

## 6-line EMI filter and ESD protection for audio interface

### Features

- 4-line EMI filter and ESD protection for internal and external (headset) microphone
- 2-line EMI filter and ESD protection for headset speaker

### Benefits

- EMI (I/O) low-pass filter
- High efficiency EMI filter
- Very low PCB space consumption: 4.6 mm<sup>2</sup>
- Very thin package: 0.65 mm
- High efficiency in ESD suppression
- High reliability offered by monolithic integration
- High reduction of parasitic elements through integration and wafer level packaging

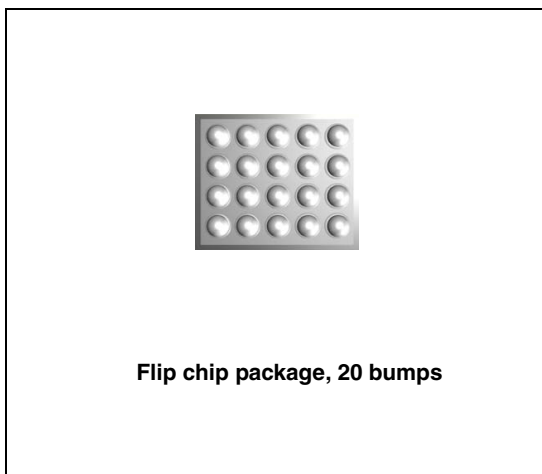
### Complies with following standards

- IEC 61000-4-2 level 4 external pins
  - 15 kV (air discharge)
  - 8 kV (contact discharge)
- IEC 61000-4-2 level 1 internal pins
  - 2 kV (air discharge)
  - 2 kV (contact discharge)

### Applications

ESD protection and EMI/RFI filtering for the audio bottom connector interface, where EMI filtering in ESD sensitive equipment is required:

- Mobile phones and communication systems
- Wireless modules

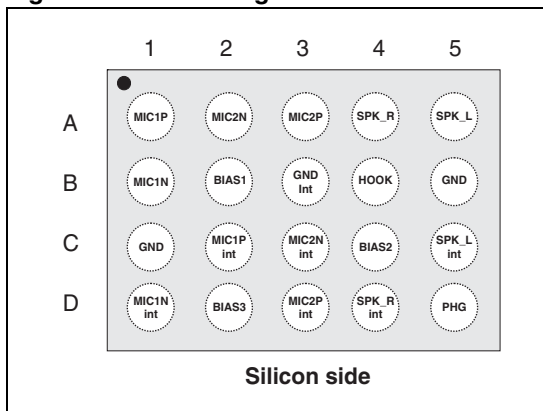


### Description

The EMIF06-AUD01F2 is a highly integrated device designed to suppress EMI/RFI noise in all systems subjected to electromagnetic interference. The flip chip packaging means the package size is equal to the die size.

This filter includes ESD protection circuitry, which prevents damage to the application when it is subjected to ESD surges up to 15 kV.

**Figure 1. Pin configuration**



# 1 Characteristics

Figure 2. Circuit schematic

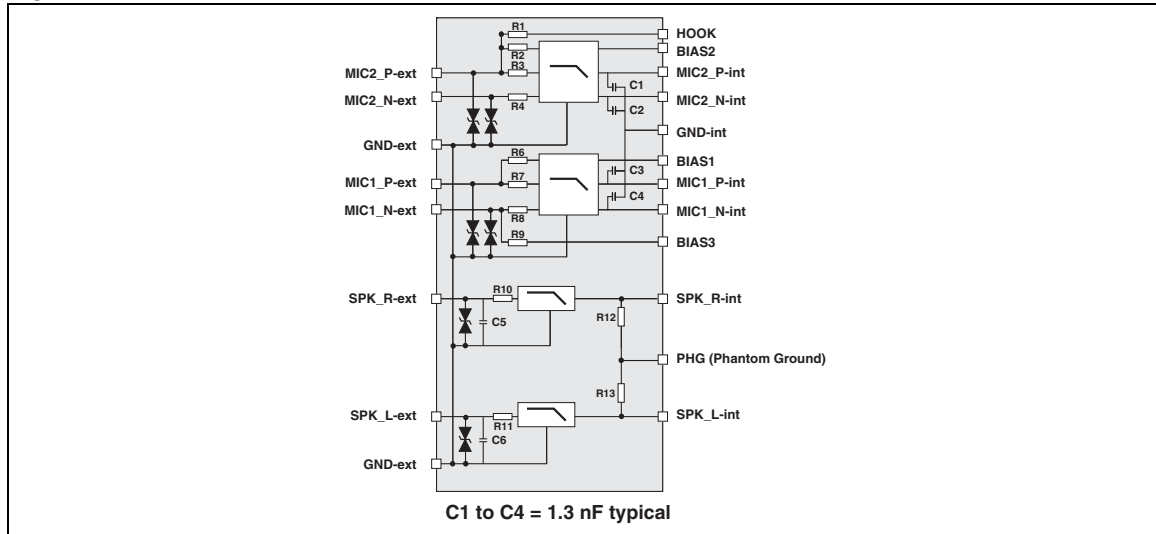


Table 1. Absolute ratings (limiting values)

| Symbol      | Parameter   | Test conditions                        | Min | Max  | Unit               |
|-------------|---|--|-----|------|--------------------|
| $V_{PP}$    | IEC61000-4-2 air discharge on external lines          |  |     | 15   | kV                 |
|             | IEC61000-4-2 contact discharge on external lines      |  |     | 15   |                    |
|             | IEC61000-4-2 air discharge on internal lines          |  |     | 2    |                    |
|             | IEC61000-4-2 contact discharge on internal lines      |  |     | 2    |                    |
| $P_{SPK}$   | Continuous power dissipation per channel SPK_L, SPK_R | $T_{amb} = 85\text{ }^{\circ}\text{C}$ |     | 180  | mW                 |
| $I_{SPK}$   | Continuous current per channel SPK_L, SPK_R           | $T_{amb} = 85\text{ }^{\circ}\text{C}$ |     | 135  | mA                 |
| $P_{total}$ | Total continuous power dissipation                    | $T_{amb} = 85\text{ }^{\circ}\text{C}$ |     | 285  | mW                 |
| $T_{op}$    | Operating temperature range                           |  | -40 | +85  | $^{\circ}\text{C}$ |
| $T_{stg}$   | Storage temperature range                             |  | -40 | +125 | $^{\circ}\text{C}$ |
| $T_j$       | Junction temperature                                  |  |     | +125 | $^{\circ}\text{C}$ |

Table 2. Electrical characteristics - definitions ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ )

| Symbol     | Parameters                 |
|------------|----------------------------|
| $V_{BR}$   | Breakdown voltage          |
| $I_{RM}$   | Leakage current @ $V_{RM}$ |
| $V_{RM}$   | Stand-off voltage          |
| $V_{CL}$   | Clamping voltage           |
| $R_d$      | Dynamic impedance          |
| $I_{PP}$   | Peak pulse current         |
| $C_{line}$ | Input capacitance per line |

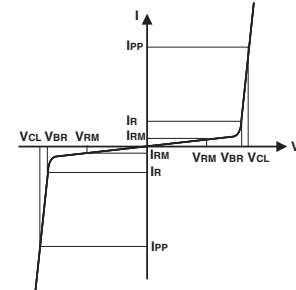


Table 3. Electrical characteristics - values ( $T_{amb} = -40\text{ °C}$  to  $+85\text{ °C}$  unless otherwise specified)

| Symbol                       | Parameter  | Test conditions   | Min  | Typ | Max | Unit          |
|------------------------------|--|---|------|-----|-----|---------------|
| $V_{BR}$                     | Diode reverse breakdown voltage                      | $I_R = 1\text{ mA}$<br>$T_{amb} = 25\text{ °C}$   | 14.0 |     |     | V             |
| $I_{RM}$                     | Leakage current through clamping diodes              | $V_R = 3\text{ V DC per line}$<br>$T_{amb} = 25\text{ °C}$  |      |     | 0.5 | $\mu\text{A}$ |
| C1-C4 <sup>(1)</sup>         | Capacitance on MIC lines                             | $V = 0\text{ V}$ , $F = 1\text{ MHz}$ ,<br>$V_{OSC} = 30\text{ mV}$<br>$T_{amb} = 25\text{ °C}$   |      | 1.3 |     | nF            |
| C5-C6 <sup>(1)</sup>         | Channel Capacitance SPK_L, SPK_R                     |   |      | 60  |     | pF            |
| R1 <sup>(2)</sup>            | Hook Pull up resistance                              |   |      | 47  |     | k $\Omega$    |
| R2 <sup>(2)</sup>            | External Microphone Pull up resistance               |   |      | 2.2 |     | k $\Omega$    |
| R3,R4, R7, R8 <sup>(2)</sup> | Microphone Serial Resistance                         |   |      | 100 |     | $\Omega$      |
| R6, R9 <sup>(2)</sup>        | Internal Microphone Pull up and Pull down resistance |   |      | 1   |     | k $\Omega$    |
| R10, R11 <sup>(3)</sup>      | SPK Serial Resistance                                |   |      | 10  |     | $\Omega$      |
| R12, R13 <sup>(2)</sup>      | SPK PHG Resistance                                   |   |      | 15  |     | k $\Omega$    |
| MICx channel THD             | Distortion   | $V_{dc} = 0 - 2.4\text{ V}$ , <sup>(4)</sup><br>$F = 20\text{ Hz} - 20\text{ kHz}$ ,<br>$R_{gen} = 600\ \Omega$ ,<br>$V_{out} = 1.5\text{ V}_{PP}$ ,<br>$R_{load} = 200\text{ k}\Omega$ ,<br>$T_{amb} = 25\text{ °C}$<br>Balanced<br>(or differential mode) |      |     | -75 | dB(A)         |

1. Capacitor tolerance  $\pm 30\%$
2. Resistor tolerances  $\pm 10\%$
3. Resistor tolerances  $\pm 20\%$
4. See [Figure 20](#) and [Figure 21](#)

### 1.1 RF filtering

The low signal level on the analog inputs and the pulsed transmitter in the phone are a combination that requires efficient RF-filtering. **RF-rectification must be avoided.** Therefore, the stop band attenuation is optimized for the frequency bands 800-2480 MHz.

**Table 4. Stop band performance 800 - 2480 MHz**

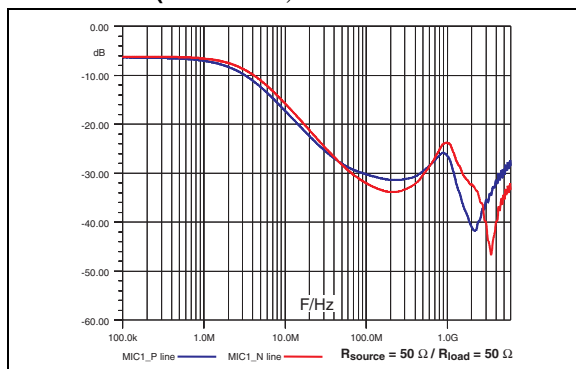
| Channel              | Test conditions                                   | Attenuation |     |     |      |
|----------------------|---|-------------|-----|-----|------|
|                      |   | Min         | Typ | Max | Unit |
| MIC1_x to MIC1_x-int | $R_{source} = 50 \Omega$ , $R_{load} = 1 k\Omega$ | 25          |     |     | dB   |
| MIC2_x to MIC2_x-int | $R_{source} = 50 \Omega$ , $R_{load} = 1 k\Omega$ | 25          |     |     | dB   |
| MIC1_P to BIAS1      | $R_{source} = 50 \Omega$ , $R_{load} = 1 k\Omega$ | 25          |     |     | dB   |
| MIC2_P to BIAS2      | $R_{source} = 50 \Omega$ , $R_{load} = 1 k\Omega$ | 25          |     |     | dB   |
| SPK_x to SPK_x-int   | $R_{source} = 50 \Omega$ , $R_{load} = 1 k\Omega$ | 25          |     |     | dB   |

**Table 5. Stop band performance 10 - 800 MHz**

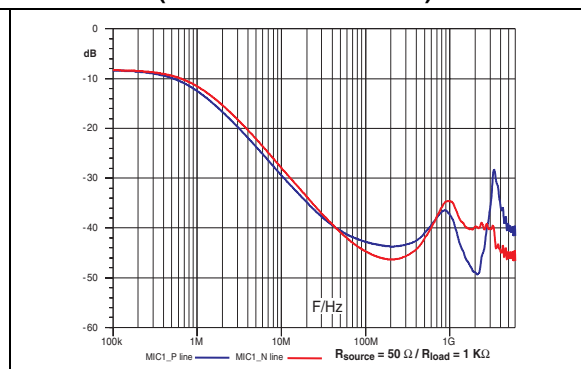
| Channel              | Test conditions                                   | Attenuation |     |     |      |
|----------------------|---|-------------|-----|-----|------|
|                      |   | Min         | Typ | Max | Unit |
| MIC1_x to MIC1_x-int | $R_{source} = 50 \Omega$ , $R_{load} = 1 k\Omega$ | 20          |     |     | dB   |
| MIC2_x to MIC2_x-int | $R_{source} = 50 \Omega$ , $R_{load} = 1 k\Omega$ | 20          |     |     | dB   |
| MIC1_P to BIAS1      | $R_{source} = 50 \Omega$ , $R_{load} = 1 k\Omega$ | 20          |     |     | dB   |
| MIC2_P to BIAS2      | $R_{source} = 50 \Omega$ , $R_{load} = 1 k\Omega$ | 20          |     |     | dB   |

### 1.2 Attenuation characteristics

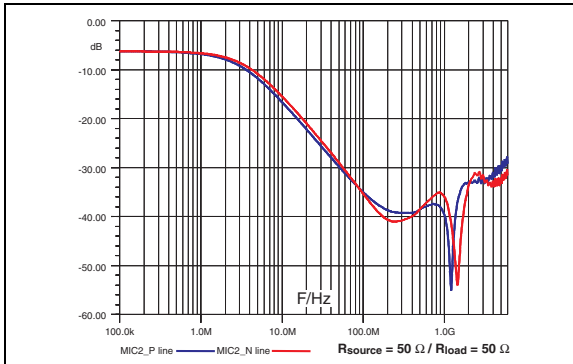
**Figure 3. S21 attenuation measurement MIC1\_P and MIC1\_N lines (50 Ω / 50 Ω)**



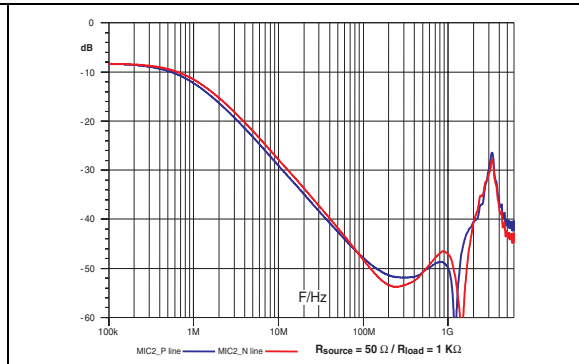
**Figure 4. S21 attenuation measurement MIC1\_P and MIC1\_N lines (50 Ω / 1 KΩ simulation)**



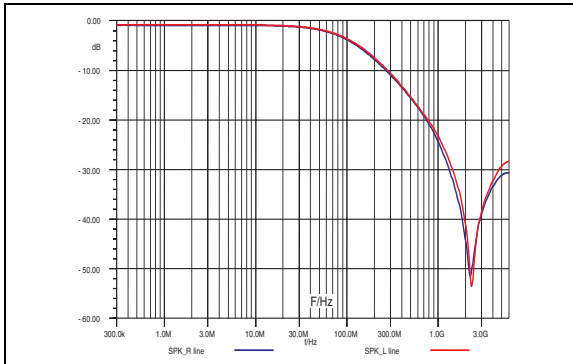
**Figure 5. S21 attenuation measurement MIC2\_P and MIC2\_N lines (50 Ω / 50 Ω)**



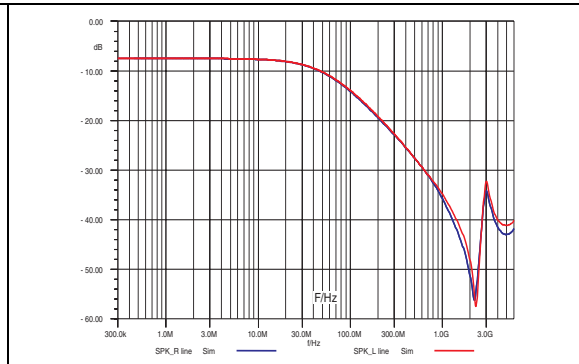
**Figure 6. S21 attenuation measurement MIC2\_P and MIC2\_N lines (50 Ω / 1 KΩ simulation)**



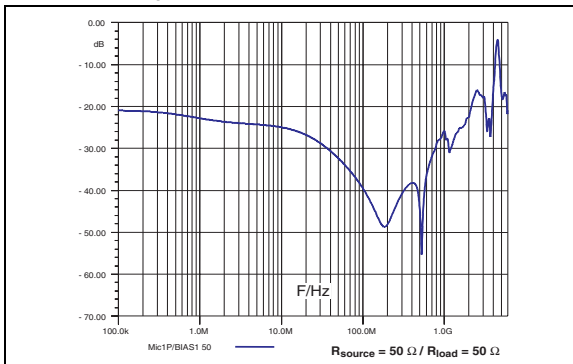
**Figure 7. S21 attenuation measurement SPK\_L and SPK\_R lines (50 Ω / 50 Ω)**



**Figure 8. S21 attenuation measurement SPK\_L and SPK\_R lines (50 Ω / 1 KΩ simulation)**



**Figure 9. S21 attenuation measurement MIC1\_P and BIAS1 lines (50 Ω / 50 Ω)**



**Figure 10. S21 attenuation measurement MIC1\_P and BIAS1 lines (50 Ω / 1 KΩ simulation)**

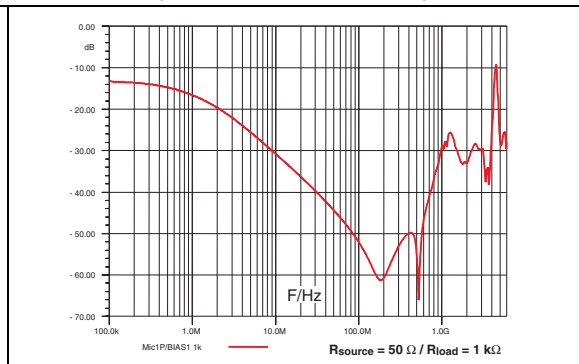


Figure 11. S21 attenuation measurement MIC2\_P and BIAS2 lines (50 Ω / 50 Ω)

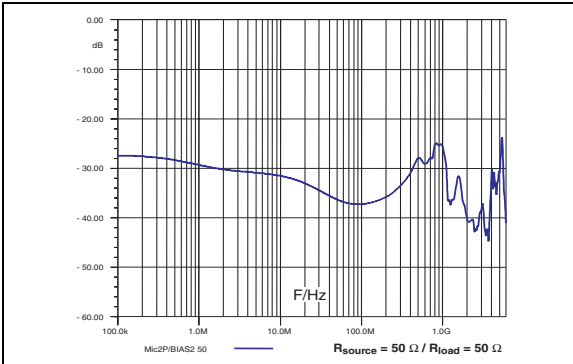
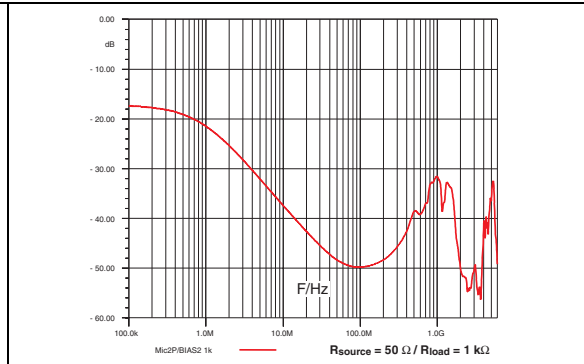


Figure 12. S21 attenuation measurement MIC2\_P and BIAS2 lines (50 Ω / 1 KΩ simulation)



### 1.3 ESD characteristics

Figure 13. ESD response to IEC 61000-4-2 (+15 kV air discharge) on input V<sub>in</sub> and output V<sub>out</sub> Mic1 line

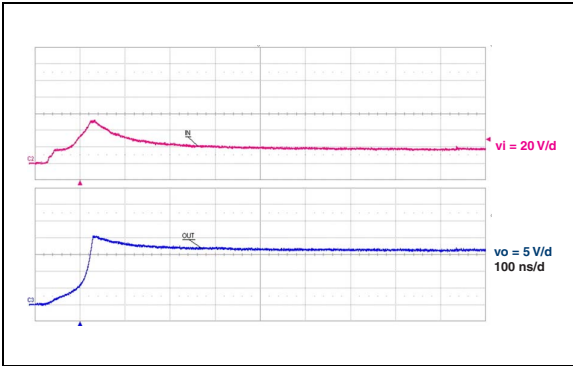


Figure 14. ESD response to IEC 61000-4-2 (-15 kV air discharge) on input V<sub>in</sub> and output V<sub>out</sub> Mic1 line

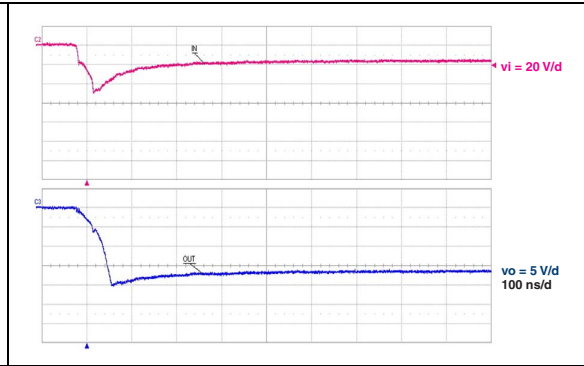


Figure 15. ESD response to IEC 61000-4-2 (+15 kV air discharge) on input V<sub>in</sub> and output V<sub>out</sub> Mic2 line

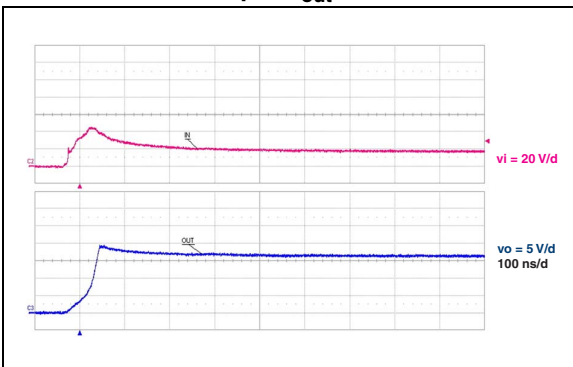
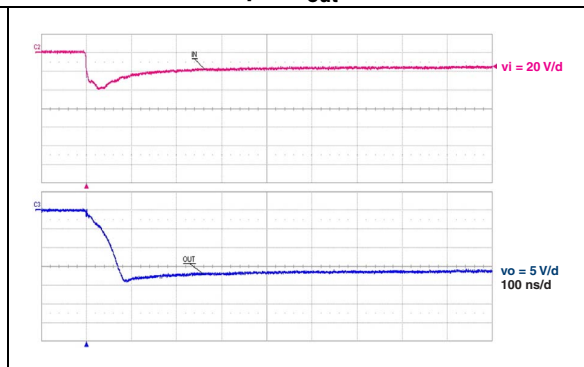


Figure 16. ESD response to IEC 61000-4-2 (-15 kV air discharge) on input V<sub>in</sub> and output V<sub>out</sub> Mic2 line



### 1.4 Filter characteristics

Figure 17. Analog crosstalk MIC2\_P and MIC1\_N lines (50 Ω / 50 Ω)

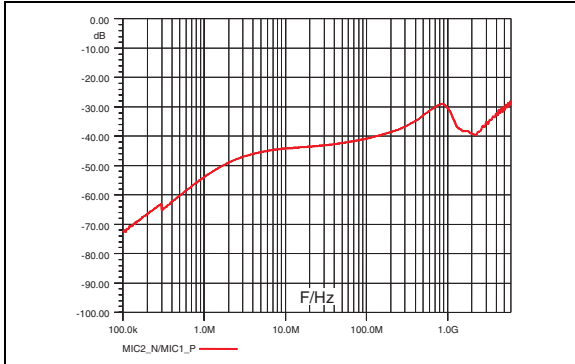
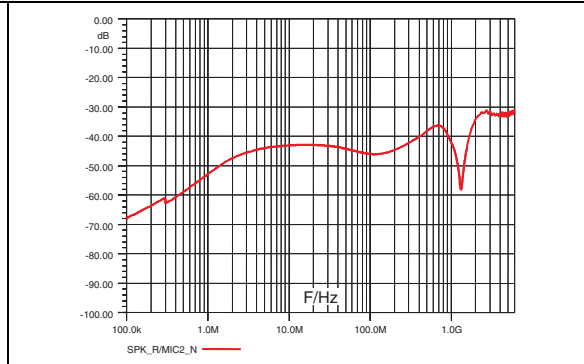


Figure 18. Analog crosstalk SPK\_R and MIC2\_N lines (50 Ω / 50 Ω)



### 1.5 Total harmonic distortion characteristics

Figure 19. Total harmonic distortion and noise with only cables and environmental circuit versus frequency,  $V_{BIAS} = 0 V$

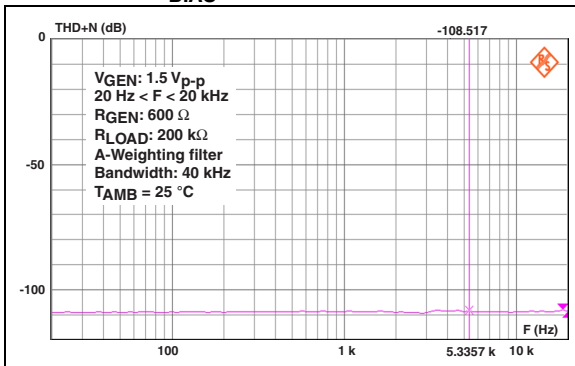


Figure 20. Variation of total harmonic distortion and noise in microphone lines versus frequency, balanced (or differential) mode,  $V_{BIAS} = 0 V$

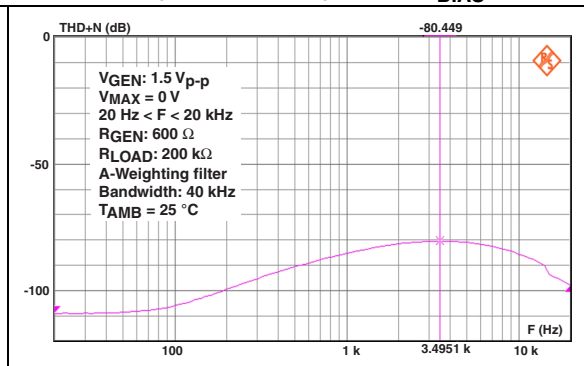


Figure 21. Variation of total harmonic distortion and noise in microphone lines versus frequency, balanced (or differential) mode,  $V_{BIAS} = 2.4\text{ V}$

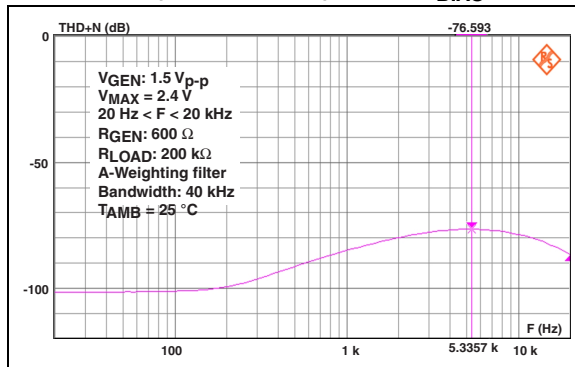


Figure 22. Variation of total harmonic distortion and noise in microphone lines versus frequency, unbalanced (or single-ended) mode

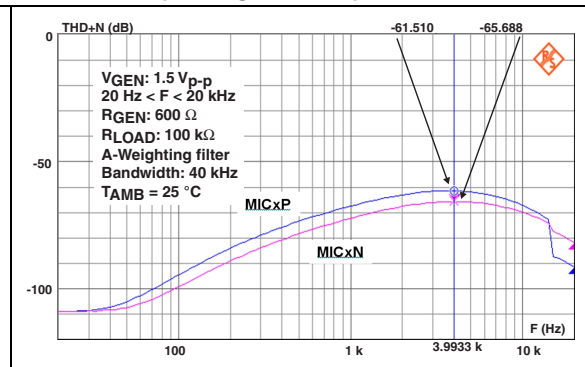


Figure 23. Test setup for measurement of distortion on MIC channels

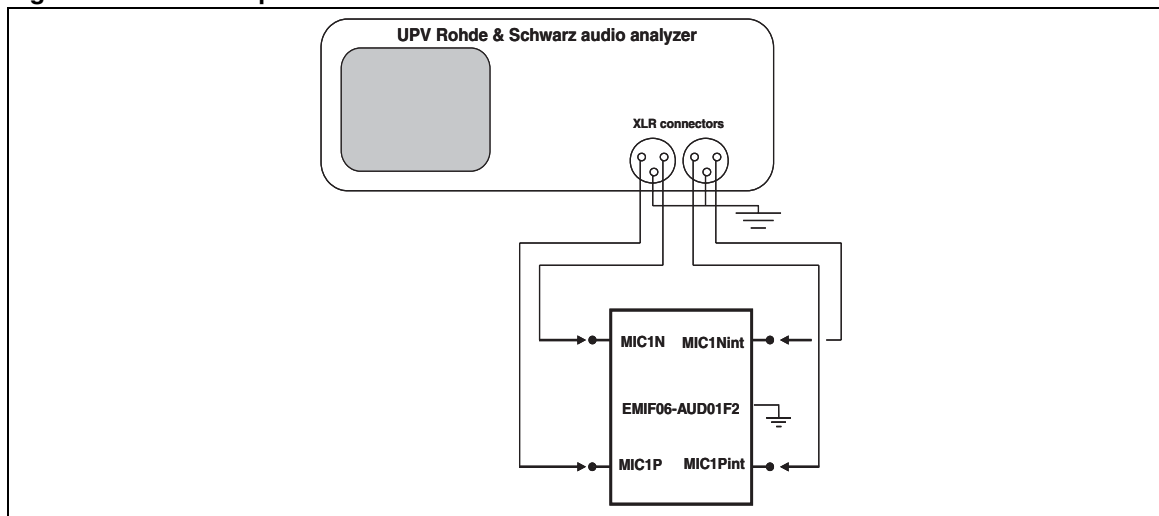
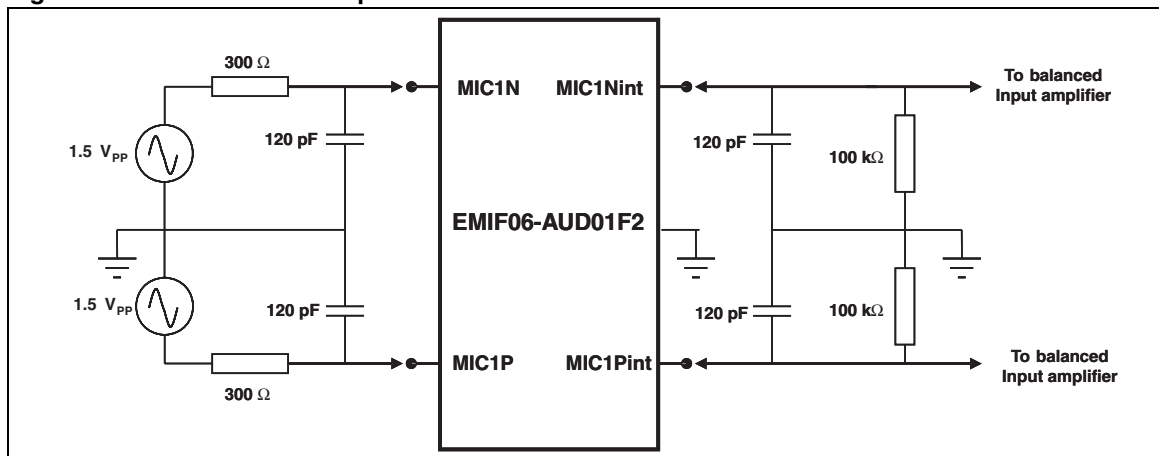


Figure 24. Internal UPV setup schematic





## 2 Application schematics

Figure 25. Basic configuration scheme

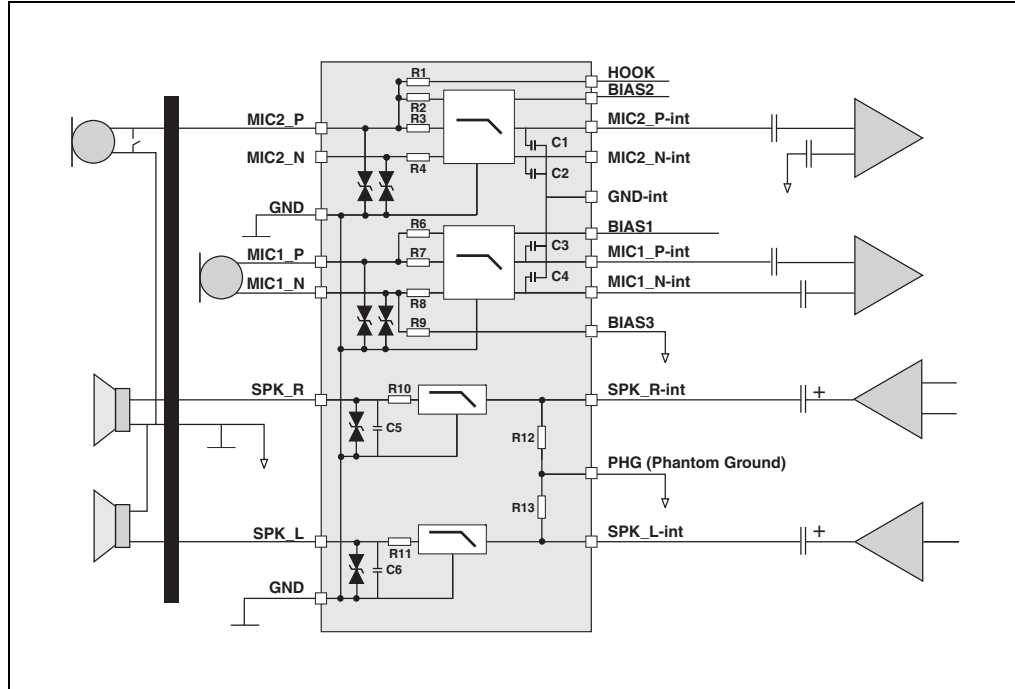


Figure 26. Stereo line in

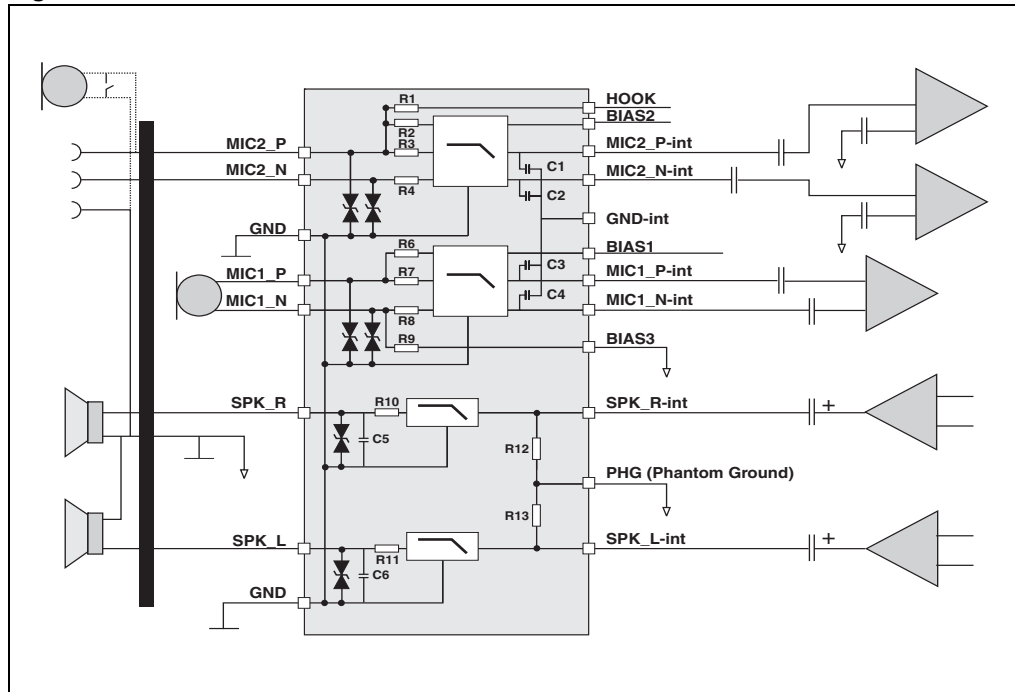


Figure 27. Stereo microphone / line in

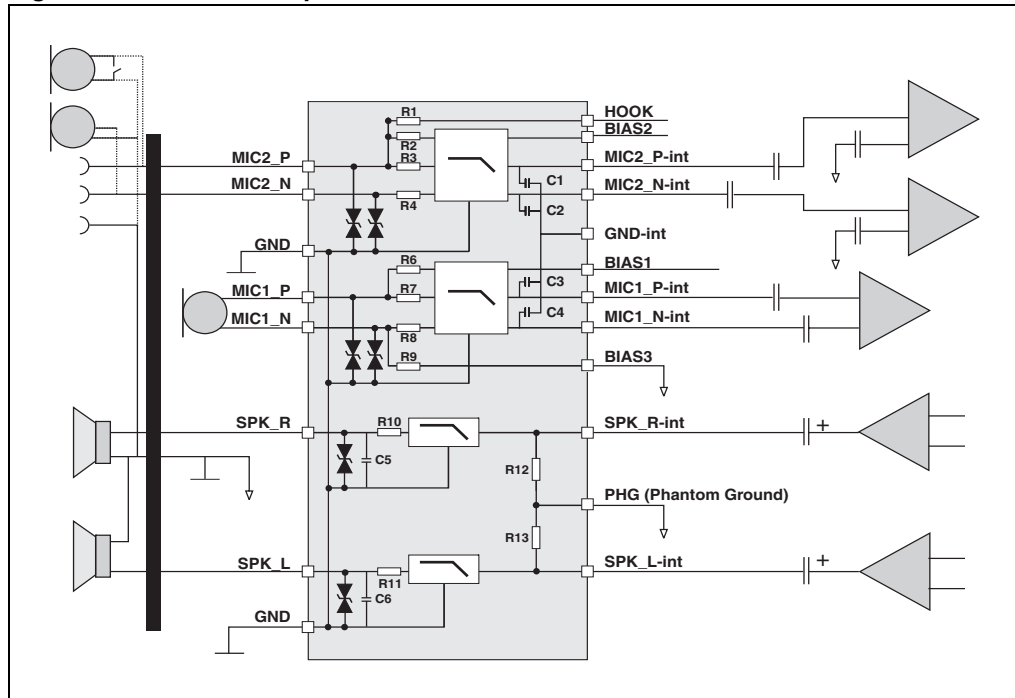
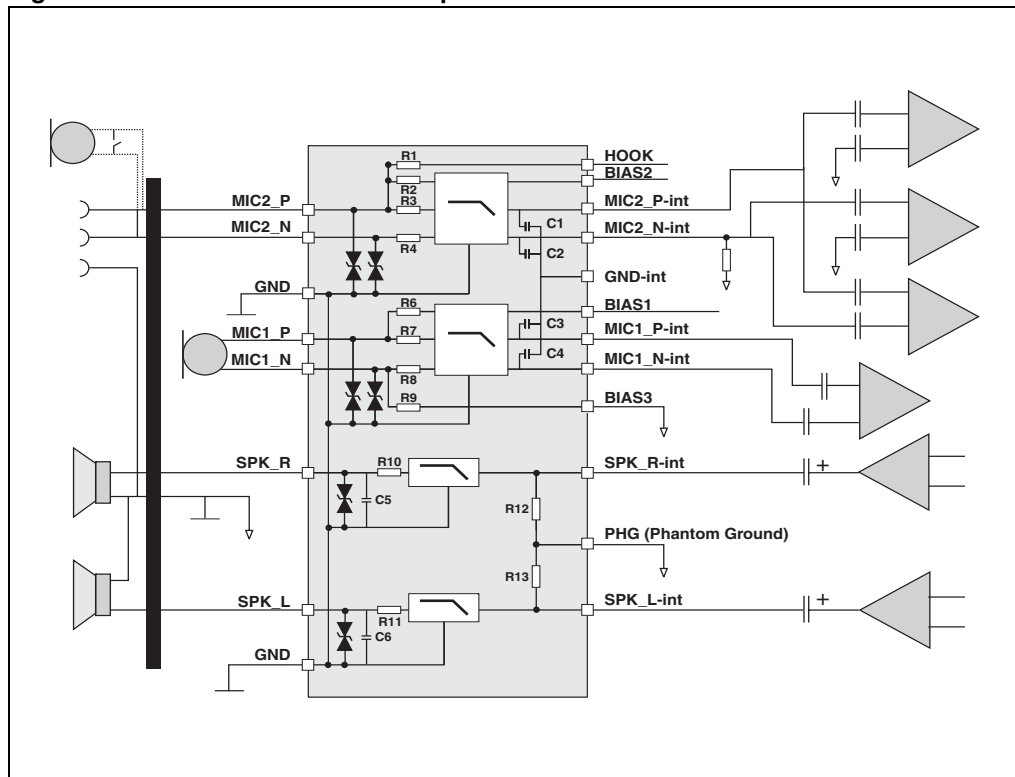
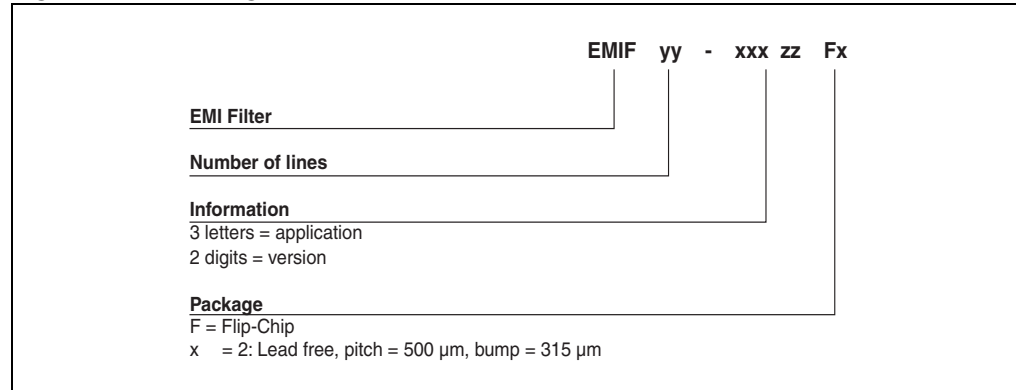


Figure 28. External balanced microphone / stereo line in



### 3 Ordering information scheme

Figure 29. Ordering information scheme



### 4 Package information

In order to meet environmental requirements, ST offers these devices in ECOPACK<sup>®</sup> packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at [www.st.com](http://www.st.com).

Figure 30. Flip chip dimensions

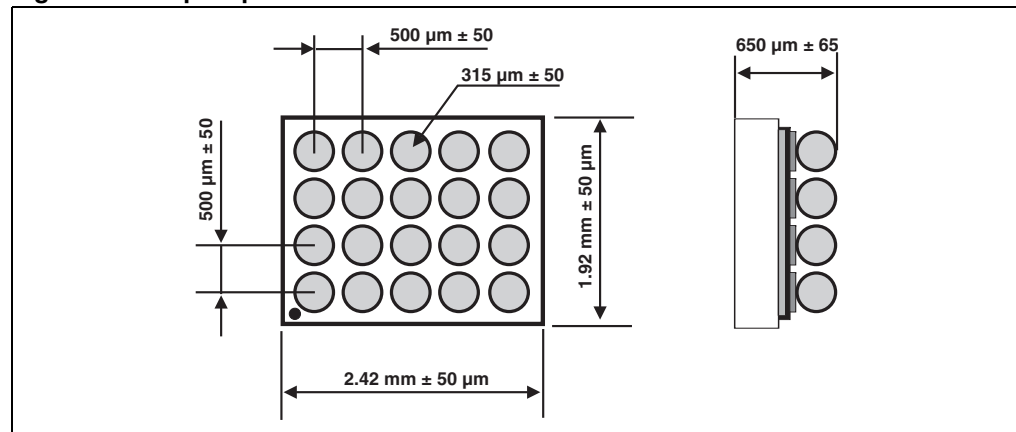


Figure 31. Marking

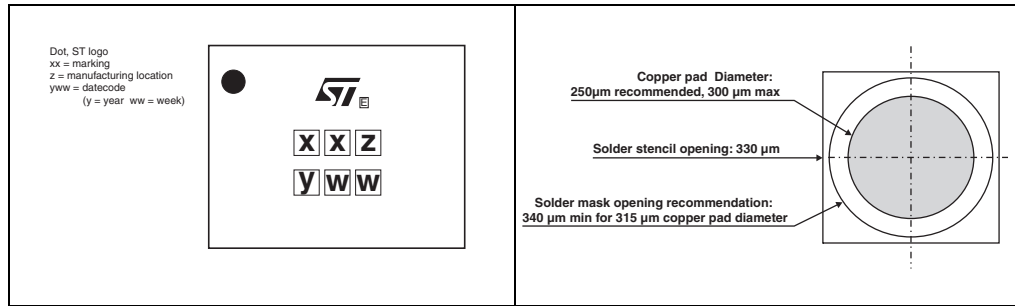


Figure 32. Footprint recommendation

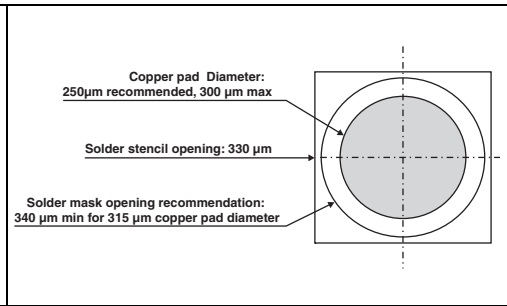
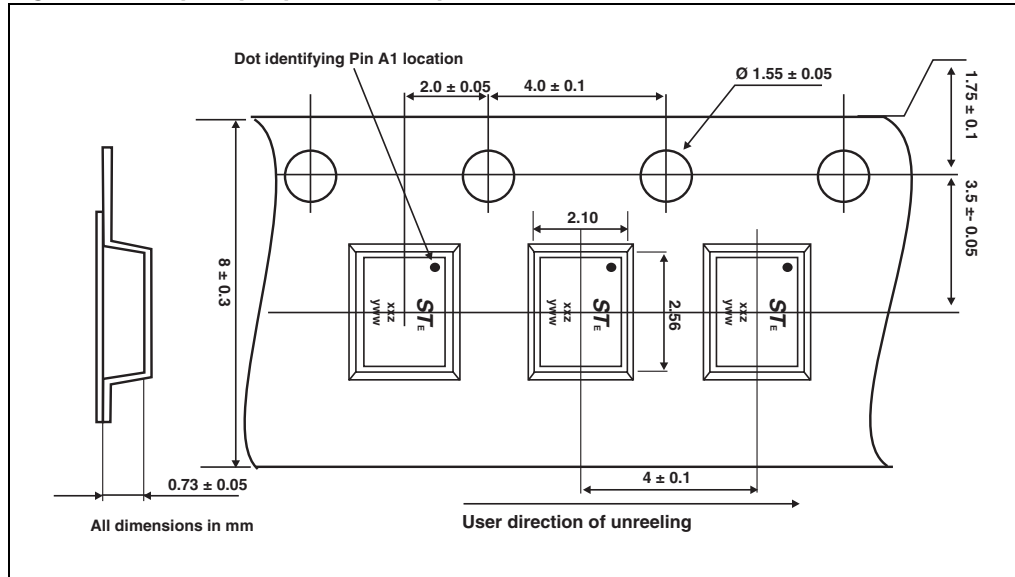


Figure 33. Flip chip tape and reel specification



Note: More packing information is available in the application notes:  
 AN1235: "Flip chip: Package description and recommendations for use"  
 AN1751: "EMI Filters: Recommendations and measurements"

## 5 Ordering information

Table 6. Ordering information

| Ordering code  | Marking | Package   | Weight  | Base qty | Delivery mode    |
|----------------|---------|-----------|---------|----------|------------------|
| EMIF06-AUD01F2 | HP      | Flip chip | 6.45 mg | 5000     | 7" Tape and reel |

## 6 Revision history

Table 7. Document revision history

| Date        | Revision | Changes     |
|-------------|----------|-------------|
| 18-Feb-2008 | 1        | First issue |

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