.4  |      | Vrms  |
| Input voltage amplitude(2)                | *2   | 0.5  | 0.7  |      | Vrms  |
| Total harmonic distortion ratio Q Xpander | Lch=1Vrms, Rch=no signal, Lch=no signal, Rch=1Vrms |      | 0.4  | 1.0  | %     |
| Total harmonic distortion ratio bypass    | Lch=1Vrms, Rch=no signal, Lch=no signal, Rch=1Vrms |      | 0.03 | 0.3  | %     |
| Output noise voltage Q Xpander            | L, R channels=no signal, BW=20Hz to 20kHz, A curve |      | 60   | 100  | μVrms |
| Output noise voltage bypass               | L, R channels=no signal, BW=20Hz to 20kHz, A curve |      | 15   | 32   | μVrms |
| L-R channel balance                       | L, R channels=1Vrms, 1kHz, Bypass=0V               | -1   | 0    | 1    | dB    |
| Bypass pin voltage (H)                    | *3   | 2.1  |      |      | V     |
| Bypass pin voltage (L)                    | *4   |      |      | 0.7  | V     |
| Bypass pin voltage (H)                    | *5   |      |      | 350  | μA    |
| Bypass pin voltage (L)                    | *6   | -10  |      |      | μA    |

\*1: Input voltage amplitude at f=1 kHz such that total output harmonic distortion is 1%. However, signals input to SG1 and SG2 are in phase (phase difference 0°).

\*2: Input voltage amplitude at f=1 kHz such that total output harmonic distortion is 1%. However, signals input to SG1 and SG2 are opposite in phase (phase difference 180°).

\*3: Voltage at which bypass pin (pin 22) is regarded as H

\*4: Voltage at which bypass pin (pin 22) is regarded as L

\*5: When Vbyp=5V, current flowing into bypass pin

\*6: When Vbyp=0V, current flowing from bypass pin

[MM1369]

Absolute Maximum Ratings

| Item                  | Ratings                       | Units |
|-----------------------|-------------------------------|-------|
| Storage temperature   | -40~+125                      | °C    |
| Operating temperature | -20~+75                       | °C    |
| Power supply voltage  | 15                            | V     |
| Input voltage         | $GND \leq V_{IN} \leq V_{CC}$ | V     |
| Output voltage        | 10                            | mA    |
| Allowable loss        | 650                           | mA    |

Recommended Operating Conditions

| Item                  | Ratings  | Units |
|-----------------------|----------|-------|
| Operating temperature | -20~+75  | °C    |
| Operating voltage     | 8.0~10.0 | V     |

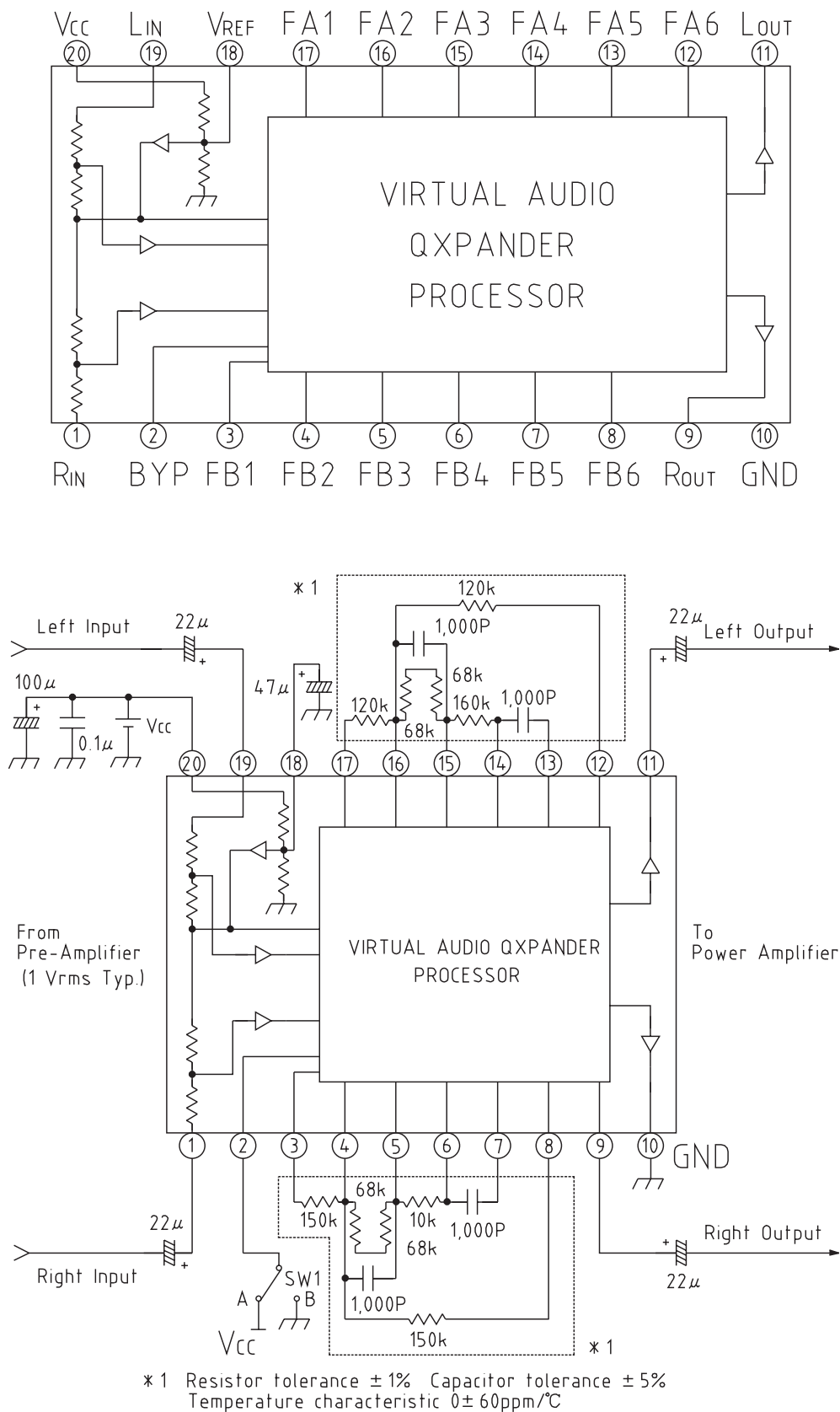
Electrical Characteristics

| Item                                      | Measurement conditions   | Min. | Typ. | Max. | Units |
|---|--|------|------|------|-------|
| Consumption current                       |  |      | 20   | 26   | mA    |
| Voltage gain Q Xpander 1                  | SG1: 1Vrms, 1kHz, SG2: no signal                               | 1.5  | 3.5  | 5.5  | dB    |
| Voltage gain Q Xpander 2                  | SG1: 1Vrms, 1kHz, SG2: no signal                               | -2   | 0    | 2    | dB    |
| Voltage gain Q Xpander 3                  | SG1: no signal, SG2: 1Vrms, 1kHz                               | 1.5  | 3.5  | 5.5  | dB    |
| Voltage gain Q Xpander 4                  | SG1: no signal, SG2: 1Vrms, 1kHz                               | -2   | 0    | 2    | dB    |
| Voltage gain bypass 1                     | SG1: 1Vrms, 1kHz, SG2: no signal                               | -7.5 | -5.5 | -3.5 | dB    |
| Voltage gain bypass 2                     | SG1: no signal, SG2: 1Vrms, 1kHz                               | -7.5 | -5.5 | -3.5 | dB    |
| Voltage gain pseudo-stereo 1              | SG: 1Vrms, 1kHz, SG2: no signal                                | -9.5 | -7.5 | -5.5 | dB    |
| Voltage gain pseudo-stereo 2              | SG1: no signal, SG2: 1Vrms, 1kHz                               | -7.5 | -5.5 | -3.5 | dB    |
| Output phase (1)                          | SG1: 1Vrms, 1kHz, SG2: no signal                               | -75  | -60  | -45  | dB    |
| Output phase (2)                          | SG1: no signal, SG2: 1Vrms, 1kHz                               | -140 | -125 | -110 | dB    |
| Input resistance (1)                      | Vbyp1, 2=0V, f=20Hz  | 21   | 30   | 39   | kΩ    |
| Input resistance (2)                      | Vbyp1, 2=0V, f=1kHz  | 8    | 11   | 14   | kΩ    |
| Input resistance (3)                      | Vbyp1, 2=0V, f=20kHz   | 5    | 7    | 9    | kΩ    |
| Input voltage amplitude (1)               | *1   | 1    | 1.4  |      | Vrms  |
| Input voltage amplitude (2)               | *2   | 0.5  | 0.7  |      | Vrms  |
| Total harmonic distortion ratio Q Xpander | Lch=1Vrms, Rch=no signal, Lch=no signal, Rch=1Vrms             |      | 0.4  | 1    | %     |
| Total harmonic distortion ratio bypass    | Lch=1Vrms, Rch=no signal, Lch=no signal, Rch=1Vrms, Vbyp=0V    |      | 0.4  | 0.8  | %     |
| Output noise voltage Q Xpander            | L, R channels=no signal, BW=20Hz to 20kHz, A curve, Vbyp2=0V   |      | 75   | 150  | μVrms |
| Output noise voltage bypass               | L, R channels=no signal, BW=20Hz to 20kHz, A curve, Vbyp1,2=0V |      | 20   | 40   | μVrms |
| L-R channel balance                       | L, R channels=1Vrms, 1kHz, Vbyp1,2=0V                          | -1.5 | 0    | 1.5  | dB    |
| Bypass pin voltage (H)                    | *3   | 2.1  |      |      | V     |
| Bypass pin voltage (L)                    | *4   |      |      | 0.7  | V     |
| Bypass pin voltage (H)                    | Vbyp=5V *5   |      |      | 350  | μA    |
| Bypass pin voltage (L)                    | Vbyp=0V *6   | -10  |      |      | μA    |
| Pin 13 offset voltage                     | Vbyp1=0V *7  | -30  | 0    | 30   | mV    |
| Pin 3 offset voltage                      | Vbyp1=0V *8  | -30  | 0    | 30   | mV    |
| Pin 4 offset voltage                      | Vbyp1=0V *9  | -30  | 0    | 30   | mV    |
| Pin 5 offset voltage                      | Vbyp1=0V *10   | -30  | 0    | 30   | mV    |

- \*1: Input voltage amplitude at f=1 kHz such that total output harmonic distortion is 1%. However, signals input to SG1 and SG2 are in phase (phase difference 0°).
- \*2: Input voltage amplitude at f=1 kHz such that total output harmonic distortion is 1%. However, signals input to SG1 and SG2 are opposite in phase (phase difference 180°).
- \*3: Voltage at which bypass pin (pin 22) is regarded as H
- \*4: Voltage at which bypass pin (pin 22) is regarded as L
- \*5: When Vbyp=5V, current flowing into bypass pin
- \*6: When Vbyp=0V, current flowing from bypass pin
- \*7: Defined as the difference in pin 13 DC output voltages on switching from normal stereo mode to pseudo-stereo mode.
- \*8: Defined as the difference in pin 3 DC output voltages on switching from normal stereo mode to pseudo-stereo mode.
- \*9: Defined as the difference in pin 4 DC output voltages on switching from normal stereo mode to pseudo-stereo mode.
- \*10: Defined as the difference in pin 5 DC output voltages on switching from normal stereo mode to pseudo-stereo mode.

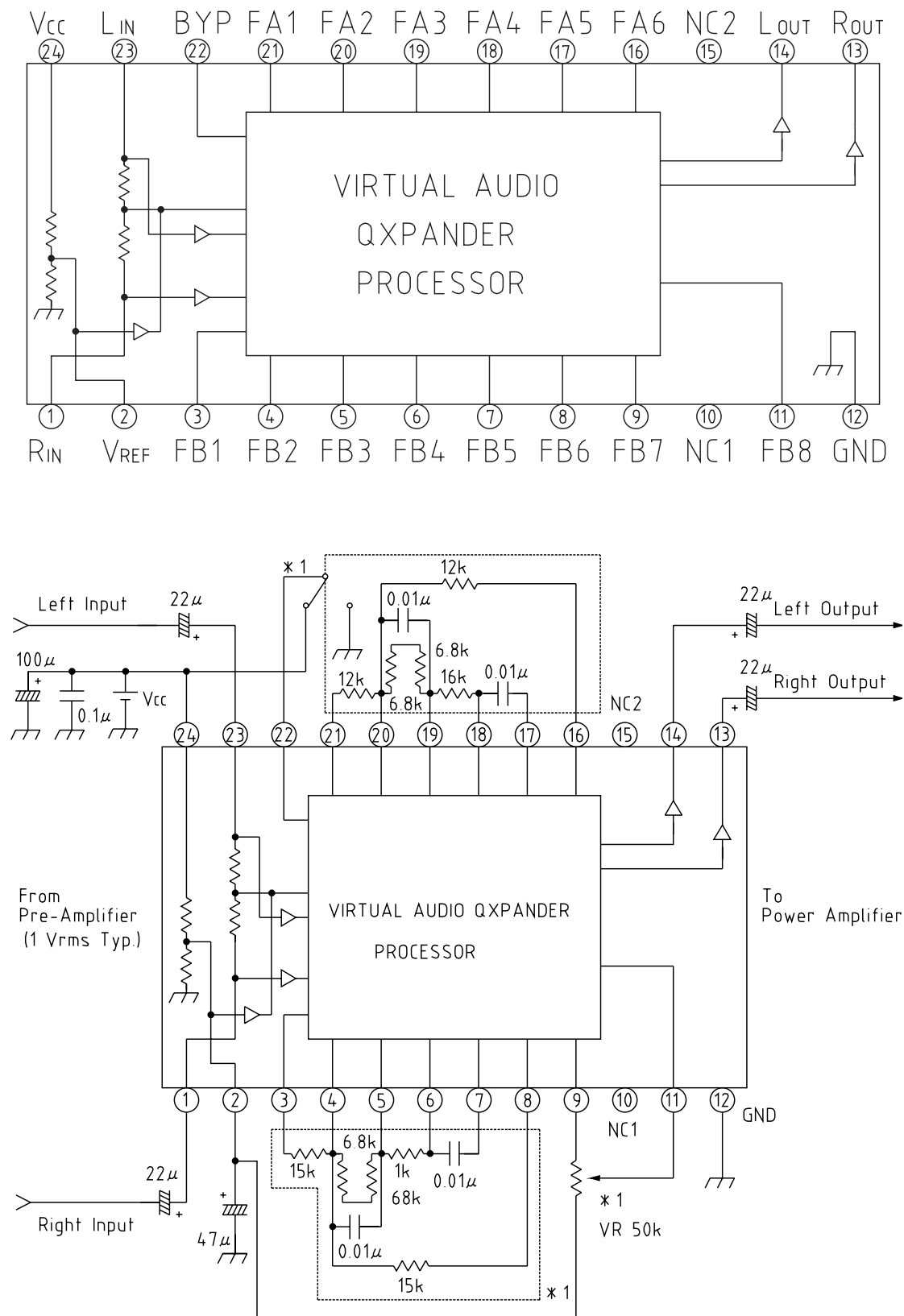
**[MM1326]**

**Block Diagram and Application Circuits**



[MM1354]

Block Diagram and Application Circuits

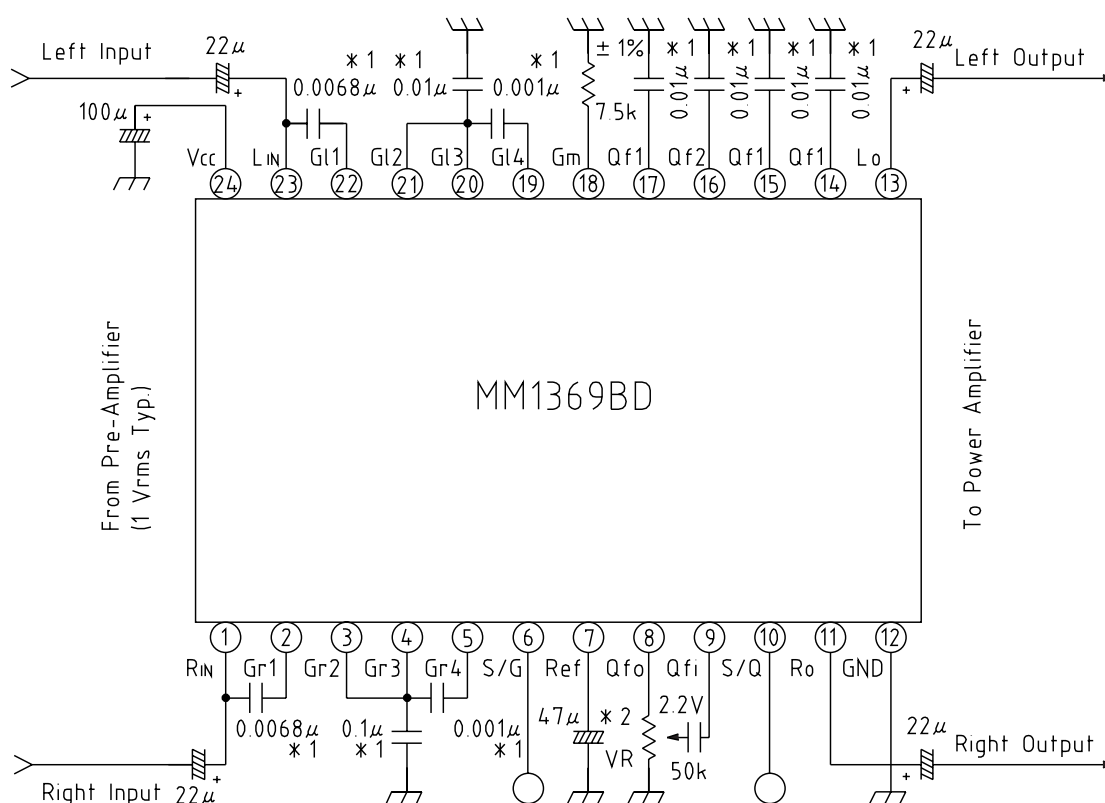
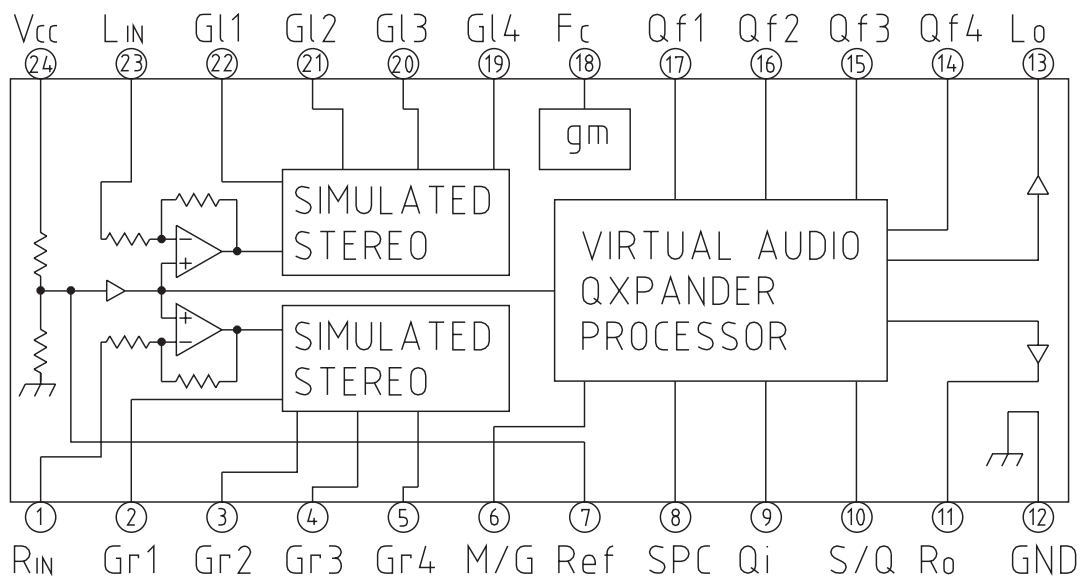


\*1 Resistor tolerance  $\pm 1\%$  Capacitor tolerance  $\pm 5\%$

Note : \*1 VR can be used to adjust the Q Xpander effect (extent of sound spreading).  
Spreading effect is maximum at 0  $\Omega$  (pins 9 and 11 shorted);  
normal stereo results at 50 k $\Omega$  (pins 2 and 11 shorted).

[MM1369]

Block Diagram and Application Circuits

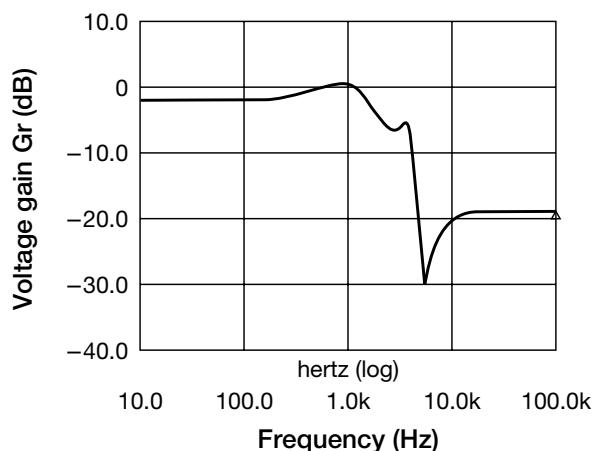


A low-impedance signal source should be used for SG1 and SG2.  
 Note 1: \*1 A capacitor with a  $\pm 5\%$  tolerance is recommended.  
 Note 2: \*2 VR can be used to adjust the Q Xpander effect  
 (extent of sound spreading).  
 Spreading effect is maximum at 50 k $\Omega$ ;  
 normal stereo results at 0  $\Omega$ ;

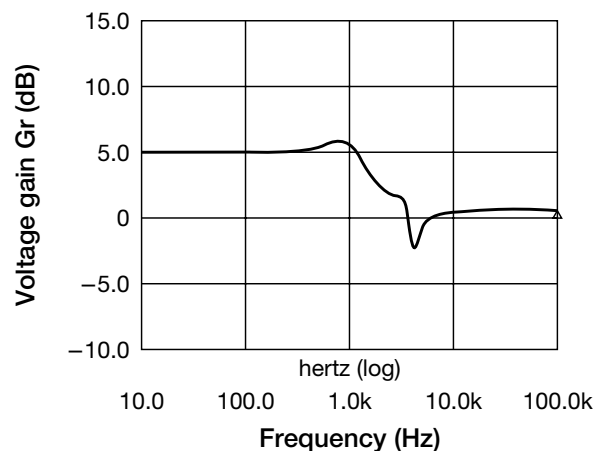
## Characteristics

### ■ [MM1326]

#### ■ LIN-ROUT (RIN-LOUT) Frequency characteristic LIN-ROUT (RIN-LOUT) Voltage gain–Frequency

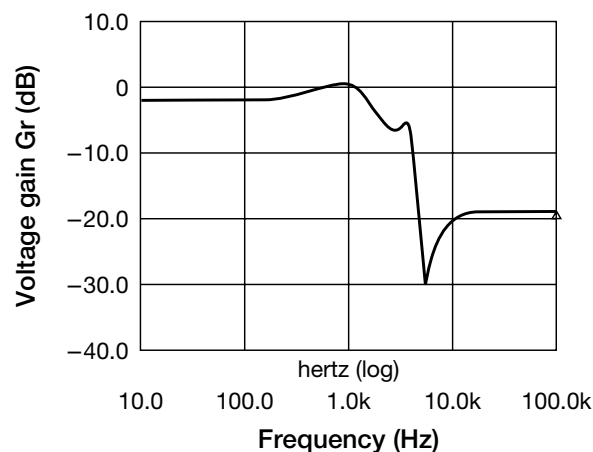


#### ■ LIN-LOUT (RIN-ROUT) Frequency characteristic LIN-LOUT (RIN-ROUT) Voltage gain–Frequency

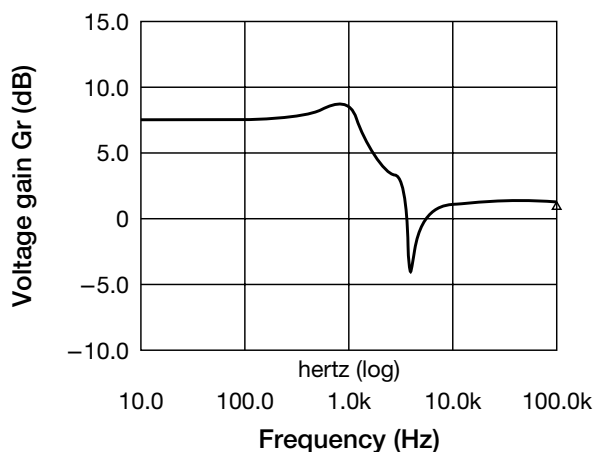


### ■ [MM1354]

#### ■ LIN-ROUT (RIN-LOUT) Frequency characteristic LIN-ROUT (RIN-LOUT) Voltage gain–Frequency

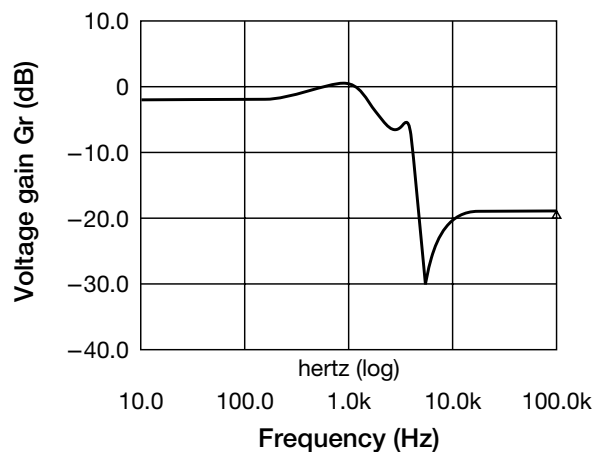


#### ■ LIN-LOUT (RIN-ROUT) Frequency characteristic LIN-LOUT (RIN-ROUT) Voltage gain–Frequency

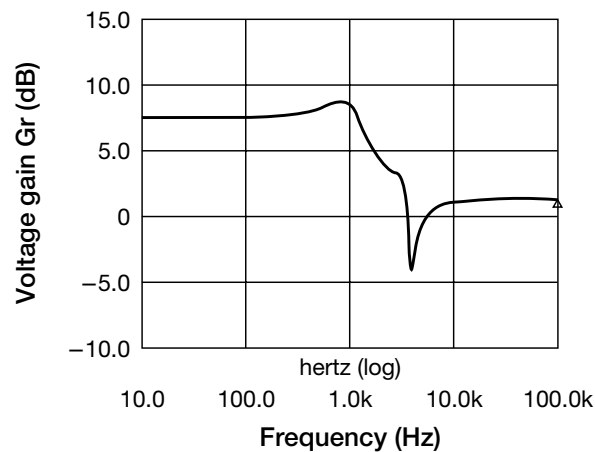


### ■ [MM1369]

#### ■ LIN-ROUT (RIN-LOUT) Frequency characteristic LIN-ROUT (RIN-LOUT) Voltage gain–Frequency



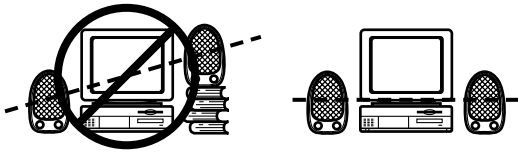
#### ■ LIN-LOUT (RIN-ROUT) Frequency characteristic LIN-LOUT (RIN-ROUT) Voltage gain–Frequency



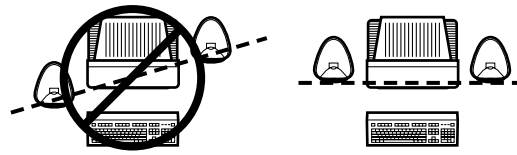


## Ideal Settings for Q Sound

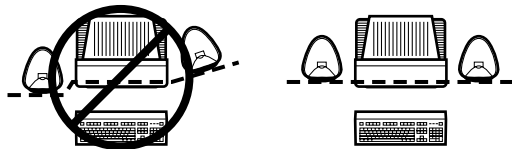
1. Speaker heights should be equal



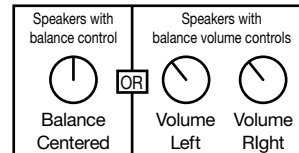
2. Speaker faces should be aligned



3. Speaker orientations should be the same



4. Right and left channel volumes should be equal



5. Listening is best midway between the speakers

