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# HA12167FB/HA12169FB

Audio Signal Processor for Cassette Deck (Deck 1 Chip)

## HITACHI

ADE-207-110B (Z)

3rd. Edition

June 1997

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### Description

HA12167FB/HA12169FB is silicon monolithic bipolar IC providing REC volume system, Level meter system and Dolby noise reduction system in one chip.

### Functions

- REC equalizer  $\times 2$  channel
- Equalizer volume  $\times 2$  channel
- Dolby B/C NR  $\times 2$  channel
- REC/PB input electronic volume  $\times 2$  channel
- Level Meter  $\times 2$  channel
- DAC for adjusting bias  $\times 2$  channel

### Features

- Available to create characteristics of REC equalizer by changing external resistor, no coil
- Equalizer volume is available to calibrate recording automatically with micro-controller
- Electronic volume built-in is available to set the level of recording and play back automatically with micro-controller
- 4 types of input (3 out of 4 are by way of electronic volume)
- Input electronic control switching is irrelevant to REC/PB electronic control switching
- Dolby noise reduction system is available with double cassette decks (Unprocessed signal output available from recording out terminals during PB mode)
- Log-compressed level meter output is range from 0 V to 5 V (Usable as music search switchable gain of 0 dB and 20 dB respectively)
- Normal-speed/high-speed, normal/metal/chrome fully electronic control switching built-in
- NR-ON/OFF, Dolby B/C, MPX ON/OFF fully electronic control switching built-in
- Reduction of the number of pins by transfered serial data to electronic volume control switching and another control switching (Controllable from micro-controller directly)
- Small the number of external parts



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## HA12167FB/HA12169FB

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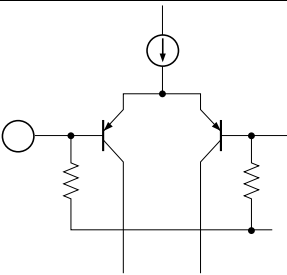
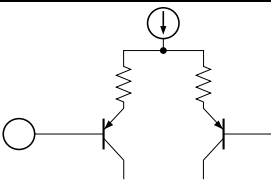
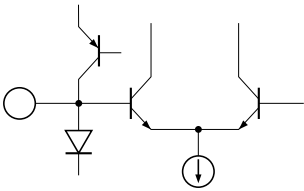
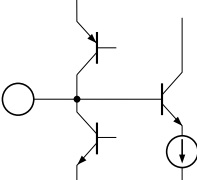
### Ordering Information

| Type      | Package   | PB-OUT Level | REC-OUT Level | Dolby Level | Operating Voltage |        |
|-----------|-----------|--------------|---------------|-------------|-------------------|--------|
|           |           |              |               |             | Min               | Max    |
| HA12167FB | QFP-80    | 775 mVrms    | 300 mVrms     | 300 mVrms   | 12.0 V            | 15.0 V |
| HA12169FB | (14 × 14) | 580 mVrms    |               |             | 11.0 V            | 15.0 V |

\* Dolby is a trademark of Dolby Laboratories Licensing Corporation.  
A license from Dolby Laboratories Licensing Corporation is required for the use of this IC.

## HA12167FB/HA12169FB

**Pin Description** ( $V_{cc} = 14\text{ V}$ ,  $T_a = 25^\circ\text{C}$ , No signal, The value in the show typical value.)

| Pin No.<br>(QFP-80)      | Terminal<br>Name | Zin            | DC Voltage                | Equivalent Circuit                                                                   | Description                        |
|--------------------------|------------------|----------------|---------------------------|--------------------------------------------------------------------------------------|------------------------------------|
| 65                       | RPI              | 100 k $\Omega$ | $V_{cc}/2$                |    | Recording input                    |
| 76                       |                  |                |                           |                                                                                      |                                    |
| 9                        | LM IN            | 100 k $\Omega$ |                           |                                                                                      | Level meter input                  |
| 52                       |                  |                |                           |                                                                                      |                                    |
| 12                       | EQ IN            | 100 k $\Omega$ |                           |                                                                                      | Equalizer input                    |
| 49                       |                  |                |                           |                                                                                      |                                    |
| 66, 67, 69<br>72, 74, 75 | VRI              | 100 k $\Omega$ | $V_{cc}/2 + 0.7\text{ V}$ |                                                                                      | Volume input                       |
| 30, 31                   | VCC              | —              | $V_{cc}$                  | —                                                                                    | Power supply                       |
| 77                       | REF              | —              | $V_{cc}/2$                | —                                                                                    | Ripple filter                      |
| 62                       | NR IN            | —              | $V_{cc}/2$                |  | NR processor input                 |
| 79                       |                  |                |                           |                                                                                      |                                    |
| 3                        | SS 1             | —              | $V_{cc}/2$                |  | Spectral skewing amp input         |
| 58                       |                  |                |                           |                                                                                      |                                    |
| 5                        | CCR              | —              | $V_{cc}/2$                |   | Current controlled resistor output |
| 56                       |                  |                |                           |                                                                                      |                                    |

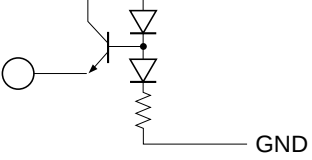
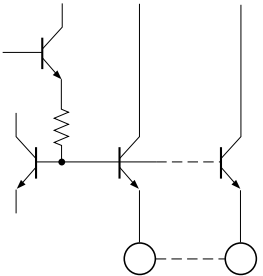
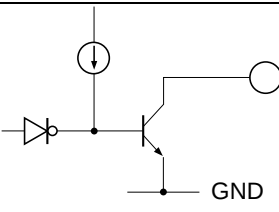
## HA12167FB/HA12169FB

**Pin Description** ( $V_{CC} = 14\text{ V}$ ,  $T_a = 25^\circ\text{C}$ , No signal, The value in the show typical value.)  
(Cont)

| Pin No.<br>(QFP-80) | Terminal<br>Name | Zin                  | DC Voltage     | Equivalent Circuit | Description                        |
|---------------------|------------------|----------------------|----------------|--------------------|------------------------------------|
| 63                  | IA OUT           | —                    | $V_{CC}/2$     |                    | Input amp output                   |
| 78                  |                  |                      |                |                    |                                    |
| 61                  | VREF             |                      |                |                    | Reference voltage                  |
| 80                  |                  |                      |                |                    | buffer output                      |
| 2                   | PB OUT           |                      |                |                    | Play back                          |
| 59                  |                  |                      |                |                    | (Decode) output                    |
| 4                   | SS 2             |                      |                |                    | Spectal skewing                    |
| 57                  |                  |                      |                |                    | amp. output                        |
| 8                   | REC OUT          |                      |                |                    | Recording                          |
| 53                  |                  |                      |                |                    | (Encode) output                    |
| 15                  | EQ OUT           |                      |                |                    | Equalizer output                   |
| 46                  |                  |                      |                |                    |                                    |
| 1                   | TP               | $1.5\text{ k}\Omega$ | $V_{CC}/2$     |                    | Bias trap terminal                 |
| 60                  |                  |                      |                |                    |                                    |
| 6                   | HLS DET          | —                    | $2.3\text{ V}$ |                    | Time constant pin<br>for rectifier |
| 55                  |                  |                      |                |                    |                                    |
| 7                   | LLS DET          |                      |                |                    |                                    |
| 54                  |                  |                      |                |                    |                                    |

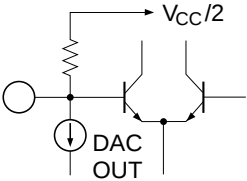
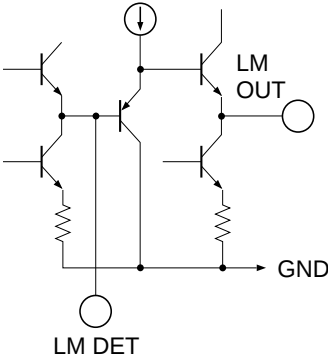
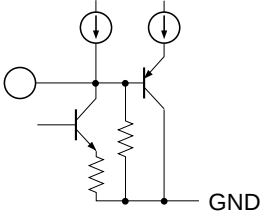
# HA12167FB/HA12169FB

**Pin Description** ( $V_{CC} = 14\text{ V}$ ,  $T_a = 25^\circ\text{C}$ , No signal, The value in the show typical value.)  
(Cont)

| Pin No.<br>(QFP-80) | Terminal<br>Name | Zin | DC Voltage | Equivalent Circuit                                                                   | Description                            |
|---------------------|------------------|-----|------------|--------------------------------------------------------------------------------------|----------------------------------------|
| 64                  | BIAS             | —   | 0.28 V     |    | Dolby NR<br>reference current<br>input |
| 14                  | IREF             | —   | 1.2 V      |    | EQ reference<br>current input          |
| 27                  | MF               |     |            |                                                                                      | EQ parameter<br>current input          |
| 26                  | fQ               |     |            |                                                                                      |                                        |
| 25                  | f/Q              |     |            |                                                                                      |                                        |
| 24                  | GH               |     |            |                                                                                      |                                        |
| 23                  | GL               |     |            |                                                                                      |                                        |
| 22                  | GP               |     |            |                                                                                      |                                        |
| 35                  | BIAS ADJ (N)     | —   | 1.2 V      |                                                                                      | Bias DAC<br>parameter current<br>input |
| 36                  | BIAS ADJ (M)     |     |            |                                                                                      |                                        |
| 37                  | BIAS ADJ (C)     |     |            |                                                                                      |                                        |
| 21                  | HM               | —   | —          |  | EQ parameter<br>selector               |
| 20                  | HC               |     |            |                                                                                      |                                        |
| 19                  | HN               |     |            |                                                                                      |                                        |
| 18                  | NM               |     |            |                                                                                      |                                        |
| 17                  | NC               |     |            |                                                                                      |                                        |
| 16                  | NN               |     |            |                                                                                      |                                        |

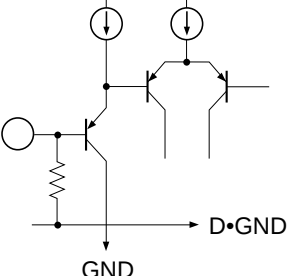
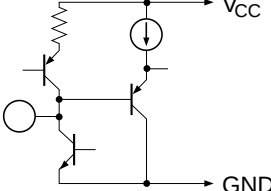
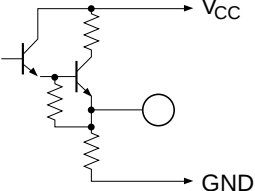
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**Pin Description** ( $V_{CC} = 14\text{ V}$ ,  $T_a = 25^\circ\text{C}$ , No signal, The value in the show typical value.)  
(Cont)

| Pin No.<br>(QFP-80) | Terminal<br>Name | Zin             | DC Voltage                                 | Equivalent Circuit                                                                   | Description                           |
|---------------------|------------------|-----------------|--------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------|
| 68                  | CONT             | 3.3 k $\Omega$  | $V_{CC}/2 - 1.5\text{ V}$<br>to $V_{CC}/2$ |    | DAC output<br>volume control<br>input |
| 73                  |                  |                 |                                            |                                                                                      |                                       |
| 13                  | EQ CONT          | 1.65 k $\Omega$ |                                            |                                                                                      |                                       |
| 48                  |                  |                 |                                            |                                                                                      |                                       |
| 10                  | LM DET           | —               | 0.2 V                                      |   | Time constant pin<br>for level meter  |
| 51                  |                  |                 |                                            |                                                                                      |                                       |
| 11                  | LM OUT           | —               | 0.2 V                                      |                                                                                      | Level meter output                    |
| 50                  |                  |                 |                                            |                                                                                      |                                       |
| 45                  | NR ON/OFF        | 100 k $\Omega$  | —                                          |  | Mode control time<br>constant         |
| 44                  | C/B              |                 |                                            |                                                                                      |                                       |
| 43                  | MPX              |                 |                                            |                                                                                      |                                       |

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**Pin Description** ( $V_{CC} = 14\text{ V}$ ,  $T_a = 25^\circ\text{C}$ , No signal, The value in the show typical value.)  
(Cont)

| Pin No.<br>(QFP-80) | Terminal<br>Name | Zin            | DC Voltage | Equivalent Circuit                                                                   | Description                    |
|---------------------|------------------|----------------|------------|--------------------------------------------------------------------------------------|--------------------------------|
| 42                  | RESET            | 100 k $\Omega$ | —          |    | Mode control input             |
| 41                  | STB              |                |            |                                                                                      |                                |
| 40                  | DATA             |                |            |                                                                                      |                                |
| 39                  | CLK              |                |            |                                                                                      |                                |
| 38                  | INJ              | —              | 0.7 V      | —                                                                                    | Injection current input $I^2L$ |
| 47                  | D-GND            | —              | 0.0 V      | —                                                                                    | Digital (Logic) ground         |
| 70                  | GND              | —              | 0.0 V      | —                                                                                    | Ground                         |
| 71, 34              |                  |                |            |                                                                                      |                                |
| 28                  | BIAS CONT        | —              | —          |  | Bias DAC output                |
| 33                  |                  |                |            |                                                                                      |                                |
| 29                  | DAC OUT          | —              | —          |  | Bias DAC buffer out            |
| 32                  |                  |                |            |                                                                                      |                                |

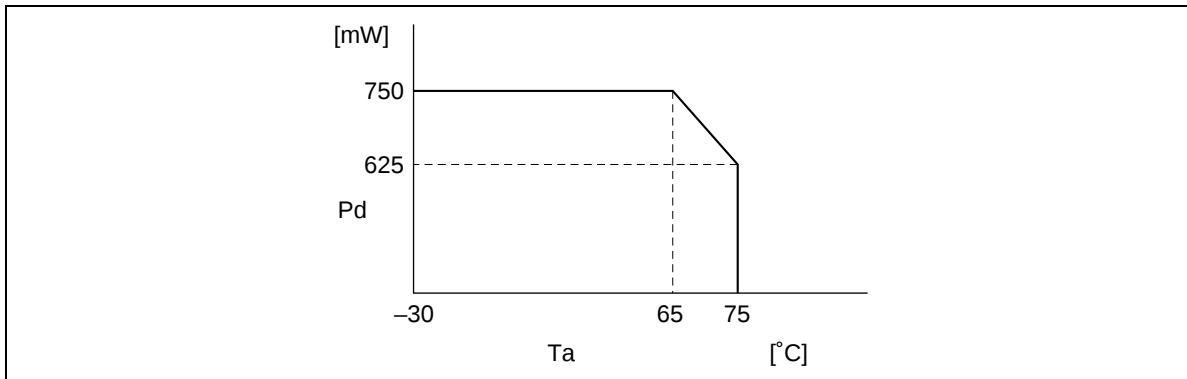


**Absolute Maximum Ratings**

| Item                  | Symbol       | Rating      | Unit | Note |
|-----------------------|--------------|-------------|------|------|
| Supply voltage        | $V_{cc}$ max | 15          | V    |      |
| Power dissipation     | $P_d$        | 750         | mW   | 1    |
| Operating temperature | $T_{opr}$    | -30 to +75  | °C   |      |
| Storage temperature   | $T_{stg}$    | -55 to +125 | °C   |      |

Note: For  $T_a$  is higher than 65°C, reduce  $P_d$  at the rate of 12.5 mW/°C.

Please, see the below graph.



# HA12167FB/HA12169FB

Electrical Characteristics (Ta = 25°C, V<sub>CC</sub> = 14 V, Dolby Level 300 mVrms at RECOU)

| Test Conditions       |                      |      |      |       |       |     |     |    |     |     |                      |                |     |           |       |            |          |          |           |       |                                     |        |        |          |    |   |
|-----------------------|----------------------|------|------|-------|-------|-----|-----|----|-----|-----|----------------------|----------------|-----|-----------|-------|------------|----------|----------|-----------|-------|-------------------------------------|--------|--------|----------|----|---|
| Item                  | Specification        |      |      |       |       |     |     |    |     |     | Application Terminal |                |     |           |       |            |          |          |           |       |                                     |        |        |          |    |   |
|                       | Symbol               | Min  | Typ  | Max   | Unit  | REC |     | RV | IPB | IPV | MPX                  | NR             | B/C | Input Pin | Meter | Tape Speed | Input EQ | Bias DAC | REC OUT   | Input |                                     |        | Output | Note     |    |   |
|                       |                      |      |      |       |       | REC | RV  |    |     |     |                      |                |     |           |       |            |          |          |           | R     | L                                   | R      |        |          | L  |   |
| Quiescent current     | I <sub>Q</sub>       | —    | 34.5 | 42.0  | mA    | PB  | PV  | PV | OFF | OFF | B                    | VR11           | NOR | NOR       | 32    | 0          | 0        | —        | No signal | —     | —                                   | —      | —      | 30<br>31 |    |   |
|                       | G <sub>V/A</sub> RPI | 18.5 | 20.0 | 21.5  | dB    | REC | RV  | ON | OFF | B   | RPI                  | NOR            | NOR | NOR       | 63    | 0          | 0        | 1 k      | 0         | 76    | 65                                  | 78     | 63     |          |    |   |
| B-type encode boost   | B-ENC -2 k           | 2.8  | 4.3  | 5.8   | dB    | REC | RV  | ON | OFF | B   | → ON                 | RPI            | NOR | NOR       | NOR   | 63         | 0        | 0        | 2 k       | —20   | 76                                  | 65     | 8      | 53       |    |   |
|                       | B-ENC -5 k           | 1.7  | 3.2  | 4.7   |       | REC | RV  | ON | OFF | B   | → ON                 | RPI            | NOR | NOR       | NOR   | 63         | 0        | 0        | 5 k       | —20   | 76                                  | 65     | 8      | 53       |    |   |
| C-type encode boost   | C-ENC -1 k (1)       | 3.9  | 5.9  | 7.9   | dB    | REC | RV  | ON | OFF | C   | → ON                 | RPI            | NOR | NOR       | NOR   | 63         | 0        | 0        | 1 k       | —20   | 76                                  | 65     | 8      | 53       |    |   |
|                       | C-ENC -1 k (2)       | 18.1 | 19.6 | 21.6  |       | REC | RV  | ON | OFF | C   | → ON                 | RPI            | NOR | NOR       | NOR   | 63         | 0        | 0        | 1 k       | —60   | 76                                  | 65     | 8      | 53       |    |   |
|                       | C-ENC -700           | 9.8  | 11.8 | 13.8  |       | REC | RV  | ON | OFF | C   | → ON                 | RPI            | NOR | NOR       | NOR   | 63         | 0        | 0        | 700       | —30   | 76                                  | 65     | 8      | 53       |    |   |
| Signal handling       | V <sub>0</sub> Max   | 12.0 | 13.0 | —     | dB    | REC | RV  | ON | ON  | C   | ON                   | C              | RPI | NOR       | NOR   | NOR        | 63       | 0        | 0         | 1 k   | —                                   | 76     | 65     | 8        | 53 | 1 |
| Signal to noise ratio | S/N (C)              | 60.0 | 63.0 | —     | dB    | REC | RV  | ON | ON  | C   | ON                   | C              | RPI | NOR       | NOR   | NOR        | 63       | 0        | 0         | —     | R <sub>g</sub> = 5.1 kΩ<br>CCIR/ARM | 76     | 65     | 8        | 53 |   |
| T.H.D.                | THD (C)              | —    | 0.08 | 0.3   | %     | REC | RV  | ON | ON  | C   | ON                   | C              | RPI | NOR       | NOR   | NOR        | 63       | 0        | 0         | 1 k   | 0                                   | 76     | 65     | 8        | 53 |   |
| Crosstalk             | CT (R→L)             | —    | —    | —85.0 | —79.0 | dB  | REC | RV | ON  | OFF | B                    | VPI1           | NOR | NOR       | NOR   | 0          | 0        | 0        | 1 k       | 6     | 72                                  | 69     | 8      | 53       |    |   |
|                       | CT (VR11 ↔ VR12)     | —    | —    | —80.0 | —74.0 |     | REC | RV | ON  | OFF | B                    | VR11 ↔<br>VR12 | NOR | NOR       | NOR   | 0          | 0        | 0        | 1 k       | 6     | 72/ 74                              | 69/ 67 | 2      | 59       |    |   |
|                       | CT (VR11 ↔ RPI)      | —    | —    | —80.0 | —74.0 |     | REC | RV | ON  | OFF | B                    | VR11 ↔<br>RPI  | NOR | NOR       | NOR   | 0/63       | 0        | 0        | 1 k       | 6     | 72/ 76                              | 69/ 65 | 2      | 59       |    |   |

**Electrical Characteristics** (Ta = 25°C, V<sub>CC</sub> = 14 V, Dolby Level 300 mVrms at RECOU) (Cont)

| Test Conditions                           |                     |       |       |      |       |            |           |     |     |      |              |       |       |      |                 |                 |                   | Application Terminal |                                                             |    |    |    |    |    |
|-------------------------------------------|---------------------|-------|-------|------|-------|------------|-----------|-----|-----|------|--------------|-------|-------|------|-----------------|-----------------|-------------------|----------------------|-------------------------------------------------------------|----|----|----|----|----|
| Item                                      | Specification       |       |       |      |       | REC<br>/PB | RV<br>/PV | MPX | NR  | B/C  | Input<br>Pin | Meter | Speed | Tape | Input EQ<br>DAC | Bias fin<br>DAC | REC<br>OUT        | Level                |                                                             |    |    |    |    |    |
|                                           | Symbol              | Min   | Typ   | Max  | Unit  |            |           |     |     |      |              |       |       |      |                 |                 |                   | REC<br>fin           | REC<br>OUT                                                  | R  | L  | R  | L  | R  |
| Serial digital<br>input level             | V <sub>SH</sub>     | 4.0   | —     | 5.3  | V     | —          | —         | —   | —   | —    | —            | —     | —     | —    | —               | —               | CLK, DATA,<br>STB | —                    | —                                                           | —  | —  | —  | 39 |    |
|                                           | V <sub>SL</sub>     | -0.2  | —     | 1.0  | —     | —          | —         | —   | —   | —    | —            | —     | —     | —    | —               | —               | —                 | —                    | —                                                           | —  | —  | —  | 40 |    |
| PB-<br>output<br>level                    | V <sub>out</sub>    | 500   | 580   | 670  | mVrms | REC        | RV        | ON  | OFF | B    | RPI          | NOR   | NOR   | NOR  | 63              | 0               | 0                 | HA12169<br>1 k       | 76                                                          | 65 | 2  | 59 | —  | 59 |
|                                           |                     | 665   | 775   | 900  | —     | —          | —         | —   | —   | —    | —            | —     | —     | —    | —               | —               | —                 | HA12167<br>Low       | —                                                           | —  | —  | —  | —  | —  |
| PB-out of fset                            | V <sub>ofs</sub>    | -100  | 0.0   | +100 | mV    | PB         | PV        | OFF | OFF | C    | RPI          | NOR   | NOR   | NOR  | 63              | 0               | 0                 | —                    | No signal                                                   | —  | —  | 2  | 59 | 2  |
| → ON                                      |                     |       |       |      |       |            |           |     |     |      |              |       |       |      |                 |                 |                   |                      |                                                             |    |    |    |    |    |
| Channel balance                           | ΔG <sub>v</sub>     | -1.0  | 0.0   | 1.0  | dB    | —          | —         | —   | —   | —    | —            | —     | —     | —    | —               | —               | —                 | —                    | 76                                                          | 65 | 78 | 63 | —  | 63 |
| REC volume<br>gain                        | G <sub>rec</sub> VR | 17.5  | 19.1  | 21.5 | dB    | REC        | RV        | ON  | OFF | B    | VR11         | NOR   | NOR   | NOR  | 0               | 0               | 0                 | 1 k                  | V <sub>n</sub> = 100 mVrms                                  | 72 | 69 | 78 | 63 | —  |
| (Max)                                     |                     |       |       |      |       |            |           |     |     |      |              |       |       |      |                 |                 |                   |                      |                                                             |    |    |    |    |    |
| G <sub>rec</sub> VR                       | -56.0               | -50.0 | -47.0 | dB   | REC   | RV         | ON        | OFF | B   | VR11 | NOR          | NOR   | NOR   | 62   | 0               | 0               | 0                 | 1 k                  | V <sub>n</sub> = 2 Vrms                                     | 72 | 69 | 78 | 63 | —  |
| (Min)                                     |                     |       |       |      |       |            |           |     |     |      |              |       |       |      |                 |                 |                   |                      |                                                             |    |    |    |    |    |
| PB volume gain                            | G <sub>VR</sub> VR  | 27.0  | 29.0  | 31.0 | dB    | PB         | PV        | ON  | OFF | B    | VR11         | NOR   | NOR   | NOR  | 0               | 0               | 0                 | 1 k                  | V <sub>n</sub> = 100 mVrms                                  | 72 | 69 | 78 | 63 | —  |
| (Max)                                     |                     |       |       |      |       |            |           |     |     |      |              |       |       |      |                 |                 |                   |                      |                                                             |    |    |    |    |    |
| G <sub>VR</sub> VR                        | 15.0                | 17.0  | 19.0  | dB   | PB    | PV         | ON        | OFF | B   | VR11 | NOR          | NOR   | NOR   | 62   | 0               | 0               | 0                 | 1 k                  | V <sub>n</sub> = 100 mVrms                                  | 72 | 69 | 78 | 63 | —  |
| (Min)                                     |                     |       |       |      |       |            |           |     |     |      |              |       |       |      |                 |                 |                   |                      |                                                             |    |    |    |    |    |
| REC volume<br>mute level                  | C <sub>rec</sub> VR | —     | -82   | -75  | dB    | REC        | RV        | ON  | OFF | B    | VR11         | NOR   | NOR   | NOR  | 63              | 0               | 0                 | 1 k                  | V <sub>n</sub> = 2 Vrms                                     | 72 | 69 | 2  | 59 | —  |
| (MUT)                                     |                     |       |       |      |       |            |           |     |     |      |              |       |       |      |                 |                 |                   |                      |                                                             |    |    |    |    |    |
| REC volume max<br>input level             | V <sub>n</sub> max  | 11.0  | 12.0  | —    | dB    | REC        | RV        | ON  | OFF | B    | VR11         | NOR   | NOR   | NOR  | 42              | 0               | 0                 | 1 k                  | THD = 1%                                                    | 72 | 69 | 2  | 59 | —  |
| (VR)                                      |                     |       |       |      |       |            |           |     |     |      |              |       |       |      |                 |                 |                   |                      |                                                             |    |    |    |    |    |
| Signal to noise<br>ratio of REC<br>volume | S/N (VR)            | 78.0  | 84.0  | —    | dB    | REC        | RV        | ON  | OFF | B    | VR11         | NOR   | NOR   | NOR  | —               | 0               | 0                 | (1 k)                | V <sub>n</sub> = 100 mVrms<br>R <sub>g</sub> = 5.1 k, A-WTG | 72 | 69 | 2  | 59 | 3  |
| 3                                         |                     |       |       |      |       |            |           |     |     |      |              |       |       |      |                 |                 |                   |                      |                                                             |    |    |    |    |    |
| T.H.D. of REC<br>volume                   | THD (VR)            | —     | 0.04  | 0.3  | %     | REC        | RV        | ON  | OFF | B    | VR11         | NOR   | NOR   | NOR  | —               | 0               | 0                 | 1 k                  | V <sub>n</sub> = 100 mVrms                                  | 72 | 69 | 2  | 59 | 3  |

# HA12167FB/HA12169FB

Electrical Characteristics (Ta = 25°C, V<sub>CC</sub> = 14 V, Dolby Level 300 mVrms at RECOU) (Cont)

| Test Conditions                         |                          |       |      |      |      |     |    |     |     |     |           |       |       |      |              |              |               |                                            |    | Application Terminal |    |      |   |  |  |
|-----------------------------------------|--------------------------|-------|------|------|------|-----|----|-----|-----|-----|-----------|-------|-------|------|--------------|--------------|---------------|--------------------------------------------|----|----------------------|----|------|---|--|--|
| Item                                    | Specification            |       |      |      |      | REC |    |     |     |     |           |       |       |      |              | Input        |               |                                            |    | Output               |    | Note |   |  |  |
|                                         | Symbol                   | Min   | Typ  | Max  | Unit | REC | RV | MPX | NR  | B/C | Input Pin | Meter | Speed | Tape | Input EQ DAC | Bias fin DAC | REC OUT Level | R                                          | L  | R                    | L  |      |   |  |  |
| Equalizer gain                          | G <sub>VEQ</sub> (500)   | 23.5  | 25.5 | 27.5 | dB   | REC | RV | ON  | OFF | B   | RPI       | NOR   | NOR   | NOR  | 63           | 0            | 0             | 500 — V <sub>n</sub> = -32 dBs             | 12 | 49                   | 15 | 46   |   |  |  |
|                                         | G <sub>VEQ</sub> (1 k)   | 23.5  | 25.5 | 27.5 |      | REC | RV | ON  | OFF | B   | RPI       | NOR   | NOR   | NOR  | 63           | 0            | 0             | 1 k — V <sub>n</sub> = -32 dBs             | 12 | 49                   | 15 | 46   |   |  |  |
|                                         | G <sub>VEQ</sub> (5 k)   | 25.0  | 27.0 | 29.0 |      | REC | RV | ON  | OFF | B   | RPI       | NOR   | NOR   | NOR  | 63           | 0            | 0             | 5 k — V <sub>n</sub> = -32 dBs             | 12 | 49                   | 15 | 46   |   |  |  |
|                                         | G <sub>VEQ</sub> (12 k)  | 31.0  | 33.5 | 36.0 |      | REC | RV | ON  | OFF | B   | RPI       | NOR   | NOR   | NOR  | 63           | 0            | 0             | 12 k — V <sub>n</sub> = -32 dBs            | 12 | 49                   | 15 | 46   |   |  |  |
| Equalizer volume variable a range (1 k) | ΔG <sub>VEQ</sub>        | 6     | 8    | 10   | dB   | REC | RV | ON  | OFF | B   | RPI       | NOR   | NOR   | NOR  | 63           | 0/30         | 0             | 1 k — V <sub>n</sub> = -32 dBs             | 12 | 49                   | 15 | 46   |   |  |  |
|                                         | V <sub>n</sub> Max (EQ)  | -10.0 | -9.0 | —    | dBs  | REC | RV | ON  | OFF | B   | RPI       | NOR   | NOR   | NOR  | 63           | 16           | 0             | 1 k — THD = 1%                             | 12 | 49                   | 15 | 46   |   |  |  |
| Equalizer volume mute gain              | G <sub>VEQ</sub> (MUT)   | —     | -75  | -62  | dB   | REC | RV | ON  | OFF | B   | RPI       | NOR   | NOR   | NOR  | 63           | 31           | 0             | 1 k — V <sub>n</sub> = -9 dBs<br>1 kHz BPF | 12 | 49                   | 15 | 46   |   |  |  |
| Signal to noise ratio of equalizer      | S/N (EQ)                 | 57.0  | 62.0 | —    | dB   | REC | RV | ON  | OFF | B   | RPI       | NOR   | NOR   | NOR  | 63           | 0            | 0             | — R <sub>g</sub> = 5.1 kΩ,<br>A-WTG        | 12 | 49                   | 15 | 46   |   |  |  |
| THD of equalizer                        | THD (EQ)                 | —     | 0.2  | 0.5  | %    | REC | RV | ON  | OFF | B   | RPI       | NOR   | NOR   | NOR  | 63           | 16           | 0             | 1 k — V <sub>n</sub> = -26 dBs             | 12 | 49                   | 15 | 46   |   |  |  |
| Equalizer of fset                       | V <sub>ofs</sub> (EQ)    | -400  | 0.0  | +400 | mV   | REC | RV | OFF | OFF | B   | RPI       | NOR   | NOR   | NOR  | 63           | 0            | 0             | — No signal                                | —  | —                    | 15 | 46   | 4 |  |  |
| Level meter output                      | LM (0 dB)                | 2.50  | 2.75 | 3.00 | V    | REC | RV | ON  | OFF | B   | RPI       | NOR   | NOR   | NOR  | 63           | 0            | 0             | 1 k 0                                      | 9  | 52                   | 11 | 50   |   |  |  |
|                                         | LM (12 dB)               | 3.55  | 3.85 | 4.15 | V    | REC | RV | ON  | OFF | B   | RPI       | NOR   | NOR   | NOR  | 63           | 0            | 0             | 1 k 12                                     | 9  | 52                   | 11 | 50   |   |  |  |
|                                         | LM (-20 dB) <sup>1</sup> | 0.70  | 1.00 | 1.30 | V    | REC | RV | ON  | OFF | B   | RPI       | NOR   | NOR   | NOR  | 63           | 0            | 0             | 1 k -20                                    | 9  | 52                   | 11 | 50   |   |  |  |
|                                         | LM (-20 dB) <sup>2</sup> | 2.45  | 2.75 | 3.05 | V    | REC | RV | ON  | OFF | B   | RPI       | 20 dB | NOR   | NOR  | 63           | 0            | 0             | 1 k -20                                    | 9  | 52                   | 11 | 50   |   |  |  |

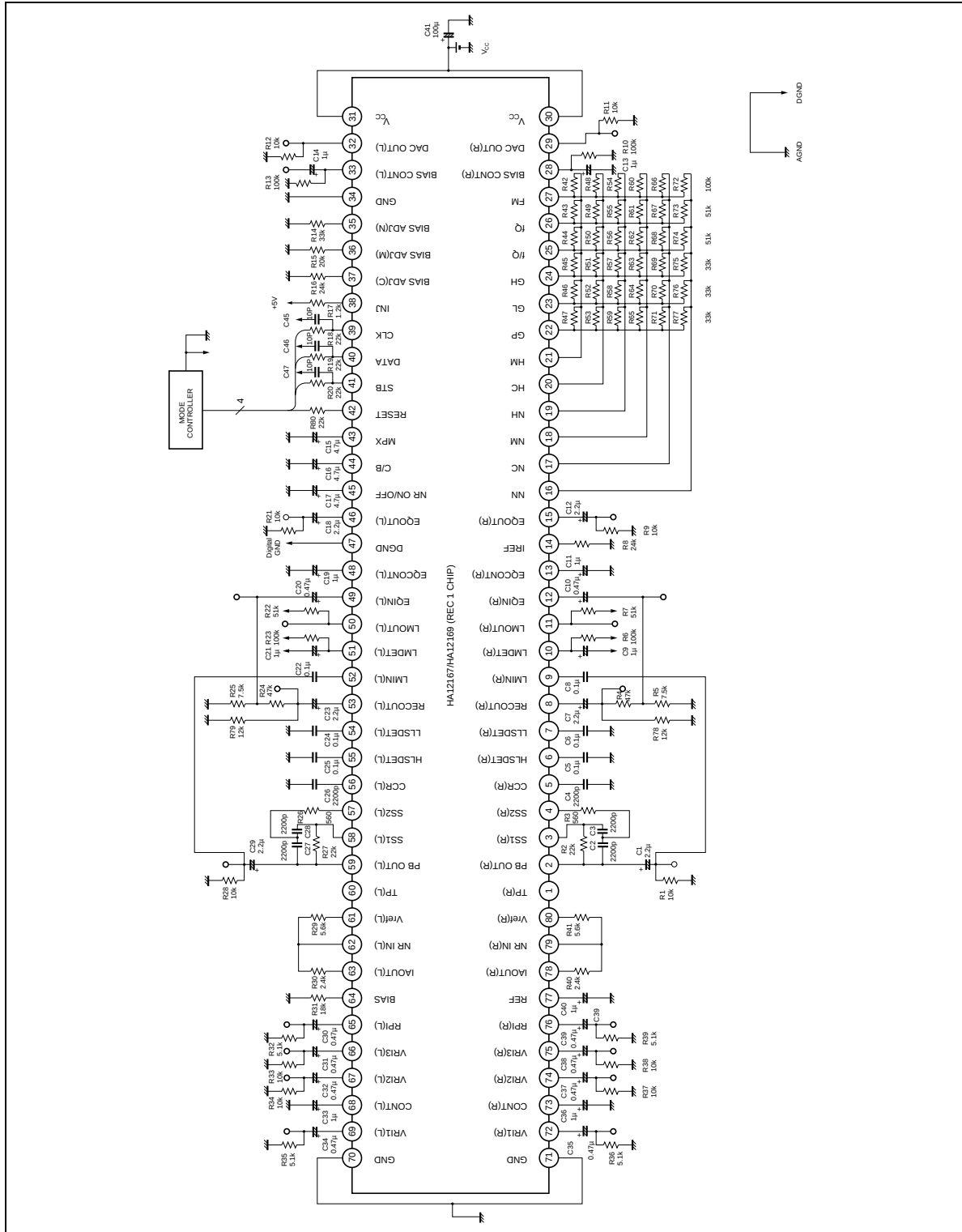
**Electrical Characteristics** ( $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 14\text{ V}$ , Dolby Level 300 mVrms at RECOU) (Cont)

| Item                | Test Conditions    |      |      |      |      |     |     |     |     |     |       |       |          |      |     | Application Terminal                                                               |                                                                          |                                                                    |           |        |   |      |    |
|---------------------|--------------------|------|------|------|------|-----|-----|-----|-----|-----|-------|-------|----------|------|-----|------------------------------------------------------------------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------|-----------|--------|---|------|----|
|                     | Specification      |      |      |      |      | REC | RV  | MPX | NR  | B/C | Input | Tape  | Input EQ | Bias | REC | Input                                                                              |                                                                          |                                                                    |           | Output |   | Note |    |
|                     | Symbol             | Min  | Typ  | Max  | Unit | /PB | /PV |     |     |     | Pin   | Meter | Speed    | DAC  | DAC | OUT                                                                                | R                                                                        | L                                                                  | R         | L      |   |      |    |
|                     | LMofs 1            | —    | 150  | 300  | mV   | REC | RV  | ON  | OFF | B   | RPI   | NOR   | NOR      | NOR  | 63  | 0                                                                                  | 0                                                                        | —                                                                  | —         | —      | — |      | 11 |
| Level meter of fset | LMofs 2            | —    | 200  | 350  |      | REC | RV  | ON  | OFF | B   | RPI   | 20 dB | NOR      | NOR  | 63  | 0 <td>0<td>—<th>No signal</th><th>—</th><th>—</th><th>11</th><th>50</th></td></td> | 0 <td>—<th>No signal</th><th>—</th><th>—</th><th>11</th><th>50</th></td> | — <th>No signal</th> <th>—</th> <th>—</th> <th>11</th> <th>50</th> | No signal | —      | — | 11   | 50 |
| DAC output Max      | V <sub>B</sub> Max | 11.0 | 12.0 | 13.0 | V    | REC | RV  | OFF | OFF | B   | VRI1  | NOR   | NOR      | MET  | 63  | 0                                                                                  | 63                                                                       | —                                                                  | No signal | —      | — | 29   | 32 |
| DAC output Min      | V <sub>B</sub> Min | —    | 0.5  | 1.0  | V    | REC | RV  | OFF | OFF | B   | VRI1  | NOR   | NOR      | MET  | 63  | 0                                                                                  | 0                                                                        | —                                                                  | —         | —      | — | 29   | 32 |

Note: 1. HA12167:  $V_{CC} = 12\text{ V}$   
 HA12169:  $V_{CC} = 11\text{ V}$   
 2.  $V_{CC} = 15\text{ V}$   
 3. Adjust the input volume to Dolby level.  
 4.  $V_{CC} = 15\text{ V}$

# HA12167FB/HA12169FB

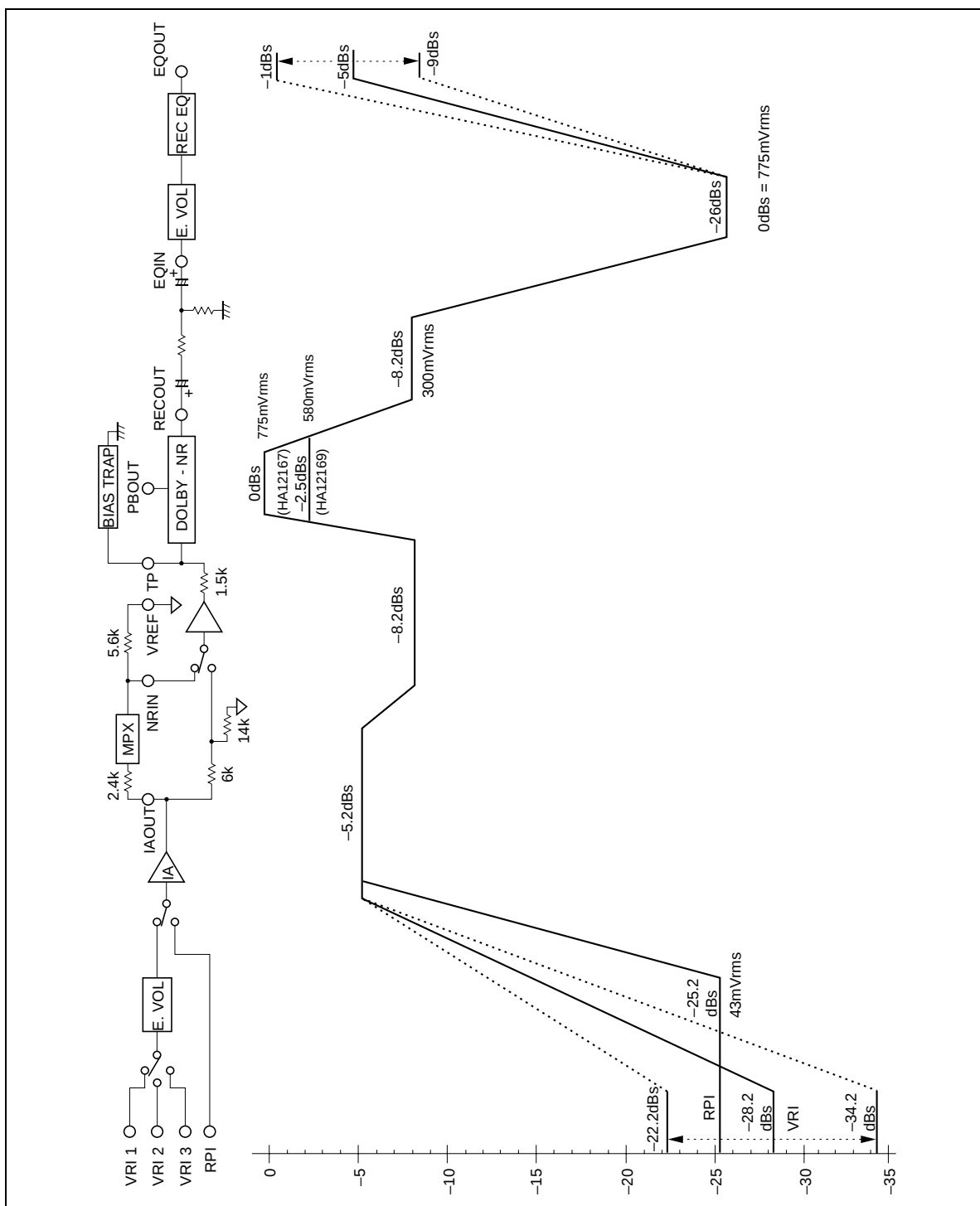
## Test Circuit







## PB Mode (1 kHz NR-OFF)



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## HA12167FB/HA12169FB

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### Application Note

#### Power Supply Range

HA12167FB/HA12169FB are designed to operate on either single supply or split supply.

The operating range of the supply voltage is shown in table 1.

**Table 1**      **Supply Voltage**

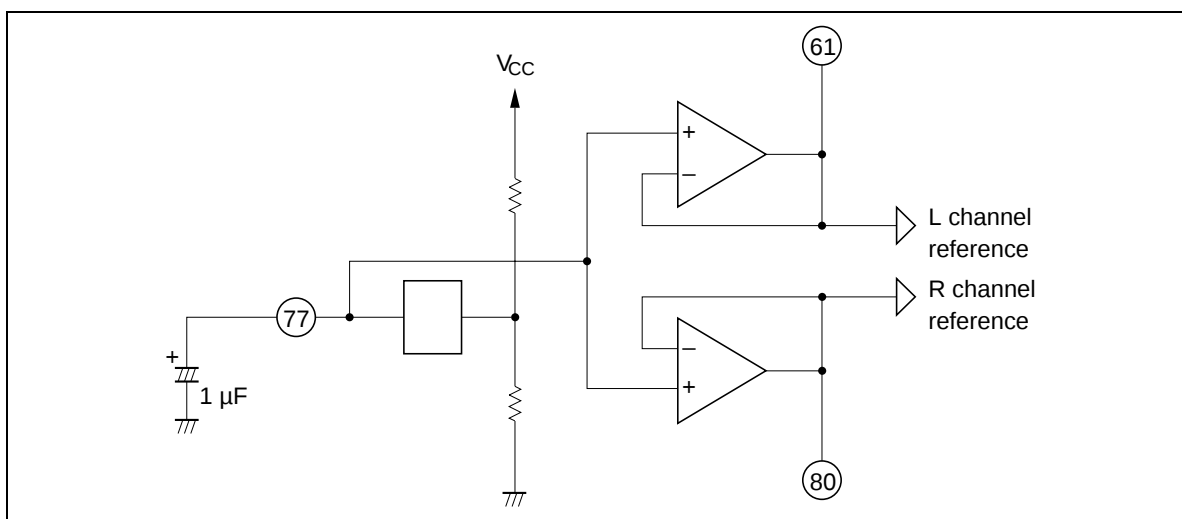
| Type No.  | Single Supply | Split Supply         |
|-----------|---------------|----------------------|
| HA12167FB | 12 V to 15 V  | $\pm 6.0$ V to 7.5 V |
| HA12169FB | 11 V to 15 V  | $\pm 6.0$ V to 7.5 V |

The lower limit of supply voltage depends on the line output reference level.

The minimum value of the overload margin is specified as 12 dB by Dolby Laboratories. HA12167 series are provided with two line output level, which will permit an optimum overload margin for power supply conditions.

#### Reference Voltage

For the single supply operation these devices provide the reference voltage of half the supply voltage that is the signal grounds. As the peculiarity of these devices, the capacitor for the ripple filter is very small about 1/100 compared with their usual value. The Reference voltage are provided for the left channel and the right channel separately. The block diagram is shown as figure 1.



**Figure 1**    **The Block Diagram of Reference Voltage Supply**

## Operating Mode Control

HA12167FB/HA12169FB provides fully electronic switching circuits. All switches are controlled by serial data.

**Table 2 Threshold Voltage (VTH)**

| Pin No.    | Lo          | Hi         | Unit |
|------------|-------------|------------|------|
| 42         | -0.2 to 1.5 | 3.5 to 5.3 | V    |
| 39, 40, 41 | -0.2 to 1.0 | 4.0 to 5.3 | V    |

Notes: 1. Voltages shown above are determined by internal circuits of LSI when take pin 47 (DGND pin) as reference pin. On split supply use, same VTH can be offered by connecting DGND pin to GND pin.

This means that it can be controlled directly by micro processor.

2. Each pins are on pulled down with 100 k $\Omega$  internal resistor.

Therefore, it will be low-level when each pins are open.

3. Note on serial data inputting

(a) The clock frequency on CLK must be less than 500 kHz.

(b) Over shoot level and under shoot level of input signal must be the value shown below.

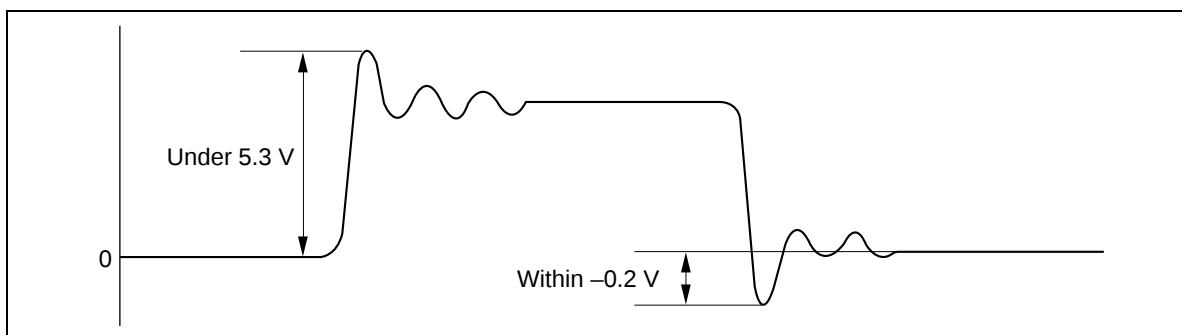
When connecting microcomputer or Logic-IC with HA12167FB/HA12169FB directly, there is apprehension of rash-current under some transition timing of raising voltage or falling voltage at  $V_{CC}$  ON/OFF.

For this countermeasure, connect 10 k $\Omega$  to 20 k $\Omega$  resistor with each pins. It is shown in test circuit on this data sheet.

In case of changing NR-ON/OFF at the C-mode, for the countermeasure of the noise of pop, perform the following processes.

In case of changing NR-OFF to NR-ON at C-mode. C-mode, NR-OFF  $\rightarrow$  B-mode, NR-OFF  $\rightarrow$  B-mode, NR-ON  $\rightarrow$  C-mode, NR-ON.

In case of changing NR-ON to NR-OFF at C-mode. C-mode, NR-ON  $\rightarrow$  B-mode, NR-ON  $\rightarrow$  B-mode, NR-OFF  $\rightarrow$  C-mode, NR-OFF.



**Figure 2 Input Level**

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## HA12167FB/HA12169FB

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### Serial Data Formatting

14 bit shift register is employed.

CLK and data are stored during STB being high and data is latched when STB goes high to low.

Reset goes reset a state when reset low and high releases reset. (High fixed at use time)

### Attention Point of Serial Interface

- Reset goes low condition when a power supply is ON or OFF.
- Characteristics select of Bias DAC is connected with equalizer tape selector.
- Bias DAC register is all low when a time of tape select.
- Bias DAC register is all low and Bias DAC out is dropped low level at compulsion by force.
- Input pin select, REC/PB select and Input volume gain select does not select at the same time.
- Input volume must go mute condition when selected of RPI is input pin select.

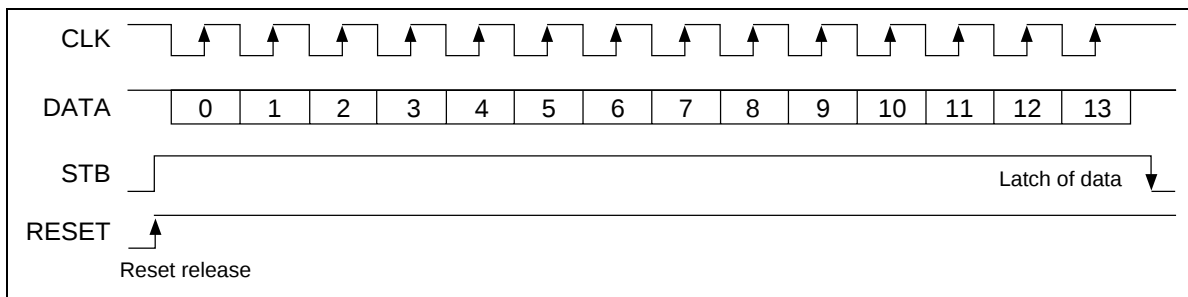


Figure 3 Serial Data Timming Chart Figure

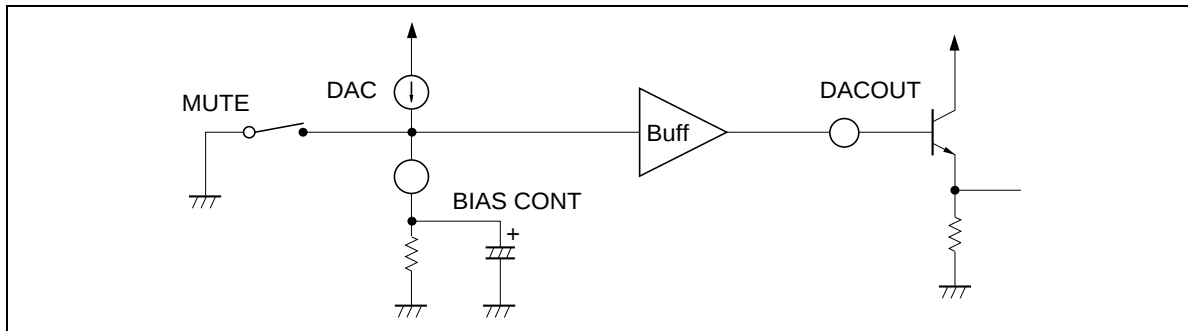


Figure 4 Bias DAC Output Circuit

**Serial Data Formatting**

| Bit | Mode Control        |                                                                                |   | Input Voltage |           | Eaqualizer Voltage |           | Basic DAC |           |
|-----|---------------------|--------------------------------------------------------------------------------|---|---------------|-----------|--------------------|-----------|-----------|-----------|
| No. |                     |                                                                                |   | Reset         |           | Reset              |           | Reset     | Reset     |
| 0   | Tape selector 1     | bit 0<br>H L<br>H Metal Normal<br>L Crom Normal                                | L | L channel     | I-bit 0 L | L channel          | E-bit 0 L | L channel | B-bit 0 L |
| 1   | Tape selector 2     |                                                                                | L |               | I-bit 1 L |                    | E-bit 1 L |           | B-bit 1 L |
| 2   | Tape speed          | H Hi speed selection<br>L Normal speed selection                               | L |               | I-bit 2 L |                    | E-bit 2 L |           | B-bit 2 L |
| 3   | Meter sensitivity   | H Meter sensitivity 20 dB up<br>L Meter sensitivity normal                     | L |               | I-bit 3 L |                    | E-bit 3 L |           | B-bit 3 L |
| 4   | Input selector 1    | bit 4<br>H L<br>H VRI3 RPI<br>L VRI2 VRI1                                      | L |               | I-bit 4 L |                    | E-bit 4 L |           | B-bit 4 L |
| 5   | Input selector 2    |                                                                                | L |               | I-bit 5 H |                    | — —       |           | B-bit 5 L |
| 6   | REC/PB              | H PB mode selection<br>L REC mode selection                                    | H | R channel     | I-bit 0 L | R channel          | E-bit 0 L | R channel | B-bit 0   |
| 7   | Input voltage gain  | H PB mode volume gain<br>L Rec mode volume gain                                | H |               | I-bit 1 L |                    | E-bit 1 L |           | B-bit 1 L |
| 8   | MPX                 | H ON<br>L OFF                                                                  | L |               | I-bit 2 L |                    | E-bit 2 L |           | B-bit 2 L |
| 9   | NR                  | H ON<br>L OFF                                                                  | L |               | I-bit 3 L |                    | E-bit 3 L |           | B-bit 3 L |
| 10  | B/C                 | H C<br>L B                                                                     | L |               | I-bit 4 L |                    | E-bit 4 L |           | B-bit 4 L |
| 11  | —                   | —                                                                              | — |               | I-bit 5 H |                    | — —       |           | B-bit 5 L |
| 12  | Registor selector 1 | bit 12<br>bit 13<br>H Bias DAC Input volume<br>L Equalizer volume Mode control | L |               |           |                    |           |           |           |
| 13  | Registor selector 2 |                                                                                |   |               |           |                    |           |           |           |

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## HA12167FB/HA12169FB

### Input Volume Register

| I-bit 5 | I-bit 4 | I-bit 3 | I-bit 2 | I-bit 1 | I-bit 0 | Gain     |
|---------|---------|---------|---------|---------|---------|----------|
| L       | L       | L       | L       | L       | L       | Increase |
| L       | L       | L       | L       | L       | H       | ↑        |
| L       | L       | L       | L       | H       | L       | :        |
| L       | L       | L       | L       | H       | H       | :        |
| :       | :       | :       | :       | :       | :       | :        |
| :       | :       | :       | :       | :       | :       | ↓        |
| H       | H       | H       | H       | H       | L       | Decrease |
| H       | H       | H       | H       | H       | H       | Mute     |

### Equalizer Volume Register

| E-bit 4 | E-bit 3 | E-bit 2 | E-bit 1 | E-bit 0 | Gain     |
|---------|---------|---------|---------|---------|----------|
| L       | L       | L       | L       | L       | Increase |
| L       | L       | L       | L       | H       | ↑        |
| L       | L       | L       | H       | L       | :        |
| L       | L       | L       | H       | H       | :        |
| :       | :       | :       | :       | :       | :        |
| :       | :       | :       | :       | :       | ↓        |
| H       | H       | H       | H       | L       | Decrease |
| H       | H       | H       | H       | H       | Mute     |

### Bias DAC Register

| B-bit 5 | B-bit 4 | B-bit 3 | B-bit 2 | B-bit 1 | B-bit 0 | Bias     |
|---------|---------|---------|---------|---------|---------|----------|
| L       | L       | L       | L       | L       | L       | Mute     |
| L       | L       | L       | L       | L       | H       | Decrease |
| L       | L       | L       | L       | H       | L       | ↑        |
| L       | L       | L       | L       | H       | H       | :        |
| :       | :       | :       | :       | :       | :       | :        |
| :       | :       | :       | :       | :       | :       | :        |
| H       | H       | H       | H       | H       | L       | ↓        |
| H       | H       | H       | H       | H       | H       | Increase |

### MPX ON/OFF Switch

MPX-OFF mode means that signal from input amp doesn't go through the MPX filter, but signal goes through the NR circuit after being attenuated 3 dB by internal resistor. Refer to figure 5. For not cause any level difference between MPX-ON mode and MPX-OFF mode, it is requested to use MPX-filter which has definitely 3 dB attenuated. And when applying other usage except figure 5,

take consideration to give bias voltage to NR-IN terminal by resistor or so on because internal of NR-IN terminal has no bias resistor.

### Application as for the Dubbing Cassette Deck

HA12167FB/HA12169FB series has unprocessor signal from recording out terminals during playback mode. So, it is simply applied for dubbing cassette decks.

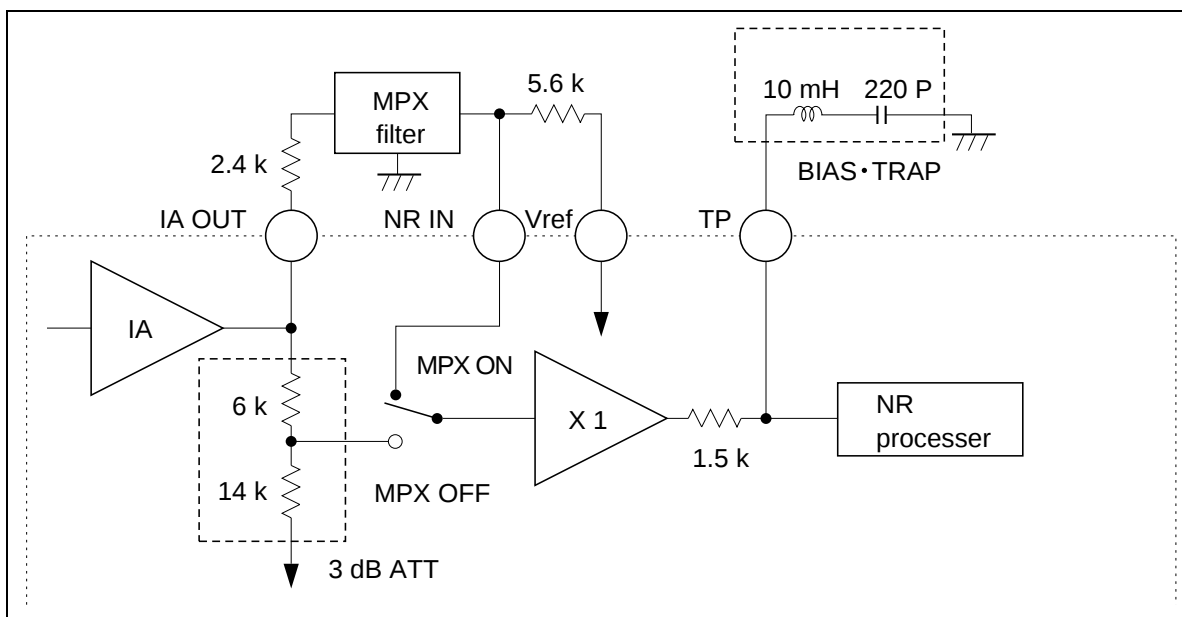


Figure 5 MPX ON/OFF Switch Block Diagram

## HA12167FB/HA12169FB

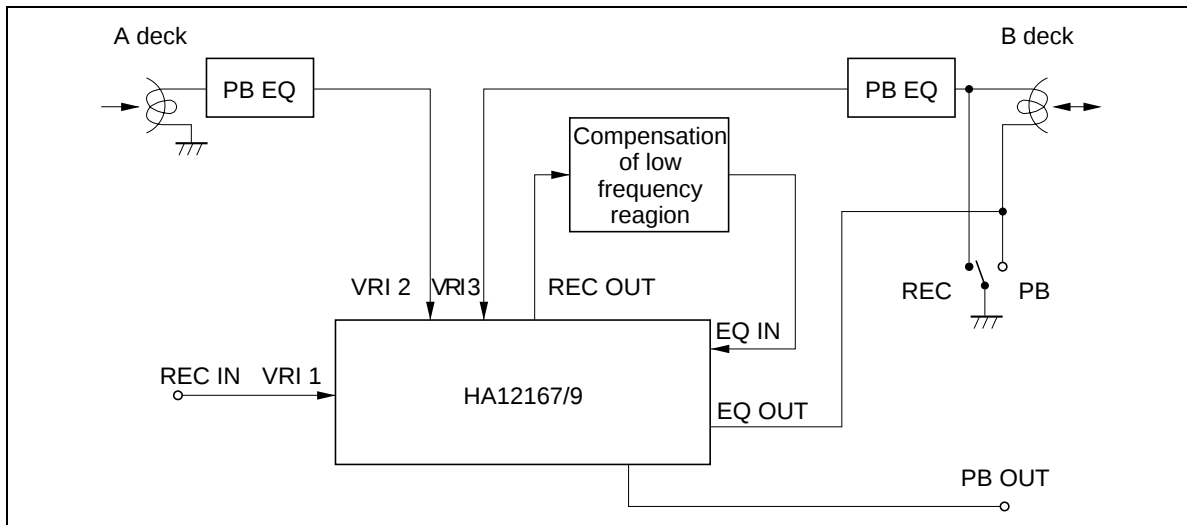


Figure 6 Application for Dubbing Deck

### Injector Current

HA12167FB/HA12169FB has logic circuit which is fabricated by  $I^2L$  into IC. To operate this circuit, it is required enough injector current. Injector current goes into from the INJ pin (pin 38) and external resistor is required to connect to this pin for adequate current. The value of external resistor is obtained by using following equations. And put them with  $\pm 10\%$  tolerance value which is calculated.  $V_{INJ}$  can allow to connect to  $V_{CC}$  shown below. Large injector current fear to cause mis-operation of Logic under the condition of high temperature. Also, small injector current fear to cause mis-operation (stop operation). Under the condition of low temperature. Therefore, pay attention to have good stability of  $V_{INJ}$ .

$$R_{INJ} = \frac{V_{INJ} - 0.7}{3.6} \text{ [k}\Omega\text{]} \quad \text{Single supply}$$

$$R_{INJ} = \frac{V_{INJ} + V_{EE} - 0.7}{3.6} \text{ [k}\Omega\text{]} \quad \text{Split supply}$$

### Gain Control of Electronic Volume

HA12167FB/HA12169FB is designed in order to change the gain by DAC fabricated into IC. To reduce the click noise when changing volume gain instantaneously, required to connect the capacitor and resistor (CR time constant) to CONT pin (pin 13, 48, 68, 73). These terminals are also be used as output pin of DAC. Therefore, by forcing voltage and current to these terminals, it is applicable to control volume gain directly. But, voltage forced to these terminals must be from  $V_{CC}/2 - 2 \text{ V}$  to  $V_{CC}/2$  (for split supply use,  $-2 \text{ V}$  to  $0 \text{ V}$ ) in this case. And, this case, change of a gain depending on a temperature gets large.

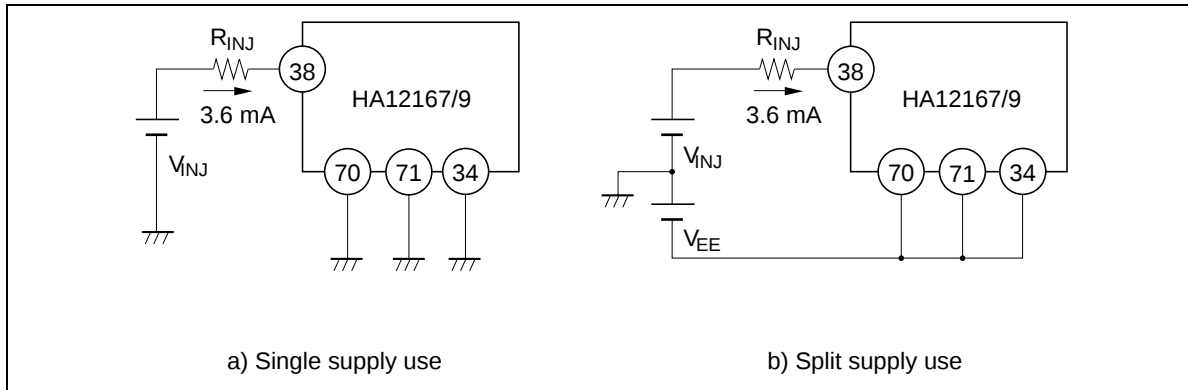


Figure 7 Injector Current Application

### The Tolerances of External Components for Dolby NR-Block

For adequate Dolby NR tracking response, take external components shown below.

For C5, C6, C24, and C25, please employ a few object of the leak, though you can be useful for an electrolytic-capacitor.

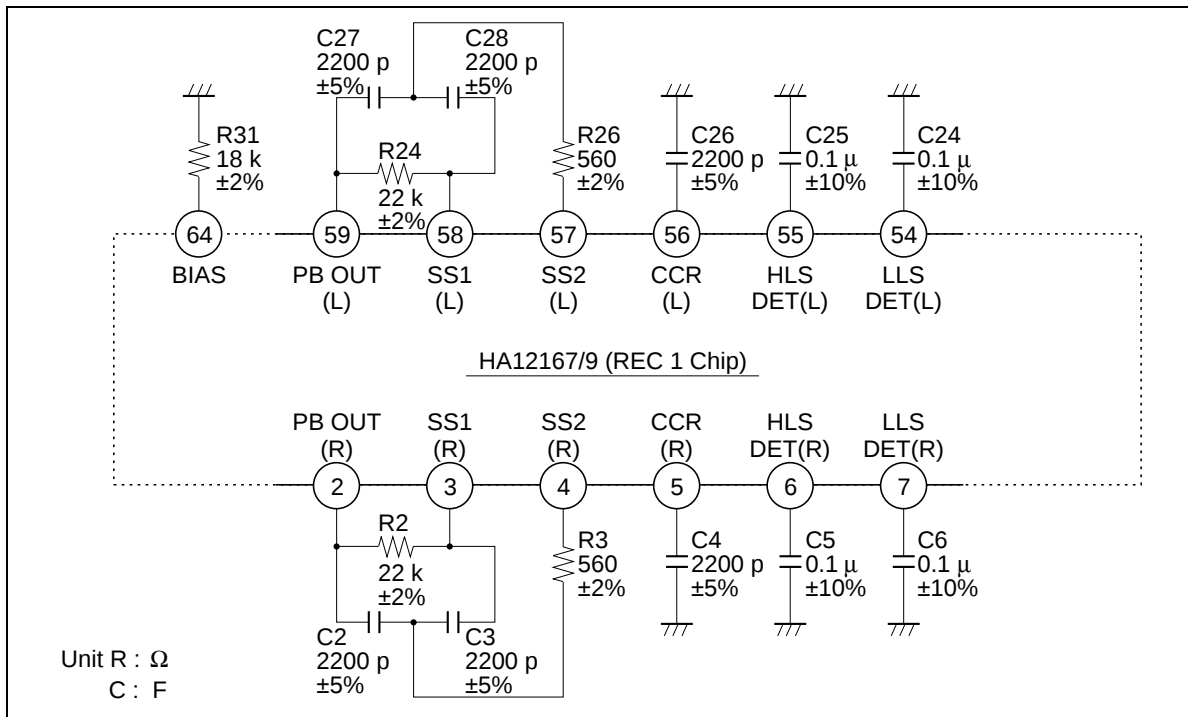


Figure 8 Tolerances of External Components

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## HA12167FB/HA12169FB

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### BIAS DAC

The full-scale of DAC is computed by the formula mentioned below.

$$V_{29} = \frac{2.4}{R_{14 \text{ to } 16}} \times R_{10} \quad [\text{V}]$$

$$V_{32} = \frac{2.4}{R_{14 \text{ to } 16}} \times R_{13} \quad [\text{V}]$$

R<sub>14</sub>: Normal Tape (pin 35)

R<sub>15</sub>: Metal Tape (pin 36)

R<sub>16</sub>: Chrome Tape (pin 37)

The maximum source current of DAC output (pin 29, 32) is 2 mA. Therefor the Bias-osc is driven through external transistor of emitter-follower.

### Level Meter

The coupling capacitor of LMIN pin (9 pin and 52 pin).

For these capacitors, please employ a small object of the leak.

The Application of Equalizer Frequency Response

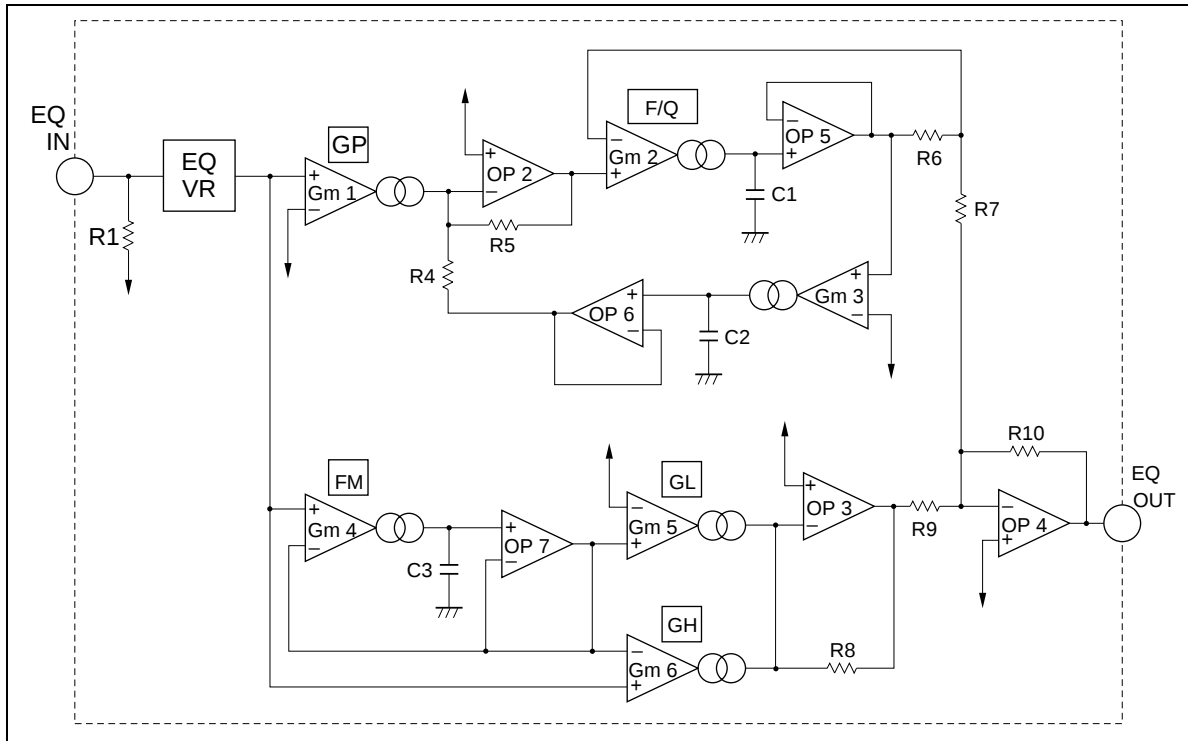


Figure 9 REC Equalizer Block Diagram

Transfer Function:

$$\frac{V_{out}}{V_{in}} = G_v \left( G_{m5} \cdot \frac{R_8 \cdot R_{10}}{R_9} \cdot \frac{1 + \frac{C_3}{G_{m4}} \cdot \frac{G_{m6}}{G_{m5}} \cdot S}{1 + \frac{C_3}{G_{m4}} \cdot S} + G_{m1} \cdot \frac{R_4 \cdot R_{10}}{R_6 + R_7} \cdot \frac{\frac{C_3}{G_{m4}} \cdot S}{1 + \frac{R_4}{R_5} \cdot \frac{R_7}{R_6 + R_7} \cdot \frac{C_2}{G_{m3}} \cdot S + \frac{R_4}{R_5} \cdot \frac{C_1}{G_{m2}} \cdot \frac{C_2}{G_{m3}} \cdot S^2} \right)$$

$$= \frac{9}{R_{REF}} \left( R_{GL} \cdot \frac{1 + 6.67 \times 10^{-10} \frac{R_{FM} \cdot R_{GH}}{R_{FM}} \cdot S}{1 + 6.67 \times 10^{-10} \frac{R_{GL}}{R_{FM}} \cdot S} + R_{GP} \cdot \frac{3.0 \times 10^{-10} \cdot R_{FQ} \cdot S}{1 + 4.5 \times 10^{-11} \cdot R_{FQ} \cdot S + 2.5 \times 10^{-20} \cdot R_{FQ} \cdot R_{F/Q} \cdot S^2} \right)$$

Note:  $R_{REF}$ ..... 14 pin bias resistance

$G_v$ ..... Gain of EQ-VR

## HA12167FB/HA12169FB

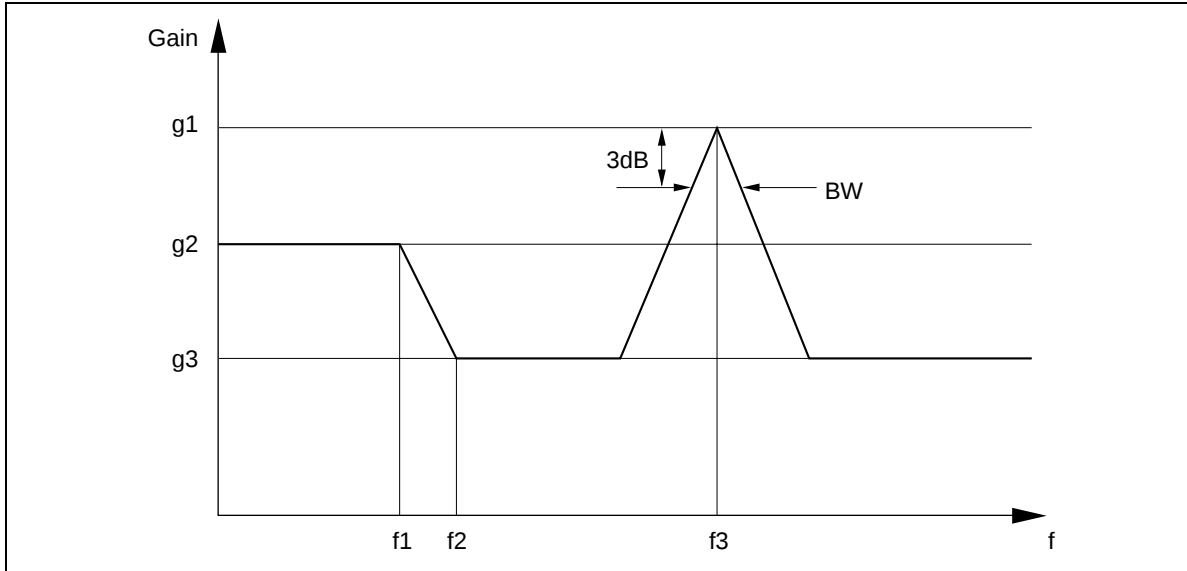


Figure 10 REC Equalizer Frequency Response

$$\left. \begin{aligned} g1 &= \frac{9}{R_{REF}} (6.67 \times R_{GP} + R_{GH}) \\ g2 &= \frac{9 \times R_{GL}}{R_{REF}} \\ g3 &= \frac{9 \times R_{GH}}{R_{REF}} \end{aligned} \right\} \text{when Gain of EQ - VR is center}$$

$$f1 = \frac{1}{2\pi \times 6.67 \times 10^{-10} \times R_{FM}}$$

$$f2 = \frac{R_{GL}}{2\pi \times 6.67 \times 10^{-10} \times R_{FM} \times R_{GH}}$$

$$f3 = \frac{1}{2\pi} \cdot \frac{0.3}{\sqrt{2.25 \times 10^{-21} \times R_{FQ} \times R_{F/Q}}}$$

$$BW = \frac{1}{4\pi \times 2.78 \times 10^{-10} \times R_{F/Q}}$$

$$Q = \frac{f3}{BW} = 3.51 \times \sqrt{\frac{R_{F/Q}}{R_{FQ}}}$$

### Equalizer Characteristics Control Using a Bias DAC

When only one of the bias DAC channels is used, any one of the six parameters (FM, fQ, f/Q, GH, GL, and GP) that set the equalizer's characteristics can be controlled by the unused bias DAC.

The figure below gives one example.

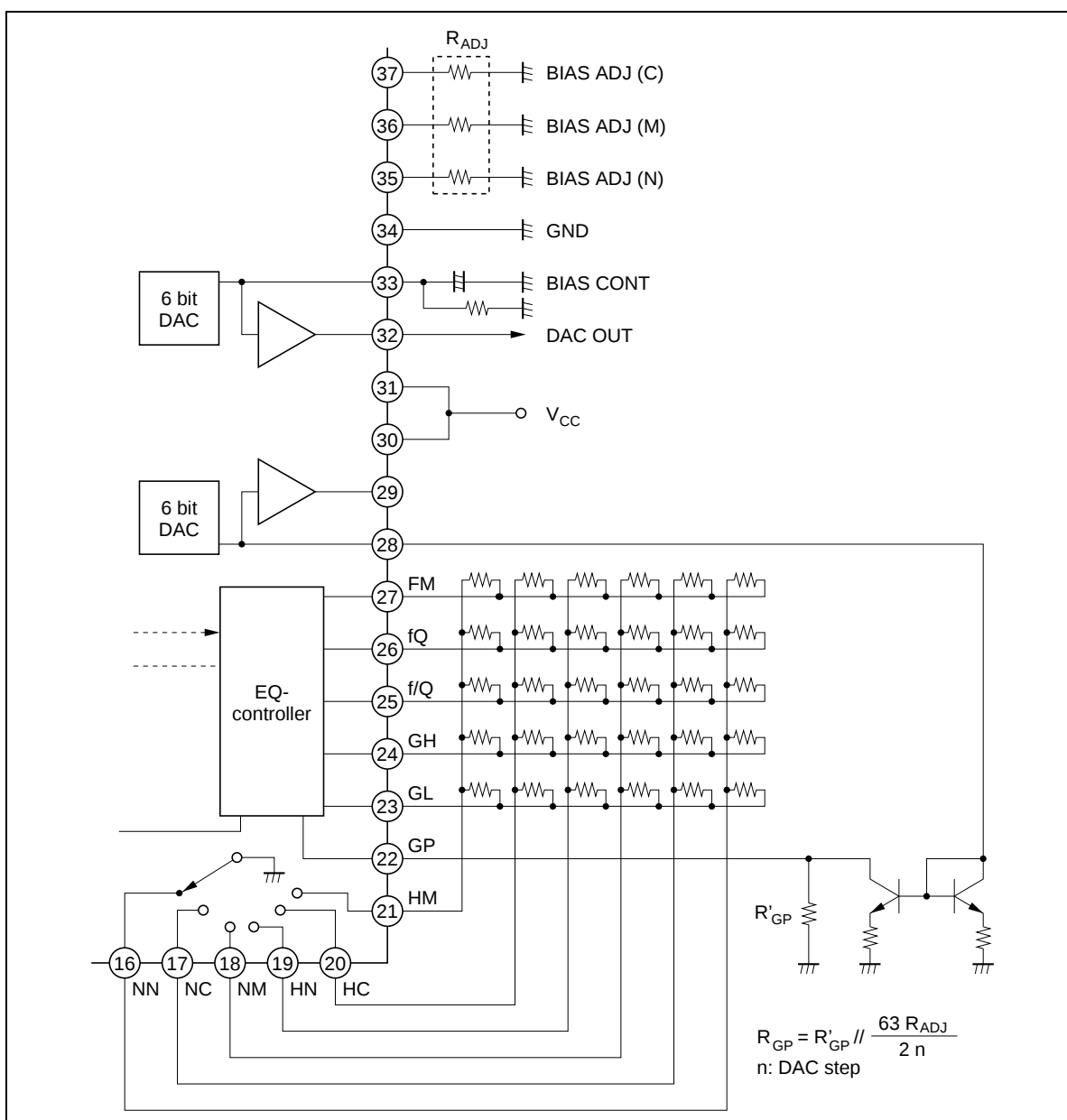


Figure 11 Bias DAC Control of the GP Parameter

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Figures 12, 13, and 14 show the characteristics when GP is controlled by a bias DAC.

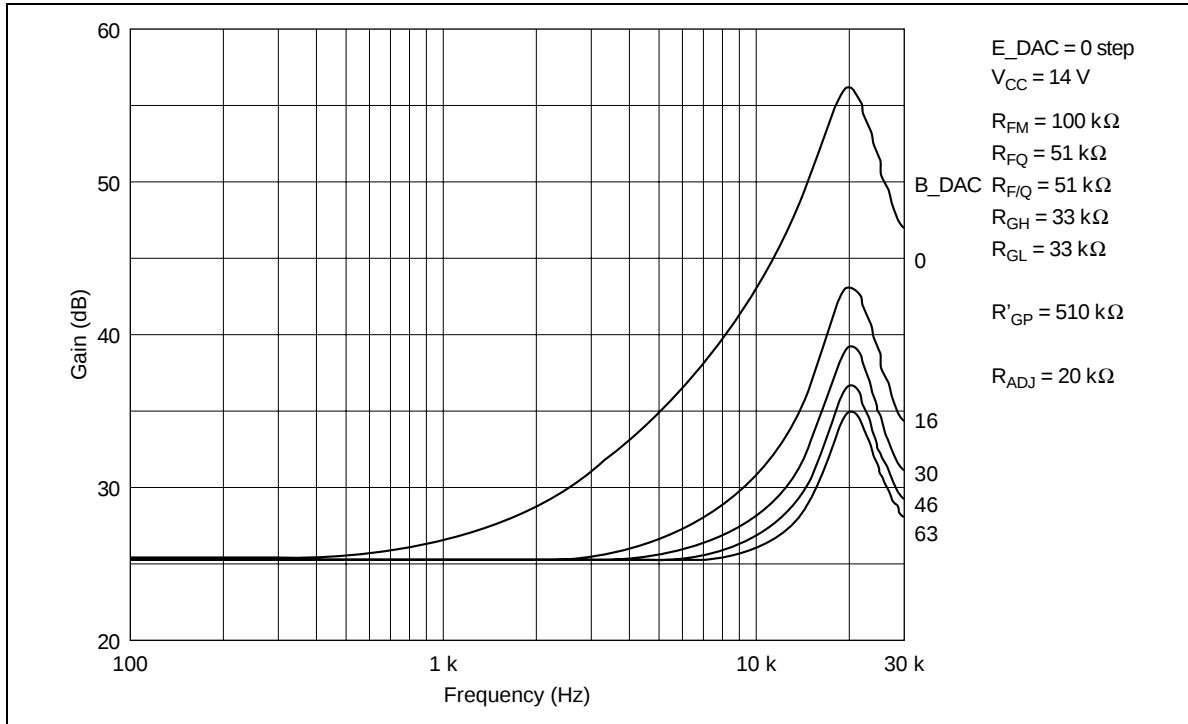


Figure 12 Equalizer Gain vs. Frequency

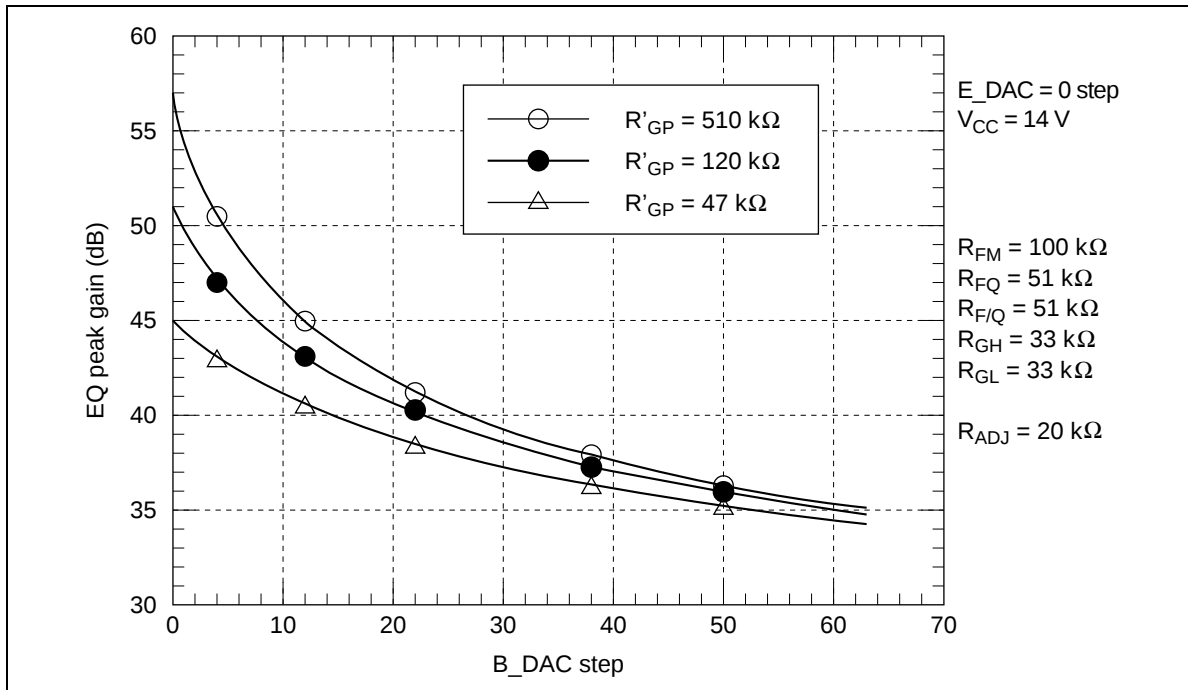


Figure 13 Equalizer Peak Gain vs. DAC Step Characteristics (1)

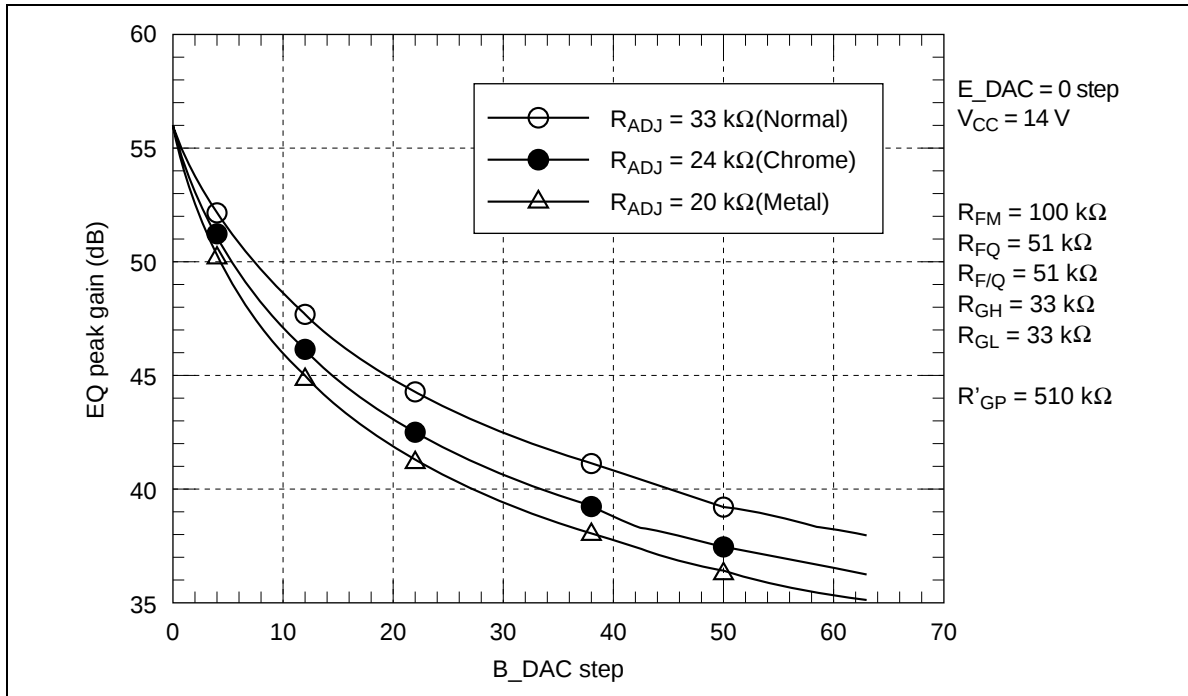


Figure 14 Equalizer Peak Gain vs. DAC Step Characteristics (2)

When the (variable) width of the DAC step is to be changed, the gain at step 0 or at step 63 must be changed. The step 0 gain can be changed using  $R'_{GP}$  as shown in figure 13. Also,  $R'_{GP}$  can be switched using the tape selector, as shown in figure 15. However, it is necessary to take into account that the value of  $R_{ADJ}$ , which sets the step 63 gain, is also used for the output bias. When the load resistance on pin 33 is  $R_L$ , the following formula gives the output bias,  $V_{BMAX}$ .

$$V_{BMAX} = 2.4 \times R_L / R_{ADJ}$$

Therefore, it is possible to compensate the output bias,  $V_{BMAX}$  for the  $R_{ADJ}$  setting by changing  $R_L$ .

Note:  $R_{ADJ}$  should be in the range 16 k $\Omega$  to 75 k $\Omega$ .

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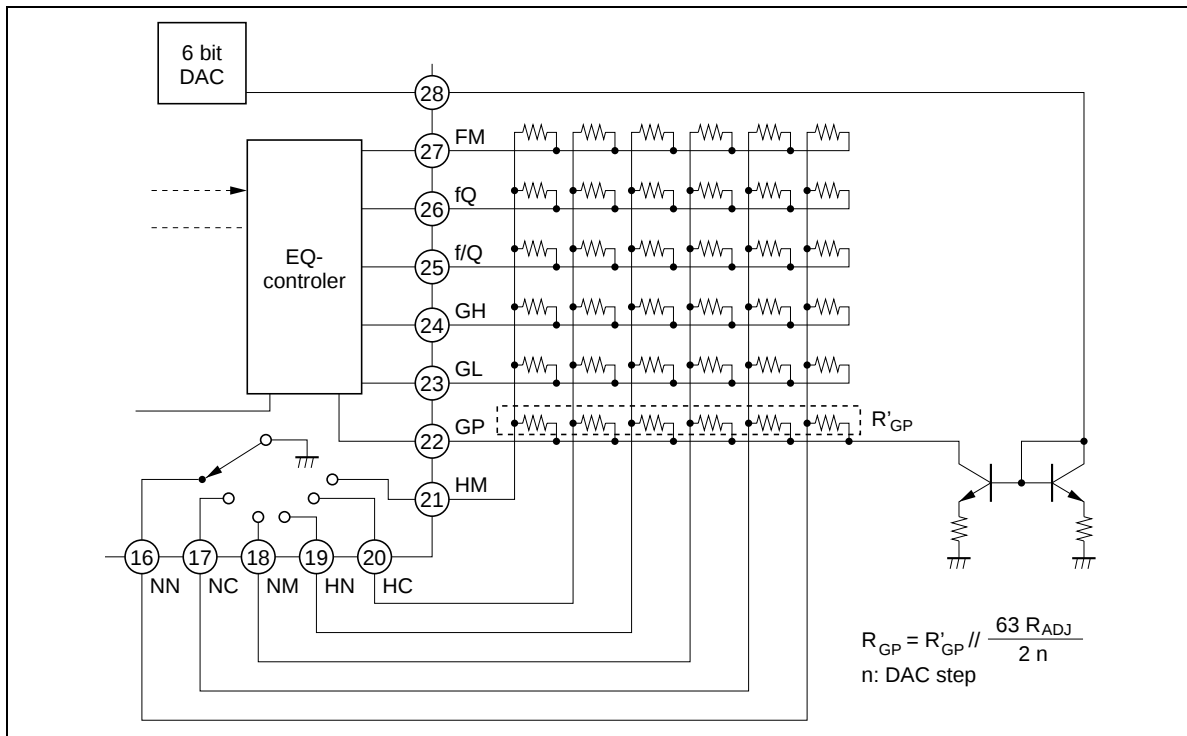
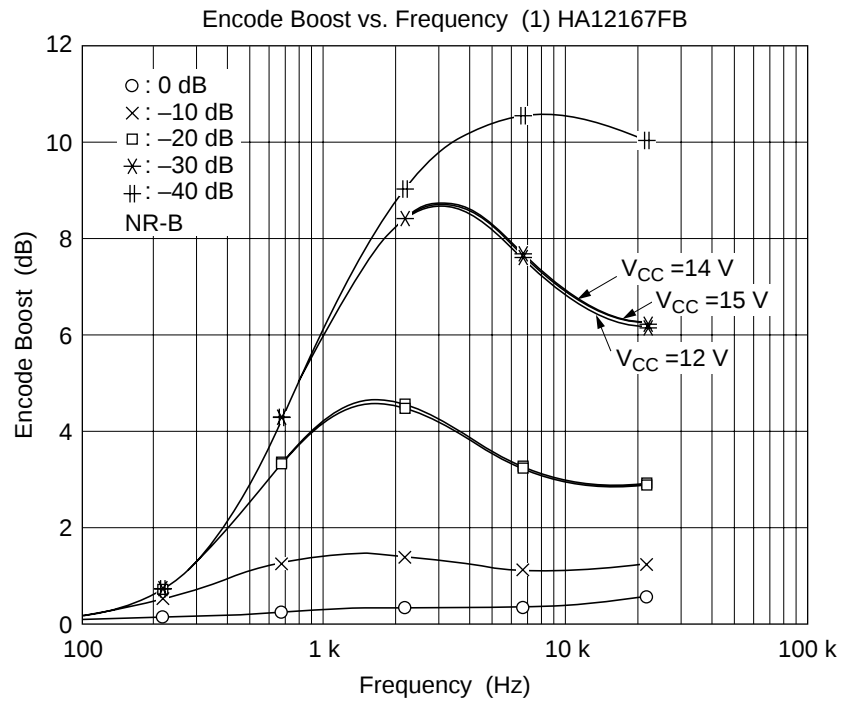
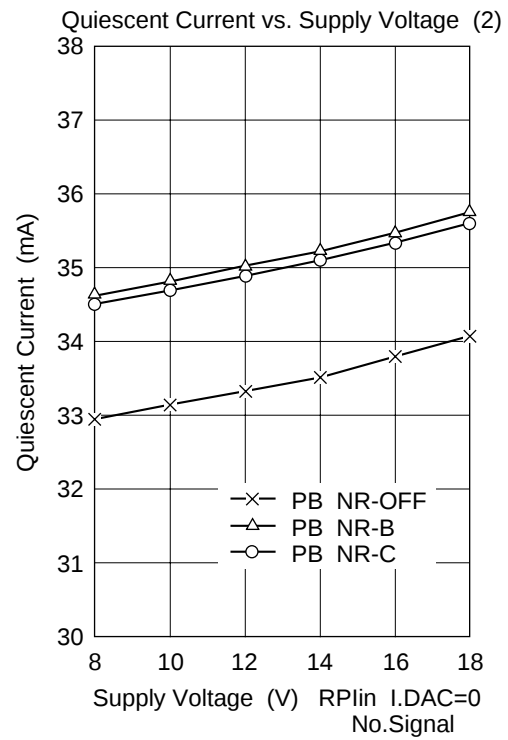
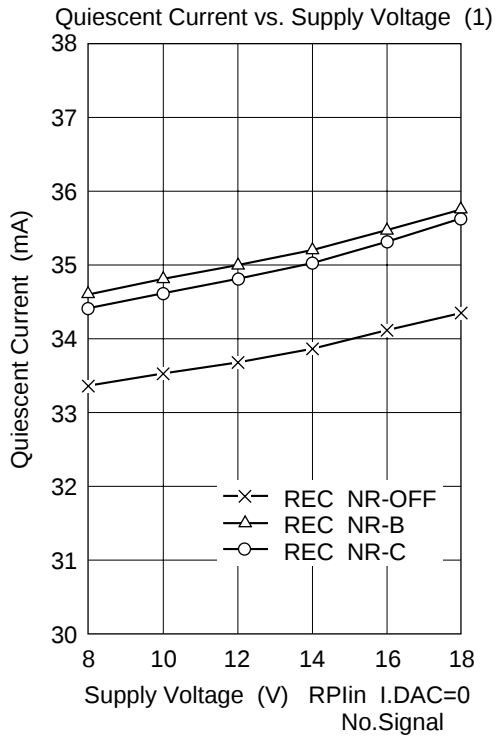
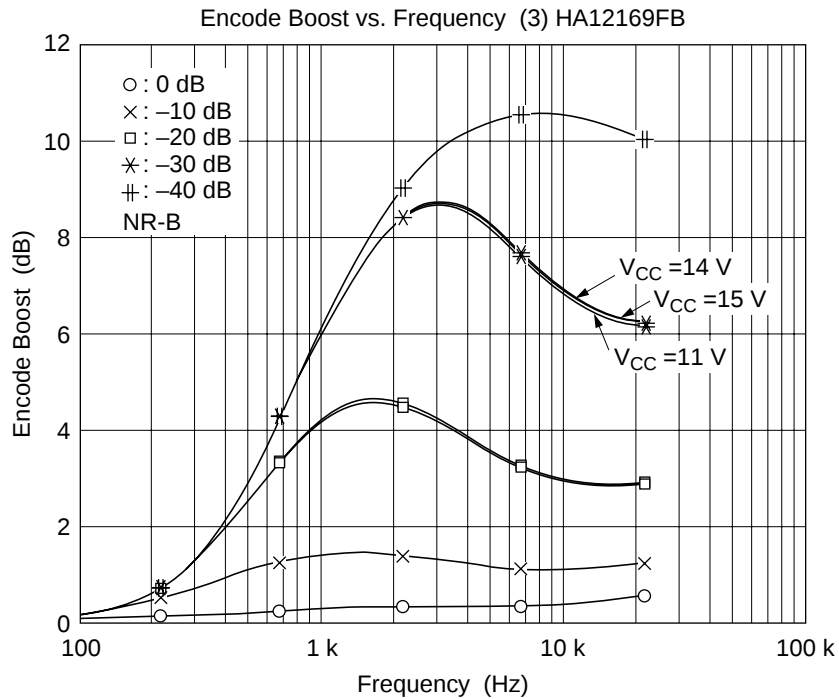
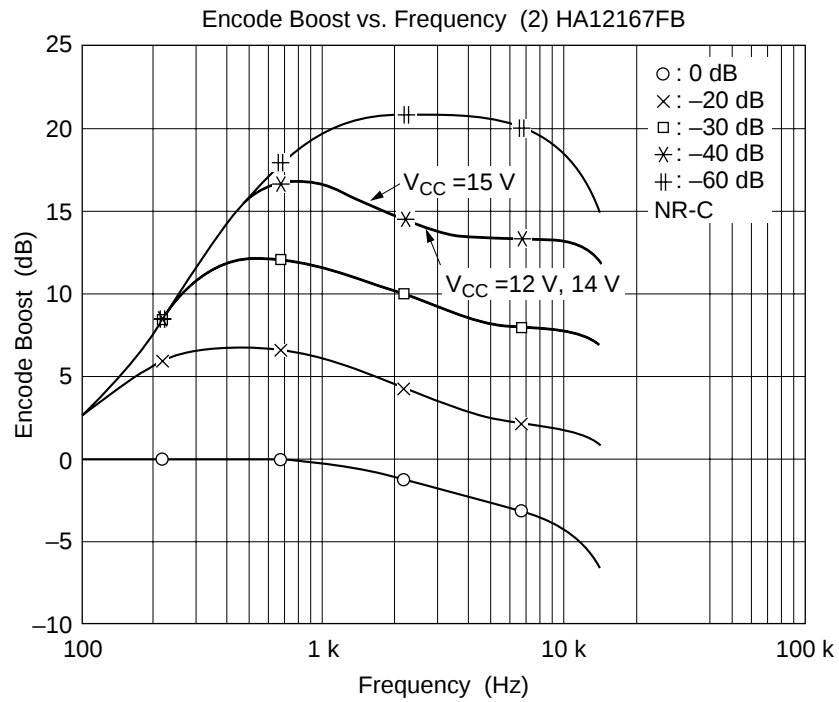
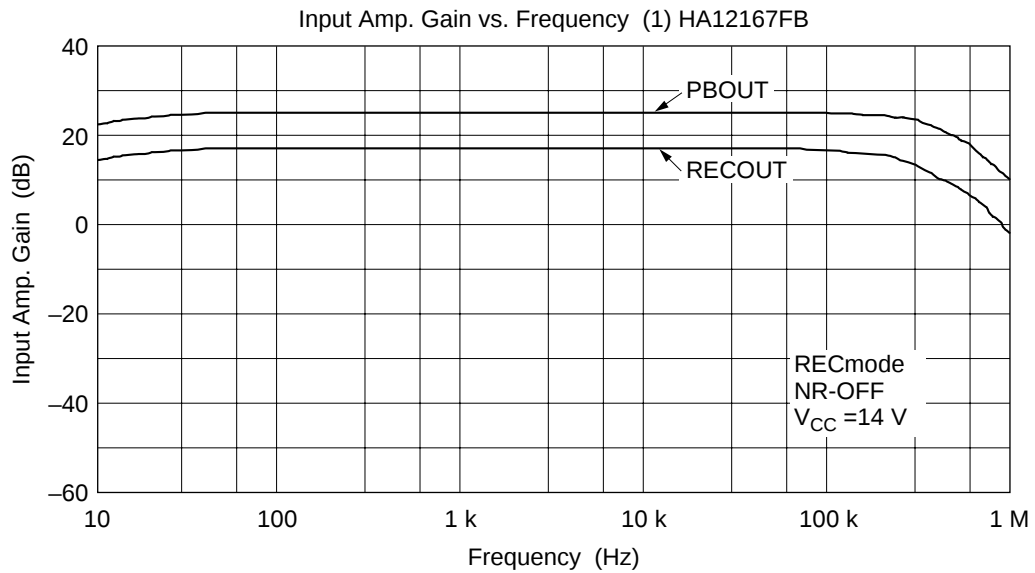
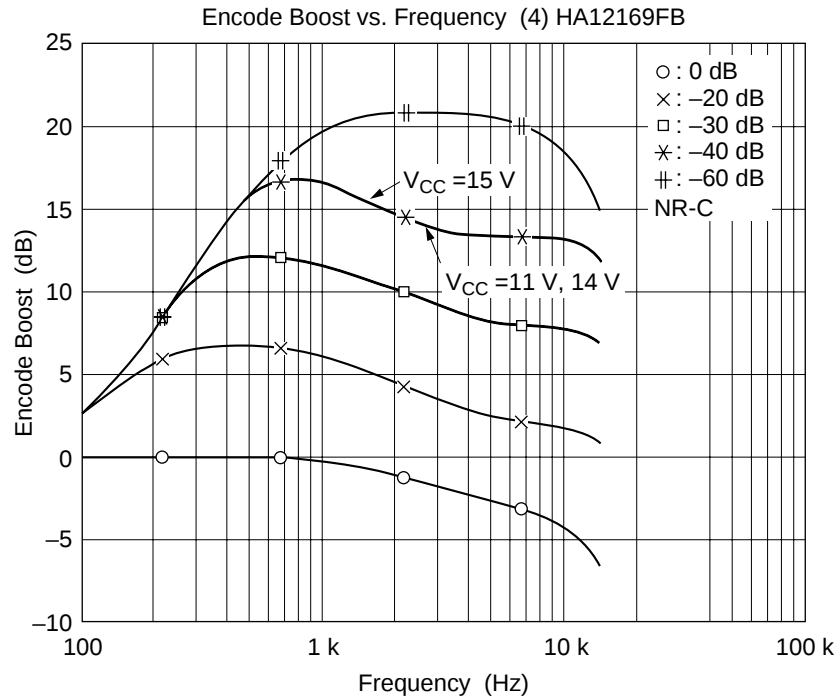


Figure 15 Switch by Tape Select

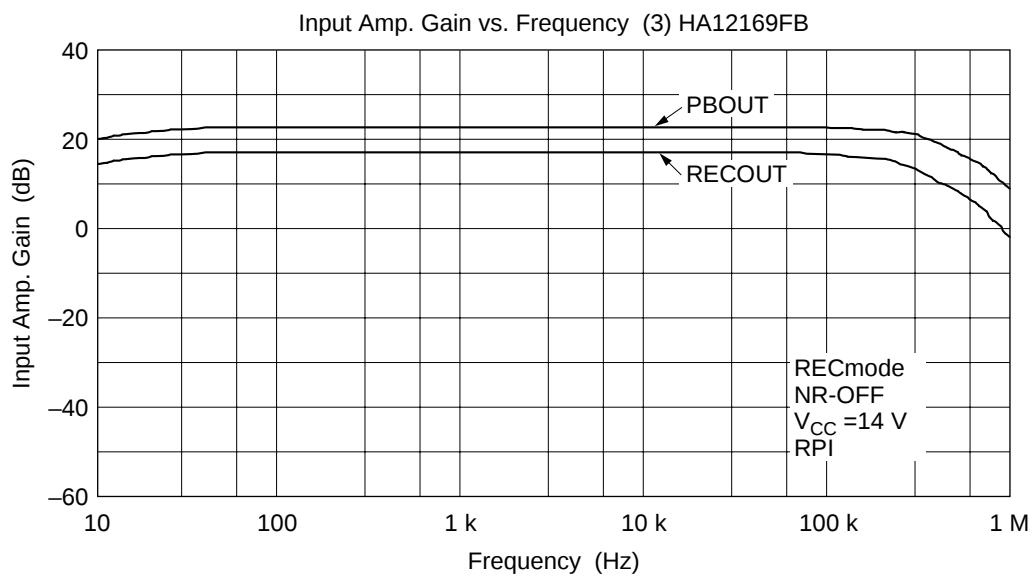
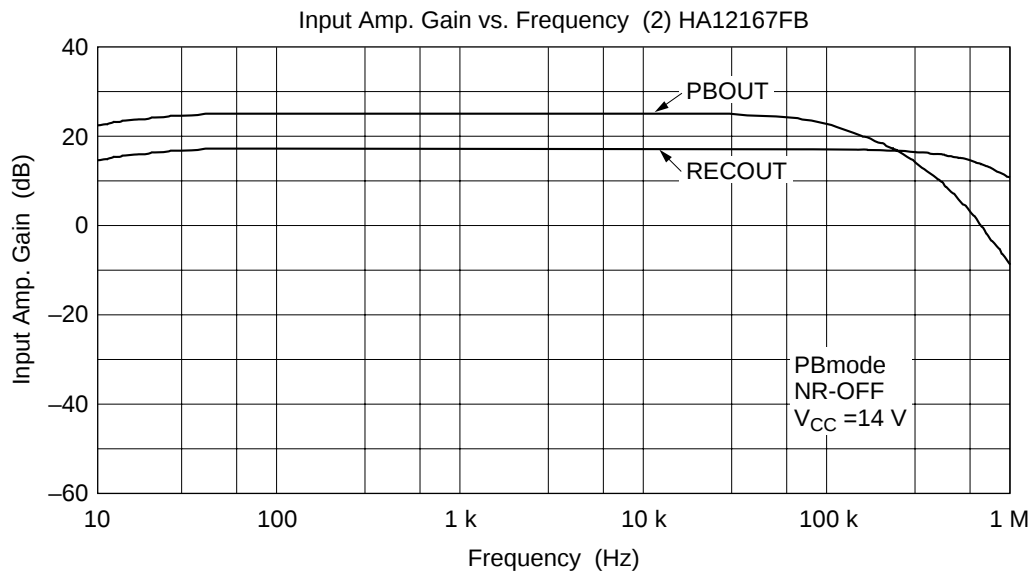


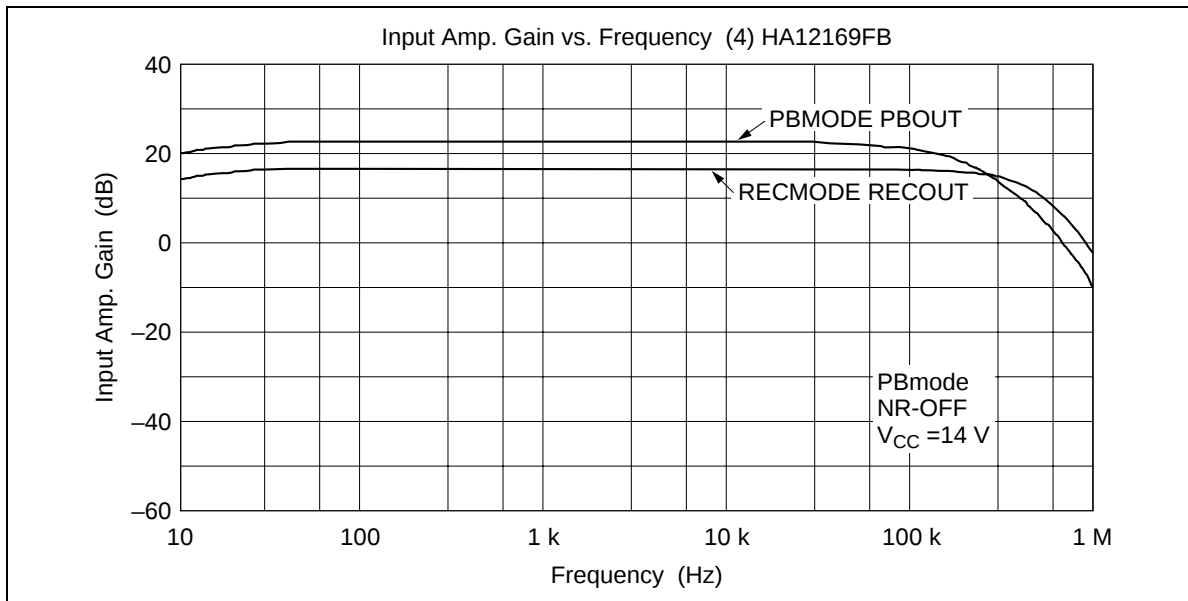
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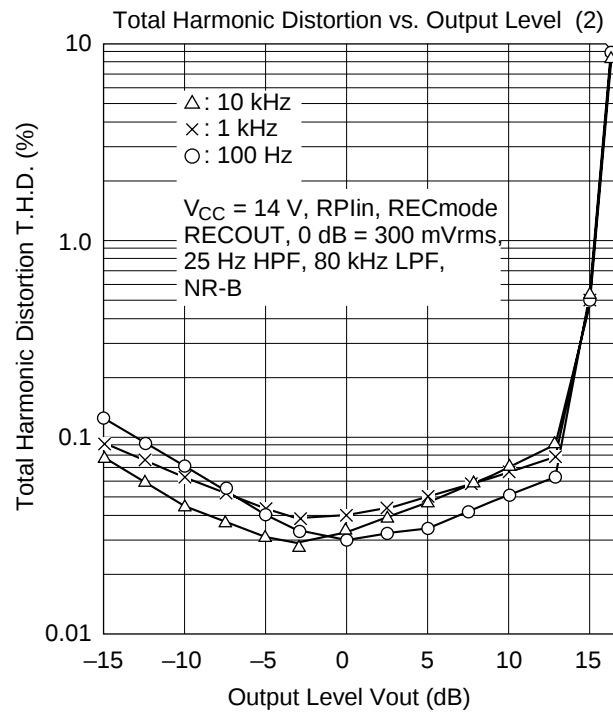
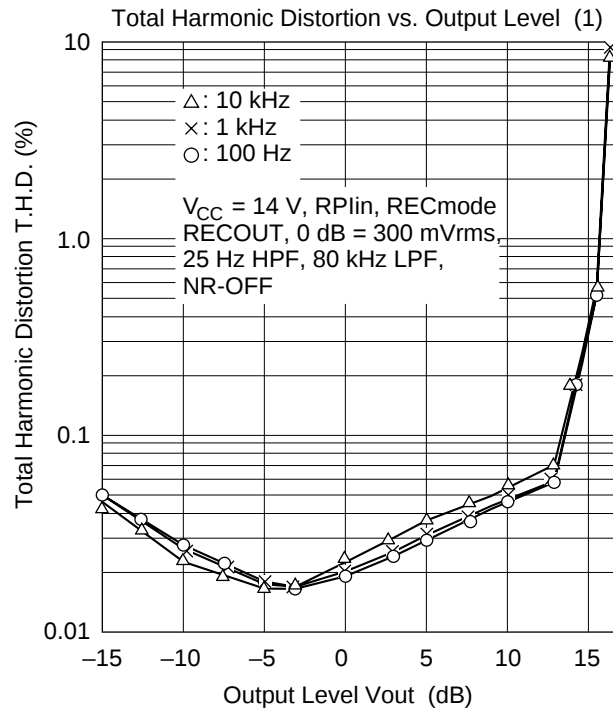


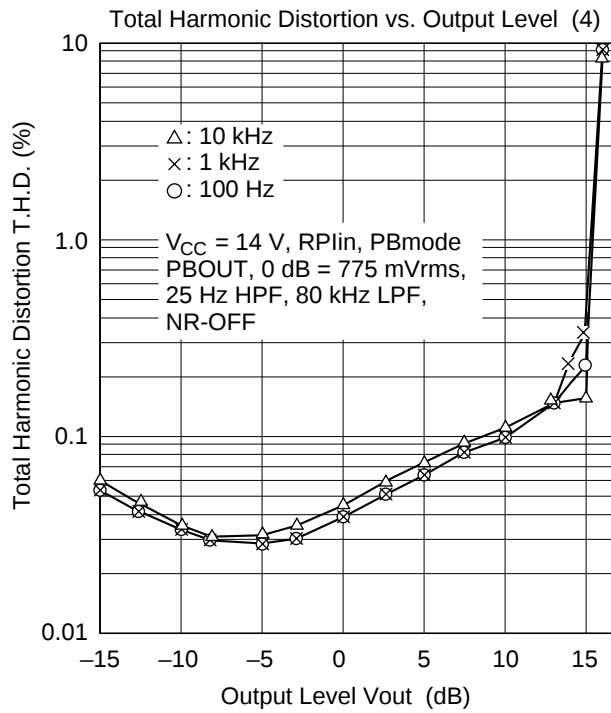
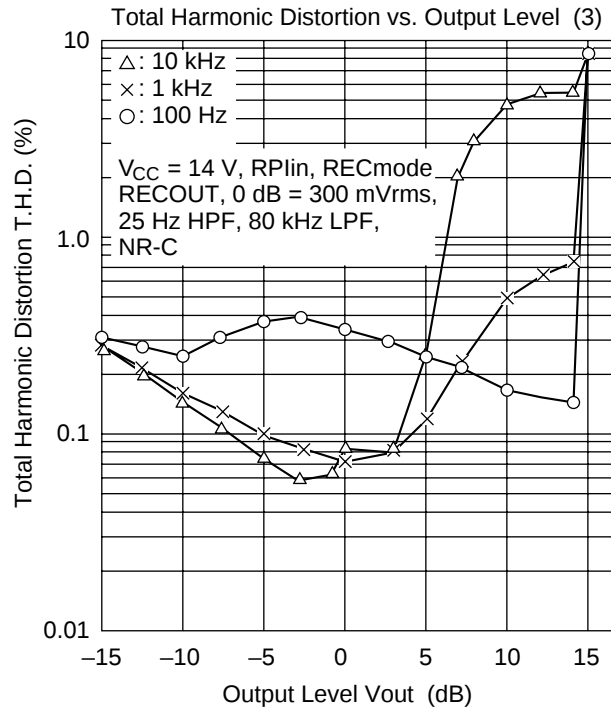
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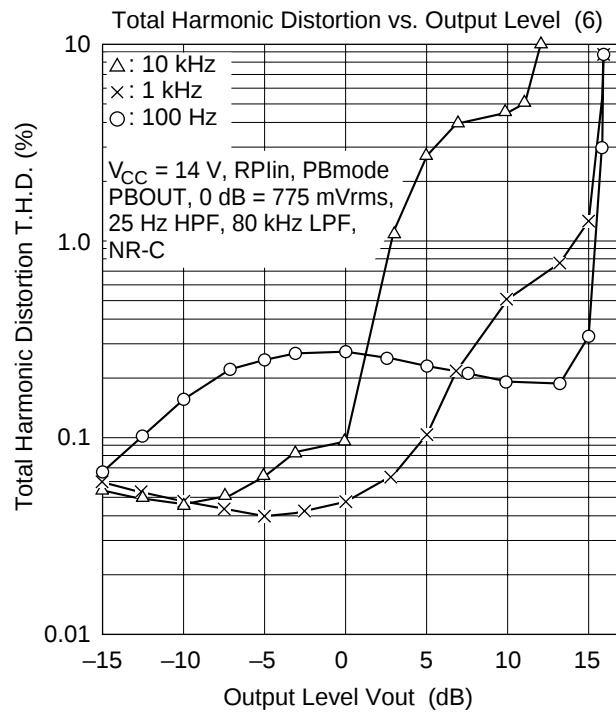
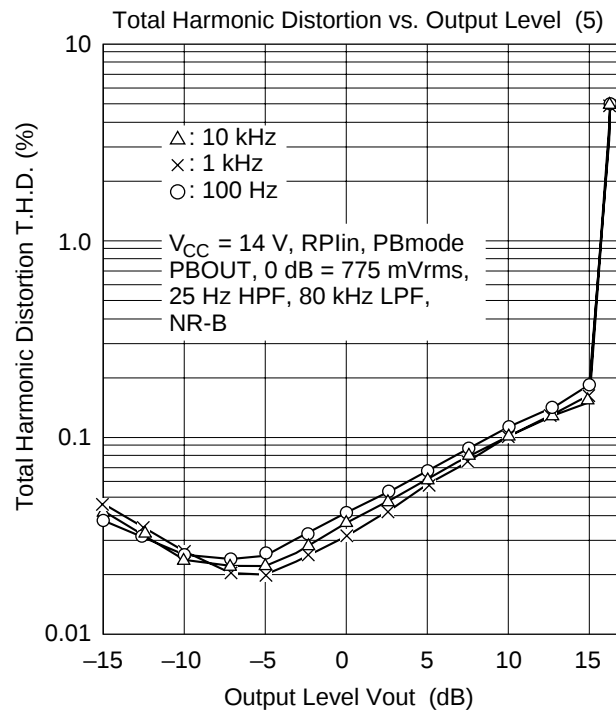


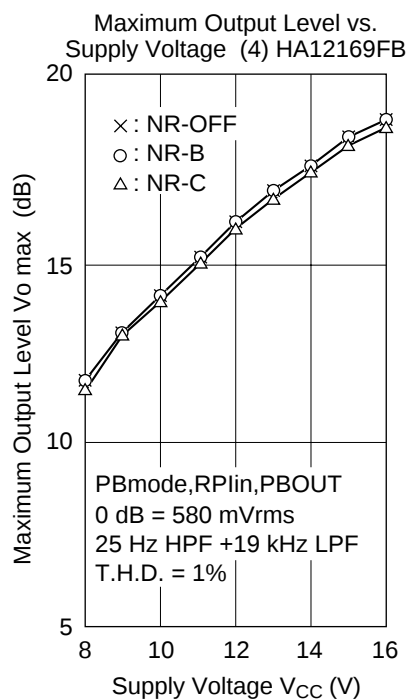
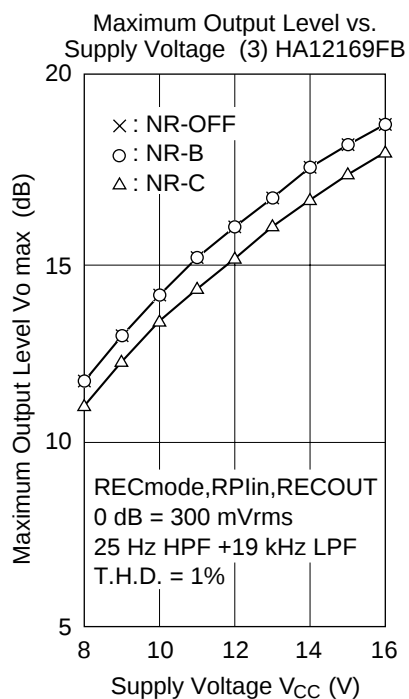
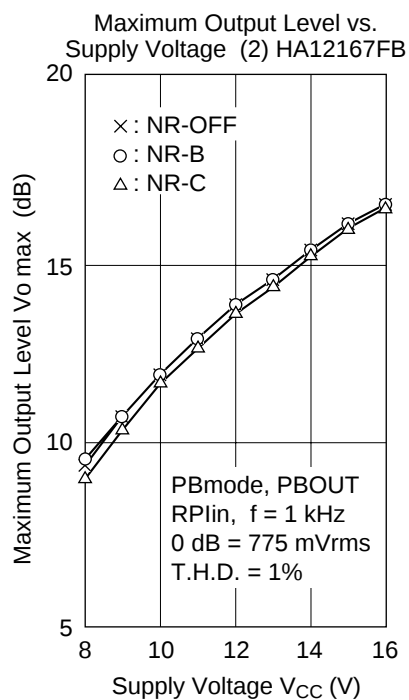
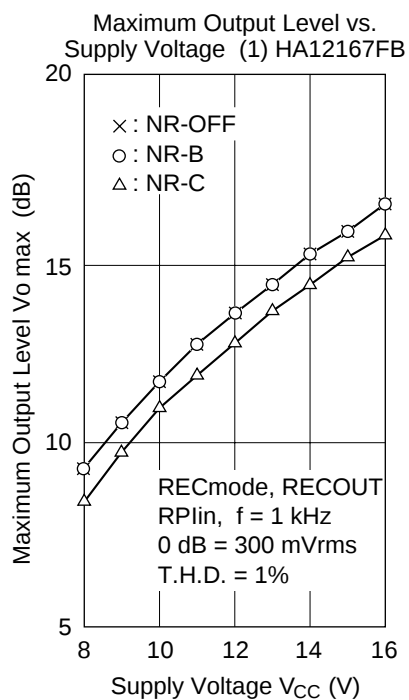
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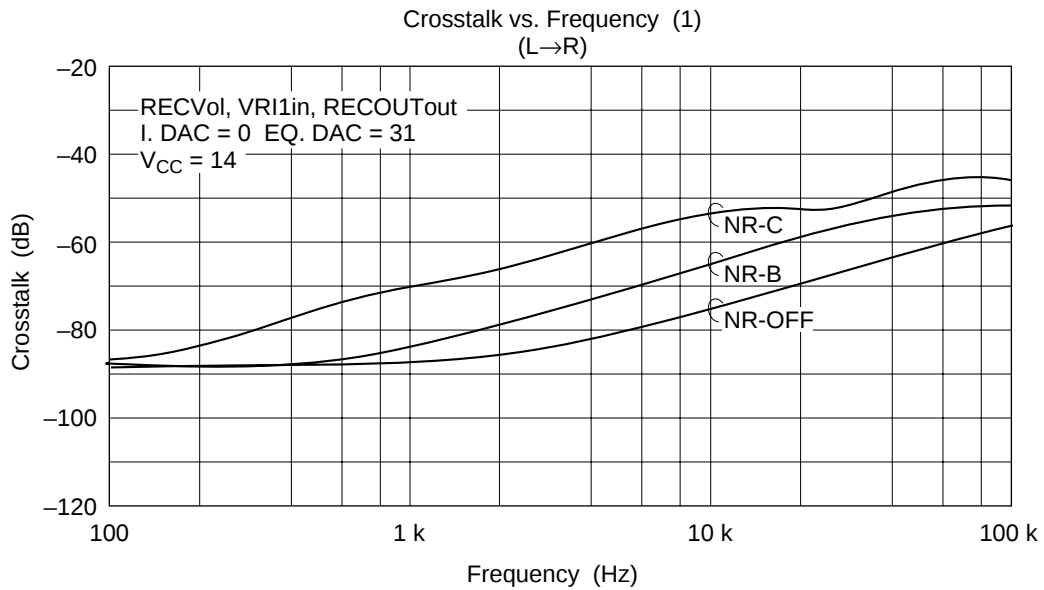
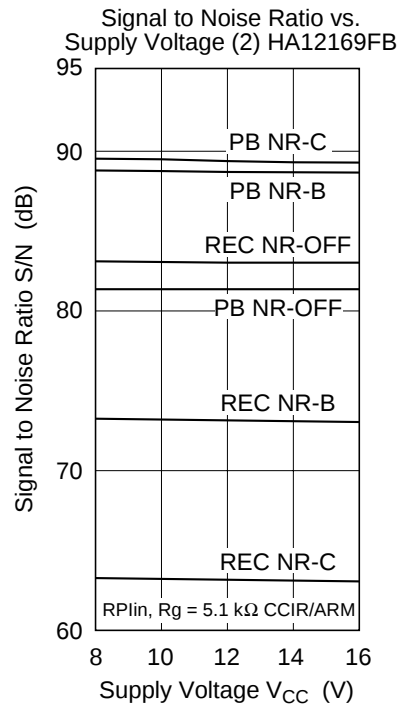
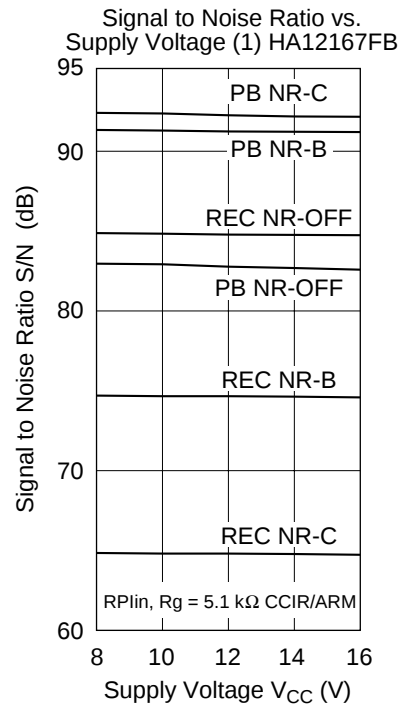


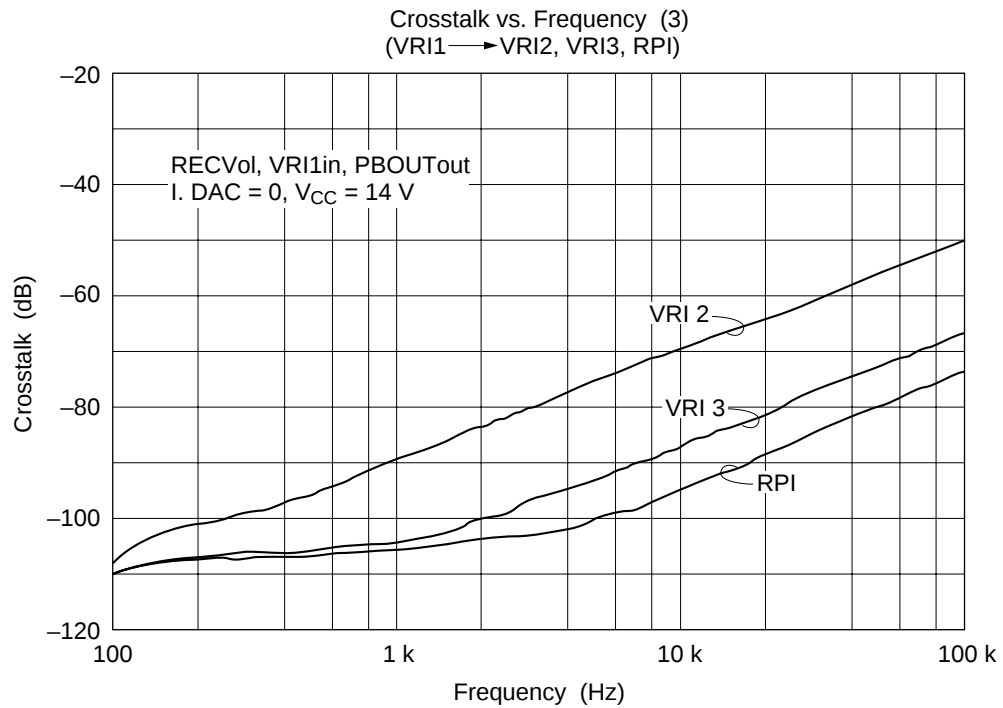
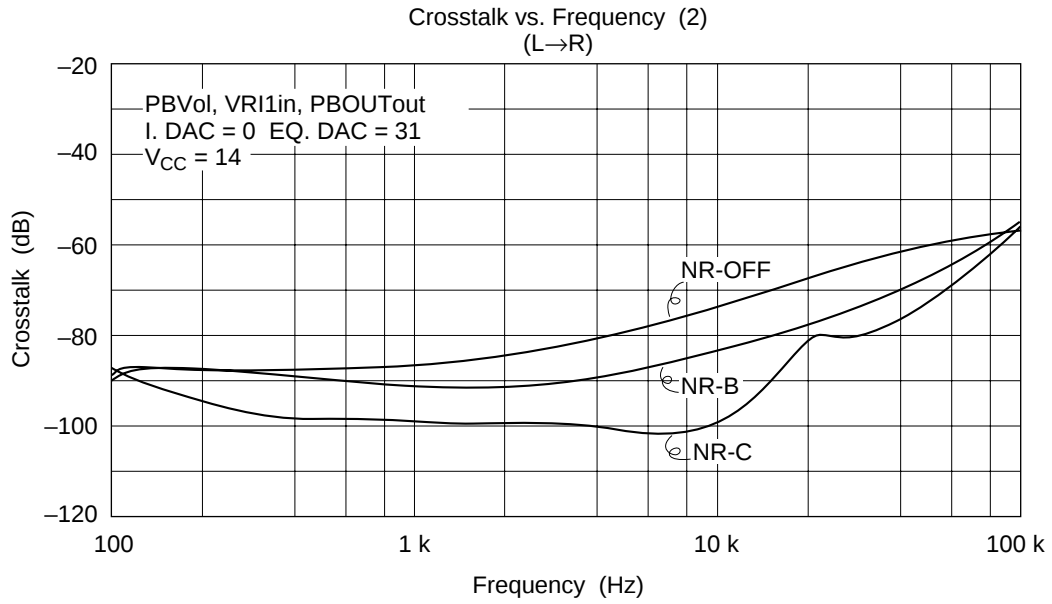
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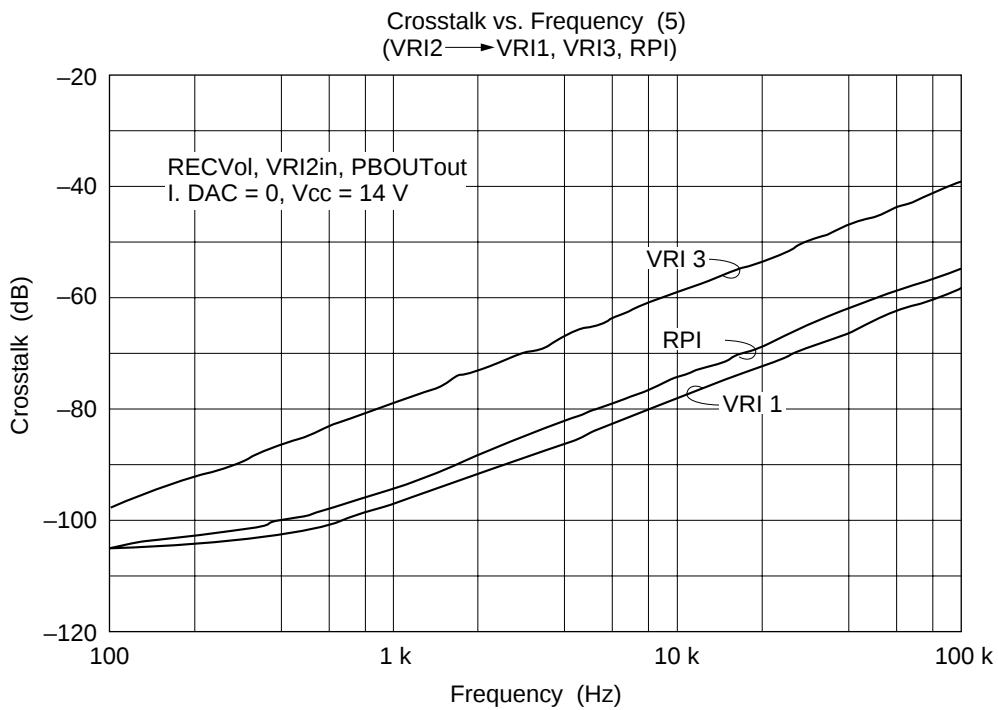
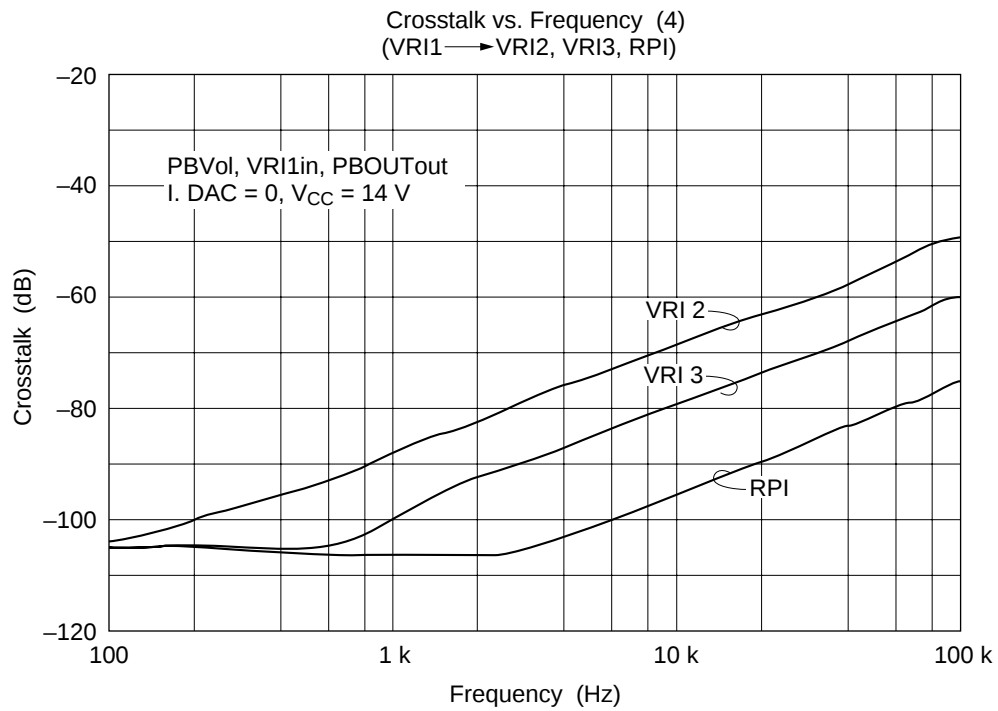


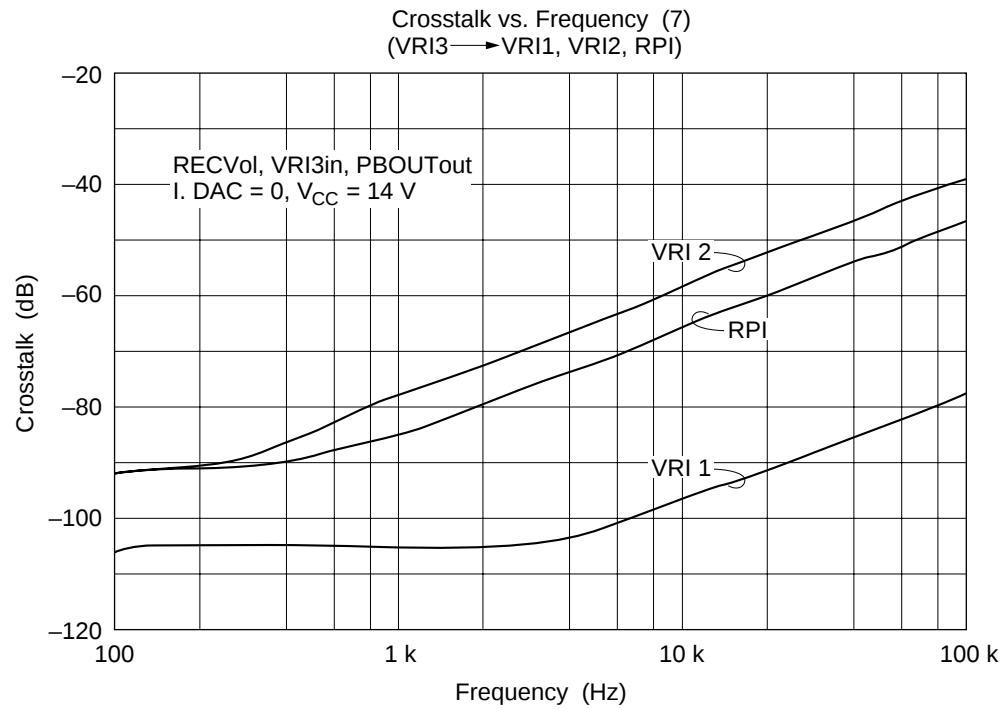
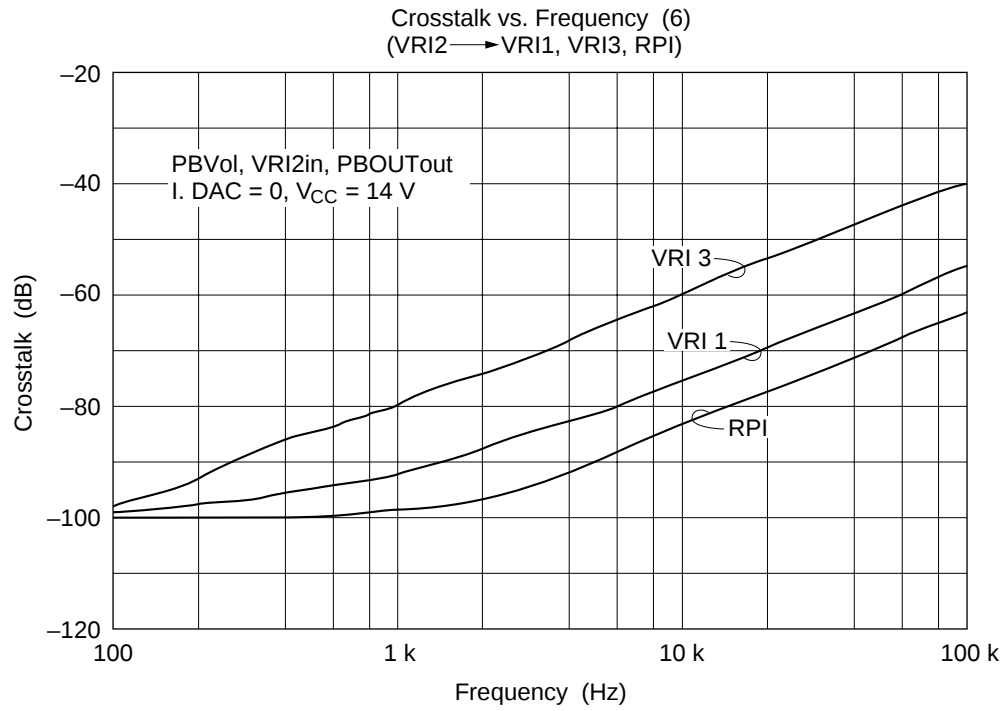
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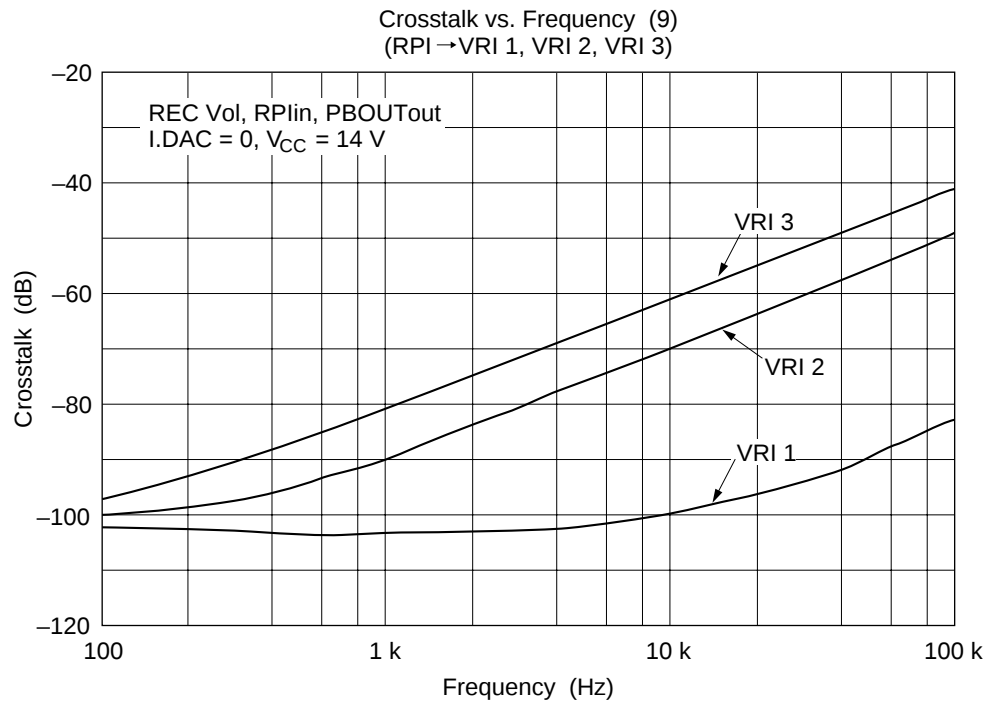
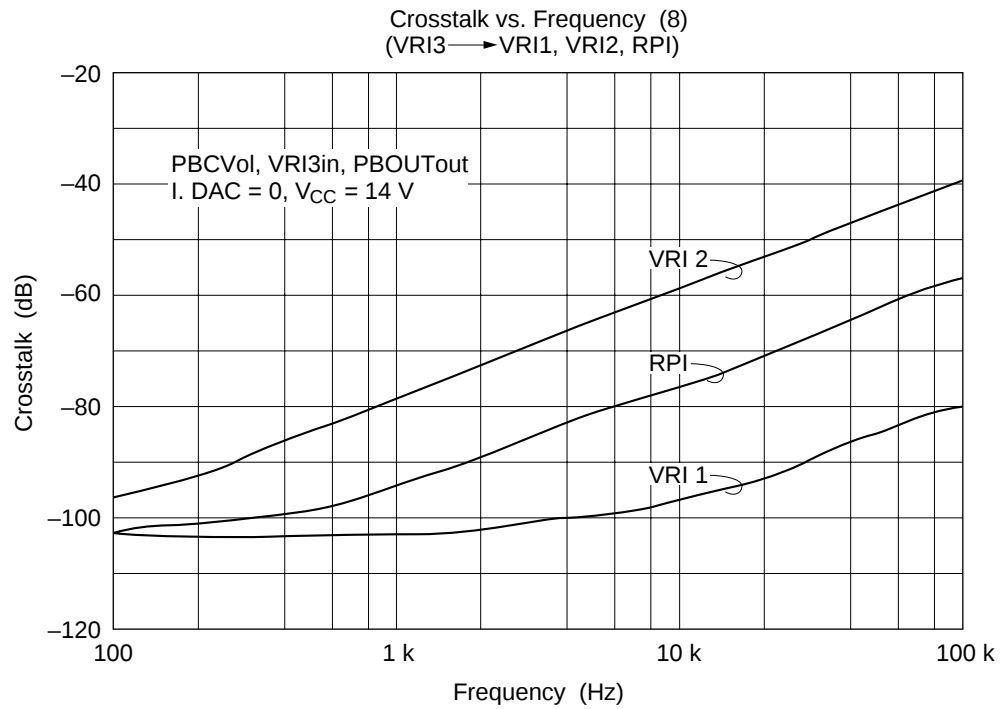


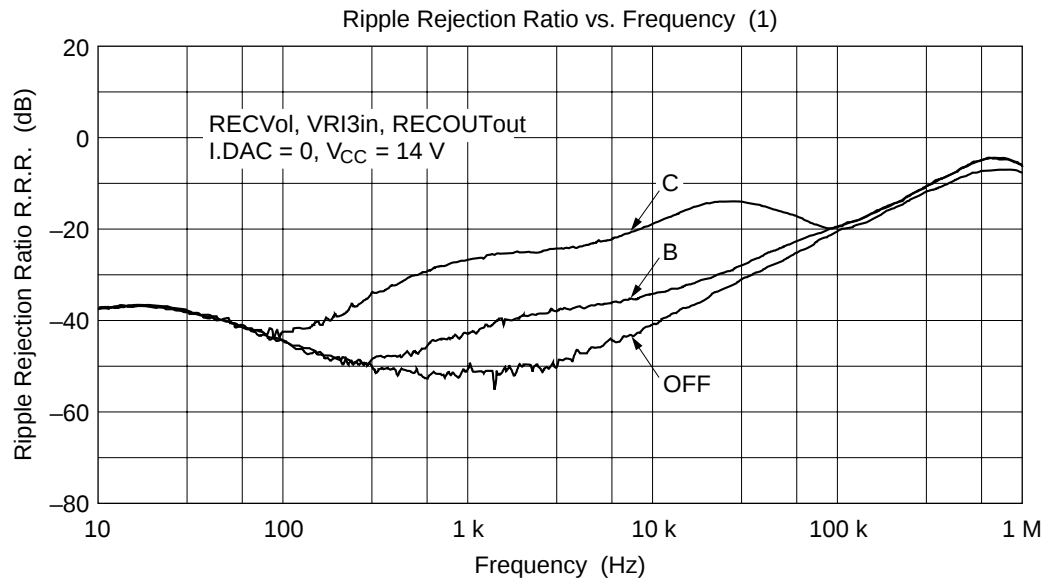
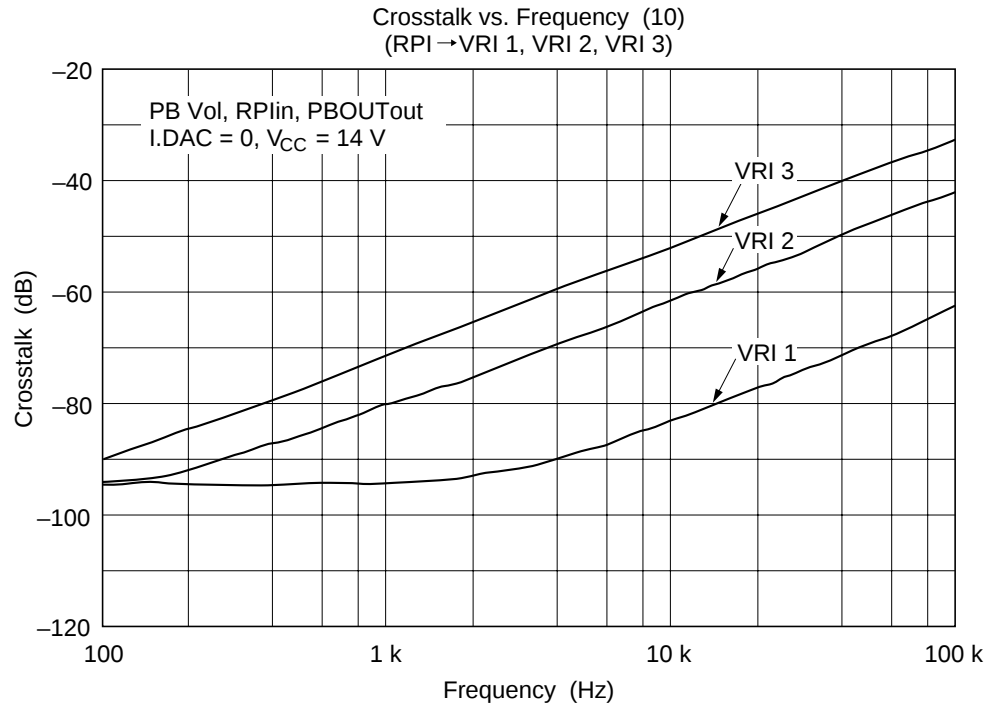
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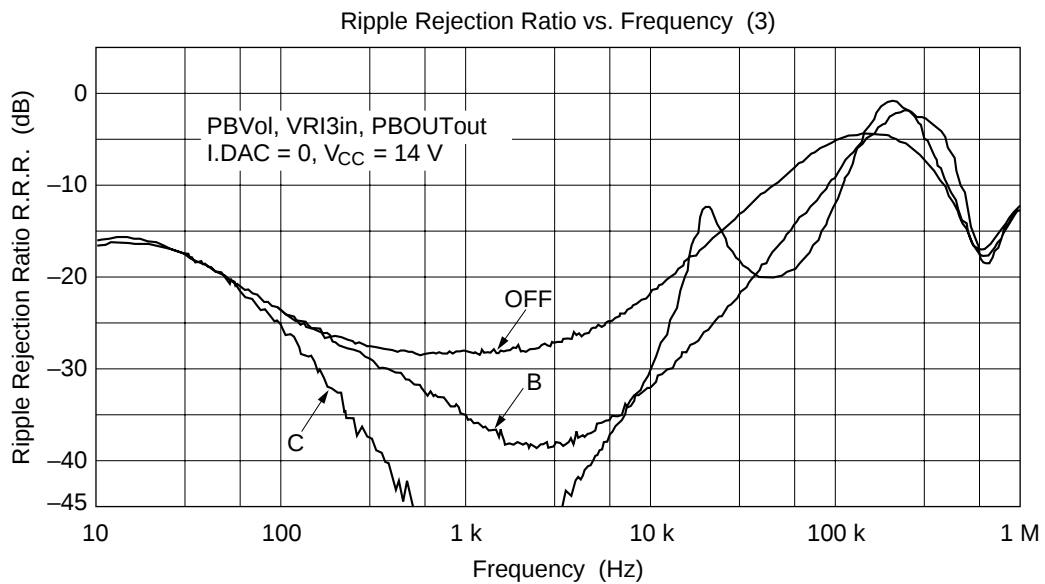
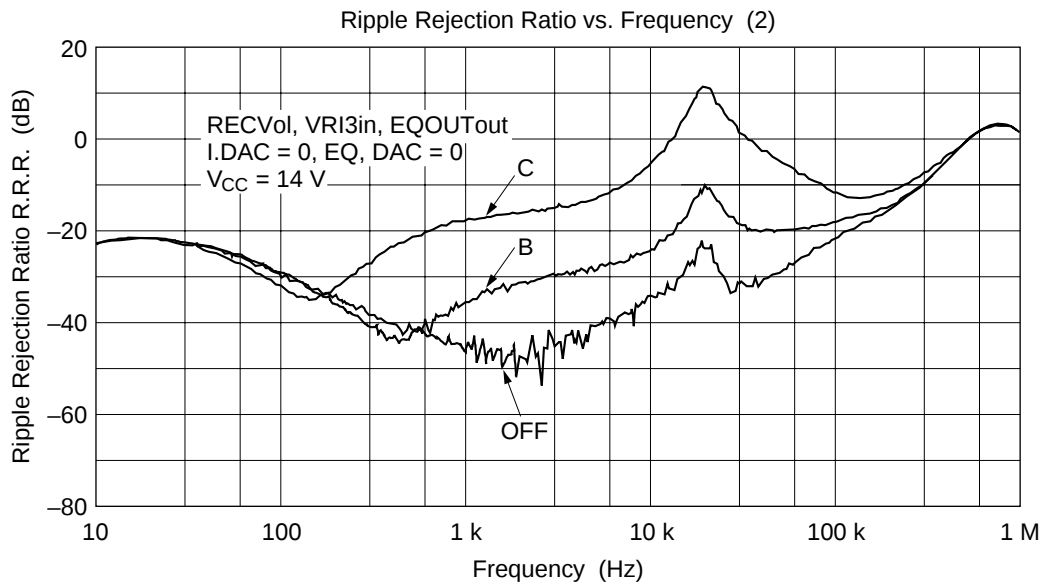


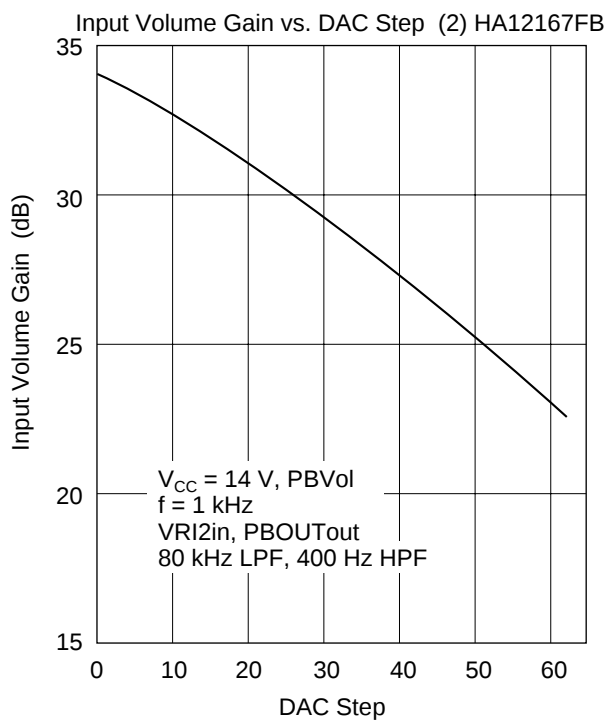
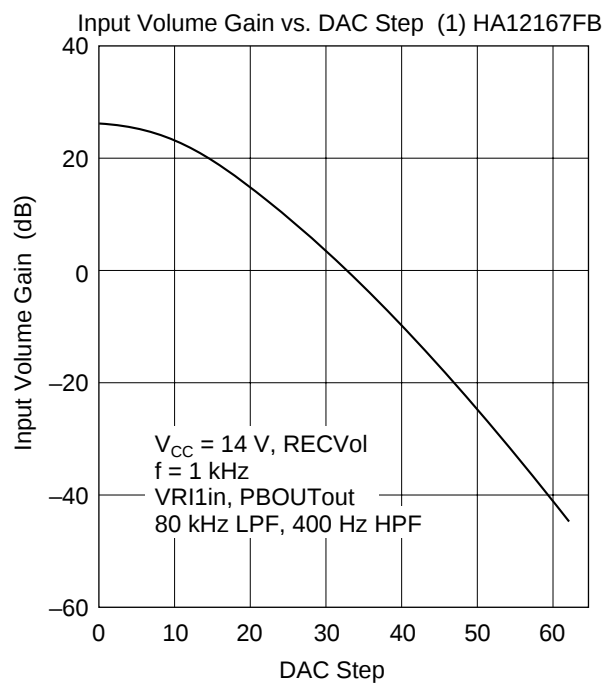
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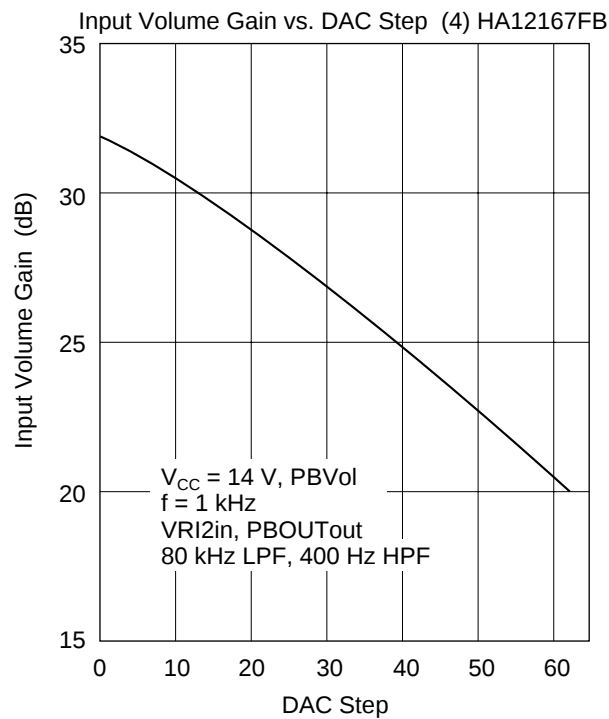
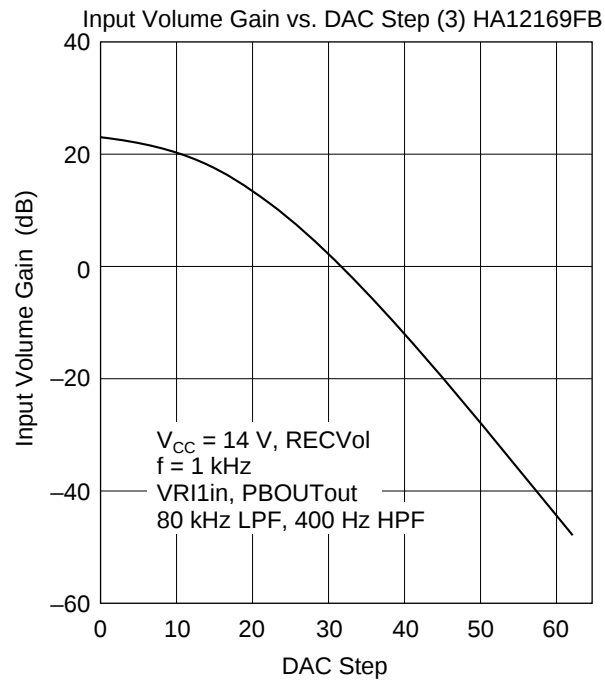


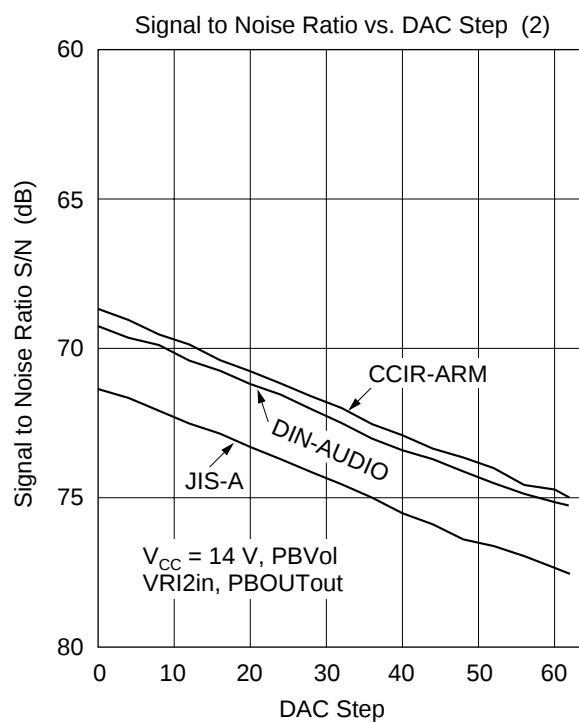
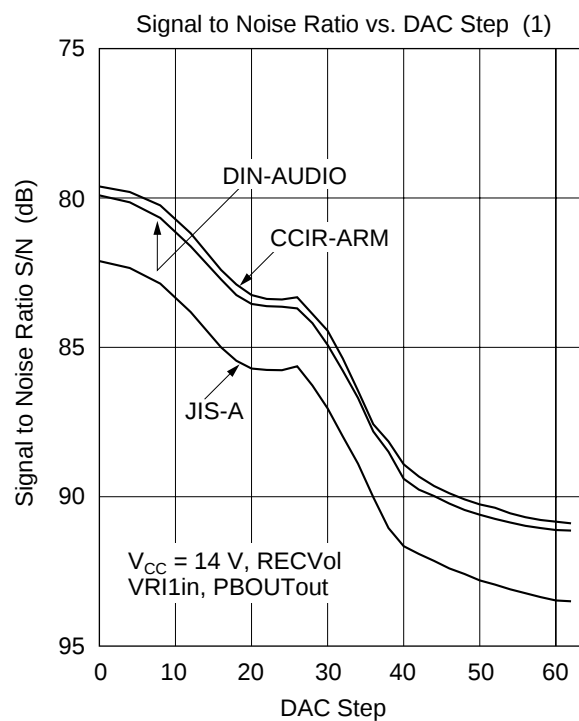
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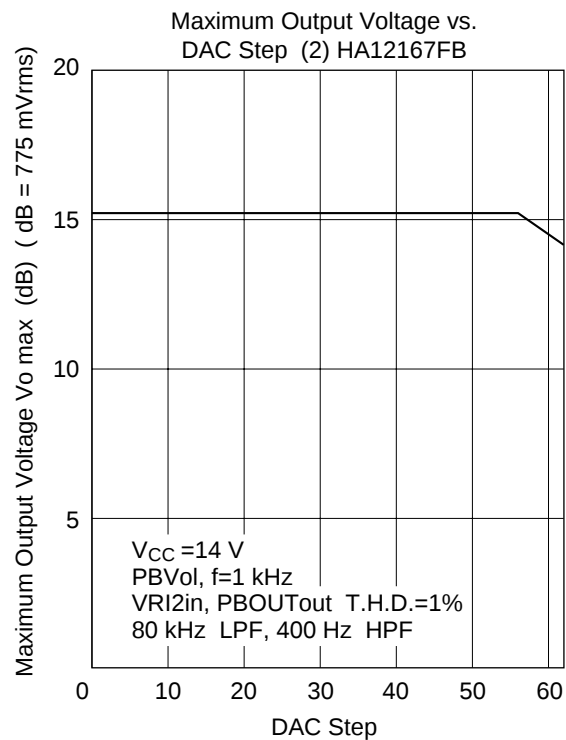
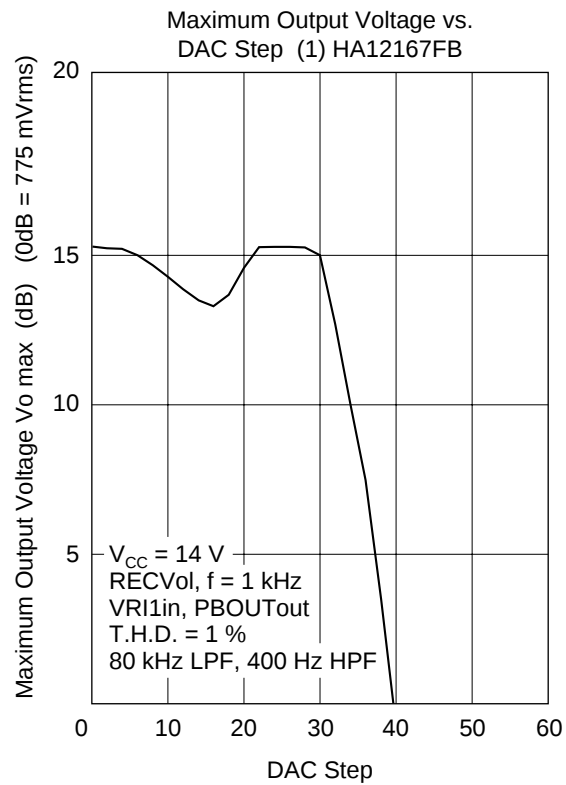


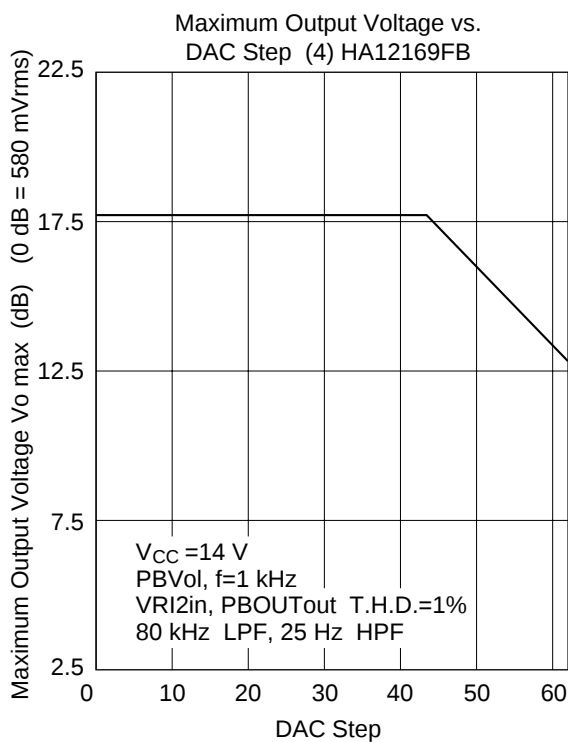
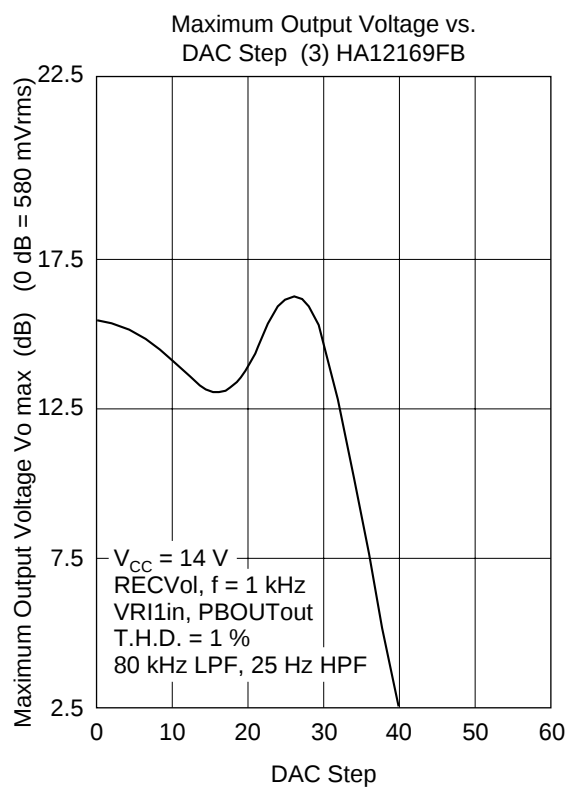
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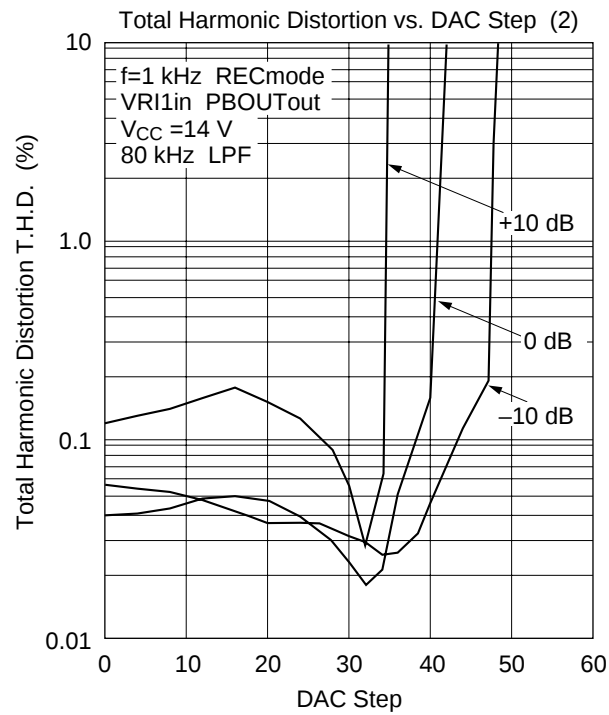
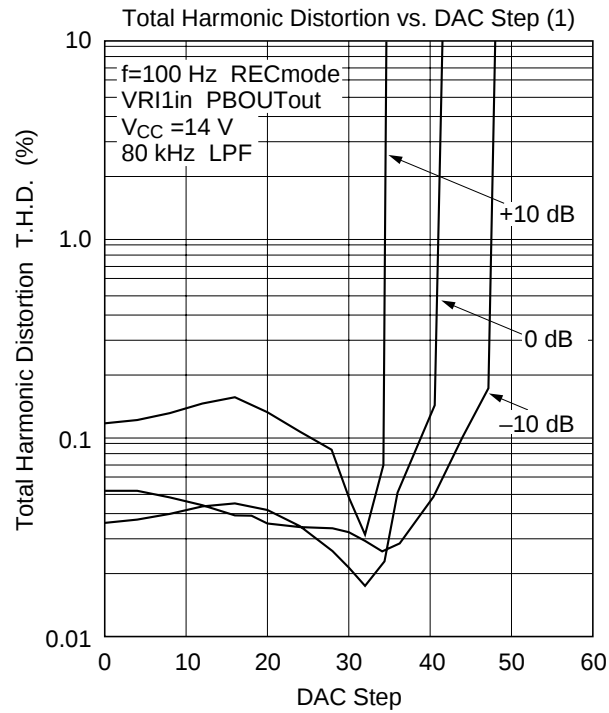


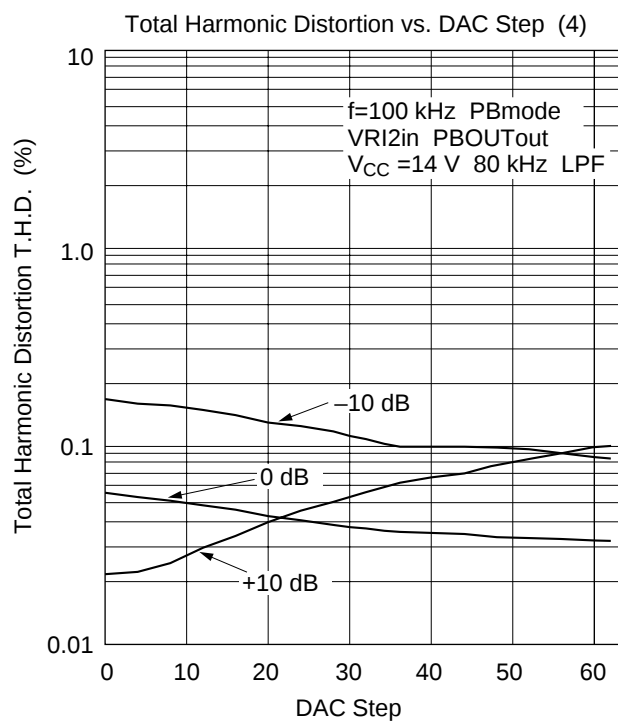
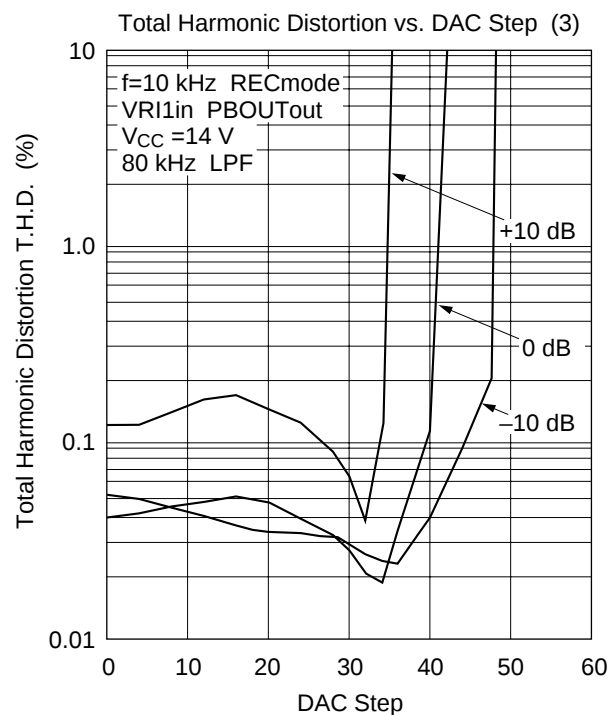
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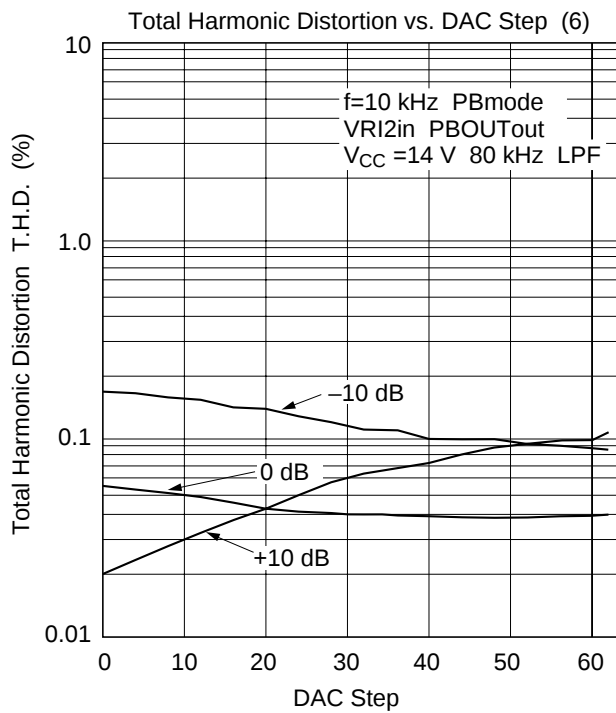
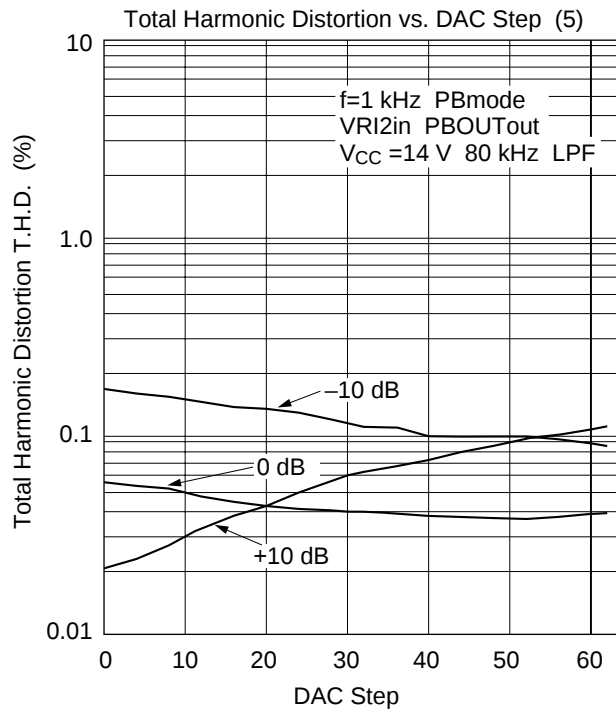


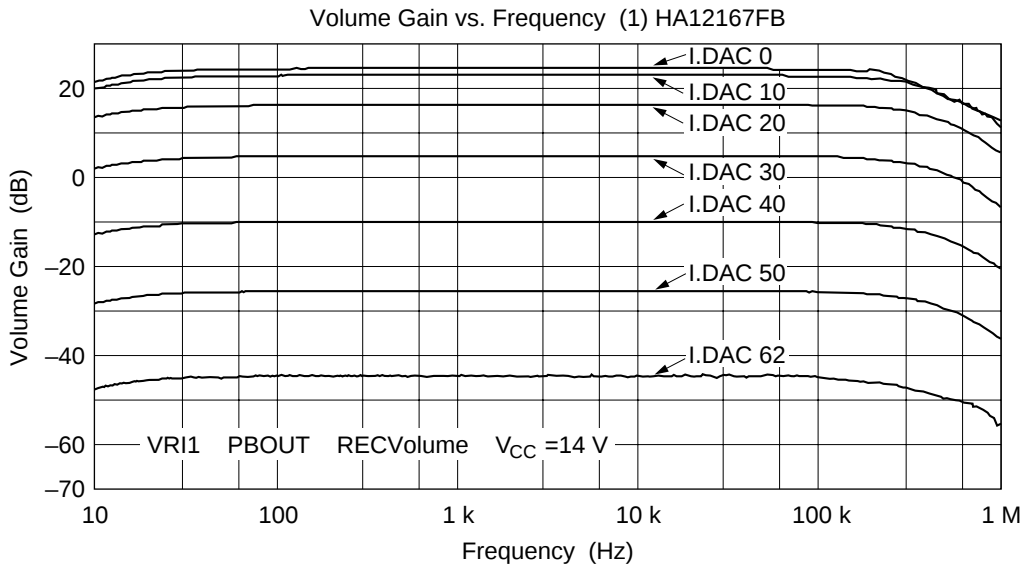
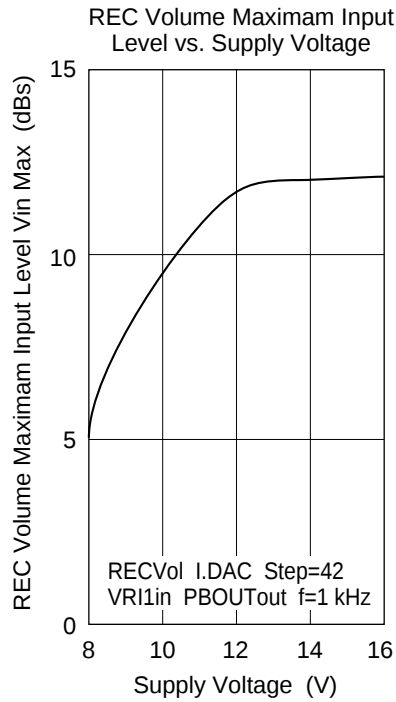
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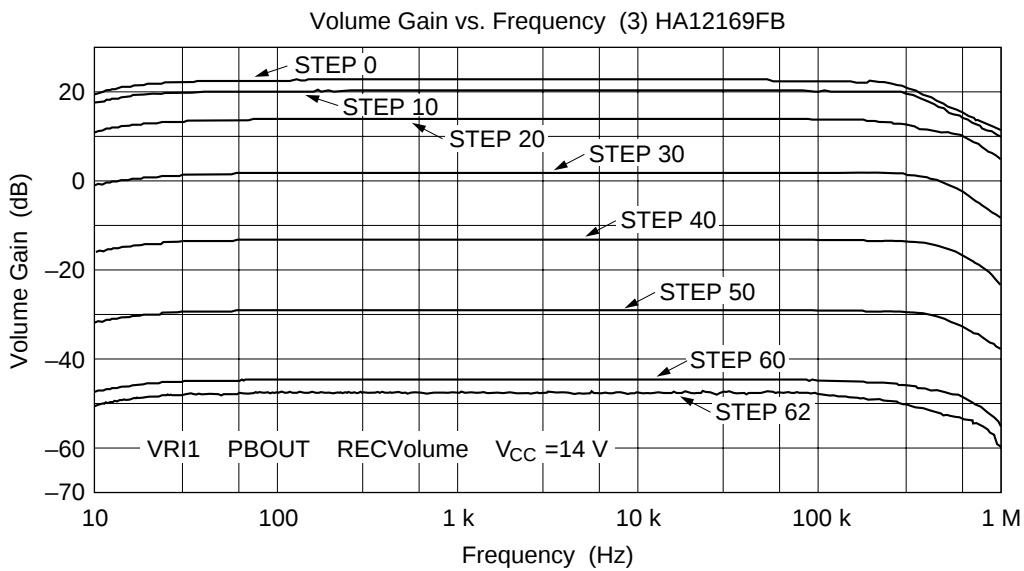
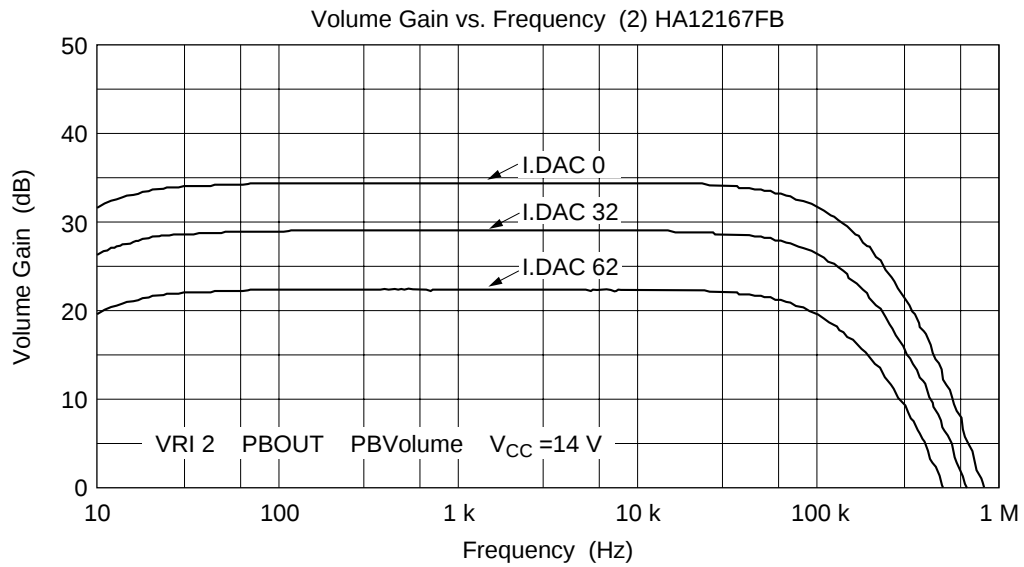


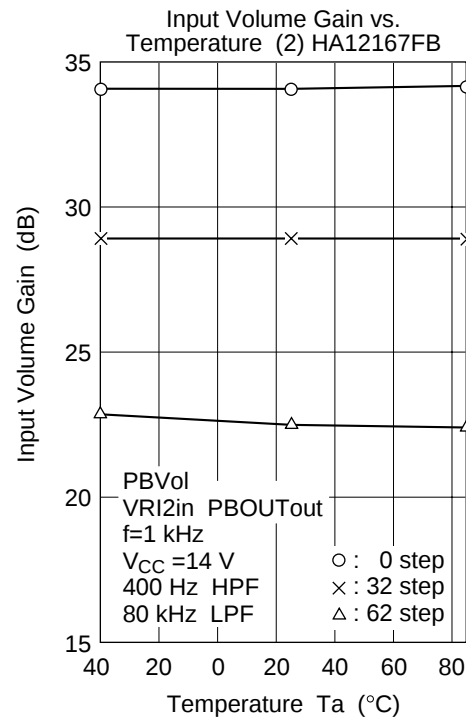
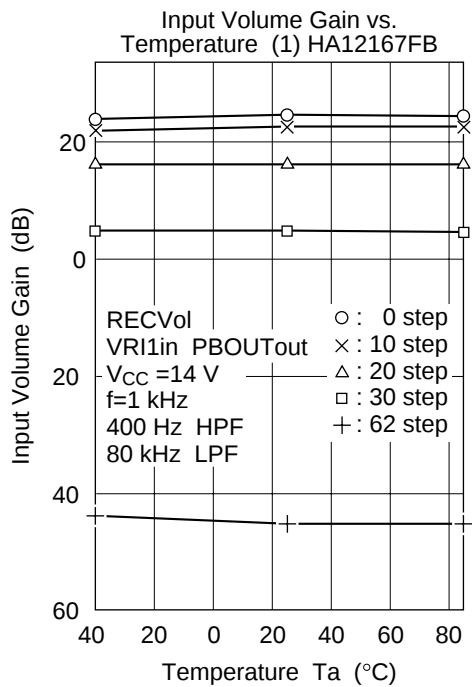
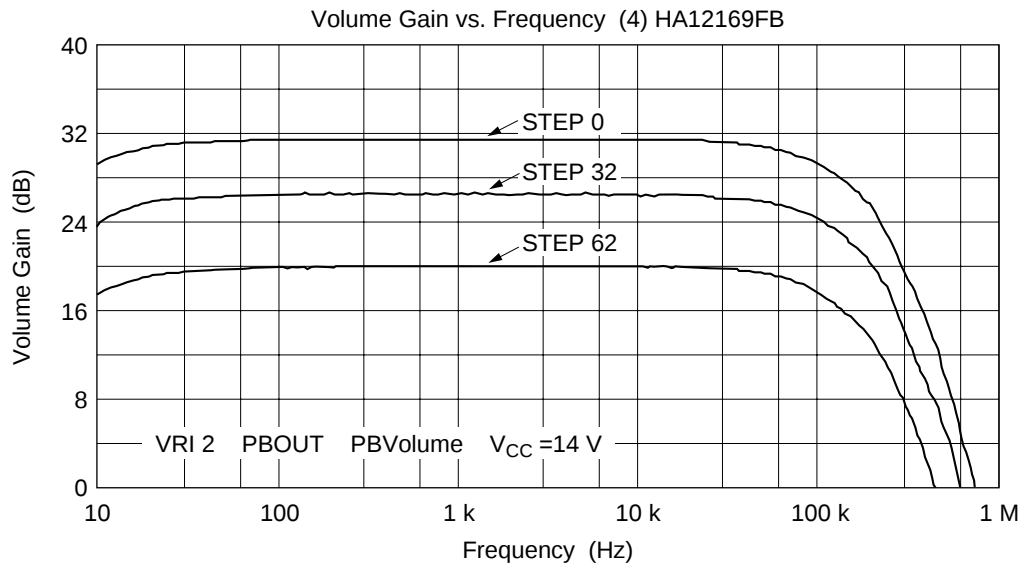
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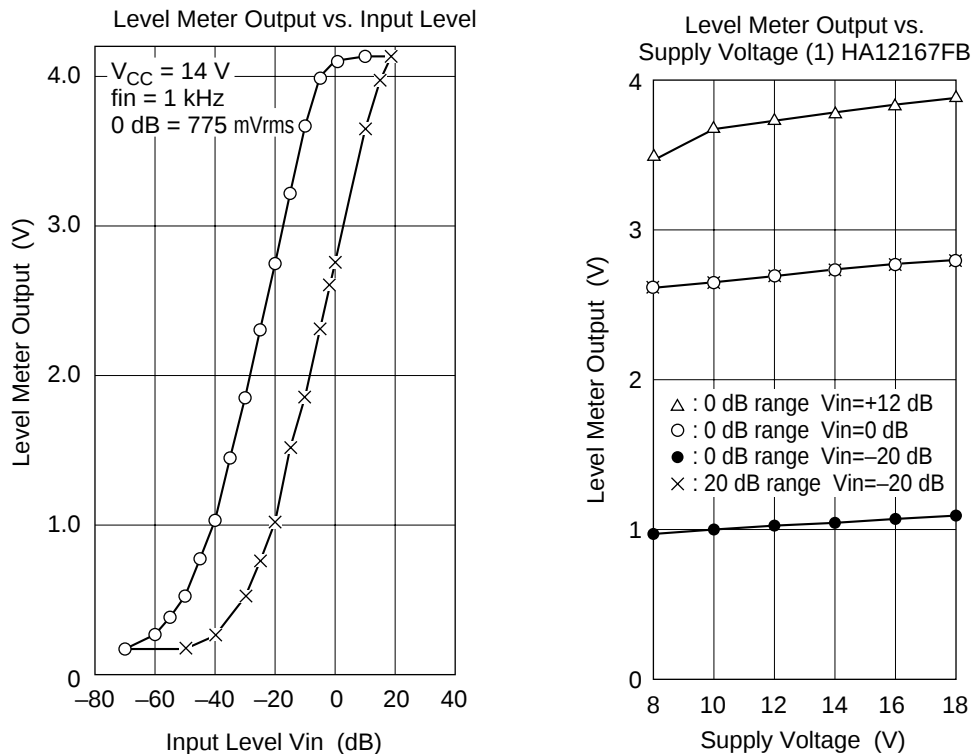
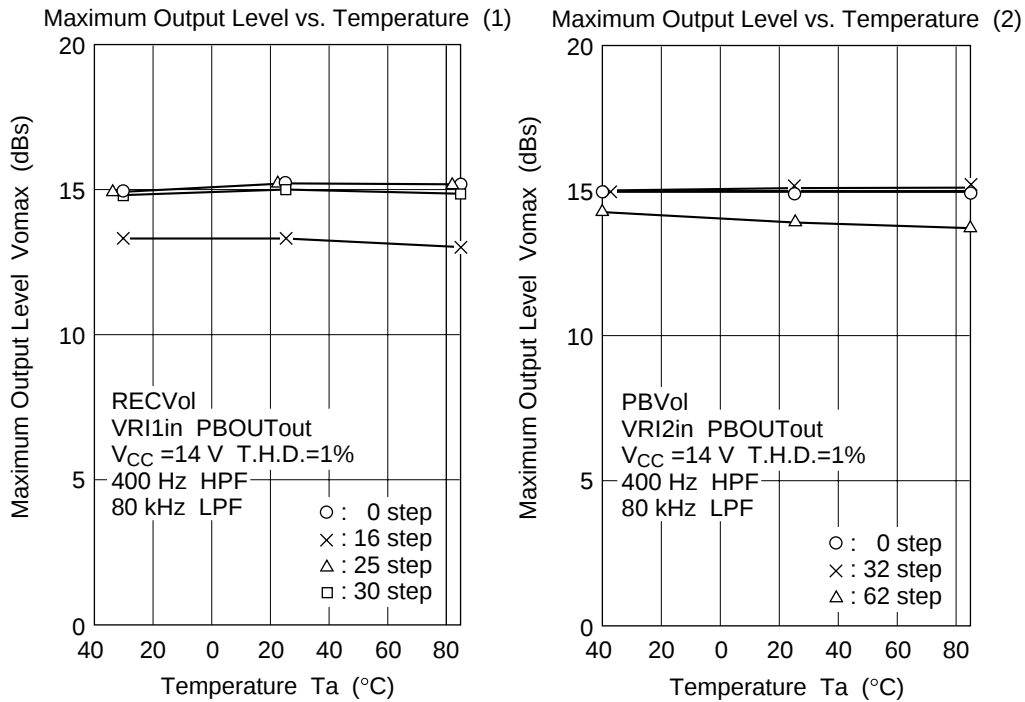


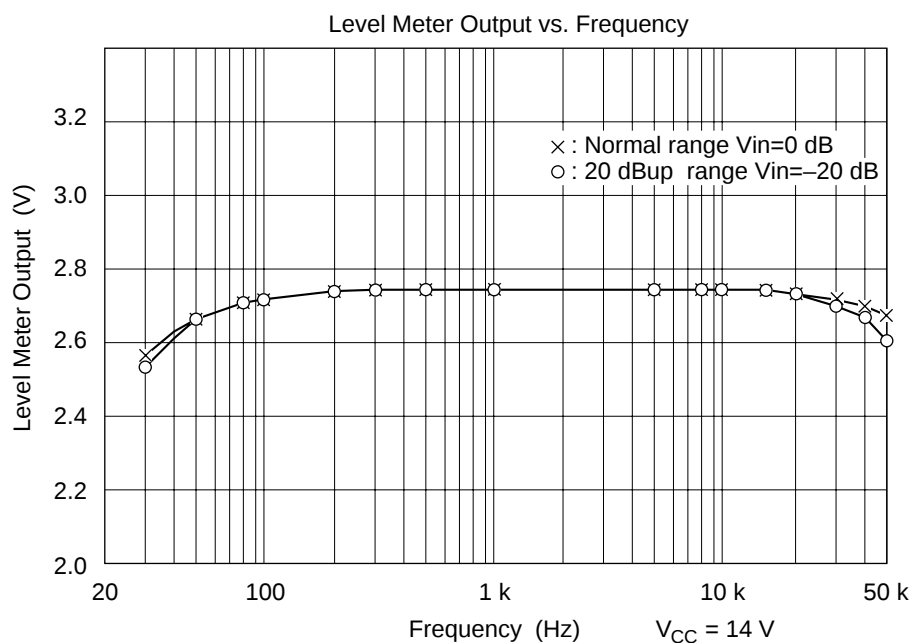
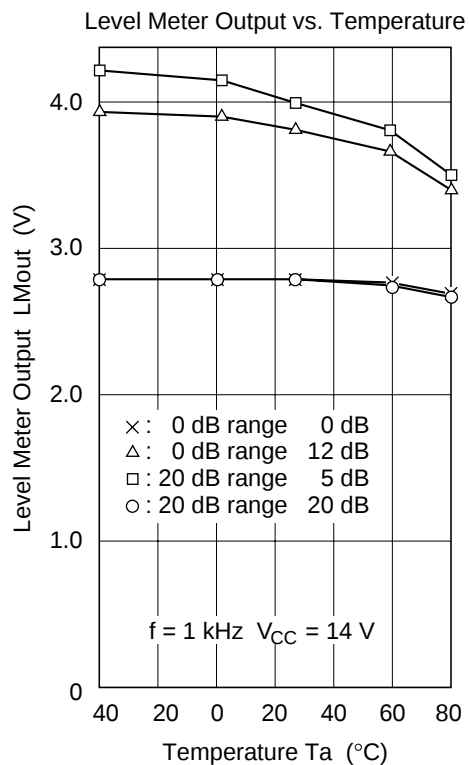
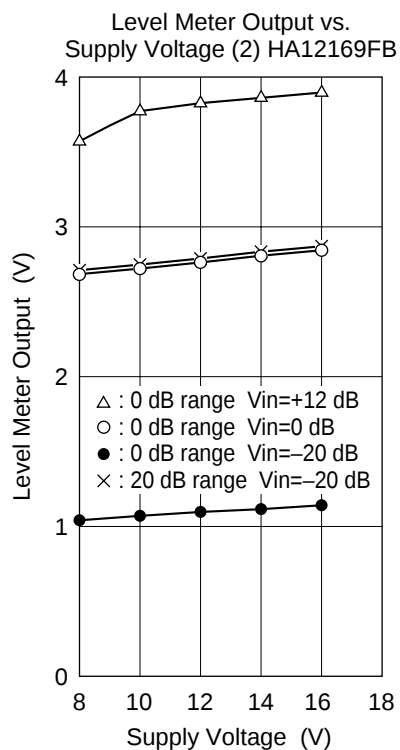
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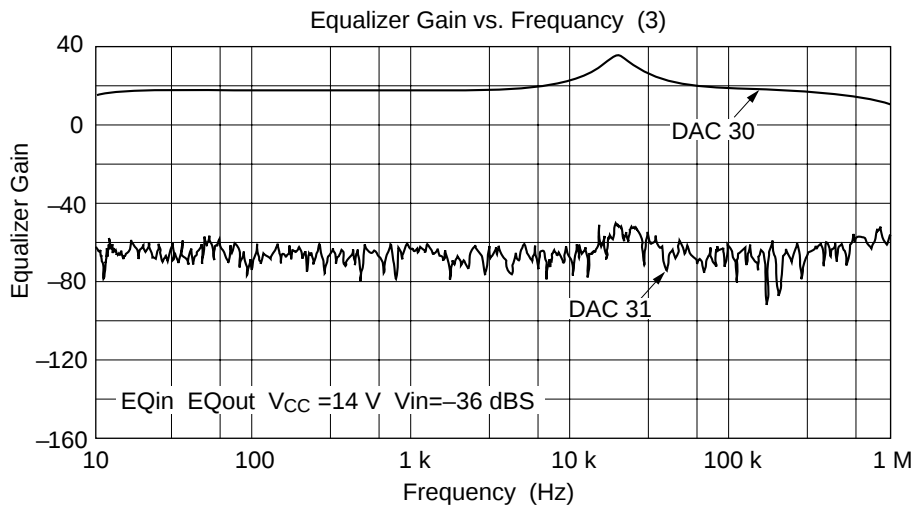
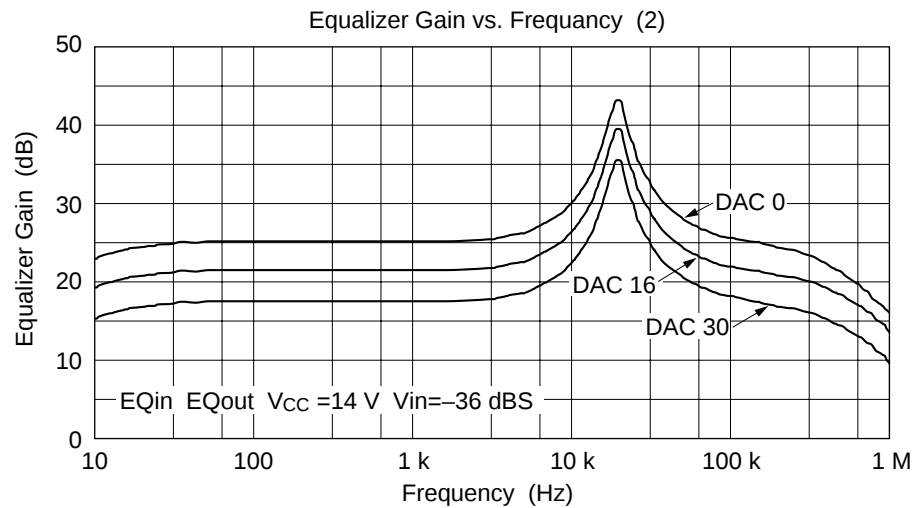
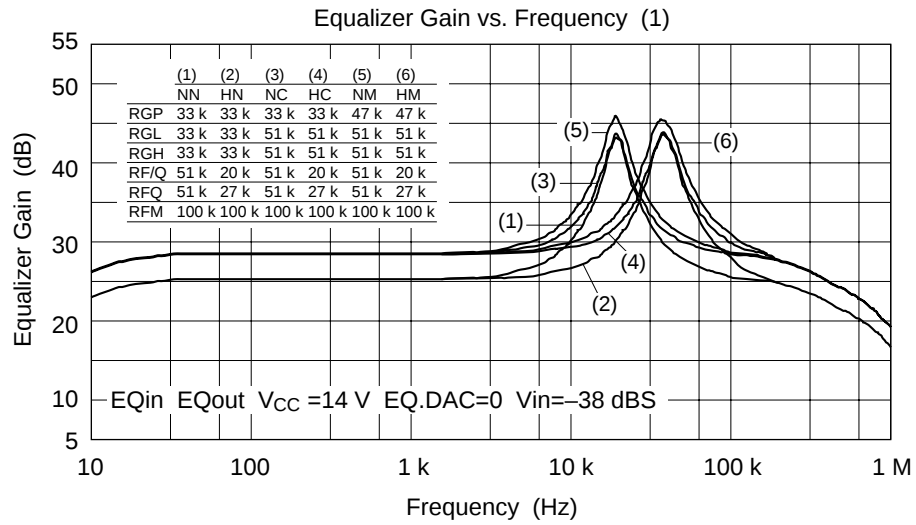


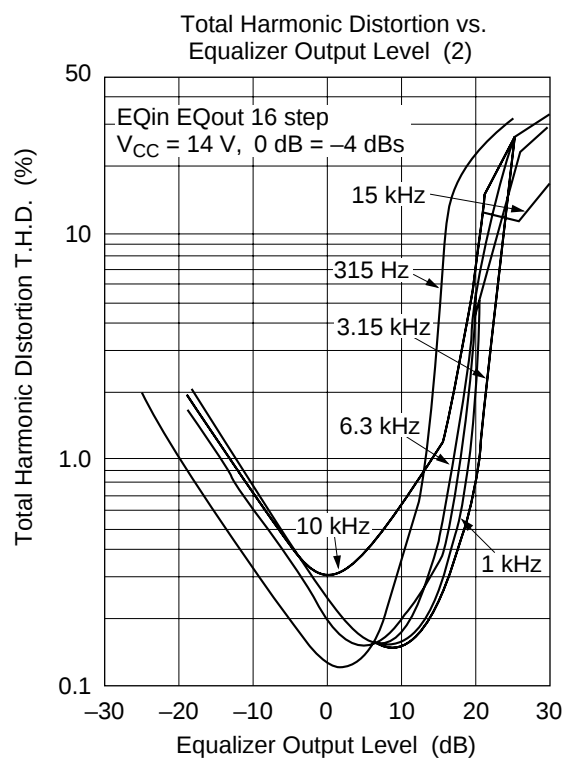
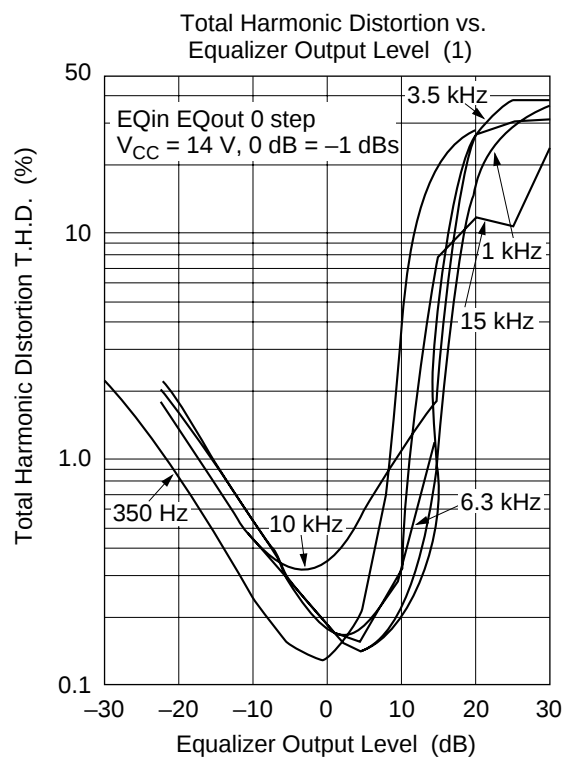
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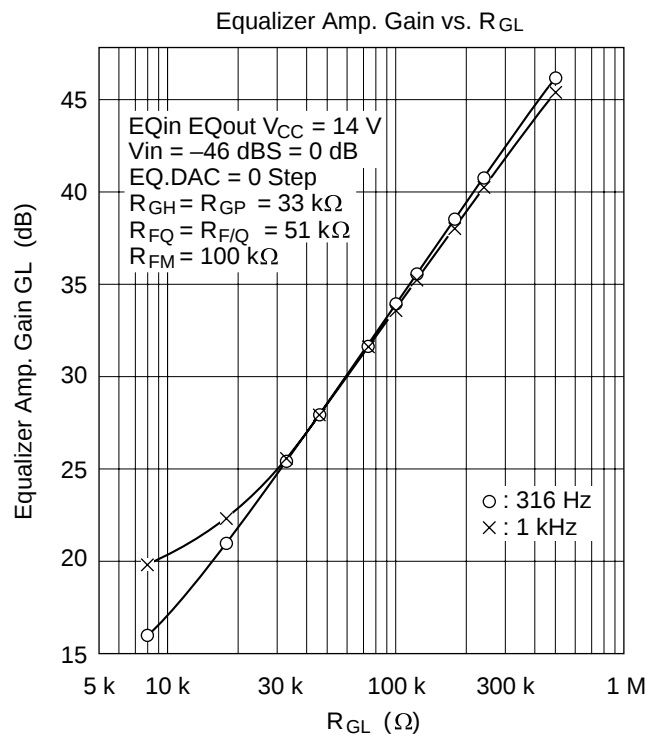
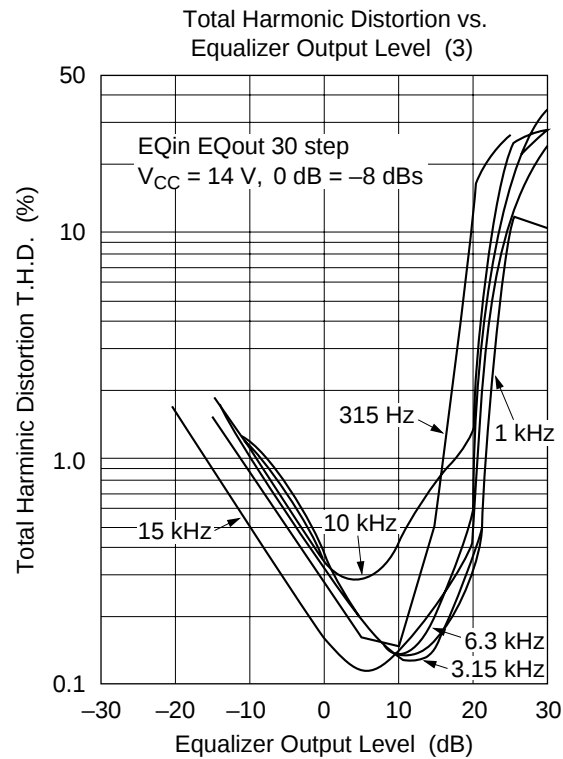


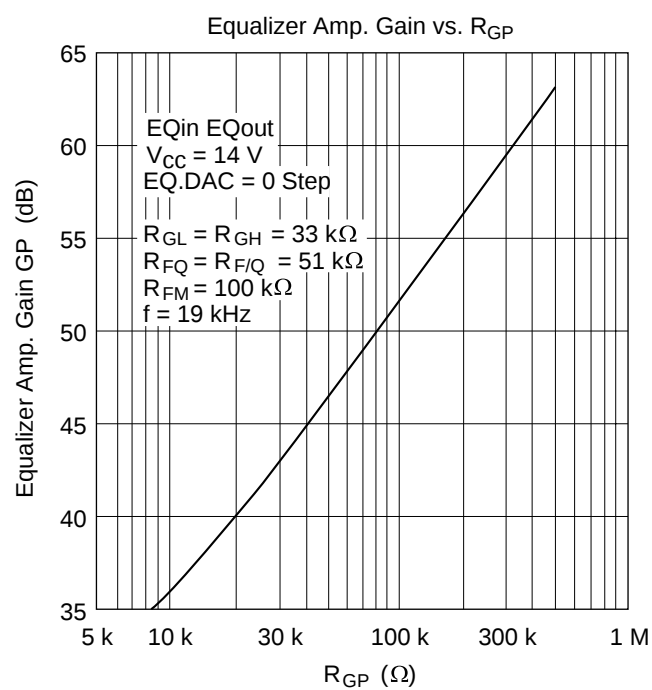
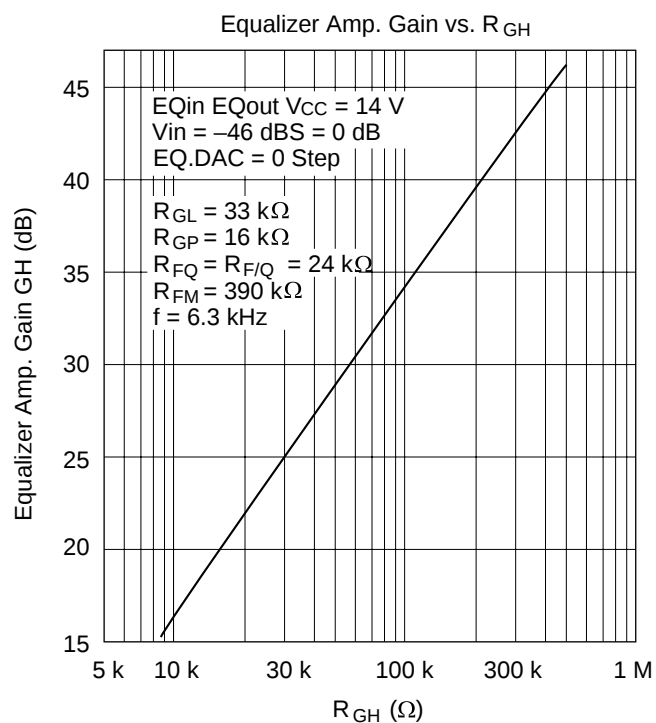
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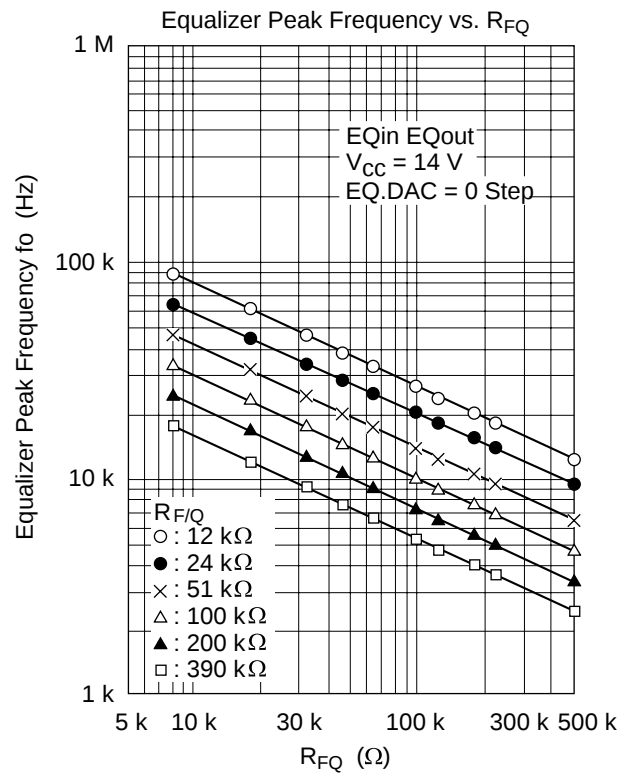
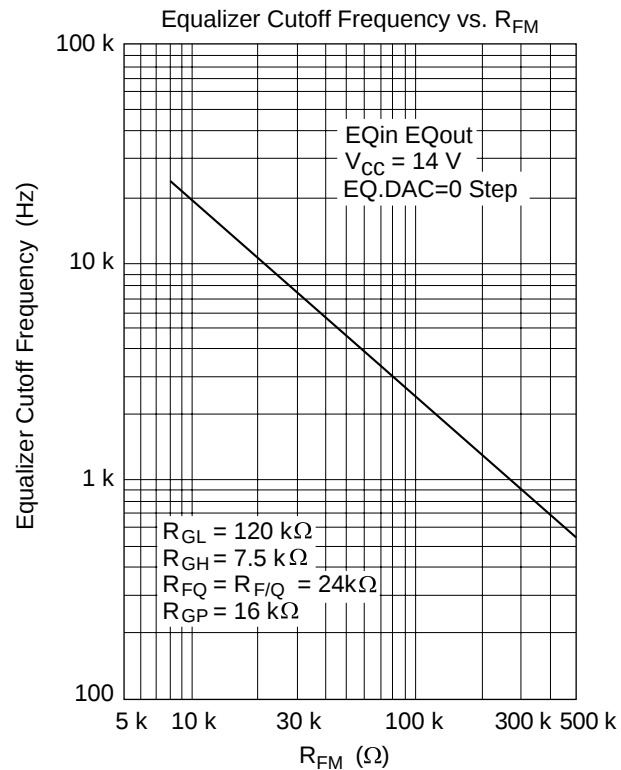


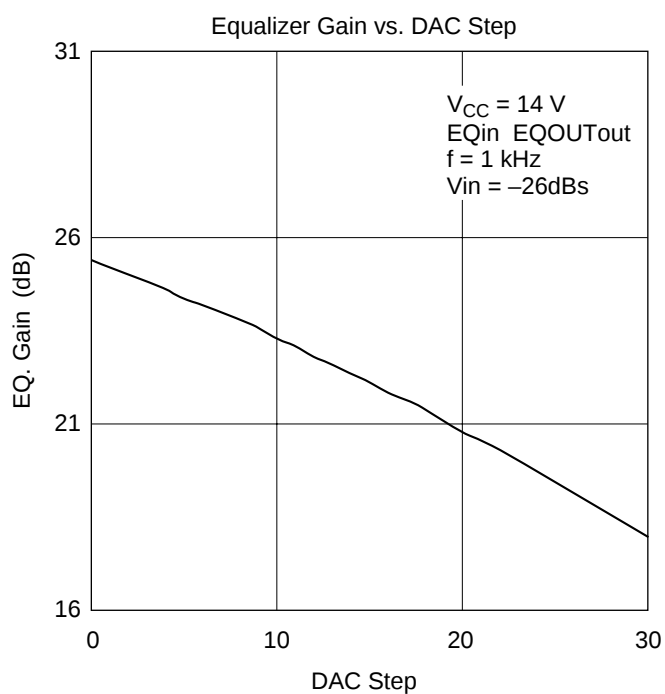
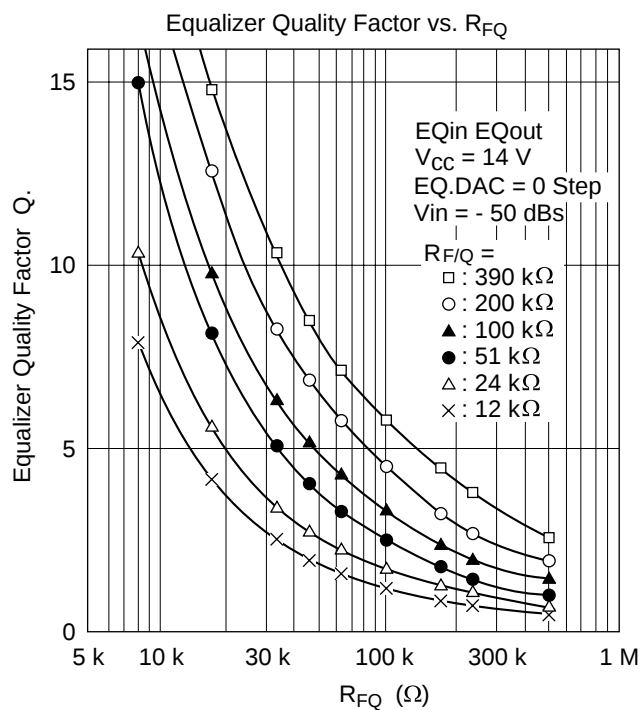


# HA12167FB/HA12169FB

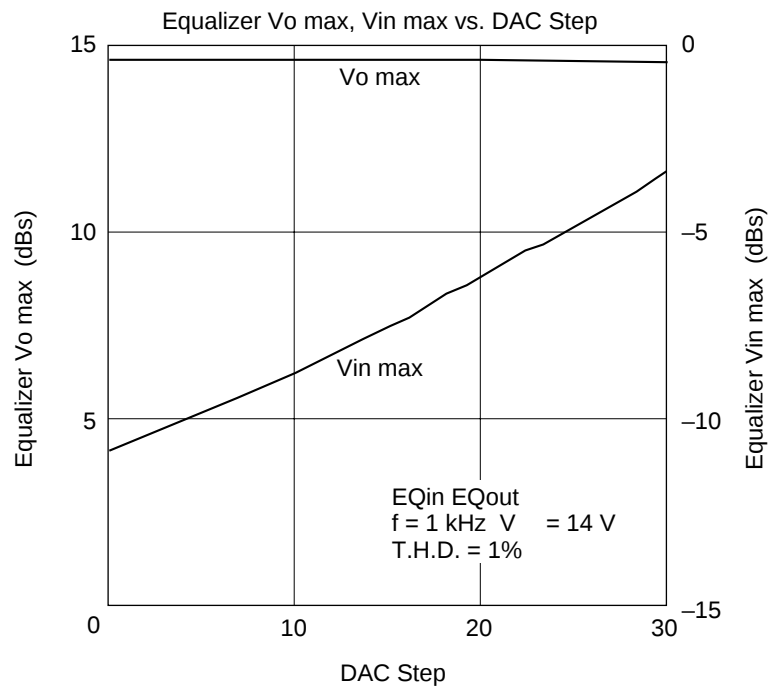
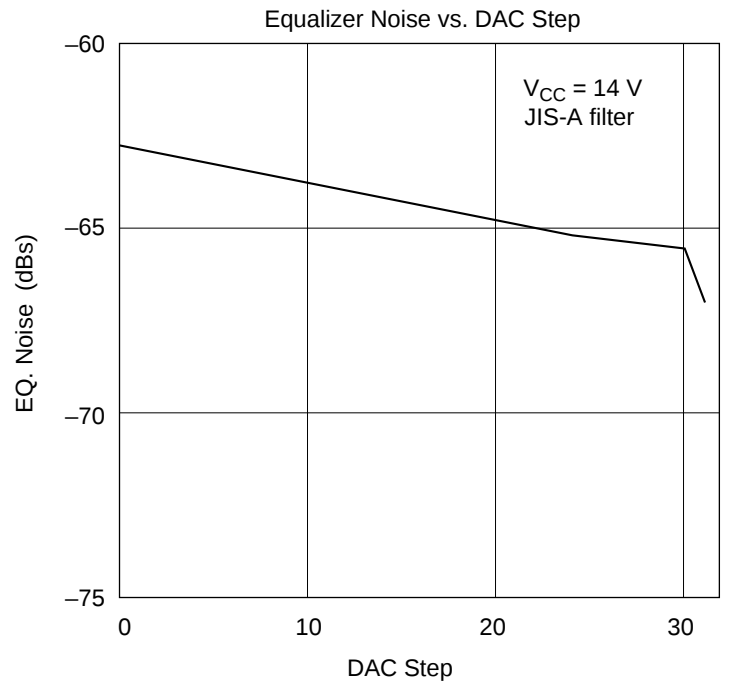




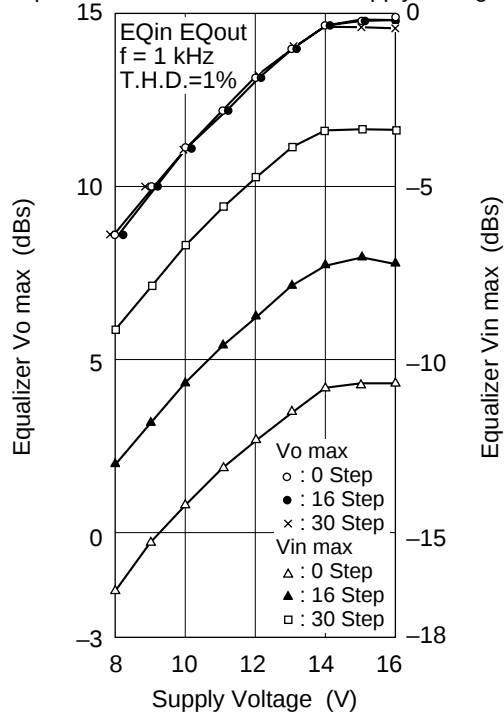




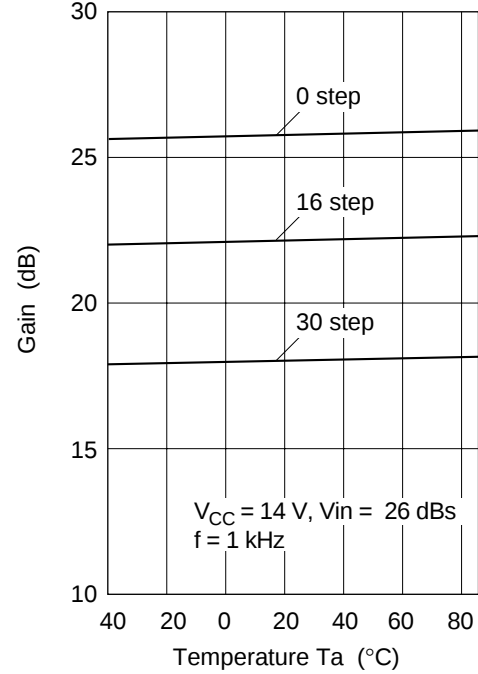
## HA12167FB/HA12169FB



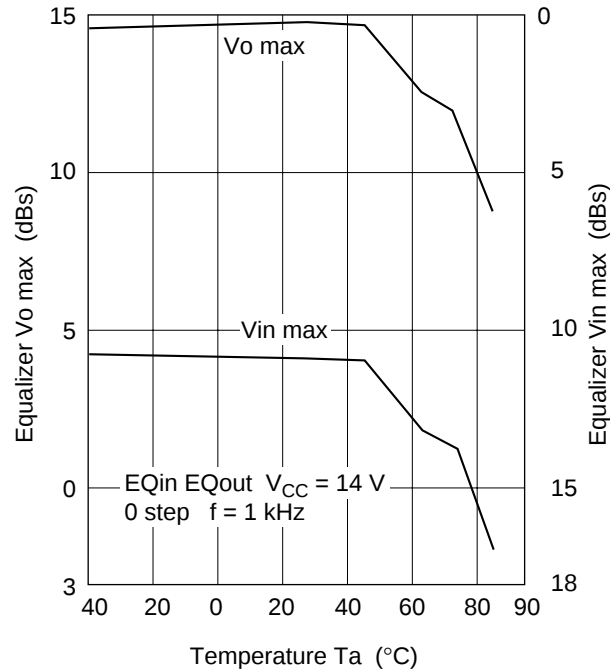
Equalizer Vo max, Vin max vs. Supply Voltage



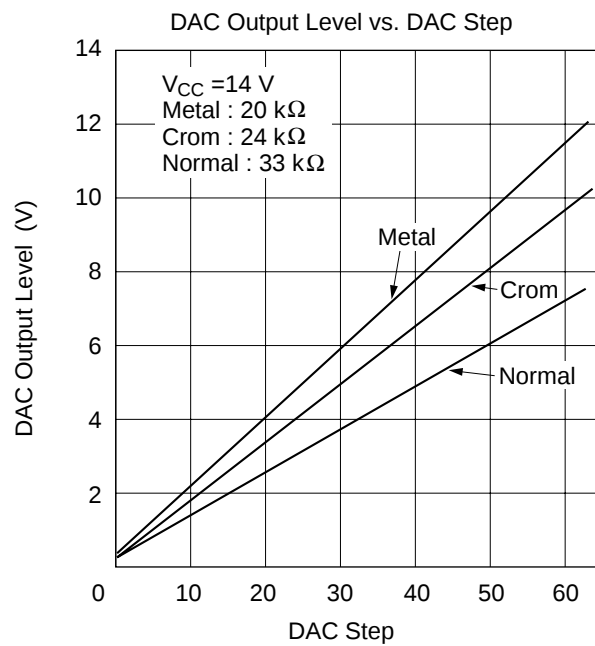
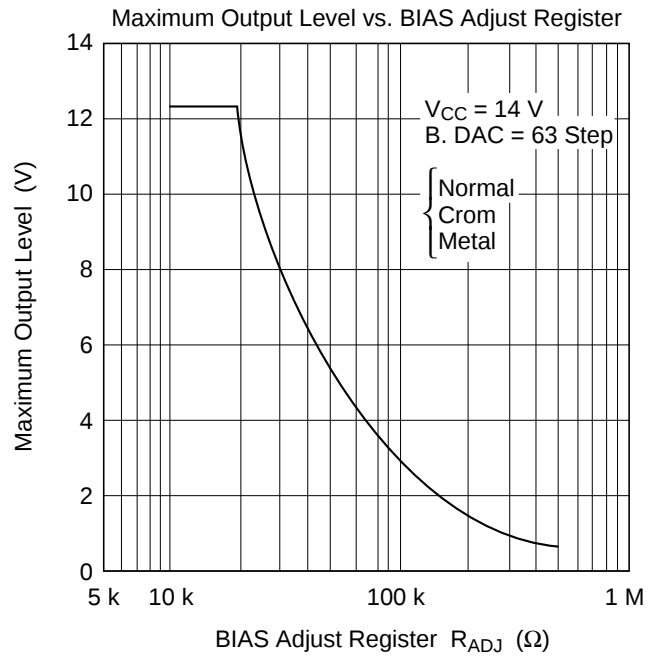
Equalizer Gain vs. Temperature

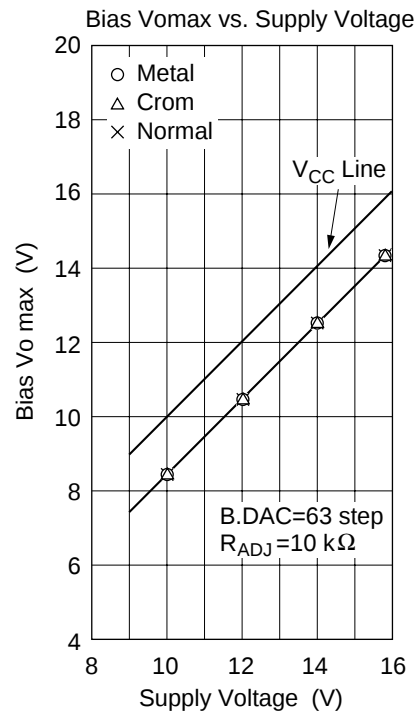


Equalizer Vo max, Vin max vs. Temperature



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