



## LC75411ES, 75411WS

### Electronic Volume Controller for Car Audio Systems



#### Overview

The LC75411ES and 75411WS are electronic volume controllers that enable control of volume, balance, fader, bass/treble, loudness, input switching, and input gain using only a small number of external components.

#### Functions

- Volume: 0 dB to -79.5 dB in 0.5-dB steps, and  $-\infty$  (161 positions) Balance function with separate L/R control
- Fader: rear output or front output can be attenuated across 16 positions (in 1-dB steps from 0 dB to -2 dB, 2-dB steps from -2 dB to 20 dB, 10-dB steps from -20 dB to -30 dB, and -45 dB, -60 dB,  $-\infty$ )
- Bass/treble: Both bass and treble can be controlled in 1-dB steps from 0 dB to  $\pm 6$  dB, and in 2-dB steps from  $\pm 8$  dB to  $\pm 12$  dB.
- Input gain: 0 dB to +18.75 dB (1.25-dB steps) amplification is possible for the input signal.
- Input switching: four input signals can be selected for Left and for Right
- Loudness: A tap is output from the -32 dB position of a 2 dB step volume control resistor ladder. A loudness function can be implemented by connecting an external RC circuit.

#### Features

- On-chip buffer amplifier cuts down number of external components
- Low switching noise generated by on-chip switch through use of silicon gate CMOS process, for low switching noise when there is no signal
- Low switching noise when there is a signal due to use of on-chip zero-cross switching circuit
- On-chip 1/2 VDD reference voltage circuit
- Controls performed with serial input (CCB)

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- CCB is SANYO's original bus format and all the bus addresses are controlled by SANYO.

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**SANYO Electric Co.,Ltd. Semiconductor Company**

TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110-8534 JAPAN

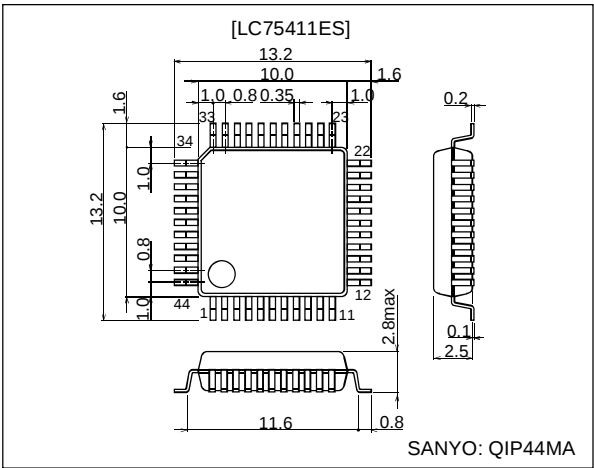
62901RM (OT) No. 6928-1/34

LC75411ES, 75411WS

Package Dimensions

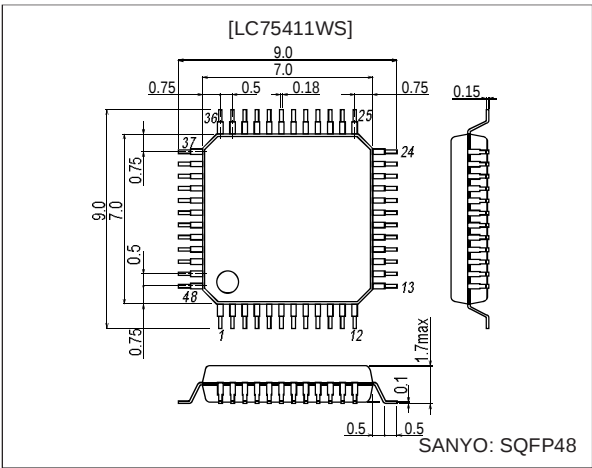
unit: mm

3148-QIP44MA



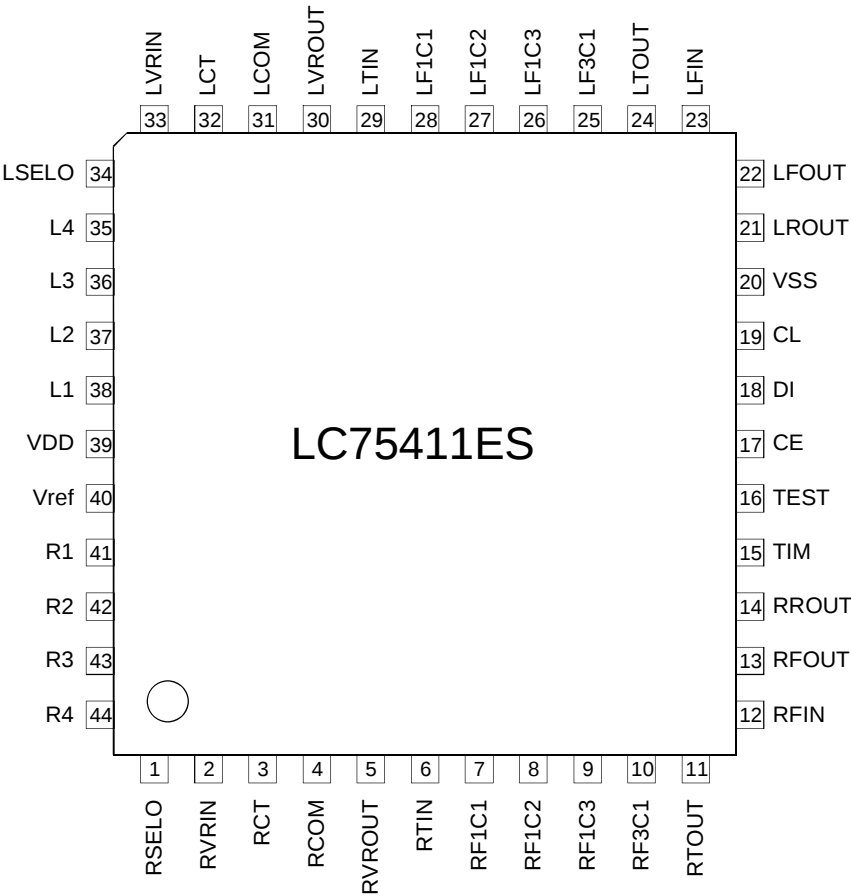
unit: mm

3163A-SQFP48



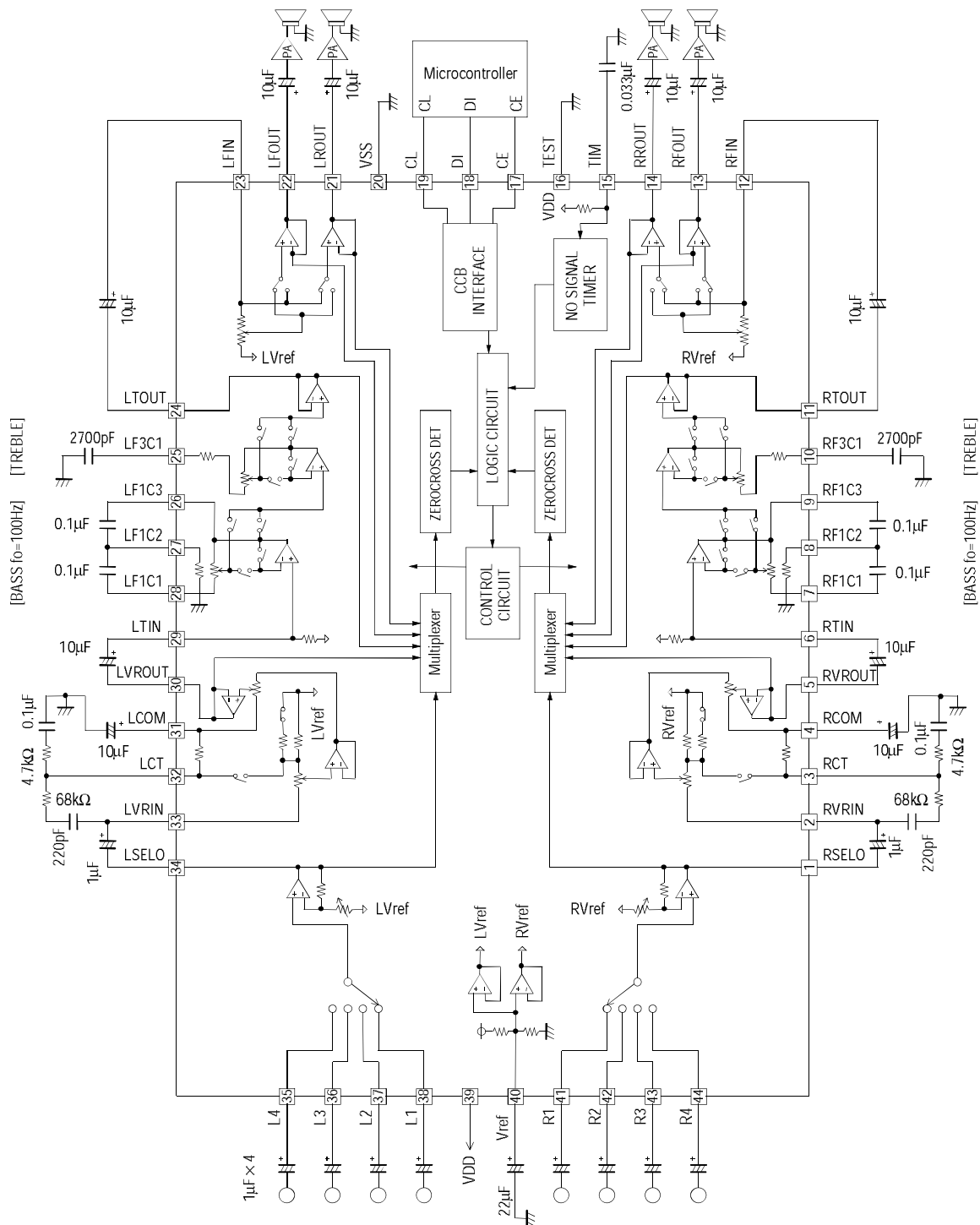
Pin Assignment

[LC75411ES]



# Equivalent Circuit Block Diagram

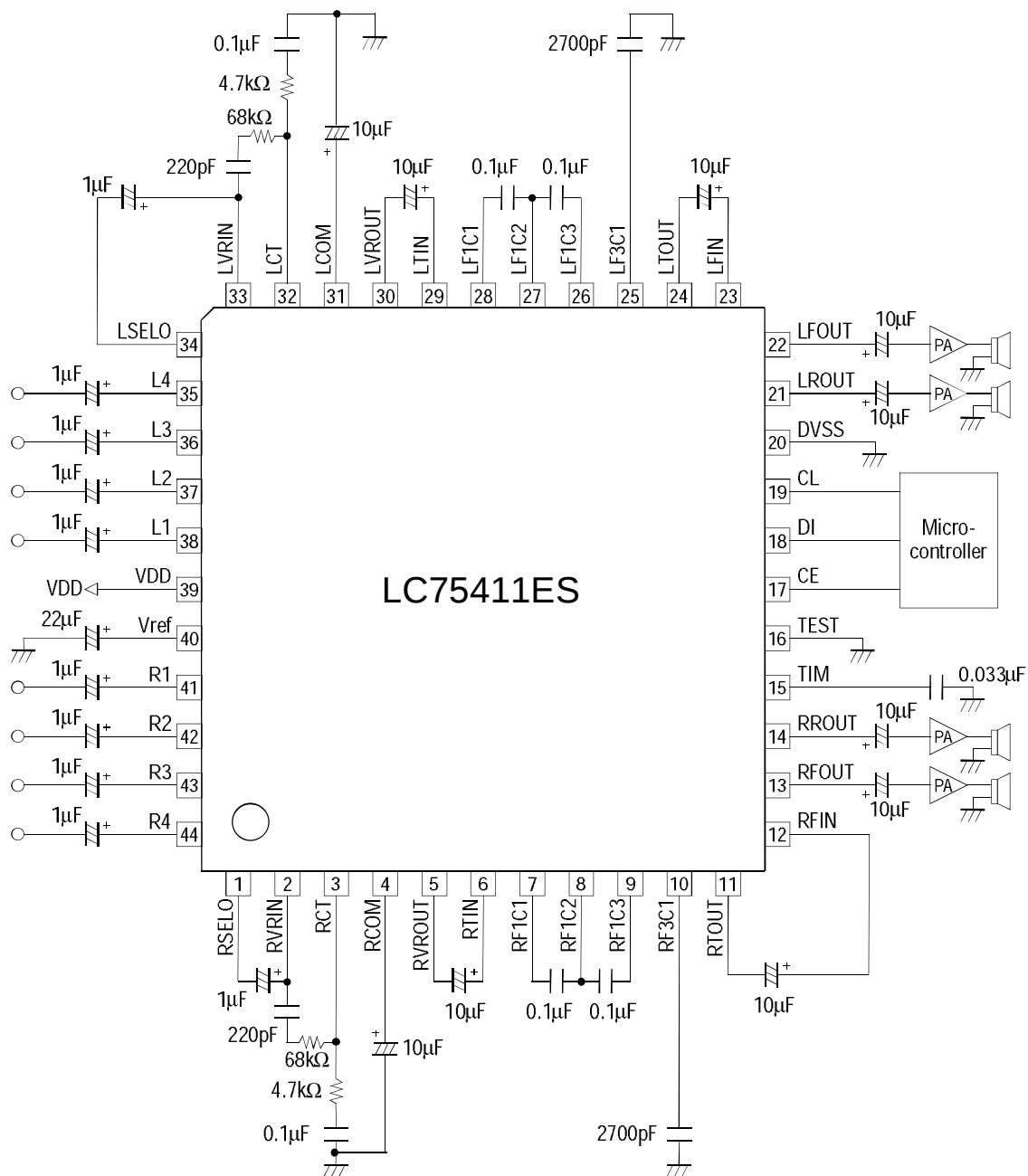
[LC75411ES]



## LC75411ES, 75411WS

### Sample Application Circuit

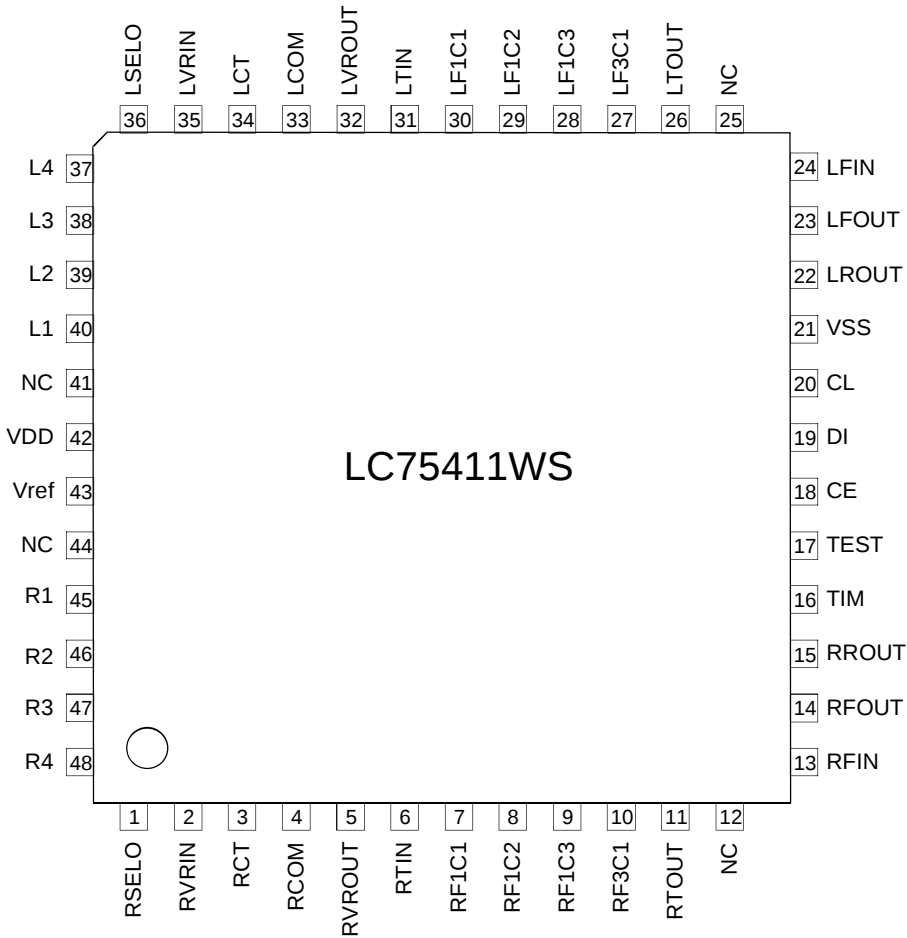
[LC75411ES]



LC75411ES, 75411WS

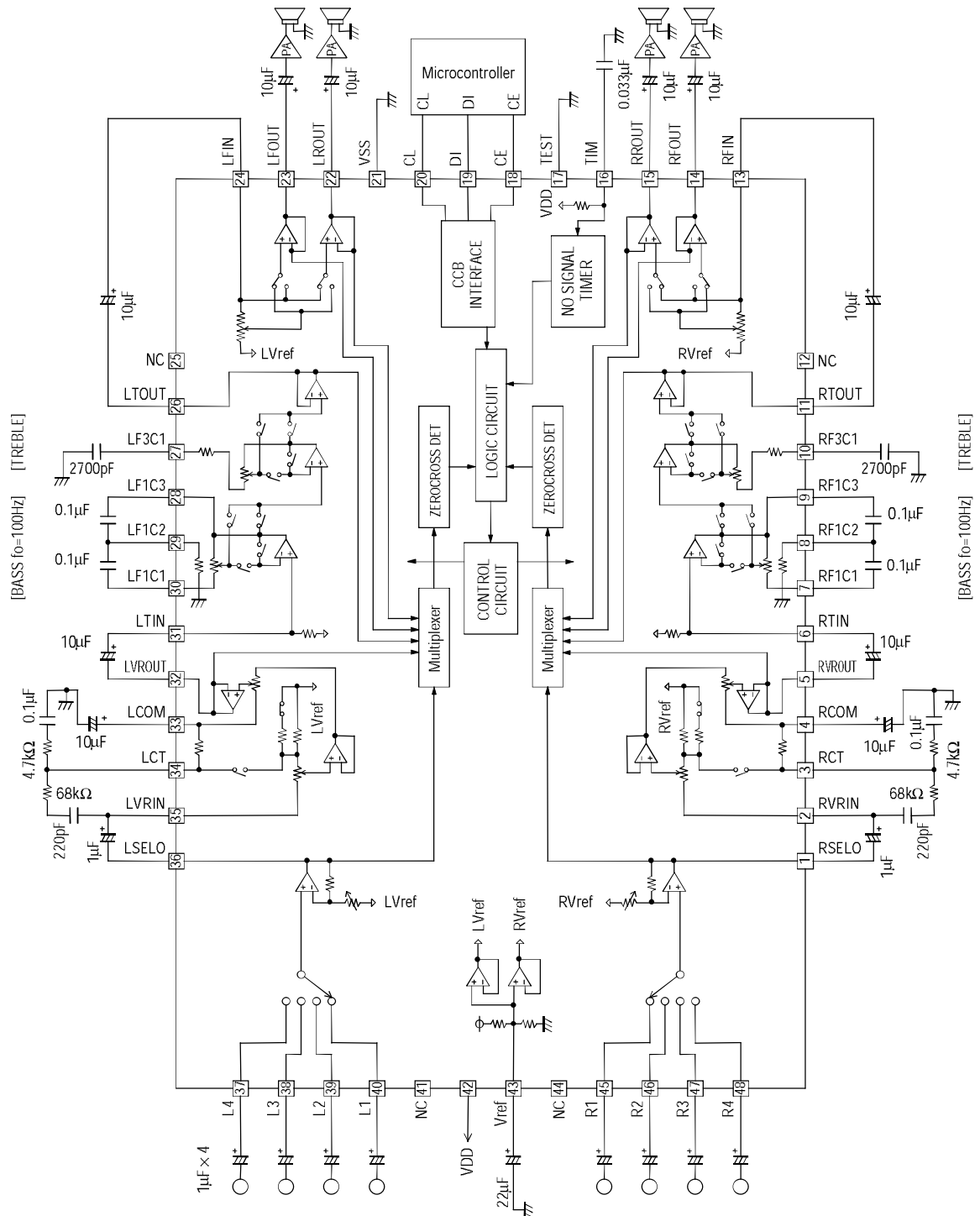
Pin Assignment

[LC75411WS]



# Equivalent Circuit Block Diagram

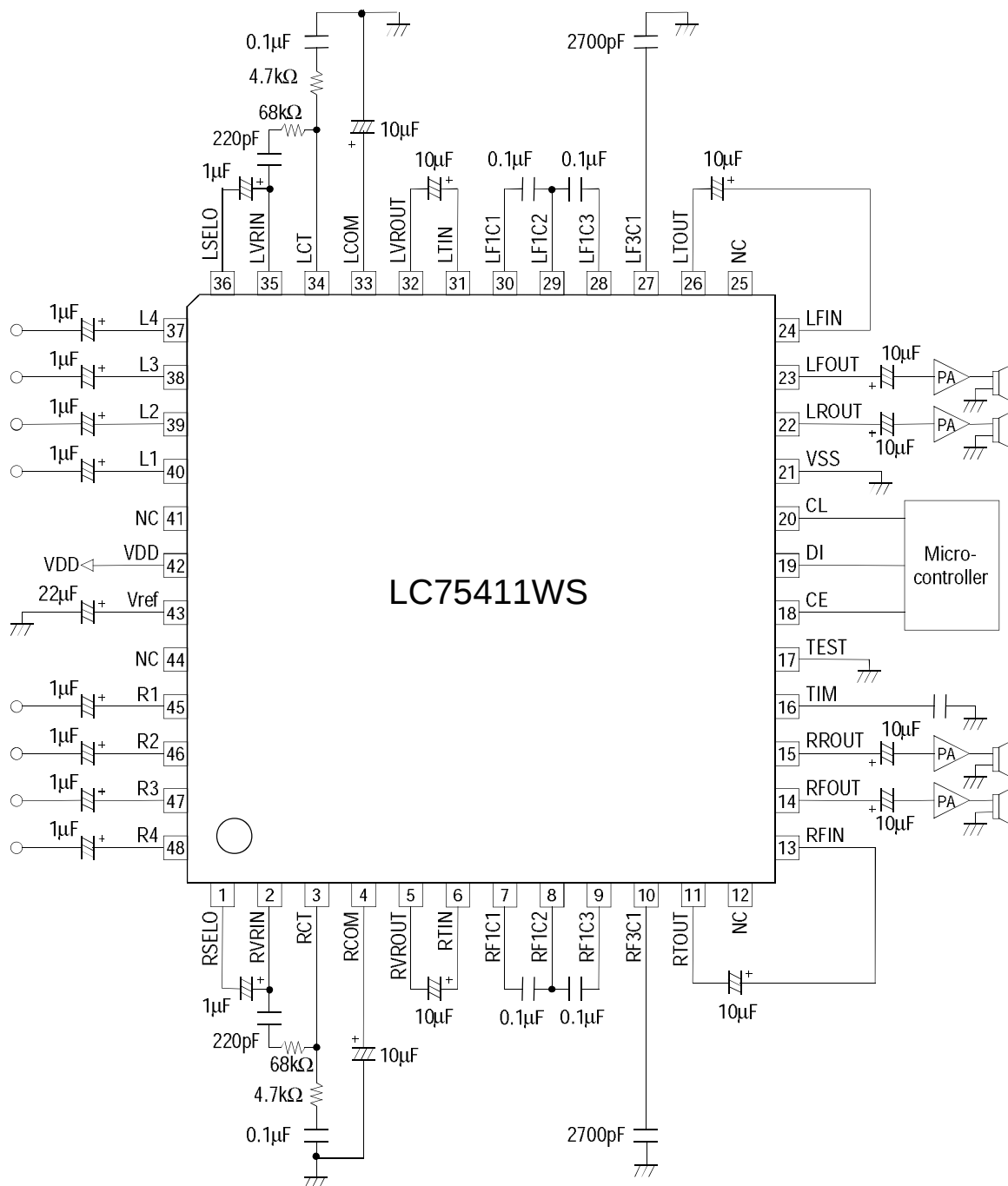
[LC75411WS]



## LC75411ES, 75411WS

### Sample Application Circuit

[LC75411WS]



## LC75411ES, 75411WS

### Specifications

**Absolute Maximum Ratings at Ta = 25°C, V<sub>SS</sub> = 0 V**

| Parameter                   | Symbol              | Conditions                       |           | Ratings                                        | Unit |
|-----------------------------|---------------------|----------------------------------|-----------|------------------------------------------------|------|
| Maximum supply voltage      | V <sub>DD</sub> max | V <sub>DD</sub>                  |           | 11                                             | V    |
| Maximum input voltage       | V <sub>IN</sub> max | All input pins                   |           | V <sub>SS</sub> – 0.3 to V <sub>DD</sub> + 0.3 | V    |
| Allowable power dissipation | Pd max              | Ta ≤ 85°C, when mounted on board | LC75411ES | 600                                            | mW   |
|                             |                     |                                  | LC75411WS | 550                                            |      |
| Operating temperature       | Topr                |                                  |           | –40 to +85                                     | °C   |
| Storage temperature         | Tstg                |                                  |           | –50 to +125                                    | °C   |

**Allowable Operating Ranges at Ta = 25°C, V<sub>SS</sub> = 0 V**

| Parameter                | Symbol             | Conditions       | Ratings         |     |                 | Unit |
|--------------------------|--------------------|------------------|-----------------|-----|-----------------|------|
|                          |                    |                  | min             | typ | max             |      |
| Supply voltage           | V <sub>DD</sub>    | V <sub>DD</sub>  | 6.0             |     | 10.5            | V    |
| Input high-level voltage | V <sub>IH</sub>    | CL, DI, CE, TEST | 4.0             |     | 10.5            | V    |
| Input low-level voltage  | V <sub>IL</sub>    | CL, DI, CE, TEST | V <sub>SS</sub> |     | 1.0             | V    |
| Input amplitude voltage  | V <sub>IN</sub>    |                  | V <sub>SS</sub> |     | V <sub>DD</sub> | Vp-p |
| Input pulse width        | T <sub>øW</sub>    | CL               | 1               |     |                 | μs   |
| Setup time               | T <sub>setup</sub> | CL, DI, CE       | 1               |     |                 | μs   |
| Hold time                | T <sub>hold</sub>  | CL, DI, CE       | 1               |     |                 | μs   |
| Operating frequency      | f <sub>opg</sub>   | CL               |                 |     | 500             | kHz  |

**Electrical Characteristics at Ta = 25°C, V<sub>DD</sub> = 9 V, V<sub>SS</sub> = 0 V**

| Parameter            | Symbol | Pin Name                   | Conditions     | Ratings |        |      | Unit |
|----------------------|--------|----------------------------|----------------|---------|--------|------|------|
|                      |        |                            |                | min     | typ    | max  |      |
| [Input block]        |        |                            |                |         |        |      |      |
| Input resistance     | Rin    | L1 to L4, R1 to R4         |                | 25      | 50     | 100  | kΩ   |
| Minimum input gain   | Ginmin | L1 to L4, R1 to R4         |                | −1      | 0      | +1   | dB   |
| Maximum input gain   | Ginmax |                            |                | +16.5   | +18.75 | +21  | dB   |
| Step setting error   | ATerr  |                            |                |         |        | ±0.5 | dB   |
| L/R balance          | BAL    |                            |                |         |        | ±0.5 | dB   |
| [Volume Block]       |        |                            |                |         |        |      |      |
| Input resistance     | Rvr    | LVRIN, RVRIN, loudness off |                | 113     | 226    | 452  | kΩ   |
| Step setting error   | ATerr  |                            |                |         |        | ±0.5 | dB   |
| L/R balance          | BAL    |                            |                |         |        | ±0.5 | dB   |
| [Tone block]         |        |                            |                |         |        |      |      |
| Step setting error   | ATerr  |                            |                |         |        | ±1.0 | dB   |
| Bass control range   | Gbass  |                            | max. boost/cut | ±9      | ±12    | ±15  | dB   |
| Treble control range | Gtre   |                            | max. boost/cut | ±9      | ±12    | ±15  | dB   |
| L/R balance          | BAL    |                            |                |         |        | ±0.5 | dB   |

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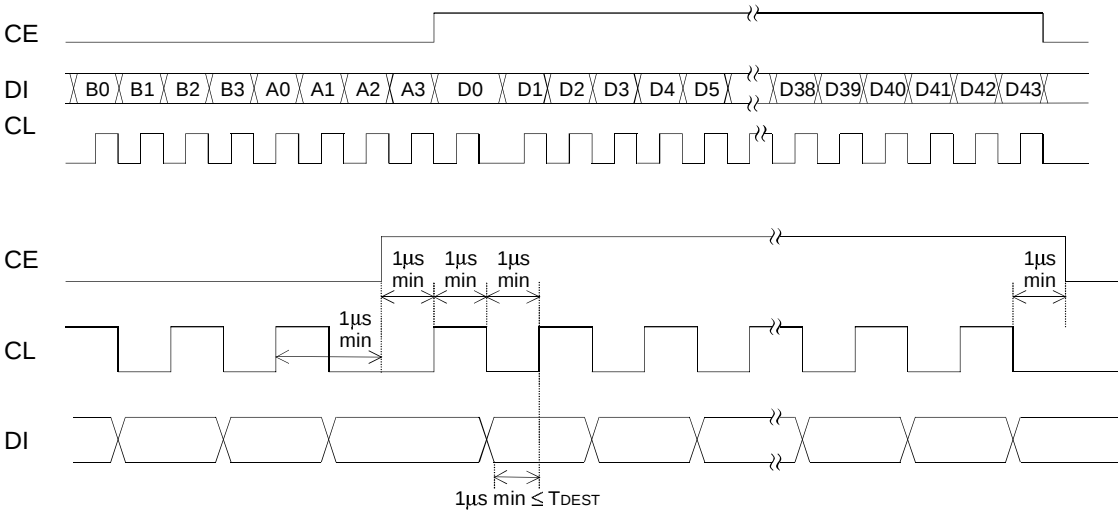
**LC75411ES, 75411WS**

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| Parameter                 | Symbol             | Pin Name                                                                  | Conditions     | Ratings |       |      | Unit |
|---------------------------|--------------------|---------------------------------------------------------------------------|----------------|---------|-------|------|------|
|                           |                    |                                                                           |                | min     | typ   | max  |      |
| [Fader Block]             |                    |                                                                           |                |         |       |      |      |
| Input resistance          | Rfed               | LFIN, RFIN                                                                |                | 25      | 50    | 100  | kΩ   |
| Step setting error        | ATerr              |                                                                           | 0dB to −2dB    |         |       | ±0.5 | dB   |
|                           |                    |                                                                           | −2dB to −20dB  |         |       | ±1   | dB   |
|                           |                    |                                                                           | −20dB to −30dB |         |       | ±2   | dB   |
|                           |                    |                                                                           | −30dB to −60dB |         |       | ±3   | dB   |
| L/R balance               | BAL                |                                                                           |                |         |       | ±0.5 | dB   |
| [General]                 |                    |                                                                           |                |         |       |      |      |
| Total harmonic distortion | THD (1)            | V <sub>IN</sub> = −10dBV, f = 1 kHz                                       |                |         | 0.004 | 0.01 | %    |
|                           | THD (2)            | V <sub>IN</sub> = −10dBV, f = 10 kHz                                      |                |         | 0.006 | 0.01 | %    |
| Input crosstalk           | CT                 | V <sub>IN</sub> = 1Vrms, f = 1 kHz                                        |                | 80      | 88    |      | dB   |
| L/R crosstalk             | CT                 | V <sub>IN</sub> = 1Vrms, f = 1 kHz                                        |                | 80      | 88    |      | dB   |
| Maximum attenuated output | Vomin (1)          | V <sub>IN</sub> = 1Vrms, f = 1 kHz                                        |                | 80      | 88    |      | dB   |
|                           | Vomin (2)          | V <sub>IN</sub> = 1Vrms, f = 1 kHz<br>INMUTE, fader →∞                    |                | 90      | 95    |      | dB   |
| Output noise voltage      | V <sub>N</sub> (1) | Flat overall, IHF-A filter                                                |                |         | 5     | 10   | μV   |
|                           | V <sub>N</sub> (2) | Flat overall, 20 to 20 kHzBPF                                             |                |         | 7     | 15   | μV   |
| Current drain             | I <sub>DD</sub>    |                                                                           |                |         | 33    | 40   | mA   |
| Input high-level current  | I <sub>IH</sub>    | CL, DI, CE, V <sub>IN</sub> = 9 V                                         |                |         |       | 10   | μA   |
| Input low-level current   | I <sub>IL</sub>    | CL, DI, CE, V <sub>IN</sub> = 0 V                                         |                | −10     |       |      | μA   |
| Maximum input voltage     | V <sub>CL</sub>    | THD = 1%, R <sub>L</sub> = 10 kΩ<br>flat overall, f <sub>IN</sub> = 1 kHz |                | 2.5     | 2.9   |      | Vrms |

**Control Timing and Data Format**

To control the LC75411ES and LC75411WS input specified serial data to the CE, CL, and DI pins.  
The data configuration consists of a total of 52 bits broken down into 8 address bits and 44 data bits.



**LC75411ES, 75411WS****Address code (B0 to A3)**

The LC75411ES and 75411WS use 8-bit address code and can be used in common with ICs that support SANYO's CCB serial bus.

**Address Code**

|       |    |    |    |    |    |    |    |    |         |
|-------|----|----|----|----|----|----|----|----|---------|
| (LSB) | B0 | B1 | B2 | B3 | A0 | A1 | A2 | A3 | (81HEX) |
|       | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 1  |         |

**Control code allocation****Input Switching Control**

| D0 | D1 | D2 | Setting | Setting                           |
|----|----|----|---------|-----------------------------------|
| 0  | 0  | 0  | L1 (R1) |                                   |
| 1  | 0  | 0  | L2 (R2) |                                   |
| 0  | 1  | 0  | L3 (R3) |                                   |
| 1  | 1  | 0  | L4 (R4) |                                   |
|    |    |    |         |                                   |
| 0  | 1  | 1  |         | For IC testing: Normally not used |
| 1  | 1  | 1  |         |                                   |

|    |                                       |
|----|---------------------------------------|
| D3 | Bit for IC testing: Normally set to 0 |
|----|---------------------------------------|

**Input Gain Control**

| D4 | D5 | D6 | D7 | Operation |
|----|----|----|----|-----------|
| 0  | 0  | 0  | 0  | 0dB       |
| 1  | 0  | 0  | 0  | +1.25dB   |
| 0  | 1  | 0  | 0  | +2.50dB   |
| 1  | 1  | 0  | 0  | +3.75dB   |
| 0  | 0  | 1  | 0  | +5.00dB   |
| 1  | 0  | 1  | 0  | +6.25dB   |
| 0  | 1  | 1  | 0  | +7.50dB   |
| 1  | 1  | 1  | 0  | +8.75dB   |
| 0  | 0  | 0  | 1  | +10.0dB   |
| 1  | 0  | 0  | 1  | +11.25dB  |
| 0  | 1  | 0  | 1  | +12.5dB   |
| 1  | 1  | 0  | 1  | +13.75dB  |
| 0  | 0  | 1  | 1  | +15.0dB   |
| 1  | 0  | 1  | 1  | +16.25dB  |
| 0  | 1  | 1  | 1  | +17.5dB   |
| 1  | 1  | 1  | 1  | +18.75dB  |

**LC75411ES, 75411WS**

Volume Control (0 to -20.5dB)

| D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | Operation |
|----|----|-----|-----|-----|-----|-----|-----|-----------|
| 0  | 0  | 0   | 0   | 0   | 0   | 0   | 0   | 0dB       |
| 0  | 0  | 0   | 0   | 0   | 0   | 0   | 1   | -0.5dB    |
| 1  | 0  | 0   | 0   | 0   | 0   | 0   | 0   | -1dB      |
| 1  | 0  | 0   | 0   | 0   | 0   | 0   | 1   | -1.5dB    |
| 0  | 1  | 0   | 0   | 0   | 0   | 0   | 0   | -2dB      |
| 0  | 1  | 0   | 0   | 0   | 0   | 0   | 1   | -2.5dB    |
| 1  | 1  | 0   | 0   | 0   | 0   | 0   | 0   | -3dB      |
| 1  | 1  | 0   | 0   | 0   | 0   | 0   | 1   | -3.5dB    |
| 0  | 0  | 1   | 0   | 0   | 0   | 0   | 0   | -4dB      |
| 0  | 0  | 1   | 0   | 0   | 0   | 0   | 1   | -4.5dB    |
| 1  | 0  | 1   | 0   | 0   | 0   | 0   | 0   | -5dB      |
| 1  | 0  | 1   | 0   | 0   | 0   | 0   | 1   | -5.5dB    |
| 0  | 1  | 1   | 0   | 0   | 0   | 0   | 0   | -6dB      |
| 0  | 1  | 1   | 0   | 0   | 0   | 0   | 1   | -6.5dB    |
| 1  | 1  | 1   | 0   | 0   | 0   | 0   | 0   | -7dB      |
| 1  | 1  | 1   | 0   | 0   | 0   | 0   | 1   | -7.5dB    |
| 0  | 0  | 0   | 1   | 0   | 0   | 0   | 0   | -8dB      |
| 0  | 0  | 0   | 1   | 0   | 0   | 0   | 1   | -8.5dB    |
| 1  | 0  | 0   | 1   | 0   | 0   | 0   | 0   | -9dB      |
| 1  | 0  | 0   | 1   | 0   | 0   | 0   | 1   | -9.5dB    |
| 0  | 1  | 0   | 1   | 0   | 0   | 0   | 0   | -10dB     |
| 0  | 1  | 0   | 1   | 0   | 0   | 0   | 1   | -10.5dB   |
| 1  | 1  | 0   | 1   | 0   | 0   | 0   | 0   | -11dB     |
| 1  | 1  | 0   | 1   | 0   | 0   | 0   | 1   | -11.5dB   |
| 0  | 0  | 1   | 1   | 0   | 0   | 0   | 0   | -12dB     |
| 0  | 0  | 1   | 1   | 0   | 0   | 0   | 1   | -12.5dB   |
| 1  | 0  | 1   | 1   | 0   | 0   | 0   | 0   | -13dB     |
| 1  | 0  | 1   | 1   | 0   | 0   | 0   | 1   | -13.5dB   |
| 0  | 1  | 1   | 1   | 0   | 0   | 0   | 0   | -14dB     |
| 0  | 1  | 1   | 1   | 0   | 0   | 0   | 1   | -14.5dB   |
| 1  | 1  | 1   | 1   | 0   | 0   | 0   | 0   | -15dB     |
| 1  | 1  | 1   | 1   | 0   | 0   | 0   | 1   | -15.5dB   |
| 0  | 0  | 0   | 0   | 1   | 0   | 0   | 0   | -16dB     |
| 0  | 0  | 0   | 0   | 1   | 0   | 0   | 1   | -16.5dB   |
| 1  | 0  | 0   | 0   | 1   | 0   | 0   | 0   | -17dB     |
| 1  | 0  | 0   | 0   | 1   | 0   | 0   | 1   | -17.5dB   |
| 0  | 1  | 0   | 0   | 1   | 0   | 0   | 0   | -18dB     |
| 0  | 1  | 0   | 0   | 1   | 0   | 0   | 1   | -18.5dB   |
| 1  | 1  | 0   | 0   | 1   | 0   | 0   | 0   | -19dB     |
| 1  | 1  | 0   | 0   | 1   | 0   | 0   | 1   | -19.5dB   |
| 0  | 0  | 1   | 0   | 1   | 0   | 0   | 0   | -20dB     |
| 0  | 0  | 1   | 0   | 1   | 0   | 0   | 1   | -20.5dB   |

**LC75411ES, 75411WS**

Volume Control (–21 to –40.5dB)

| D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | Operation |
|----|----|-----|-----|-----|-----|-----|-----|-----------|
| 1  | 0  | 1   | 0   | 1   | 0   | 0   | 0   | –21dB     |
| 1  | 0  | 1   | 0   | 1   | 0   | 0   | 1   | –21.5dB   |
| 0  | 1  | 1   | 0   | 1   | 0   | 0   | 0   | –22dB     |
| 0  | 1  | 1   | 0   | 1   | 0   | 0   | 1   | –22.5dB   |
| 1  | 1  | 1   | 0   | 1   | 0   | 0   | 0   | –23dB     |
| 1  | 1  | 1   | 0   | 1   | 0   | 0   | 1   | –23.5dB   |
| 0  | 0  | 0   | 1   | 1   | 0   | 0   | 0   | –24dB     |
| 0  | 0  | 0   | 1   | 1   | 0   | 0   | 1   | –24.5dB   |
| 1  | 0  | 0   | 1   | 1   | 0   | 0   | 0   | –25dB     |
| 1  | 0  | 0   | 1   | 1   | 0   | 0   | 1   | –25.5dB   |
| 0  | 1  | 0   | 1   | 1   | 0   | 0   | 0   | –26dB     |
| 0  | 1  | 0   | 1   | 1   | 0   | 0   | 1   | –26.5dB   |
| 1  | 1  | 0   | 1   | 1   | 0   | 0   | 0   | –27dB     |
| 1  | 1  | 0   | 1   | 1   | 0   | 0   | 1   | –27.5dB   |
| 0  | 0  | 1   | 1   | 1   | 0   | 0   | 0   | –28dB     |
| 0  | 0  | 1   | 1   | 1   | 0   | 0   | 1   | –28.5dB   |
| 1  | 0  | 1   | 1   | 1   | 0   | 0   | 0   | –29dB     |
| 1  | 0  | 1   | 1   | 1   | 0   | 0   | 1   | –29.5dB   |
| 0  | 1  | 1   | 1   | 1   | 0   | 0   | 0   | –30dB     |
| 0  | 1  | 1   | 1   | 1   | 0   | 0   | 1   | –30.5dB   |
| 1  | 1  | 1   | 1   | 1   | 0   | 0   | 0   | –31dB     |
| 1  | 1  | 1   | 1   | 1   | 0   | 0   | 1   | –31.5dB   |
| 0  | 0  | 0   | 0   | 0   | 1   | 0   | 0   | –32dB     |
| 0  | 0  | 0   | 0   | 0   | 1   | 0   | 1   | –32.5dB   |
| 1  | 0  | 0   | 0   | 0   | 1   | 0   | 0   | –33dB     |
| 1  | 0  | 0   | 0   | 0   | 1   | 0   | 1   | –33.5dB   |
| 0  | 1  | 0   | 0   | 0   | 1   | 0   | 0   | –34dB     |
| 0  | 1  | 0   | 0   | 0   | 1   | 0   | 1   | –34.5dB   |
| 1  | 1  | 0   | 0   | 0   | 1   | 0   | 0   | –35dB     |
| 1  | 1  | 0   | 0   | 0   | 1   | 0   | 1   | –35.5dB   |
| 0  | 0  | 1   | 0   | 0   | 1   | 0   | 0   | –36dB     |
| 0  | 0  | 1   | 0   | 0   | 1   | 0   | 1   | –36.5dB   |
| 1  | 0  | 1   | 0   | 0   | 1   | 0   | 0   | –37dB     |
| 1  | 0  | 1   | 0   | 0   | 1   | 0   | 1   | –37.5dB   |
| 0  | 1  | 1   | 0   | 0   | 1   | 0   | 0   | –38dB     |
| 0  | 1  | 1   | 0   | 0   | 1   | 0   | 1   | –38.5dB   |
| 1  | 1  | 1   | 0   | 0   | 1   | 0   | 0   | –39dB     |
| 1  | 1  | 1   | 0   | 0   | 1   | 0   | 1   | –39.5dB   |
| 0  | 0  | 0   | 1   | 0   | 1   | 0   | 0   | –40dB     |
| 0  | 0  | 0   | 1   | 0   | 1   | 0   | 1   | –40.5dB   |

**LC75411ES, 75411WS**

Volume Control (–41 to –59.5dB)

| D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | Operation |
|----|----|-----|-----|-----|-----|-----|-----|-----------|
| 1  | 0  | 0   | 1   | 0   | 1   | 0   | 0   | –41dB     |
| 1  | 0  | 0   | 1   | 0   | 1   | 0   | 1   | –41.5dB   |
| 0  | 1  | 0   | 1   | 0   | 1   | 0   | 0   | –42dB     |
| 0  | 1  | 0   | 1   | 0   | 1   | 0   | 1   | –42.5dB   |
| 1  | 1  | 0   | 1   | 0   | 1   | 0   | 0   | –43dB     |
| 1  | 1  | 0   | 1   | 0   | 1   | 0   | 1   | –43.5dB   |
| 0  | 0  | 1   | 1   | 0   | 1   | 0   | 0   | –44dB     |
| 0  | 0  | 1   | 1   | 0   | 1   | 0   | 1   | –44.5dB   |
| 1  | 0  | 1   | 1   | 0   | 1   | 0   | 0   | –45dB     |
| 1  | 0  | 1   | 1   | 0   | 1   | 0   | 1   | –45.5dB   |
| 0  | 1  | 1   | 1   | 0   | 1   | 0   | 0   | –46dB     |
| 0  | 1  | 1   | 1   | 0   | 1   | 0   | 1   | –46.5dB   |
| 1  | 1  | 1   | 1   | 0   | 1   | 0   | 0   | –47dB     |
| 1  | 1  | 1   | 1   | 0   | 1   | 0   | 1   | –47.5dB   |
| 0  | 0  | 0   | 0   | 1   | 1   | 0   | 0   | –48dB     |
| 0  | 0  | 0   | 0   | 1   | 1   | 0   | 1   | –48.5dB   |
| 1  | 0  | 0   | 0   | 1   | 1   | 0   | 0   | –49dB     |
| 1  | 0  | 0   | 0   | 1   | 1   | 0   | 1   | –49.5dB   |
| 0  | 1  | 0   | 0   | 1   | 1   | 0   | 0   | –50dB     |
| 0  | 1  | 0   | 0   | 1   | 1   | 0   | 1   | –50.5dB   |
| 1  | 1  | 0   | 0   | 1   | 1   | 0   | 0   | –51dB     |
| 1  | 1  | 0   | 0   | 1   | 1   | 0   | 1   | –51.5dB   |
| 0  | 0  | 1   | 0   | 1   | 1   | 0   | 0   | –52dB     |
| 0  | 0  | 1   | 0   | 1   | 1   | 0   | 1   | –52.5dB   |
| 1  | 0  | 1   | 0   | 1   | 1   | 0   | 0   | –53dB     |
| 1  | 0  | 1   | 0   | 1   | 1   | 0   | 1   | –53.5dB   |
| 0  | 1  | 1   | 0   | 1   | 1   | 0   | 0   | –54dB     |
| 0  | 1  | 1   | 0   | 1   | 1   | 0   | 1   | –54.5dB   |
| 1  | 1  | 1   | 0   | 1   | 1   | 0   | 0   | –55dB     |
| 1  | 1  | 1   | 0   | 1   | 1   | 0   | 1   | –55.5dB   |
| 0  | 0  | 0   | 1   | 1   | 1   | 0   | 0   | –56dB     |
| 0  | 0  | 0   | 1   | 1   | 1   | 0   | 1   | –56.5dB   |
| 1  | 0  | 0   | 1   | 1   | 1   | 0   | 0   | –57dB     |
| 1  | 0  | 0   | 1   | 1   | 1   | 0   | 1   | –57.5dB   |
| 0  | 1  | 0   | 1   | 1   | 1   | 0   | 0   | –58dB     |
| 0  | 1  | 0   | 1   | 1   | 1   | 0   | 1   | –58.5dB   |
| 1  | 1  | 0   | 1   | 1   | 1   | 0   | 0   | –59dB     |
| 1  | 1  | 0   | 1   | 1   | 1   | 0   | 1   | –59.5dB   |

**LC75411ES, 75411WS**

Volume Control (–60 to –∞)

| D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | Operation |
|----|----|-----|-----|-----|-----|-----|-----|-----------|
| 0  | 0  | 1   | 1   | 1   | 1   | 0   | 0   | –60dB     |
| 0  | 0  | 1   | 1   | 1   | 1   | 0   | 1   | –60.5dB   |
| 1  | 0  | 1   | 1   | 1   | 1   | 0   | 0   | –61dB     |
| 1  | 0  | 1   | 1   | 1   | 1   | 0   | 1   | –61.5dB   |
| 0  | 1  | 1   | 1   | 1   | 1   | 0   | 0   | –62dB     |
| 0  | 1  | 1   | 1   | 1   | 1   | 0   | 1   | –62.5dB   |
| 1  | 1  | 1   | 1   | 1   | 1   | 0   | 0   | –63dB     |
| 1  | 1  | 1   | 1   | 1   | 1   | 0   | 1   | –63.5dB   |
| 0  | 0  | 0   | 0   | 0   | 0   | 1   | 0   | –64dB     |
| 0  | 0  | 0   | 0   | 0   | 0   | 1   | 1   | –64.5dB   |
| 1  | 0  | 0   | 0   | 0   | 0   | 1   | 0   | –65dB     |
| 1  | 0  | 0   | 0   | 0   | 0   | 1   | 1   | –65.5dB   |
| 0  | 1  | 0   | 0   | 0   | 0   | 1   | 0   | –66dB     |
| 0  | 1  | 0   | 0   | 0   | 0   | 1   | 1   | –66.5dB   |
| 1  | 1  | 0   | 0   | 0   | 0   | 1   | 0   | –67dB     |
| 1  | 1  | 0   | 0   | 0   | 0   | 1   | 1   | –67.5dB   |
| 0  | 0  | 1   | 0   | 0   | 0   | 1   | 0   | –68dB     |
| 0  | 0  | 1   | 0   | 0   | 0   | 1   | 1   | –68.5dB   |
| 1  | 0  | 1   | 0   | 0   | 0   | 1   | 0   | –69dB     |
| 1  | 0  | 1   | 0   | 0   | 0   | 1   | 1   | –69.5dB   |
| 0  | 1  | 1   | 0   | 0   | 0   | 1   | 0   | –70dB     |
| 0  | 1  | 1   | 0   | 0   | 0   | 1   | 1   | –70.5dB   |
| 1  | 1  | 1   | 0   | 0   | 0   | 1   | 0   | –71dB     |
| 1  | 1  | 1   | 0   | 0   | 0   | 1   | 1   | –71.5dB   |
| 0  | 0  | 0   | 1   | 0   | 0   | 1   | 0   | –72dB     |
| 0  | 0  | 0   | 1   | 0   | 0   | 1   | 1   | –72.5dB   |
| 1  | 0  | 0   | 1   | 0   | 0   | 1   | 0   | –73dB     |
| 1  | 0  | 0   | 1   | 0   | 0   | 1   | 1   | –73.5dB   |
| 0  | 1  | 0   | 1   | 0   | 0   | 1   | 0   | –74dB     |
| 0  | 1  | 0   | 1   | 0   | 0   | 1   | 1   | –74.5dB   |
| 1  | 1  | 0   | 1   | 0   | 0   | 1   | 0   | –75dB     |
| 1  | 1  | 0   | 1   | 0   | 0   | 1   | 1   | –75.5dB   |
| 0  | 0  | 1   | 1   | 0   | 0   | 1   | 0   | –76dB     |
| 0  | 0  | 1   | 1   | 0   | 0   | 1   | 1   | –76.5dB   |
| 1  | 0  | 1   | 1   | 0   | 0   | 1   | 0   | –77dB     |
| 1  | 0  | 1   | 1   | 0   | 0   | 1   | 1   | –77.5dB   |
| 0  | 1  | 1   | 1   | 0   | 0   | 1   | 0   | –78dB     |
| 0  | 1  | 1   | 1   | 0   | 0   | 1   | 1   | –78.5dB   |
| 1  | 1  | 1   | 1   | 0   | 0   | 1   | 0   | –79dB     |
| 1  | 1  | 1   | 1   | 0   | 0   | 1   | 1   | –79.5dB   |
| 0  | 1  | 1   | 1   | 1   | 1   | 1   | 0   | –∞        |

**LC75411ES, 75411WS****Tone Control**

| D16 | D17 | D18 | D19 | D40 | Bass   |
|-----|-----|-----|-----|-----|--------|
| D24 | D25 | D26 | D27 | D42 | Treble |
| 0   | 1   | 1   | 0   | 0   | +12dB  |
| 1   | 0   | 1   | 0   | 0   | +10dB  |
| 0   | 0   | 1   | 0   | 0   | +8dB   |
| 1   | 1   | 0   | 0   | 0   | +6dB   |
| 1   | 1   | 0   | 0   | 1   | +5dB   |
| 0   | 1   | 0   | 0   | 0   | +4dB   |
| 0   | 1   | 0   | 0   | 1   | +3dB   |
| 1   | 0   | 0   | 0   | 0   | +2dB   |
| 1   | 0   | 0   | 0   | 1   | +1dB   |
| 0   | 0   | 0   | 0   | 0   | 0dB    |
| 1   | 0   | 0   | 1   | 1   | -1dB   |
| 1   | 0   | 0   | 1   | 0   | -2dB   |
| 0   | 1   | 0   | 1   | 1   | -3dB   |
| 0   | 1   | 0   | 1   | 0   | -4dB   |
| 1   | 1   | 0   | 1   | 1   | -5dB   |
| 1   | 1   | 0   | 1   | 0   | -6dB   |
| 0   | 0   | 1   | 1   | 0   | -8dB   |
| 1   | 0   | 1   | 1   | 0   | -10dB  |
| 0   | 1   | 1   | 1   | 0   | -12dB  |

| D20 | D21 | D22 | D23 | D41 | Setting  |
|-----|-----|-----|-----|-----|----------|
| 0   | 0   | 0   | 0   | 0   | Set to 0 |

**Fader Volume Control**

| D28 | D29 | D30 | D31 | Operation |
|-----|-----|-----|-----|-----------|
| 0   | 0   | 0   | 0   | 0dB       |
| 1   | 0   | 0   | 0   | -1dB      |
| 0   | 1   | 0   | 0   | -2dB      |
| 1   | 1   | 0   | 0   | -4dB      |
| 0   | 0   | 1   | 0   | -6dB      |
| 1   | 0   | 1   | 0   | -8dB      |
| 0   | 1   | 1   | 0   | -10dB     |
| 1   | 1   | 1   | 0   | -12dB     |
| 0   | 0   | 0   | 1   | -14dB     |
| 1   | 0   | 0   | 1   | -16dB     |
| 0   | 1   | 0   | 1   | -18dB     |
| 1   | 1   | 0   | 1   | -20dB     |
| 0   | 0   | 1   | 1   | -30dB     |
| 1   | 0   | 1   | 1   | -45dB     |
| 0   | 1   | 1   | 1   | -60dB     |
| 1   | 1   | 1   | 1   | -∞        |

**Channel Selection Control**

| D32 | D33 | Operation                            |
|-----|-----|--------------------------------------|
| 0   | 0   | Initial setting mode: Rapid charging |
| 1   | 0   | RCH                                  |
| 0   | 1   | LCH                                  |
| 1   | 1   | L/R simultaneously                   |

## LC75411ES, 75411WS

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### Fader Rear/Front Control

| D34 | Setting |
|-----|---------|
| 0   | Rear    |
| 1   | Front   |

### Loudness Control

| D35 | Setting |
|-----|---------|
| 0   | OFF     |
| 1   | ON      |

### Zero-Cross Control

| D36 | D37 | Setting                                                         |
|-----|-----|-----------------------------------------------------------------|
| 0   | 0   | Data write through zero-cross detection                         |
| 1   | 1   | Zero-cross detection stopped (data write at falling edge of CE) |

### Zero-Cross Signal Detection Block Control

| D38 | D39 | Setting  |
|-----|-----|----------|
| 0   | 0   | Selector |
| 1   | 0   | Volume   |
| 0   | 1   | Tone     |
| 1   | 1   | Fader    |

### Test Mode Control

| D43 | Setting                          |
|-----|----------------------------------|
| 0   | For IC testing. Always set to 0. |

## LC75411ES, 75411WS

## Pin Functions

| Pin Name                                     | Pin No.                                      |                                              | Function                                                                                                                                                | Equivalent circuit |
|----------------------------------------------|----------------------------------------------|----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
|                                              | LC75411ES                                    | LC75411WS                                    |                                                                                                                                                         |                    |
| L1<br>L2<br>L3<br>L4<br>R1<br>R2<br>R3<br>R4 | 38<br>37<br>36<br>35<br>41<br>42<br>43<br>44 | 40<br>39<br>38<br>37<br>45<br>46<br>47<br>48 | • Single-end input pin                                                                                                                                  |                    |
| LSEL0<br>RSEL0                               | 34<br>1                                      | 36<br>1                                      | • Input selector output pins                                                                                                                            |                    |
| LVRIN<br>RVRIN                               | 33<br>2                                      | 35<br>2                                      | • 2-dB step volume input pins<br>• Perform input at low-impedance.                                                                                      |                    |
| LCT<br>RCT                                   | 32<br>3                                      | 34<br>3                                      | • Loudness pins. Connect high-pass compensation RC between LCT (RCT) and LVRIN (RVRIN), and connect low-pass compensation RC between LCT (RCT) and GND. |                    |
| LCOM<br>RCOM                                 | 31<br>4                                      | 33<br>4                                      | • 2-dB stop volume output pins.<br>• Connect these pins to GND through coupling capacitors to reduce switching noise.                                   |                    |
| LVROUT<br>RVROUT                             | 30<br>5                                      | 32<br>5                                      | • 0.5-dB step volume output pin                                                                                                                         |                    |
| LTIN<br>RTIN                                 | 29<br>6                                      | 31<br>6                                      | • Equalizer input pin                                                                                                                                   |                    |

Continued on next page.

# LC75411ES, 75411WS

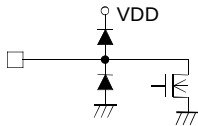
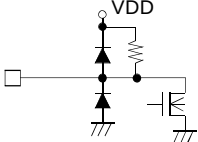
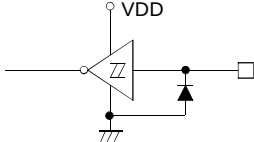
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| Pin Name                                           | Pin No.                       |                               | Function                                                                                                                                                                                                            | Equivalent circuit |
|----------------------------------------------------|-------------------------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
|                                                    | LC75411ES                     | LC75411WS                     |                                                                                                                                                                                                                     |                    |
| LF1C1<br>LF1C2<br>LF1C3<br>RF1C1<br>RF1C2<br>RF1C3 | 28<br>27<br>26<br>7<br>8<br>9 | 30<br>29<br>28<br>7<br>8<br>9 | <ul style="list-style-type: none"> <li>Equalizer F1 band filter configuration capacitor connection pins.</li> </ul> Connect capacitor between<br>LF1C1 (RF1C1) and LF1C2 (RF1C2)<br>LF1C2 (RF1C2) and LF1C3 (RF1C3) |                    |
| LF3C1<br>RF3C1                                     | 25<br>10                      | 27<br>10                      | <ul style="list-style-type: none"> <li>Equalizer F3 band circuit filter configuration capacitor connection pins.</li> </ul> Connect high-pass compensation capacitor between LF3C1 (RF3C1) and VSS.                 |                    |
| LTOUT<br>RTOUT                                     | 24<br>11                      | 26<br>11                      | <ul style="list-style-type: none"> <li>Equalizer output pins</li> </ul>                                                                                                                                             |                    |
| LFIN<br>RFIN                                       | 23<br>12                      | 24<br>13                      | <ul style="list-style-type: none"> <li>Fader block input pins</li> <li>Drive at low impedance.</li> </ul>                                                                                                           |                    |
| LFOUT<br>LROUT<br>RFOUT<br>RROUT                   | 22<br>21<br>13<br>14          | 23<br>22<br>14<br>15          | <ul style="list-style-type: none"> <li>Fader output pins. Attenuation is possible separately for the front end and rear end. The attenuation amount is the same for L and R.</li> </ul>                             |                    |
| Vref                                               | 40                            | 43                            | <ul style="list-style-type: none"> <li>Connect a capacitor of a few tens of <math>\mu\text{F}</math> between Vref and VSS as a 0.55 VDD voltage generator, current ripple countermeasure.</li> </ul>                |                    |

Continued on next page.

# LC75411ES, 75411WS

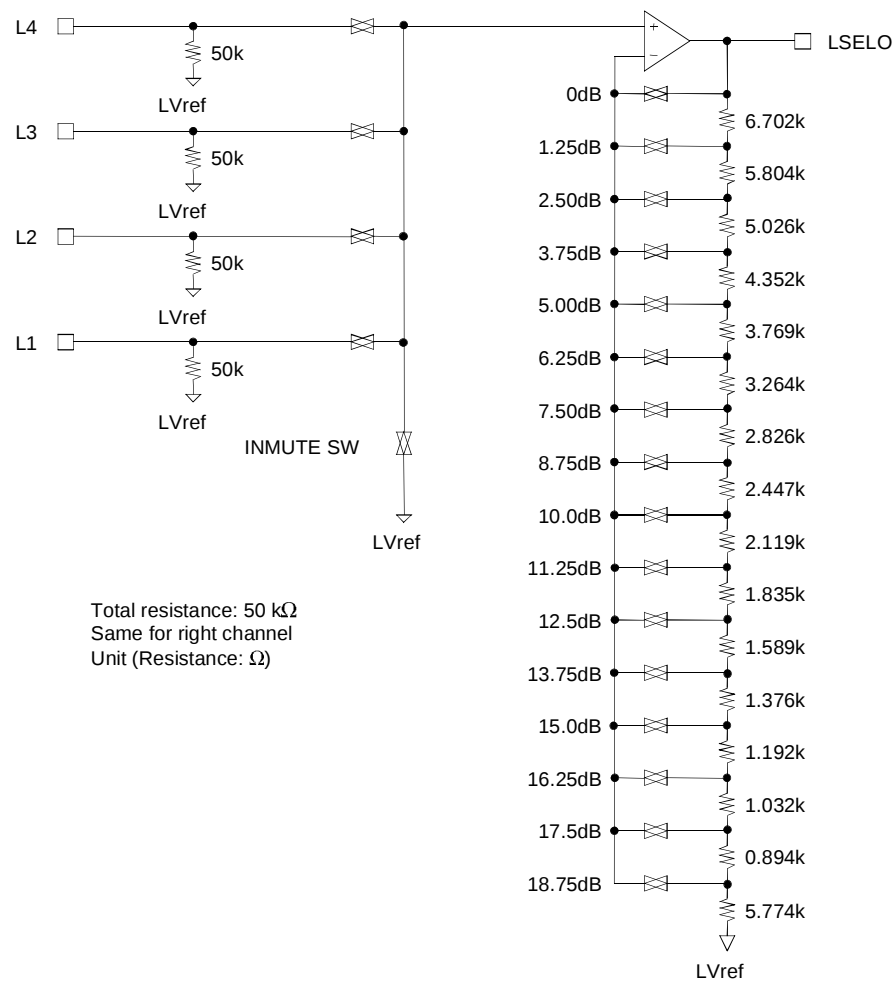
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| Pin Name | Pin No.   |                      | Function                                                                                                                                                                                   | Equivalent circuit                                                                    |
|----------|-----------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|          | LC75411ES | LC75411WS            |                                                                                                                                                                                            |                                                                                       |
| VDD      | 39        | 42                   | • Power supply pin                                                                                                                                                                         |                                                                                       |
| VSS      | 20        | 21                   | • Ground pin                                                                                                                                                                               |                                                                                       |
| TEST     | 16        | 17                   | • Dedicated IC test pin<br>• Normally this pin is used connected to GND.                                                                                                                   |    |
| TIM      | 15        | 16                   | • Timer pin when there is no signal in the zero-cross circuit.<br>Forcibly set data when there is no zero-cross signal, from the time the data is set until the timer ends.                |    |
| CL<br>DI | 19<br>18  | 20<br>19             | • Input pin for serial data and clock used for control                                                                                                                                     |  |
| CE       | 17        | 18                   | • Chip enable pin. Data is written to the internal latch and the analog switches are operated when the level changes from High to Low.<br>Data transfer is enabled when the level is High. |                                                                                       |
| NC       | —         | 12<br>25<br>41<br>44 | • No Connect pin. Leave this pin open or connect it to VSS.                                                                                                                                |                                                                                       |

LC75411ES, 75411WS

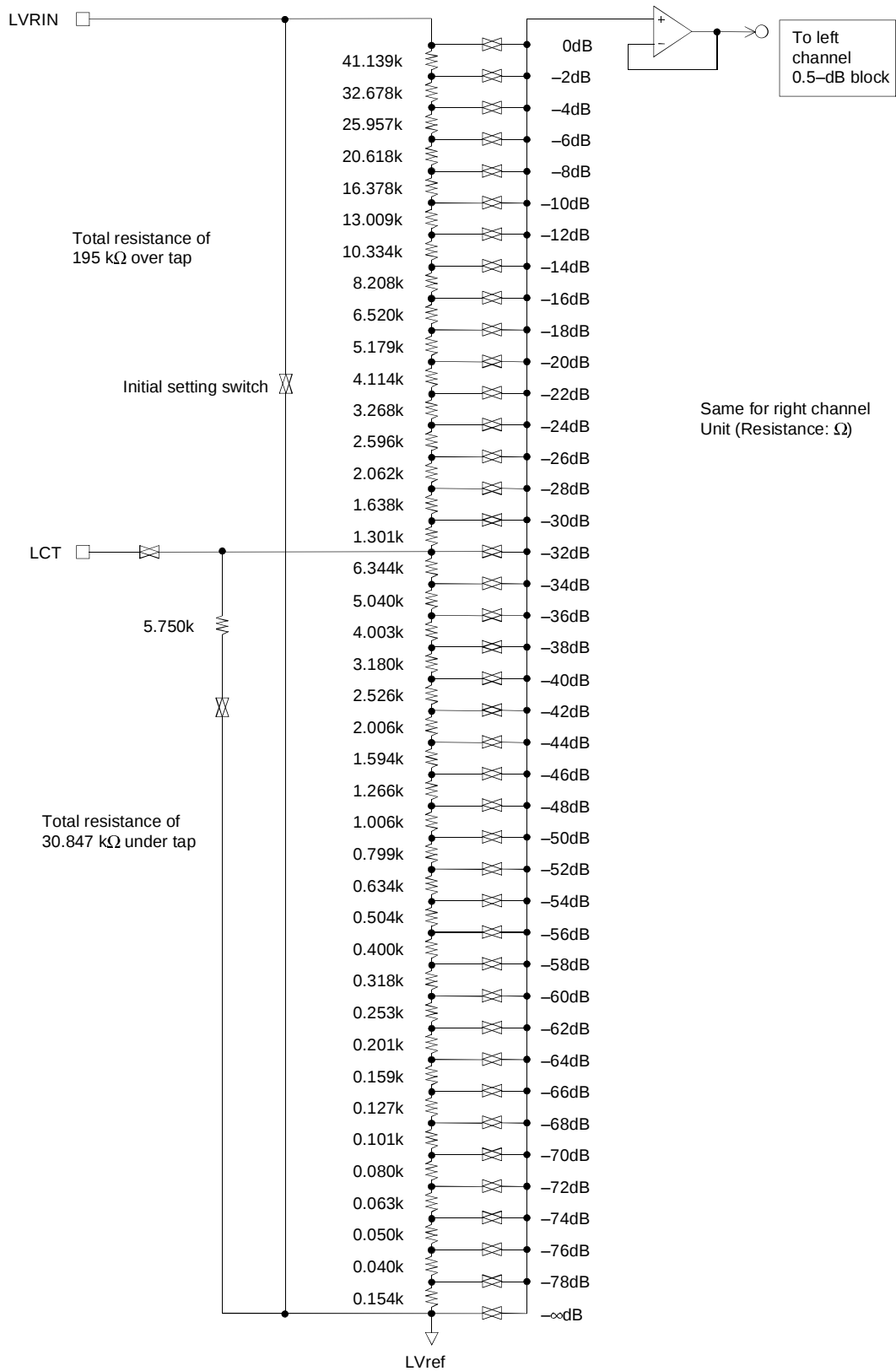
Internal Equivalent Circuit Block Diagram

Selector Block Equivalent Circuit Block Diagram



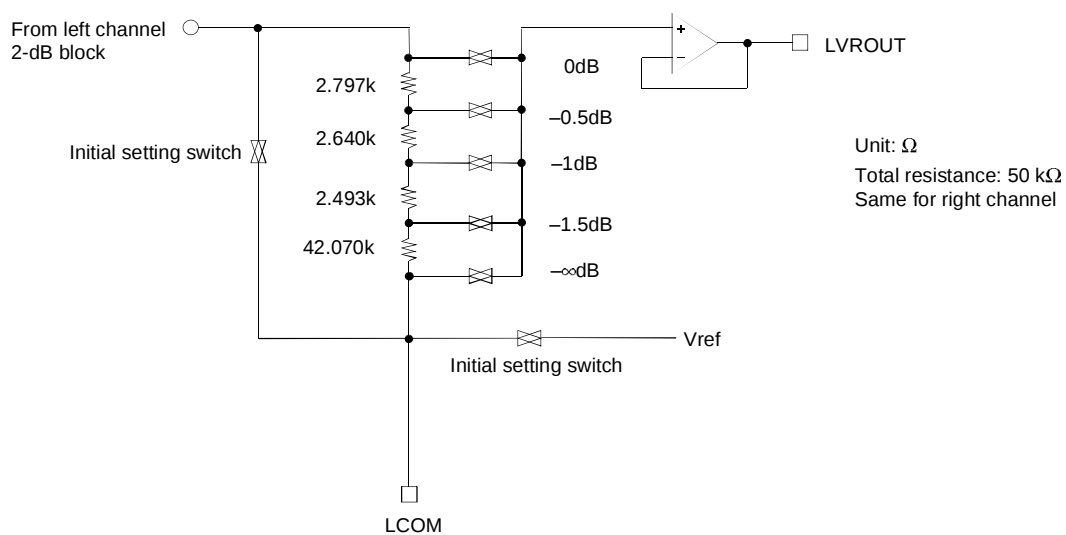
LC75411ES, 75411WS

2-dB Volume Block Equivalent Circuit Block Diagram



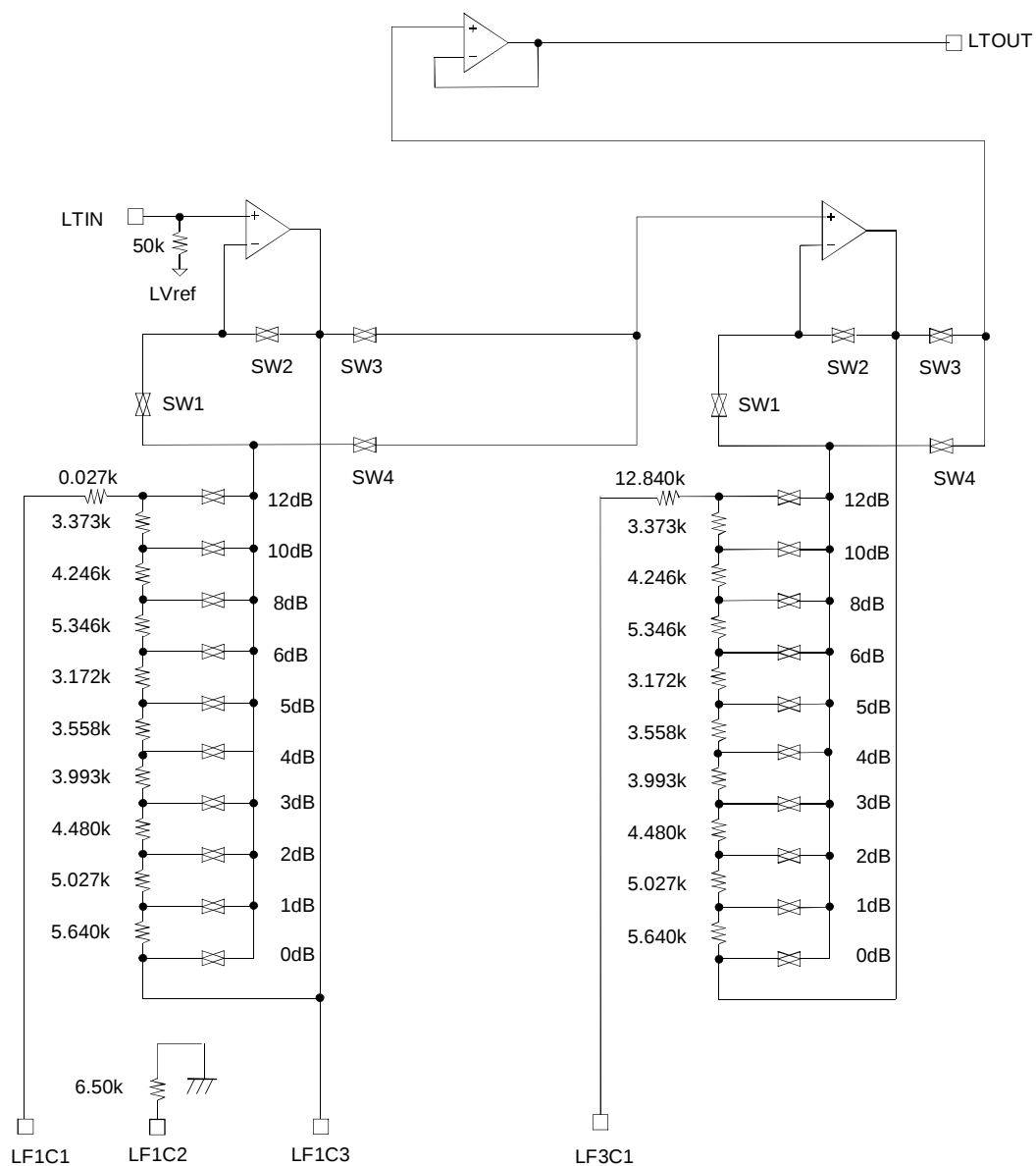
LC75411ES, 75411WS

0.5-dB Volume Block Equivalent Circuit Block Diagram



## LC75411ES, 75411WS

Tone Block Equivalent Circuit Diagram



Unit:  $\Omega$

Total resistance: 38.861 k $\Omega$

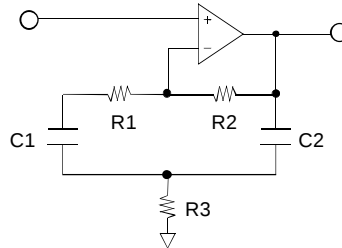
Same for right channel

During boost, SW 1 and SW 3 are ON, during cut SW 2 and SW 4 are ON,  
and when 0 dB, 0 dB SW and SW 2 and SW 3 are ON.

**Tone Circuit Constant Calculation Example****Bass Band Circuit**

The equivalent circuit and the formula for calculating the external RC with a mean frequency of 100 Hz are shown below.

- Bass band equivalent circuit block diagram



- Calculation example

Specification Mean frequency:  $f_0 = 100 \text{ Hz}$

Gain during maximum boost:  $G = 12 \text{ dB}$

Let us use  $R_1 = 0$ ,  $R_2 = 38.861 \text{ k}\Omega$ ,  $R_3 = 6.5 \text{ k}\Omega$  (assuming  $R_1 = 0$  during maximum boost), and  $C_1 = C_2 = C$ .

1. We obtain  $C$  from mean frequency  $f_0 = 100 \text{ Hz}$ , as follows.

$$f_0 = \frac{1}{2\pi\sqrt{R_3 R_2 C_1 C_2}}$$

$$C = \frac{1}{2\pi f_0 \sqrt{R_3 R_2}} = \frac{1}{2\pi \times 100 \sqrt{38861 \times 6500}} \cong 0.1 \mu\text{F}$$

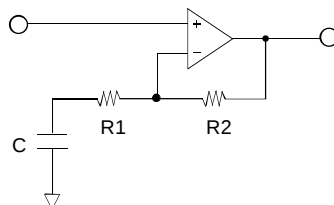
2. We obtain  $Q$  as follows.

$$Q = \frac{R_3 R_2}{2 R_3} \times \frac{1}{\sqrt{R_3 R_2}} \cong 1.223$$

### Treble Band Circuit

The shelving characteristics for the treble band can be obtained.

The equivalent circuit and the calculation formula during boost are shown below.



- Calculation example

Specification Setting frequency:  $f = 26000 \text{ Hz}$

Gain during maximum boost:  $G = 12 \text{ dB}$

Let us use  $R1 = 12.840 \text{ k}\Omega$  and  $R2 = 38.861 \text{ k}\Omega$

The above constants are inserted in the following formula.

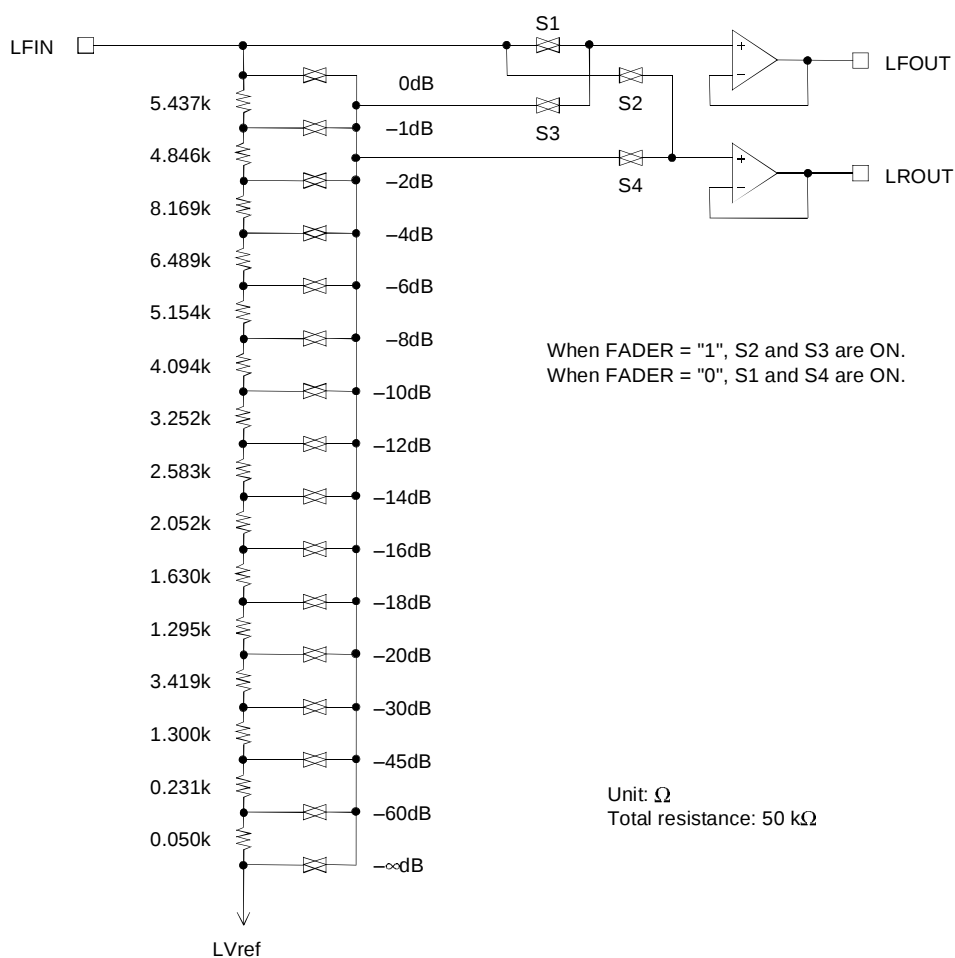
$$G = 20 \times \text{LOG}_{10} \left( 1 + \frac{R2}{\sqrt{R1^2 + (1/\omega C)^2}} \right)$$

$$C = \frac{1}{2\pi f \sqrt{\left( \frac{R2}{10^{G/20} - 1} \right)^2 - R1^2}}$$

$$= \frac{1}{2\pi \times 26000 \sqrt{\left( \frac{38861}{3.981 - 1} \right)^2 - 12840^2}} \cong 2700(\text{pF})$$

## LC75411ES, 75411WS

Fader Volume Block Equivalent Circuit Block Diagram



When  $-\infty$  data is sent to the main volume 0.5dBSTEP, S1 and S2 become open, and S3 and S4 simultaneously become ON.

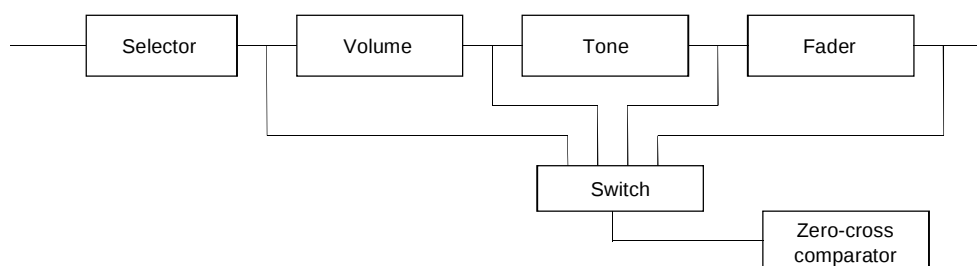
### Usage Cautions

(1) Data transmission at power ON

- The status of internal analog switches is unstable at power ON. Therefore, perform muting or some other countermeasure until the data has been set.
- At power ON, initial setting data must be sent once in order to stabilize the bias of each block in a short time.

(2) Description of zero-cross switching circuit operation

The LC75411ES and 75411WS have a function to switch zero-cross comparator signal detection locations, enabling the selection of the optimum detection location for blocks whose data is to be updated. Basically, the switching noise can be minimized by inputting the signal immediately following the block whose data is to be updated to the zero-cross comparator, so it is necessary to switch the detection location every time.



LC75411ES, 75411WS Zero-Cross Detection Circuit

(3) Zero-cross switching control method

The zero-cross switching control method consists of setting the zero-cross control bits to the zero-cross detection mode (D36, D37 = 0), and specifying the detection blocks (D38, D39) before transmitting the data. These control bits are latched immediately following data transfer, that is to say beforehand in sync with the falling edge of CE, so when updating data of volumes, etc., it is possible to perform mode setting and zero-cross switching with one data transfer. An example of control when updating the data of the volume block is shown below.

| D36 | D37 | D38 | D39 |
|-----|-----|-----|-----|
| 0   | 0   | 1   | 0   |

Zero-cross detection  
mode setting

Volume block  
setting

(4) Zero-cross timer setting

If the input signal becomes lower than the zero-cross comparator detection sensitivity, or if only low-frequency signals are input, zero-cross detection continues to be impossible, and data is not latched during this time. The zero-cross timer can set a time for forcible latch during such a status when zero-cross detection is not possible.

For example, to set 25 ms,  
using  $T = 0.69CR$  and  $C = 0.033 \mu F$ ,  
we obtain

$$R = \frac{25 \times 10^{-3}}{0.69 \times 0.033 \times 10^{-6}} \approx 1.1 \text{ M}\Omega$$

Normally, a value between 10 ms and 50 ms is set.

(5) Cautions related to serial data transfer

1. To ensure that the high-frequency digital signals transferred to the CL, DI, and CE pins do not spill over to the analog signal block, either guard these signal lines with a ground pattern, or perform transmission using shielded wires.
2. The data format of the LC75411ES and 75411WS uses 8-bit addresses and 44-bit data. When sending data using multiples of 8 (when sending 48 bits), use the method described in Figure 1.

Method for Receiving Data Using Multiple of 8 of LC75411ES and 75411WS

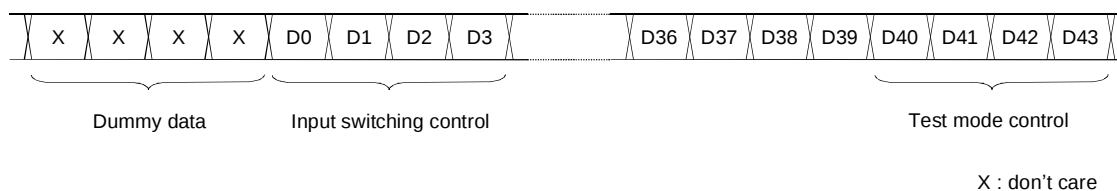
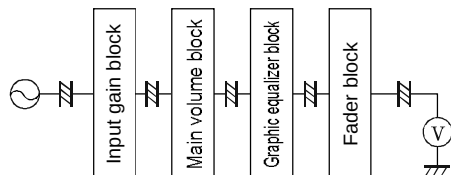
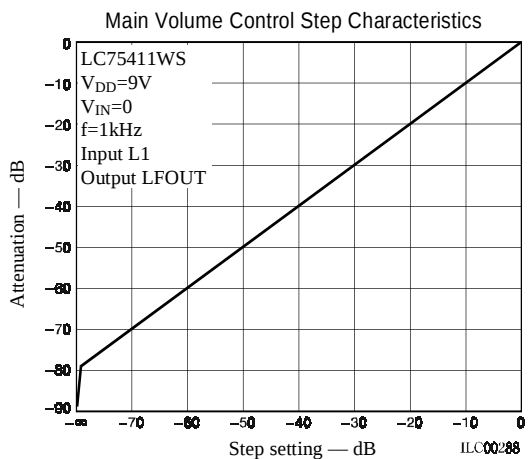
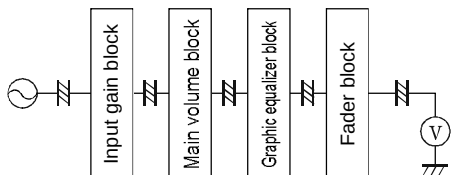
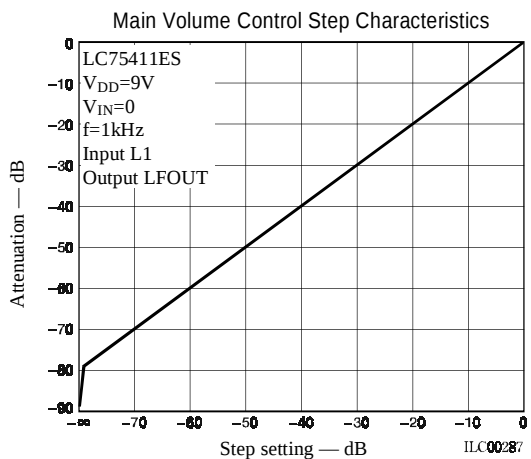
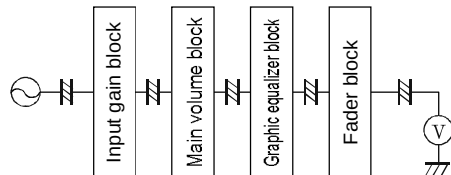
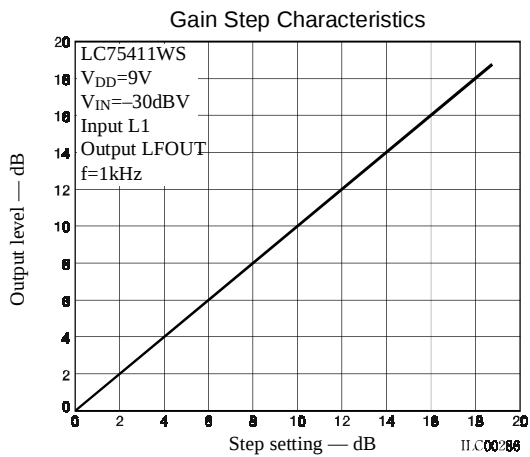
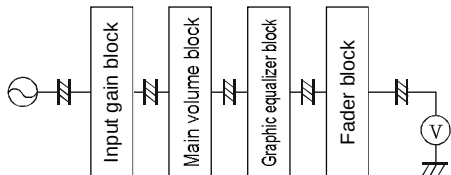
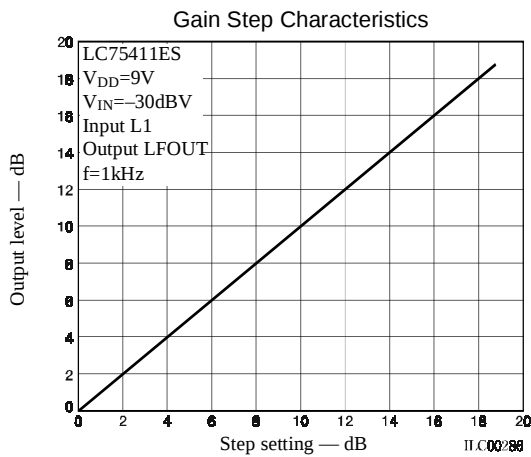
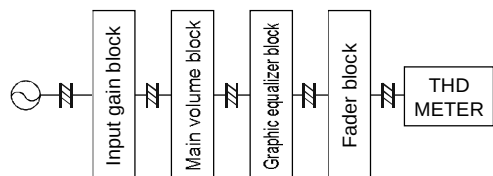
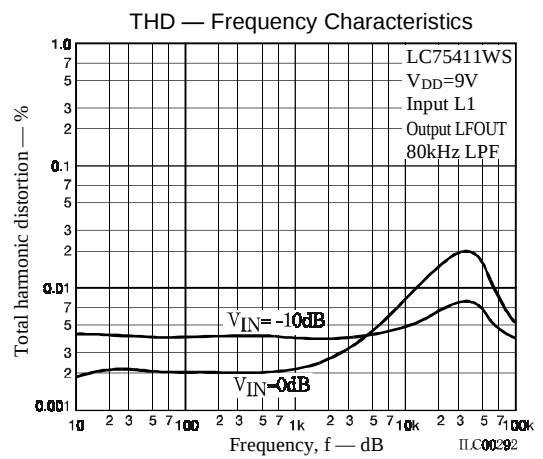
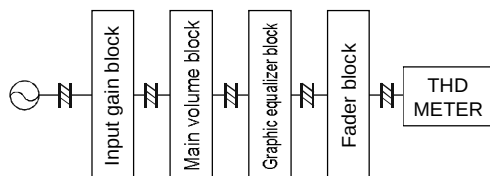
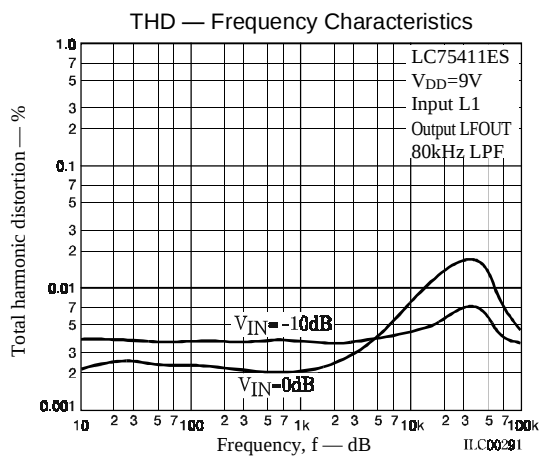
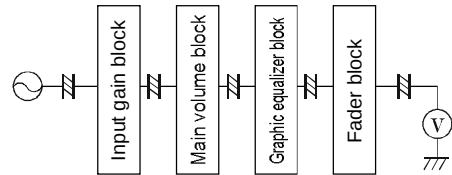
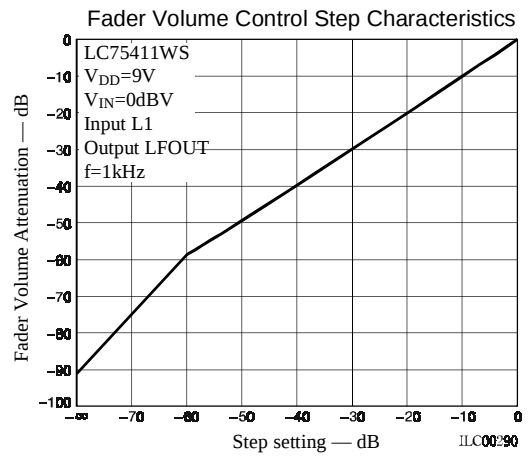
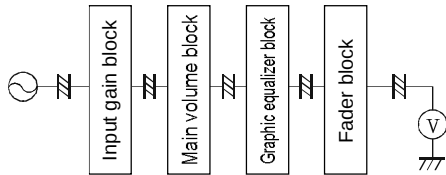
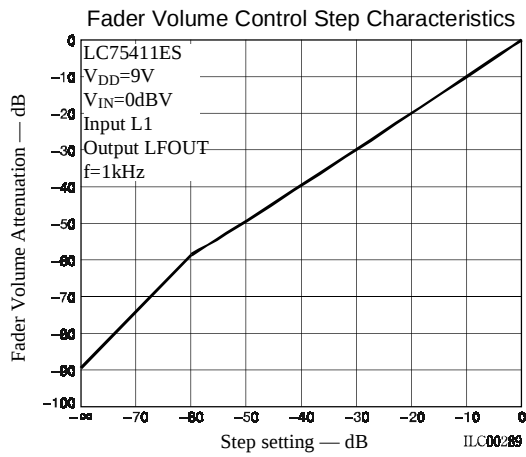
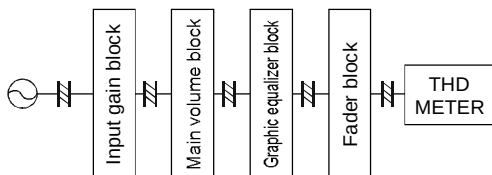
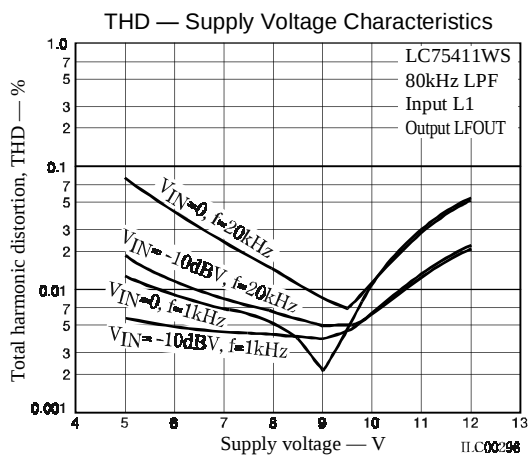
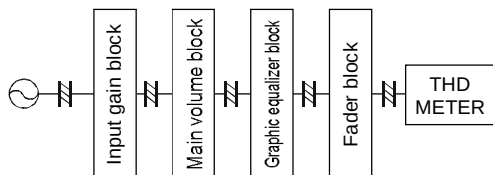
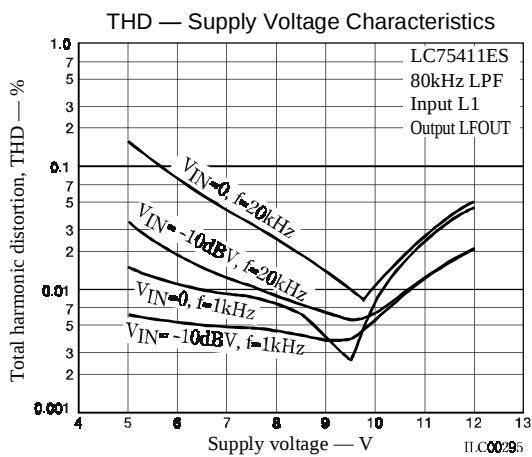
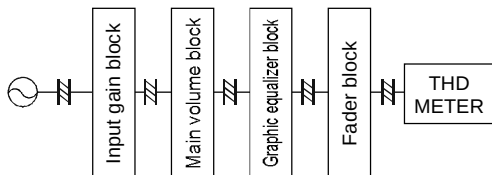
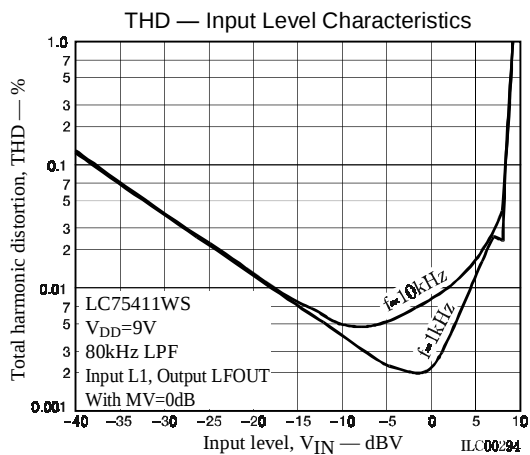
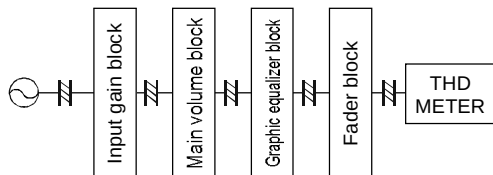
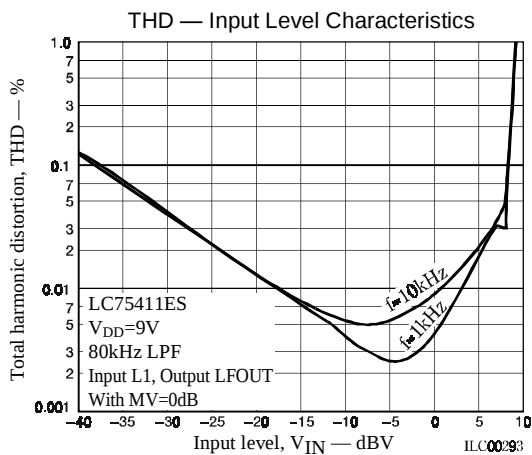


Figure 1

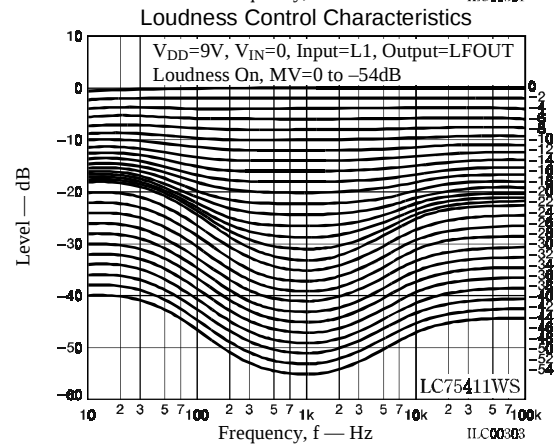
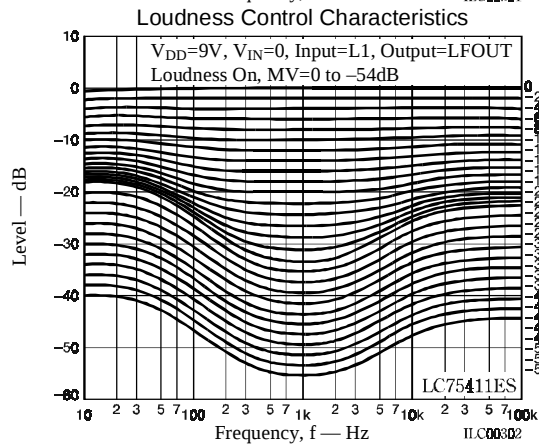
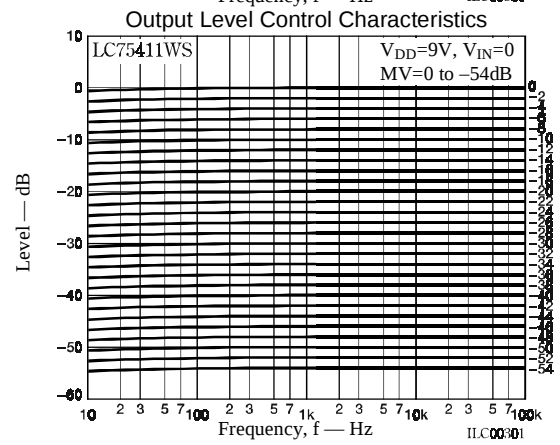
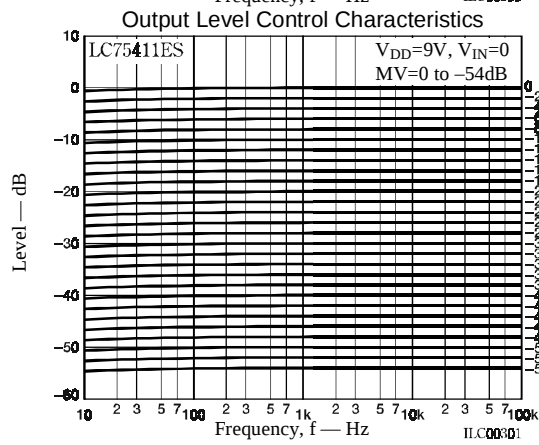
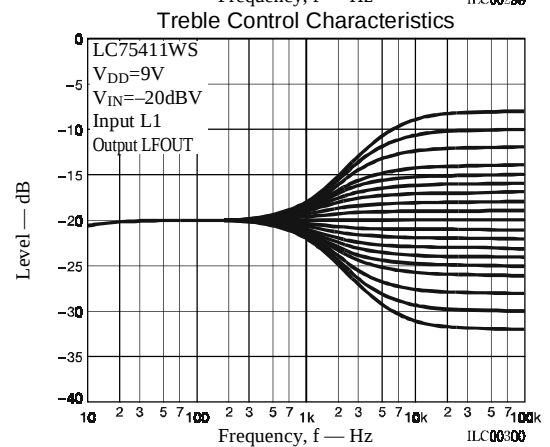
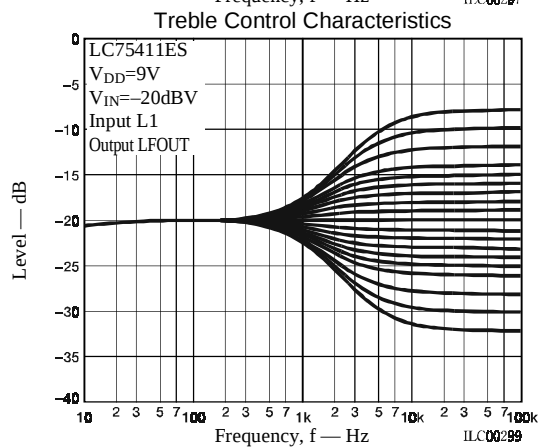
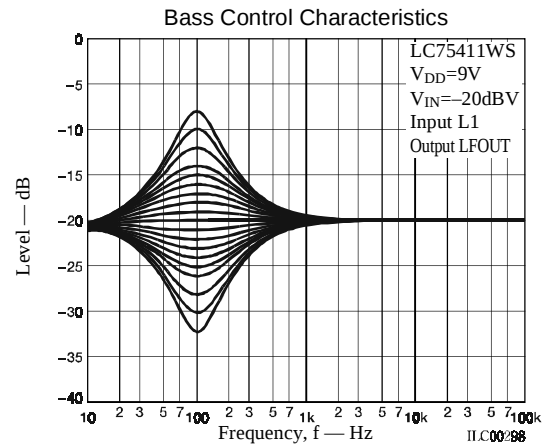
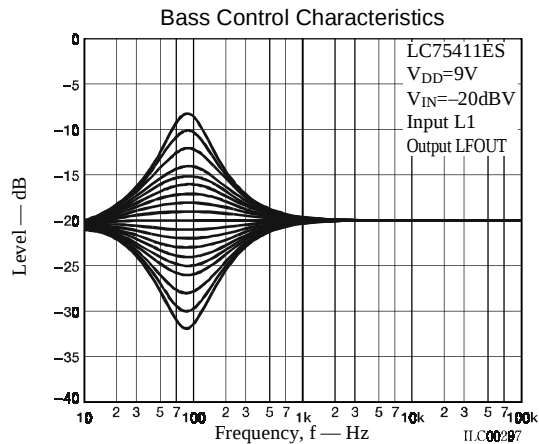


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