

# M62435FP

## Electric Volume Control with Tone Controller for 4-Speaker Applications

REJ03F0210-0201

Rev.2.01

Mar 31, 2008

### Description

- Developed for car audio
- Uses it for analog small signal handling of stage before power amplifier
- Use to Home audio system, television are thought about other than car audio system

### Features

- Built-in zero cross detector prevents click noise
- Differential amplifier
- Loudness
- Tone control bass/Mid/Treble
- Master volume/Fader Volume
- Serial data control

### Recommended Operating Conditions

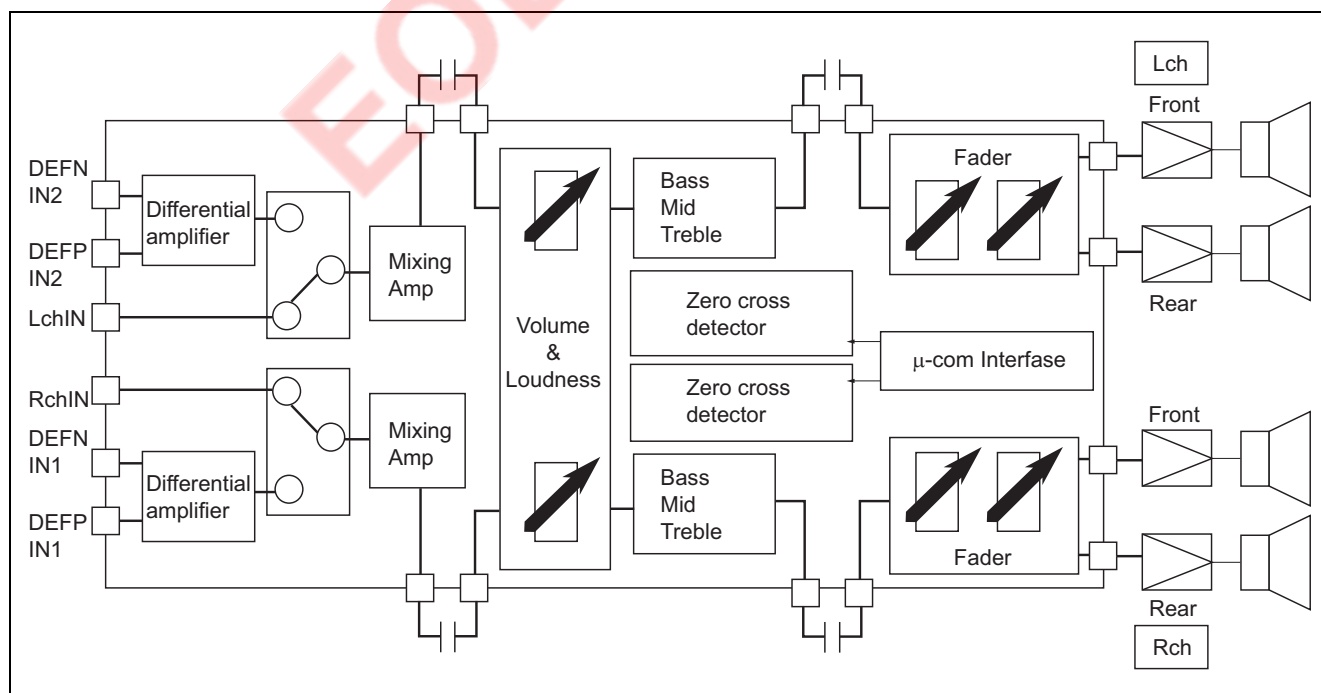
Supply voltage range:  $V_{CC} = 6$  to  $9$  V

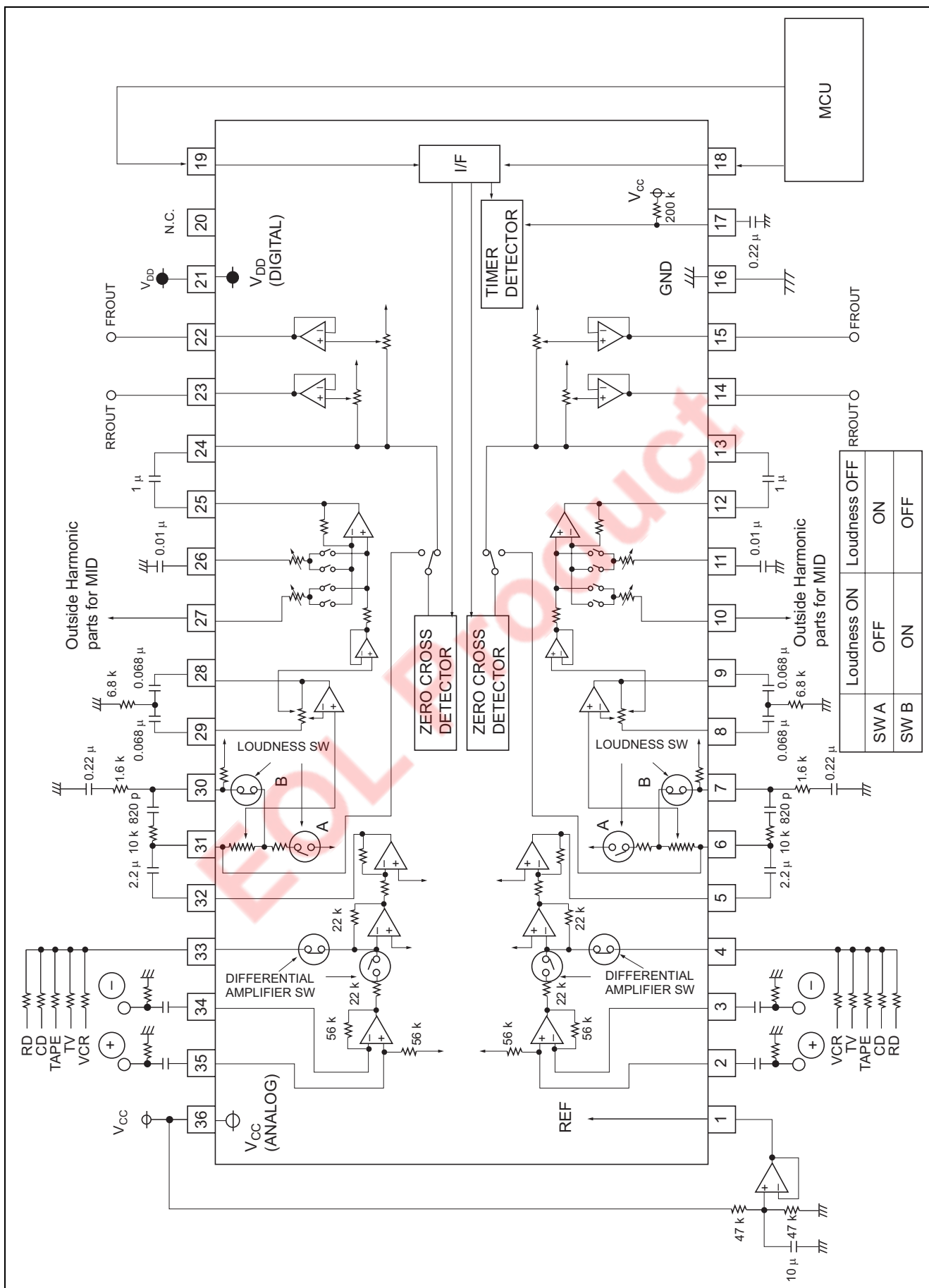
$V_{DD} = 4$  to  $6$  V

Rated supply voltage:  $V_{CC} = 8$  V

$V_{DD} = 5$  V

### Block Diagram



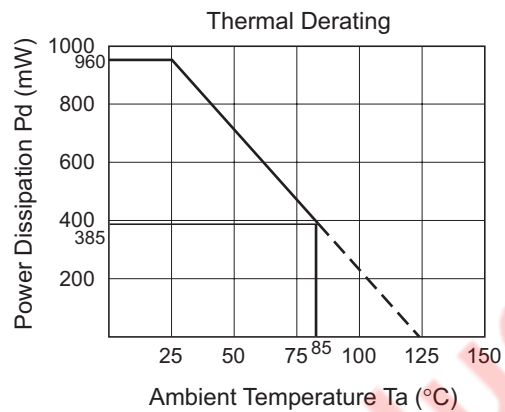


## Pin Description

| Pin No. | Symbol          | Function                                                                                                                   |
|---------|-----------------|----------------------------------------------------------------------------------------------------------------------------|
| 1       | REF             | IC signal ground. Apply 1/2 V <sub>CC</sub>                                                                                |
| 2       | DEFP IN1        | Differential amplifier input +                                                                                             |
| 3       | DEFN IN1        | Differential amplifier input –                                                                                             |
| 4       | MIX IN1         | Mixing amplifier input –                                                                                                   |
| 5       | MIX OUT1        | Mixing amplifier input +                                                                                                   |
| 6       | VOL IN1         | Input pin of the volume block                                                                                              |
| 7       | LOUD IN1        | Pin for setting the frequency characteristics of the loudness block                                                        |
| 8       | BASSA1          | Pin for setting the frequency characteristics of the tone (Bass) block                                                     |
| 9       | BASSB1          |                                                                                                                            |
| 10      | MID1            | R-ladder terminal of tone (Mid)                                                                                            |
| 11      | TRE1            | R-ladder terminal of tone (Treble)                                                                                         |
| 12      | TONE OUT1       | Output pin of the tone block                                                                                               |
| 13      | FADER IN1       | Input pin of the fader volume                                                                                              |
| 14      | REAR OUT1       | Output pin of the fader volume (Rear)                                                                                      |
| 15      | FRONT OUT1      | Output pin of the fader volume (Front)                                                                                     |
| 16      | GND             | Ground                                                                                                                     |
| 17      | TIM1            | Timer setting terminal<br>The relationship between outside parts C and setting time is $T = 13.8 \times 10^4 \cdot C$ (s). |
| 18      | DATA            | Input pin of the control data<br>This pin inputs data in synchronization with CLOCK                                        |
| 19      | CLOCK           | Clock input pin for serial data transfer                                                                                   |
| 20      | N.C.            | Non Connection                                                                                                             |
| 21      | V <sub>DD</sub> | Digital power supply pin, normally +5 V                                                                                    |
| 22      | FRONT OUT2      | Output pin of the fader volume (Front)                                                                                     |
| 23      | REAR OUT2       | Output pin of the fader volume (Rear)                                                                                      |
| 24      | FADER IN2       | Input pin of the fader volume                                                                                              |
| 25      | TONE OUT2       | Output pin of the tone block                                                                                               |
| 26      | TRE2            | R-ladder terminal of tone (Treble)                                                                                         |
| 27      | MID2            | R-ladder terminal of tone (Mid)                                                                                            |
| 28      | BASSB2          | Pin for setting the frequency characteristics of the tone (Bass) block                                                     |
| 29      | BASSA2          |                                                                                                                            |
| 30      | LOUD IN2        | Pin for setting the frequency characteristics of the loudness block                                                        |
| 31      | VOL IN2         | Input pin of the volume block                                                                                              |
| 32      | MIX OUT2        | Mixing amplifier output                                                                                                    |
| 33      | MIX IN2         | Mixing amplifier input                                                                                                     |
| 34      | DEFN IN2        | Differential amplifier input –                                                                                             |
| 35      | DEFP IN2        | Differential amplifier input +                                                                                             |
| 36      | V <sub>CC</sub> | Analog power supply pin                                                                                                    |

## Absolute Maximum Ratings

| Item                   | Symbol           | Ratings        | Unit                   | Conditions                            |
|------------------------|------------------|----------------|------------------------|---------------------------------------|
| Supply voltage         | $V_{CC}, V_{DD}$ | 10, 7          | V                      |                                       |
| Power dissipation      | $P_d$            | 990            | mW                     | $T_a \leq 25\text{ }^{\circ}\text{C}$ |
| Thermal derating ratio | $K\theta$        | 9.9            | mW/ $^{\circ}\text{C}$ | $T_a \geq 25\text{ }^{\circ}\text{C}$ |
| Operating temperature  | $T_{opr}$        | $-30 \sim 85$  | $^{\circ}\text{C}$     |                                       |
| Storage temperature    | $T_{stg}$        | $-55 \sim 125$ | $^{\circ}\text{C}$     |                                       |

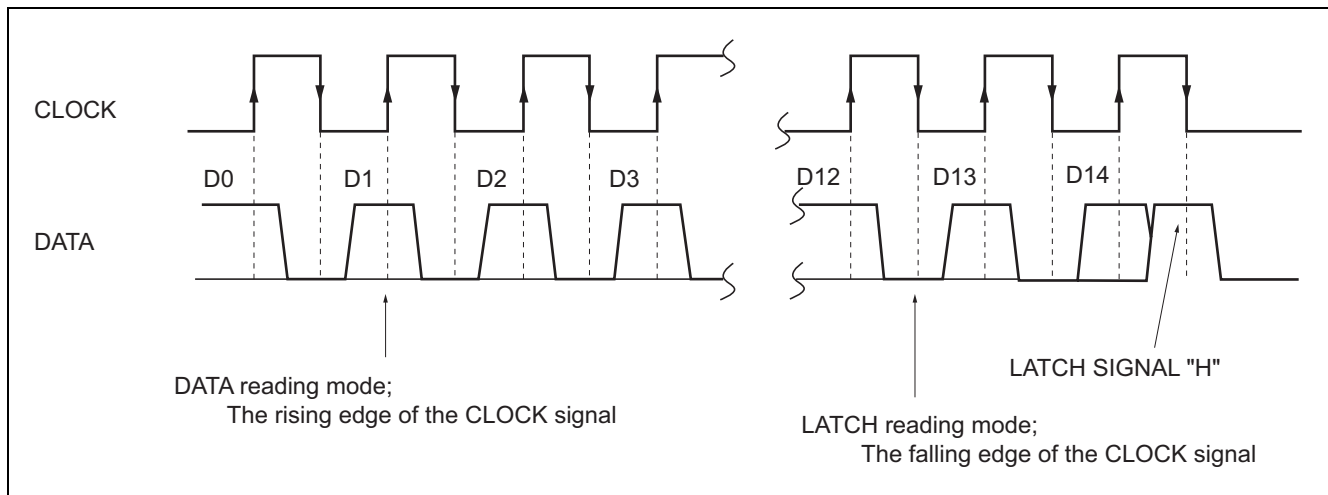


## Electrical Characteristics

T<sub>a</sub> = 25°C, V<sub>CC</sub> = 8 V, V<sub>DD</sub> = 5 V, VOL/FADER = 0 dB, TONE/FLAT, Loudness OFF unless otherwise noted

| Item                                    | Symbol                 | Limits |      |       | Unit              | Test Conditions                                                                   |
|-----------------------------------------|------------------------|--------|------|-------|-------------------|-----------------------------------------------------------------------------------|
|                                         |                        | Min    | Typ  | Max   |                   |                                                                                   |
| Circuit current                         | I <sub>CC</sub>        | —      | 20   | 35    | mA                | No input signal                                                                   |
| Pass gain                               | G <sub>v</sub>         | −3.5   | 0    | 3.5   | dB                | Outside resistor 22 kΩ of pin 4, 33<br>Outside resistor 56 kΩ of pin 2, 3, 34, 35 |
| Maximum attenuation                     | A <sub>TT</sub> (VOL)  | −32.5  | −30  | −27.5 | dB                | V <sub>i</sub> = 1 V <sub>rms</sub> , f = 1 kHz<br>ATT (VOL) = −30 dB             |
| Attenuation error                       | ΔA <sub>TT</sub> (VOL) | −2.5   | 0    | 2.5   | dB                | ATT (VOL) = 0 dB                                                                  |
| Maximum input voltage                   | V <sub>IM</sub>        | 1.8    | 2.2  | —     | V <sub>rms</sub>  | f = 1 kHz, BW: 400 to 30 kHz<br>THD = 1%                                          |
| Bass boost                              | G (Bass) B             | 13     | 16   | 19    | dB                | f = 100 Hz                                                                        |
| Bass cut                                | G (Bass) C             | −15    | −12  | −9    | dB                | f = 100 Hz                                                                        |
| MID boost                               | G (MID) B              | 9      | 12   | 15    | dB                | f = 1 kHz (Outside harmonic amplifier)                                            |
| MID cut                                 | G (MID) C              | −15    | −12  | −9    | dB                | f = 1 kHz (Outside harmonic amplifier)                                            |
| Treble boost                            | G (Tre) B              | 9      | 12   | 15    | dB                | f = 10 kHz                                                                        |
| Treble cut                              | G (Tre) C              | −15    | −12  | −9    | dB                | f = 10 kHz                                                                        |
| Maximum attenuation                     | A <sub>TT</sub> (FED)  | —      | −90  | −80   | dB                | V <sub>i</sub> = 1 V <sub>rms</sub> , f = 1 kHz<br>ATT (FED) = −∞ dB              |
| Maximum output voltage                  | V <sub>OM</sub>        | 1.8    | 2.2  | —     | V <sub>rms</sub>  | f = 1 kHz, BW: 400 to 30 kHz<br>THD = 1%                                          |
| Output noise voltage                    | V <sub>no1</sub>       | —      | 10   | 18    | μV <sub>rms</sub> | R <sub>g</sub> = 0, DIN-AUDIO                                                     |
|                                         | V <sub>no2</sub>       | —      | 3    | 8     |                   | ATT (VOL) = −30 dB<br>ATT (FED) = −∞ dB<br>R <sub>g</sub> = 0, DIN-AUDIO          |
| Total harmonic distortion               | THD                    | —      | 0.03 | 0.05  | %                 | f = 1 kHz, V <sub>o</sub> = 0.5 V <sub>rms</sub><br>BW: 400 Hz to 30 kHz          |
| Channel separation                      | CS                     | —      | −90  | −80   | dB                | f = 1 kHz                                                                         |
| Cross talk of differential amplifier SW | CT                     | —      | −75  | −65   | dB                | f = 1 kHz                                                                         |
| Voltage gain of loudness                | G (LOUD) L             | 7.0    | 11.0 | 15.0  | dB                | Loudness ON<br>f = 100 Hz, ATT (VOL) = −30 dB                                     |
|                                         | G (LOUD) H             | 3.5    | 6.5  | 9.5   |                   | Loudness ON<br>f = 10 kHz, ATT (VOL) = −30 dB                                     |

## Relationship between Data and Clock



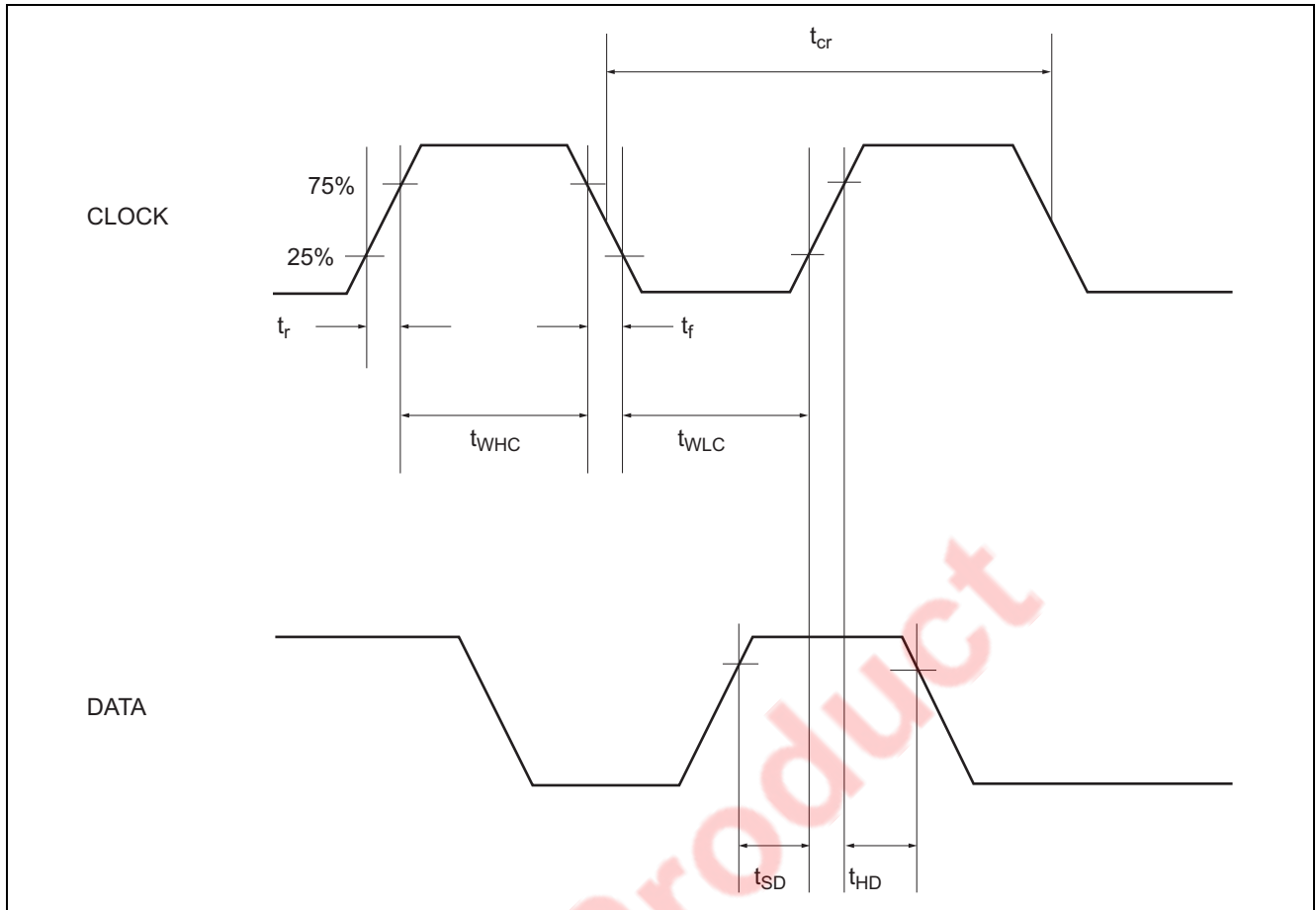
## Digital Circuit DC Characteristics

| Item                    | Symbol   | Limits       |     |              | Unit    | Test Conditions  |                  |
|-------------------------|----------|--------------|-----|--------------|---------|------------------|------------------|
|                         |          | Min          | Typ | Max          |         |                  |                  |
| "L" level input voltage | $V_{IL}$ | 0            | ~   | $0.2 V_{DD}$ | V       | DATA, CLOCK pins |                  |
| "H" level input voltage | $V_{IH}$ | $0.8 V_{DD}$ | ~   | $V_{DD}$     |         |                  |                  |
| "L" level input current | $I_{IL}$ | -10          | —   | 10           | $\mu A$ | $V_I = 0$        | DATA, CLOCK pins |
| "H" level input current | $I_{IH}$ | —            | —   | 10           |         | $V_I = V_{DD}$   |                  |

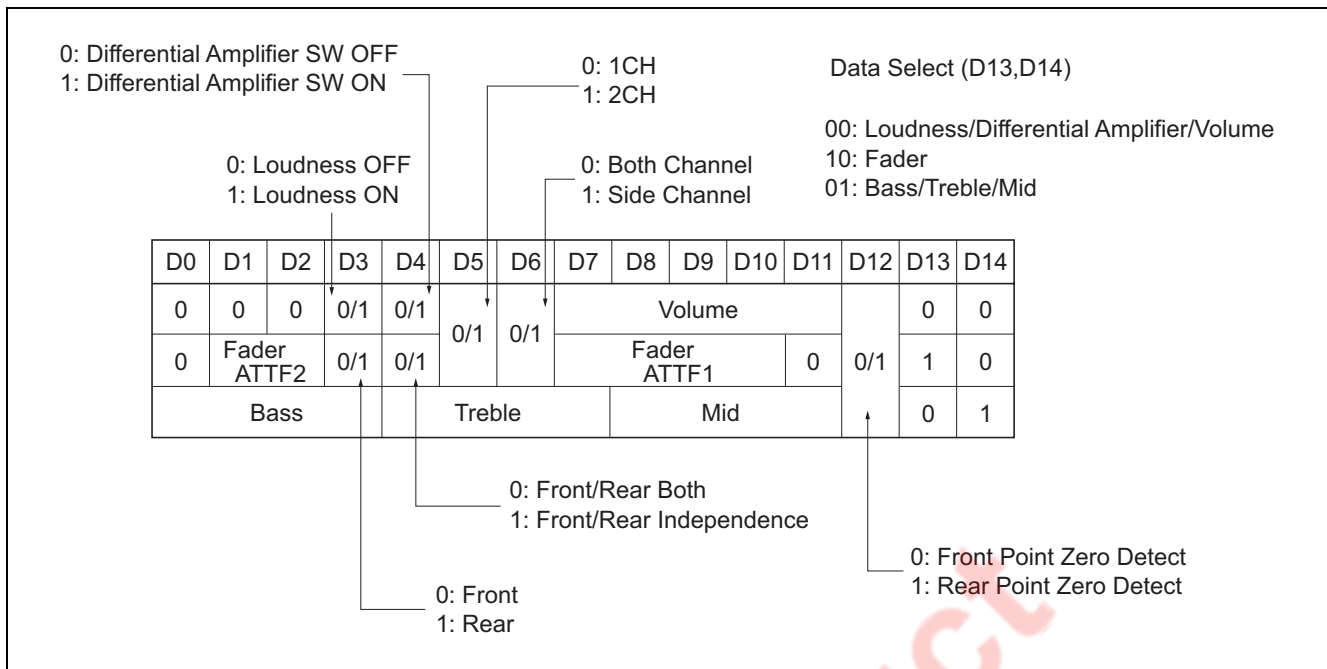
## Digital Circuit AC Characteristics

| Item                          | Symbol    | Limits |     |     | Unit    |
|-------------------------------|-----------|--------|-----|-----|---------|
|                               |           | Min    | Typ | Max |         |
| CLOCK cycle time              | $t_{cr}$  | 4      | —   | —   | $\mu s$ |
| CLOCK pulse width ("H" level) | $t_{WHC}$ | 1.6    | —   | —   |         |
| CLOCK pulse width ("L" level) | $t_{WLC}$ | 1.6    | —   | —   |         |
| CLOCK rise time               | $t_r$     | —      | —   | 0.4 |         |
| CLOCK fall time               | $t_f$     | —      | —   | 0.4 |         |
| DATA setup time               | $t_{SD}$  | 0.8    | —   | —   |         |
| DATA hold time                | $t_{HD}$  | 0.8    | —   | —   |         |

## Clock Data Timing



## Data Input Format



### Volume Code

| ATT V1 | D7 | D8 | D9 |
|--------|----|----|----|
| 0 dB   | 1  | 0  | 1  |
| -4 dB  | 0  | 0  | 1  |
| -8 dB  | 1  | 1  | 0  |
| -12 dB | 0  | 1  | 0  |
| -16 dB | 1  | 0  | 0  |
| -20 dB | 0  | 0  | 0  |
| -24 dB | 0  | 1  | 1  |
| -28 dB | 1  | 1  | 1  |

| ATT V2 | D10 | D11 |
|--------|-----|-----|
| 0 dB   | 1   | 1   |
| -1 dB  | 0   | 1   |
| -2 dB  | 1   | 0   |
| -3 dB  | 0   | 0   |

### Fader Code

| ATT F1 | D7 | D8 | D9 | D10 |
|--------|----|----|----|-----|
| 0 dB   | 1  | 0  | 0  | 1   |
| -8 dB  | 1  | 1  | 1  | 0   |
| -16 dB | 0  | 1  | 1  | 0   |
| -24 dB | 1  | 0  | 1  | 0   |
| -32 dB | 0  | 0  | 1  | 0   |
| -40 dB | 1  | 1  | 0  | 0   |
| -48 dB | 0  | 1  | 0  | 0   |
| -56 dB | 1  | 0  | 0  | 0   |
| -∞ dB  | 0  | 0  | 0  | 0   |

| ATT F2 | D1 | D2 |
|--------|----|----|
| 0 dB   | 1  | 1  |
| -2 dB  | 0  | 1  |
| -4 dB  | 1  | 0  |
| -6 dB  | 0  | 0  |

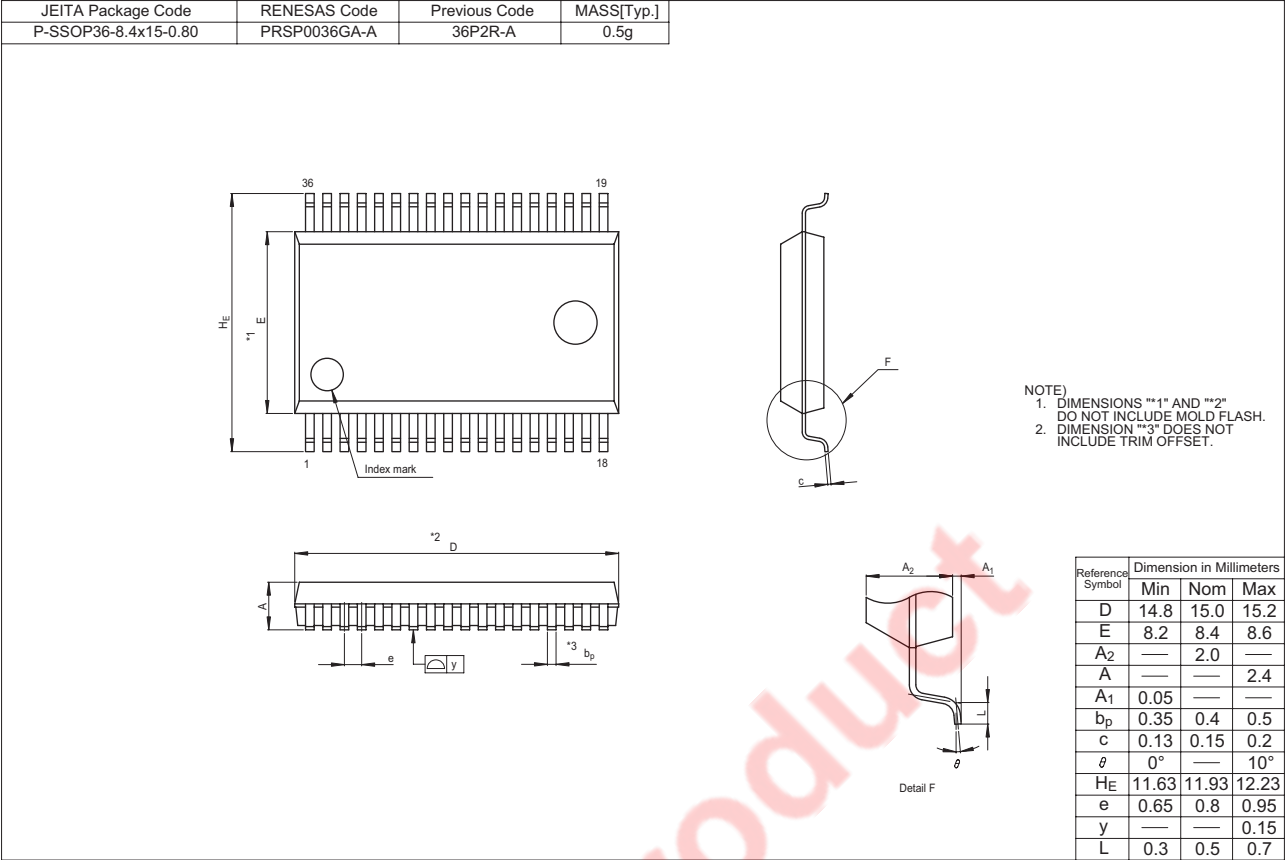
## Tone Code

| Bass   | D0 | D1 | D2 | D3 |
|--------|----|----|----|----|
| 16 dB  | 0  | 0  | 0  | 1  |
| 14 dB  | 1  | 1  | 1  | 0  |
| 12 dB  | 0  | 1  | 1  | 0  |
| 10 dB  | 1  | 0  | 1  | 0  |
| 8 dB   | 0  | 0  | 1  | 0  |
| 6 dB   | 1  | 1  | 0  | 0  |
| 4 dB   | 0  | 1  | 0  | 0  |
| 2 dB   | 1  | 0  | 0  | 0  |
| 0 dB   | 0  | 0  | 0  | 0  |
| -2 dB  | 1  | 0  | 0  | 1  |
| -4 dB  | 0  | 1  | 0  | 1  |
| -6 dB  | 1  | 1  | 0  | 1  |
| -8 dB  | 0  | 0  | 1  | 1  |
| -10 dB | 1  | 0  | 1  | 1  |
| -12 dB | 0  | 1  | 1  | 1  |

| Treble | D4 | D5 | D6 | D7 |
|--------|----|----|----|----|
| 12 dB  | 0  | 1  | 1  | 0  |
| 10 dB  | 1  | 0  | 1  | 0  |
| 8 dB   | 0  | 0  | 1  | 0  |
| 6 dB   | 1  | 1  | 0  | 0  |
| 4 dB   | 0  | 1  | 0  | 0  |
| 2 dB   | 1  | 0  | 0  | 0  |
| 0 dB   | 0  | 0  | 0  | 0  |
| -2 dB  | 1  | 0  | 0  | 1  |
| -4 dB  | 0  | 1  | 0  | 1  |
| -6 dB  | 1  | 1  | 0  | 1  |
| -8 dB  | 0  | 0  | 1  | 1  |
| -10 dB | 1  | 0  | 1  | 1  |
| -12 dB | 0  | 1  | 1  | 1  |

| Mid    | D8 | D9 | D10 | D11 |
|--------|----|----|-----|-----|
| 12 dB  | 0  | 1  | 1   | 0   |
| 10 dB  | 1  | 0  | 1   | 0   |
| 8 dB   | 0  | 0  | 1   | 0   |
| 6 dB   | 1  | 1  | 0   | 0   |
| 4 dB   | 0  | 1  | 0   | 0   |
| 2 dB   | 1  | 0  | 0   | 0   |
| 0 dB   | 0  | 0  | 0   | 0   |
| -2 dB  | 1  | 0  | 0   | 1   |
| -4 dB  | 0  | 1  | 0   | 1   |
| -6 dB  | 1  | 1  | 0   | 1   |
| -8 dB  | 0  | 0  | 1   | 1   |
| -10 dB | 1  | 0  | 1   | 1   |
| -12 dB | 0  | 1  | 1   | 1   |

Package Dimensions



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