

TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT SILICON MONOLITHIC

# TA2022AFN

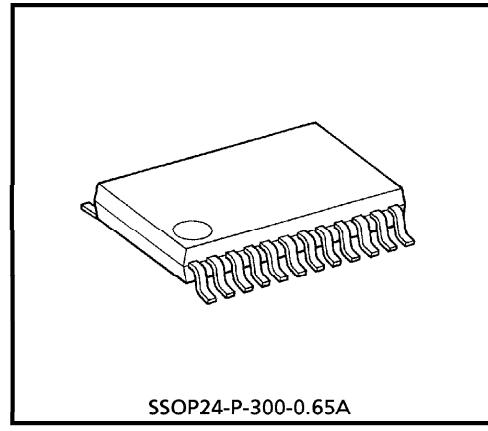
## 1.5V AM / FM IF + MPX

TA2022AFN is the AM / FM IF + MPX system IC, which is developed for headphone radio in 1.5V use.

This is included many functions and this can be used for Digital Tuning System with IF counter.

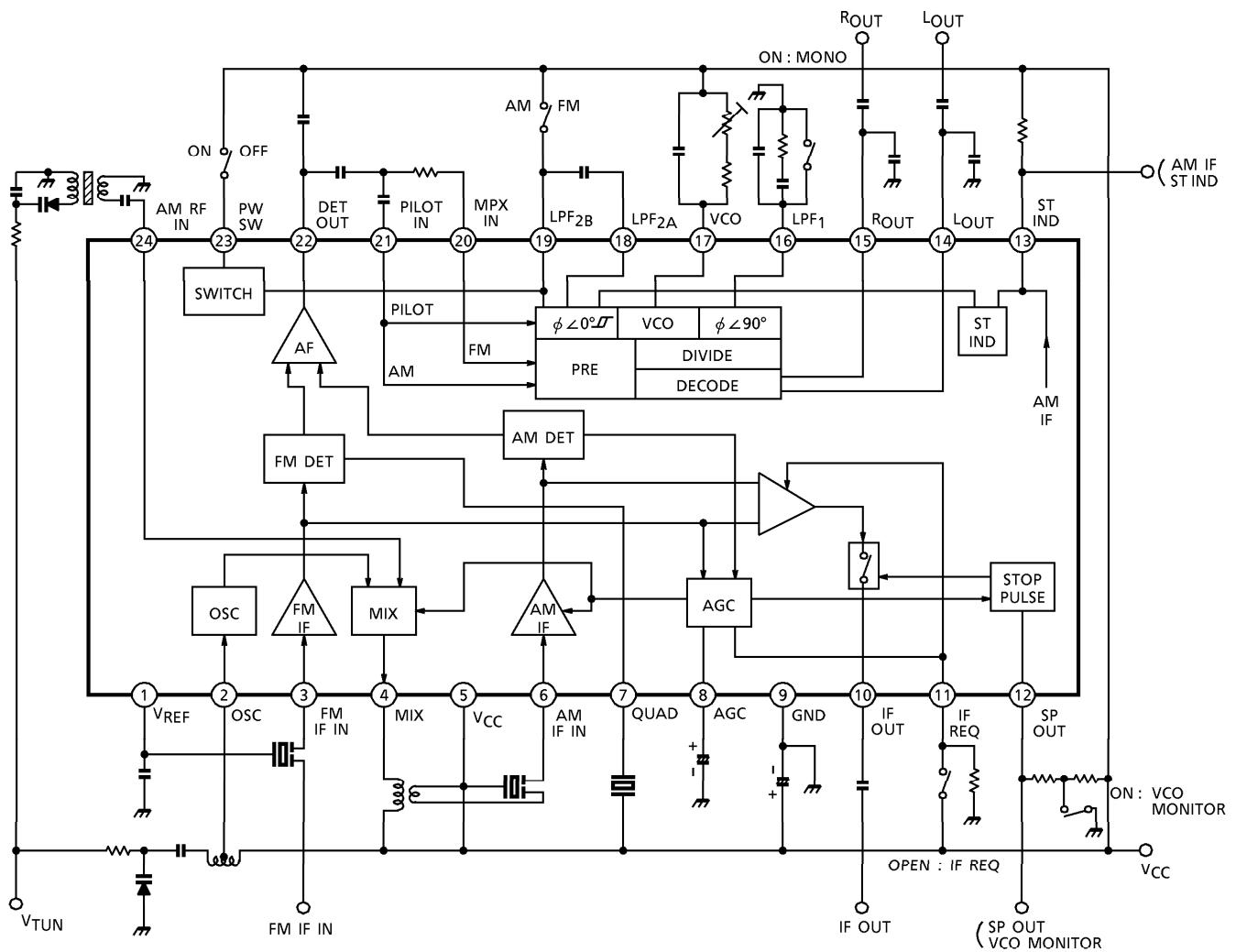
### FEATURES

- Suitable for combination with Digital Tuning System which is included IF counter.
  - Built-in AM / FM IF count output for IF counter of Digital Tuning System.  
FM : 10.7MHz  
AM : 450kHz
  - Adjustable for stop pulse sensitivity (in FM mode)
- For adopting ceramic discriminator, it is not necessary to adjust the FM QUAD detector circuit.
- Built-in AM IF output for AM stereo
- MPX input for main signal is independent of that for pilot signal. (MPX input for pilot signal is shared with AM input)
- MPX output is high-impedance in power off mode.
- Built-in power switch
- Low supply current ( $V_{CC} = 1.2V$ ,  $T_a = 25^\circ C$ )  
FM mode :  $I_{CC2} = 5.5mA$  (Typ.)  
AM mode :  $I_{CC3} = 3.7mA$  (Typ.)
- Operating supply voltage range ( $T_a = 25^\circ C$ )  
 $V_{CC(\text{opr})} = 0.95\sim 2.2V$
- Stereo operating supply voltage range ( $T_a = 25^\circ C$ )  
 $V_{CC(\text{opr})} = 1.0\sim 2.2V$



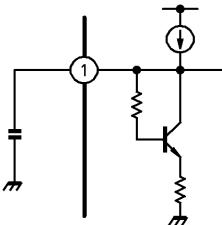
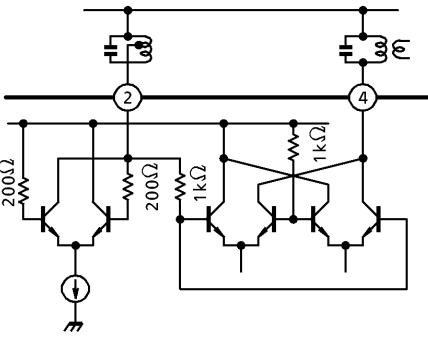
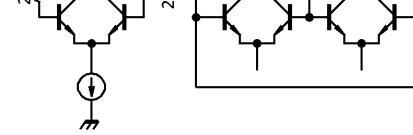
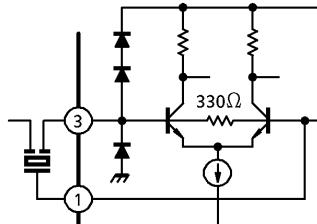
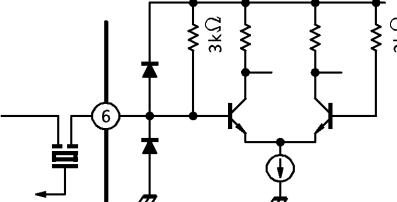
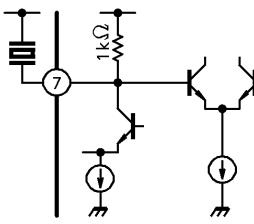
Weight : 0.14g (Typ.)

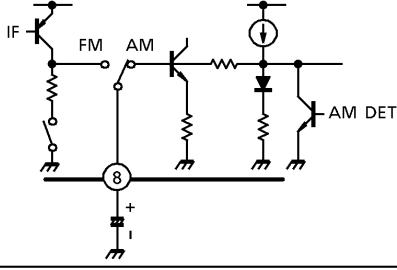
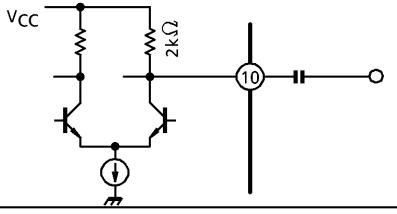
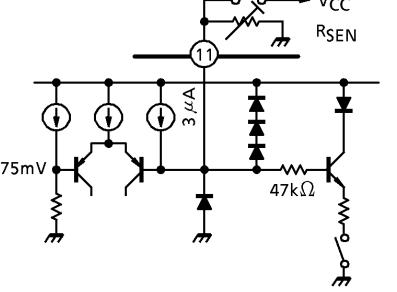
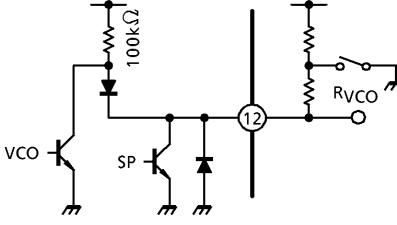
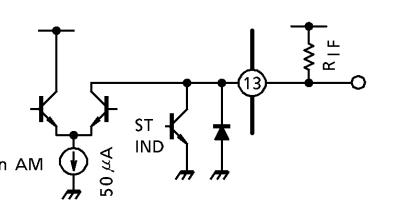
## BLOCK DIAGRAM



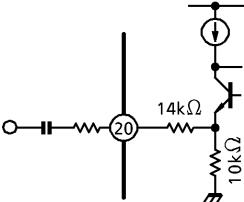
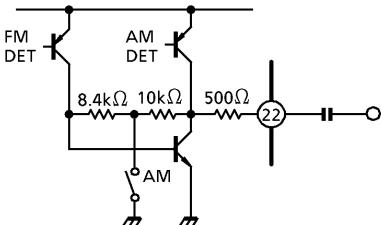
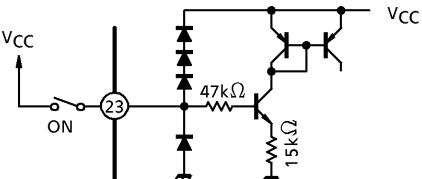
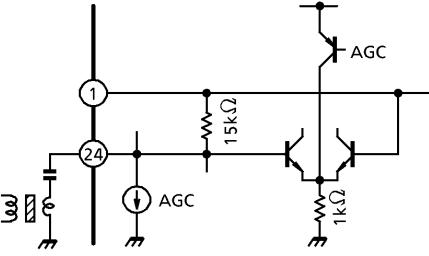
## TERMINAL EXPLANATION

Terminal voltage : Typical terminal voltage at no signal with the test circuit 1 ( $V_{CC} = 1.2V$ ,  $T_a = 25^\circ C$ )

| TERMINAL |          | FUNCTION   | INTERNAL CIRCUIT   | TERMINAL VOLTAGE (V) |     |
|----------|----------|--|--|----------------------|-----|
| No.      | NAME     |  |  | AM                   | FM  |
| 1        | VREF     | Referential voltage<br>Bypass terminal for AM RF and FM IF Amplifier |    | 0.9                  | 0.9 |
| 2        | OSC      | AM OSC   |   | 1.2                  | 1.2 |
| 4        | MIX      | Output of AM MIX   |   | 1.2                  | 1.2 |
| 3        | FM IF IN | Input of FM IF signal<br>● Input impedance 330Ω (Typ.)               |  | 0.9                  | 0.9 |
| 5        | VCC      | —  | —  | 1.2                  | 1.2 |
| 6        | AM IF IN | Input of AM IF signal<br>● Input impedance 3kΩ (Typ.)                |  | 1.2                  | 1.2 |
| 7        | QUAD     | FM QUAD Detector   |  | 1.2                  | 1.2 |

| TERMINAL |        | FUNCTION  | INTERNAL CIRCUIT   | TERMINAL VOLTAGE (V) |    |
|----------|--------|---|--|----------------------|----|
| No.      | NAME   |   |  | AM                   | FM |
| 8        | AGC    | <ul style="list-style-type: none"> <li>AM mode<br/>AGC time constant is determined by external capacitor.</li> <li>FM mode<br/>The sudden change of stop pulse sensitivity is held in by external capacitor.</li> </ul>   |    | —                    | —  |
| 9        | GND    | —   | —  | 0                    | 0  |
| 10       | IF OUT | <p>Output of IF count signal<br/>In case of IF request mode, IF count signal for IF counter is taken from this terminal.</p> <p>( FM : <math>V_{IF}(FM) = 80mV_{p-p}</math> (Typ.)<br/>AM : <math>V_{IF}(AM) = 100mV_{p-p}</math> (Typ.)</p>  |    | —                    | —  |
| 11       | IF REQ | <p>IF request switch<br/>( <math>V_{CC}</math> : Receive mode<br/>OPEN : IF request mode<br/>FM stop pulse sensitivity can be changed by connecting RSEN in IF request mode.<br/>RSEN should be smaller than <math>100k\Omega</math>.</p>   |   | —                    | —  |
| 12       | SP OUT | <p>Output of stop pulse<br/>VCO frequency can be monitored, in case that this terminal is connected with GND through a resistor (<math>R_{VCO} \approx 100k\Omega</math>).<br/>( ON : VCO monitor<br/>OPEN : SP OUT )</p>   |  | —                    | —  |
| 13       | ST IND | <p>Stereo indicator terminal</p> <ul style="list-style-type: none"> <li>This terminal shared with output of modulated AM IF signal.</li> <li>AM IF output : <math>6mV_{rms}</math> (<math>R_{IF} = 3k\Omega</math>, Typ.)</li> <li><math>R_{IF}</math> should be smaller than <math>3k\Omega</math>. In case that <math>R_{IF} &gt; 3k\Omega</math>, internal biasing circuit doesn't operate normally in AM mode.</li> </ul> |  | —                    | —  |

| TERMINAL |                   | FUNCTION   | INTERNAL CIRCUIT | TERMINAL VOLTAGE (V) |     |
|----------|-------------------|--|------------------|----------------------|-----|
| No.      | NAME              |  |                  | AM                   | FM  |
| 14       | L <sub>OUT</sub>  | Output of stereo signal<br>These terminals are high-impedance in power off mode.                                 |                  | 0.5                  | 0.5 |
| 15       | R <sub>OUT</sub>  |  |                  |                      |     |
| 16       | LPF <sub>1</sub>  | LPF terminal for phase detector  |                  | —                    | —   |
| 17       | VCO               | VCO<br>The temperature characteristic of free running frequency is +350ppm / °C.<br>Temperature coefficient : SH |                  | —                    | 1.2 |
| 18       | LPF <sub>2A</sub> | LPF terminal for synchronous detector  |                  | —                    | —   |
| 19       | LPF <sub>2B</sub> | LPF terminal for synchronous detector and AM / FM switch<br>( V <sub>CC</sub> : AM mode<br>OPEN : FM mode )      |                  | 1.2                  | —   |
| 21       | PILOT IN          | Input of FM stereo pilot signal and AM signal  |                  | 0.1                  | 0.1 |

| TERMINAL |          | FUNCTION  | INTERNAL CIRCUIT   | TERMINAL VOLTAGE (V) |     |
|----------|----------|---|--|----------------------|-----|
| No.      | NAME     |   |  | AM                   | FM  |
| 20       | MPX IN   | Input of FM stereo main signal  |    | —                    | 0.1 |
| 22       | DET OUT  | Detector output circuit<br>● Output impedance (Typ.)<br>AM : 10kΩ<br>FM : 1kΩ |    | 0.6                  | 0.6 |
| 23       | PW SW    | Power switch<br>(VCC : IC on<br>OPEN/GND : IC off)                            |  | 1.2                  | 1.2 |
| 24       | AM RF IN | Input of AM RF signal<br>● Input impedance : 13kΩ<br>(Typ., at no signal)     |  | 0.9                  | 0   |

**APPLICATION NOTE****1. Power switch**

It is necessary to connect an external pull-down resistor with the terminal of PW SW (pin⑬), in case that this IC is turned on due to external noise etc.

**2. Mode switch**

The terminal of AM / FM changeover is pin⑯.

In controlling the AM / FM mode with voltage, it is applied as follows.

(  $V_{CC}$  : AM mode  
OPEN : FM mode

In FM mode, care should be taken to eliminate influence due to external noise etc, because this terminal is opened.

The leak current flows through this terminal, in the case that the terminal is connected to  $V_{CC}$  line independently, even through this IC is off mode (the terminal of PW SW (pin⑬) is off mode).

**3. IF count output**

IF count signal can be taken from IF output terminal (pin⑩), when IF request terminal (pin⑪) is connected with GND through  $R_{SEN}$  and stop pulse sensitivity is on.

|    | SWITCH CONDITION              |          | OUTPUT FREQUENCY | OUTPUT VOLTAGE (Typ.) | OUTPUT IMPEDANCE (Typ.) |
|----|-------------------------------|----------|------------------|-----------------------|-------------------------|
|    | pin⑪                          | pin⑯     |                  |                       |                         |
| FM | OPEN                          | OPEN     | 10.7MHz          | 80mV <sub>p-p</sub>   | 2kΩ                     |
| AM | ( $R_{SEN} \leq 100k\Omega$ ) | $V_{CC}$ | 450kHz           | 100mV <sub>p-p</sub>  |                         |

Table.1 IF count output

**4. FM stop pulse sensitivity**

FM stop pulse sensitivity can be changed by connecting an external resistor  $R_{SEN}$  between IF request terminal (pin⑪) and GND. The gain of FM IF amplifier is controlled by  $R_{SEN}$ , and FM stop pulse sensitivity is changed.

It is advised that  $R_{SEN}$  is  $100k\Omega$  or less.

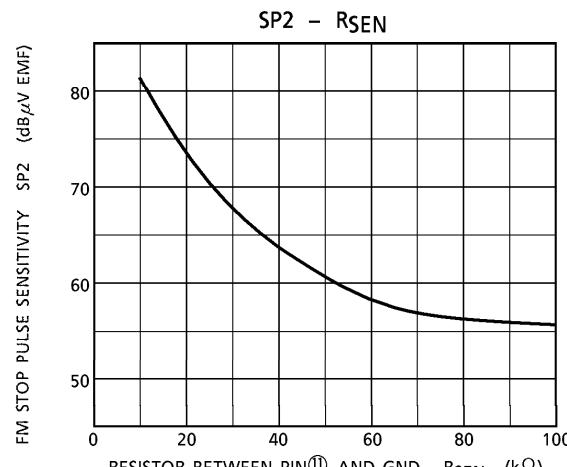


Fig.1 SP2 -  $R_{SEN}$

## 5. MPX IN

This IC can attenuate only FM stereo main signal level. Because MPX input for main signal (pin⑳) is independent of that for pilot signal (pin㉑, this terminal is shared with AM input).

Internal circuit of MPX IN terminal (pin⑳) is shown in Fig.2. FM stereo main signal level can be attenuated by connecting an external resistor  $R_X$ . Because FM stereo main signal level is attenuated by internal resistor (14k $\Omega$  and 10k $\Omega$ ) and resistor  $R_X$ . And it is applied to an emitter of transistor Q.

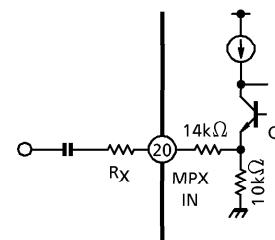


Fig.2 Internal circuit of MPX IN terminal

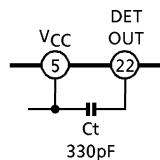


Fig.3 Countermeasures for AM tweets

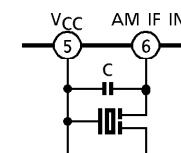


Fig.4 AM trap circuit

## 6. AM tweets

It is necessary to connect the capacitor Ct (about 330pF) between  $V_{CC}$  terminal (pin⑤) and DET OUT (pin㉒), in case that AM tweets occurs by pattern layout. (Fig.3)

This Ct can also functions as phase compensation of MPX stage.

## 7. AM AGC

It is necessary to connect a capacitor C (about 68pF) between  $V_{CC}$  terminal (pin⑧) and AM IF IN terminal (pin⑥), in case that AGC circuit doesn't operate normally. Because second harmonic of local oscillator is applied AM IF terminal (pin⑥) by pattern layout.

In case that capacitor ( $C = 68\text{pF}$ ) is connected, AM stop pulse sensitivity is delayed about 1dB.

Output DC voltage of AGC terminal (pin⑧) is  $V_8 = 0.1\text{V}$  (Typ., AM mode, at no signal).

## 8. Stereo indicator/AM IF output (for AM stereo)

- The terminal of pin⑬ is built in stereo indicator function and modulated AM IF signal output. In AM mode,  $R_{IF}$  (3k $\Omega$  or less) should be connected between  $V_{CC}$  and pin⑬, or pin⑬ should connected to  $V_{CC}$  directly. (Fig.5) In case that  $R_{IF} > 3\text{k}\Omega$  or pin⑬ is opened, this IC doesn't operate normally in AM mode. Because transistor Q<sub>2</sub> is saturated.

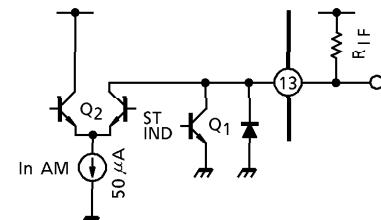


Fig.5 Internal circuit of pin⑬

- AM IF output

$V_{IF}(\text{AM MOD}) = 6\text{mV}_{\text{rms}}$  (Typ.  $R_{IF} = 3\text{k}\Omega$ )

The applications of this terminal are explained as follow.

- (a) Method to use stereo indicator and AM IF output.  
External circuit is recommended as shown in Fig.6.

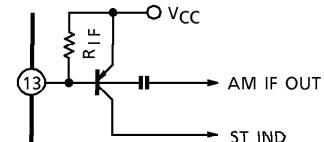


Fig.6 Method to use stereo indicator and AM IF output.

- (b) Method to use stereo indicator.

External circuit is recommended as shown in Fig.7.  
 $R_{IF}$  is not needed in case that this IC is not use in AM mode.

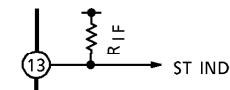


Fig.7 Method to use stereo indicator.

- (c) Method to use AM IF output

External circuit is recommended as shown in Fig.8.

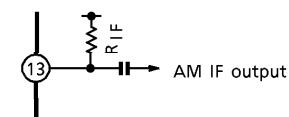


Fig.8 Method to use AM IF output.

- (d) In case that functions of this terminal are not used.

External circuit is recommended as shown in Fig.9.  
 $R_{IF}$  is not needed in case that this IC is not used in AM mode.

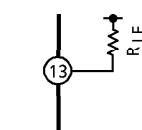


Fig.9 In case that functions of this terminal are not used.

#### MAXIMUM RATINGS ( $T_a = 25^\circ\text{C}$ )

| CHARACTERISTIC           | SYMBOL       | RATING         | UNIT |
|--------------------------|--------------|----------------|------|
| Supply Voltage           | $V_{CC}$     | 4.5            | V    |
| Stop Pulse Voltage       | $V_{SP}$     | 4.5            | V    |
| Stop Pulse Current       | $I_{SP}$     | 10             | mA   |
| Stereo Indicator Voltage | $V_{ST}$     | 4.5            | V    |
| Stereo Indicator Current | $I_{ST}$     | 10             | mA   |
| Power Dissipation        | $P_D$ (Note) | 500            | mW   |
| Operating Temperature    | $T_{opr}$    | $-25 \sim 75$  | °C   |
| Storage Temperature      | $T_{stg}$    | $-55 \sim 150$ | °C   |

(Note) Derated above  $T_a = 25^\circ\text{C}$  in the proportion of  $4\text{mW}/^\circ\text{C}$ .

**ELECTRICAL CHARACTERISTICS**

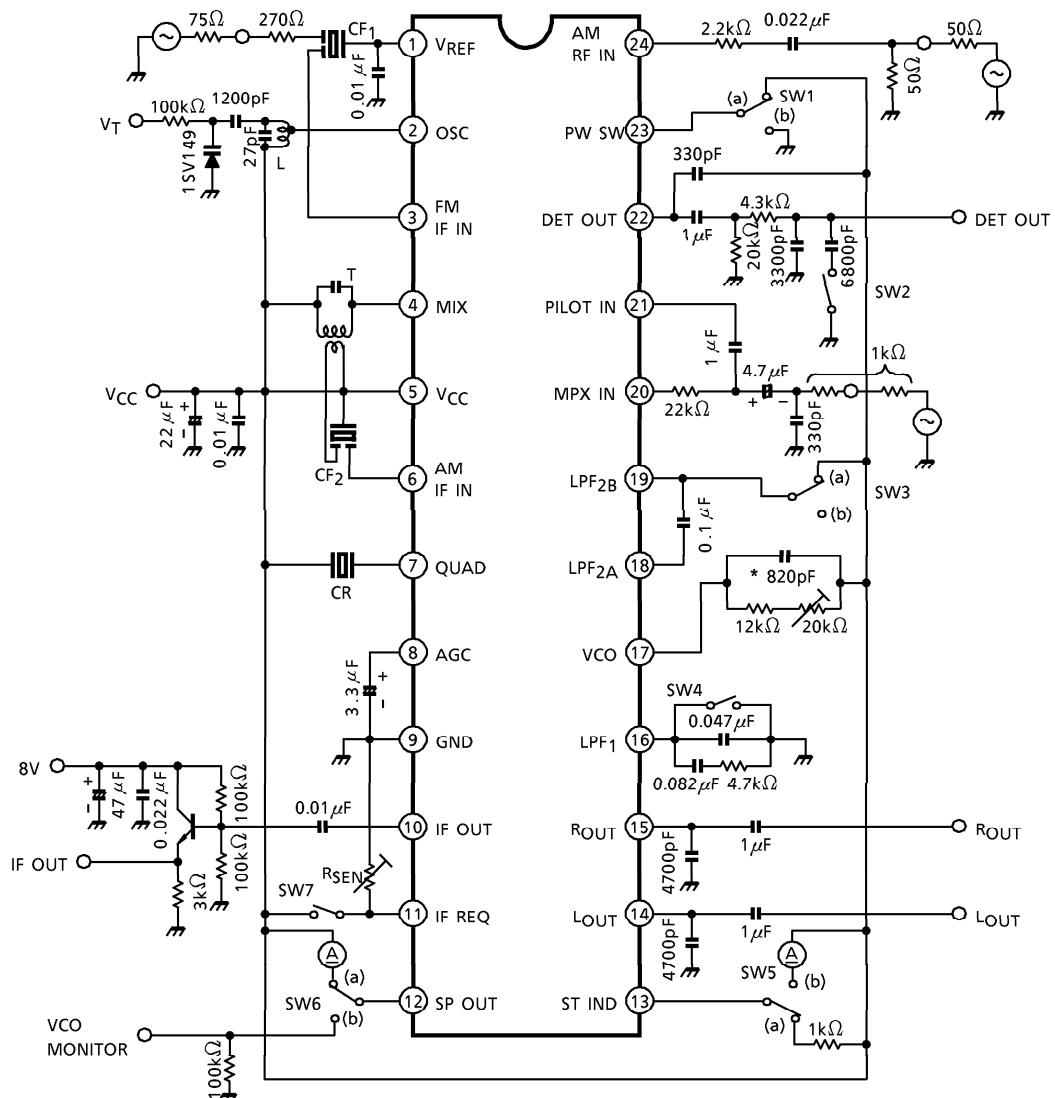
Unless otherwise specified

 $V_{CC} = 1.2V$ ,  $T_a = 25^\circ C$ , SW1 : a, SW4 : OPEN, SW5 : a, SW6 : a/b, SW7 : ONFM IF :  $f = 10.7MHz$ ,  $f_m = 1kHz$ ,  $\Delta f = \pm 22.5kHz$ ,  $V_{in} = 80dB\mu V$  EMF, SW2 : ON, SW3 : bAM :  $f = 1MHz$ ,  $f_m = 1kHz$ , MOD = 30%,  $V_{in} = 60dB\mu V$  EMF, SW2 : OPEN, SW3 : aMPX :  $f_m = 1kHz$ ,  $f_p = 19kHz$ , SW3 : b

| CHARACTERISTIC | SYMBOL                      | TEST CIR-CUIT | TEST CONDITION  | MIN. | TYP. | MAX. | UNIT          |
|----------------|-----------------------------|---------------|---|------|------|------|---------------|
| Supply Current | $I_{CC1}$                   | 1             | PW OFF, SW1 : b   | —    | —    | 5    | $\mu A$       |
|                | $I_{CC2}$                   |               | FM mode, $V_{in} = 0$   | —    | 5.5  | 7.5  | mA            |
|                | $I_{CC3}$                   |               | AM mode, $V_{in} = 0$   | —    | 3.7  | 5.5  |               |
| FM             | Input Limiting Sensitivity  | 1             | –3dB Limiting   | 43   | 48   | 53   | $dB\mu V$ EMF |
|                | Recovered Output Voltage 1  |               |   | 35   | 55   | 70   | $mV_{rms}$    |
|                | Signal To Noise Ratio 1     |               |   | —    | 60   | —    | dB            |
|                | Total Harmonic Distortion 1 |               |   | —    | 0.5  | —    | %             |
|                | AM Rejection Ratio          |               | MOD = 30%   | —    | 40   | —    | dB            |
|                | Stop Pulse Sensitivity 1    |               | $I_{12} = 0.5mA$ , SW6 : a                                      | 50   | 55   | 60   | $dB\mu V$ EMF |
|                | Stop Pulse Sensitivity 2    |               | $I_{12} = 0.5mA$ , $R_{SEN} = 39k\Omega$<br>SW6 : a, SW7 : OPEN | —    | 64   | —    |               |
|                | IF Output Voltage           |               | $\Delta f = 0$ , SW7 : OPEN                                     | —    | 80   | —    | $mV_{p-p}$    |
| AM             | Gain                        | 1             | $V_{in} = 26dB\mu V$ EMF  | 15   | 27   | —    | $mV_{rms}$    |
|                | Recovered Output Voltage 2  |               |   | 30   | 45   | 60   |               |
|                | Signal To Noise Ratio 2     |               |   | —    | 38   | —    | dB            |
|                | Total Harmonic Distortion 2 |               |   | —    | 1.5  | —    | %             |
|                | Stop Pulse Sensitivity      | 2             | $I_{12} = 0.5mA$ , SW6 : a                                      | 25   | 30   | 35   | $dB\mu V$ EMF |
|                | IF Output Voltage           |               | MOD = 0, SW7 : OPEN   | —    | 100  | —    | $mV_{p-p}$    |
|                | Oscillator Voltage          |               |   | 30   | 55   | —    | $mV_{rms}$    |
|                | Oscillator Stop Voltage     |               |   | —    | —    | 0.95 | V             |

| CHARACTERISTIC |                                      | SYMBOL                | TEST CIR-CUIT   | TEST CONDITION   |                        | MIN.  | TYP.  | MAX.              | UNIT |  |
|----------------|--------------------------------------|-----------------------|-----------------|--|------------------------|-------|-------|-------------------|------|--|
| M P X          | Voltage Gain 1                       | GV (FM)               | 1               | V <sub>in</sub> = 100mV <sub>rms</sub> (MONO)          | - 1.5                  | + 0.5 | + 2.5 | dB                |      |  |
|                | Voltage Gain 2                       | GV (AM)               |                 |  | - 0.5                  | + 1.5 | + 3.5 |                   |      |  |
|                | Channel Balance                      | CB                    |                 |  | - 2                    | —     | + 2   |                   |      |  |
|                | Maximum Composite Signal Input Level | V <sub>in</sub> (MAX) |                 | L + R = 90%, P = 10%<br>THD = 3%                       | —                      | 220   | —     | mV <sub>rms</sub> |      |  |
|                | Total Harmonic Distortion            | MONO                  |                 | V <sub>in</sub> = 100mV <sub>rms</sub> (MONO)          | —                      | 0.2   | 0.5   | %                 |      |  |
|                |                                      | STEREO                |                 | L + R = 90mV <sub>rms</sub> , P = 10mV <sub>rms</sub>  | —                      | 0.3   | —     |                   |      |  |
|                |                                      | AM                    |                 | V <sub>in</sub> = 100mV <sub>rms</sub>                 | —                      | 0.2   | —     |                   |      |  |
|                | Separation                           |                       |                 | L + R = 90mV <sub>rms</sub><br>P = 10mV <sub>rms</sub> | f <sub>m</sub> = 100Hz | —     | 36    | —                 | dB   |  |
|                | Stereo Indicator Sensitivity         | ON                    |                 |  | f <sub>m</sub> = 1kHz  | 25    | 35    | —                 |      |  |
|                |                                      | OFF                   |                 |  | f <sub>m</sub> = 10kHz | —     | 34    | —                 |      |  |
|                | Stereo Indicator Hysteresis          |                       |                 | Pilot signal input<br>I <sub>13</sub> = 0.5mA, SW5 : a | —                      | 5.5   | 8     | mV <sub>rms</sub> |      |  |
|                | Capture Range                        |                       |                 |  | 2                      | 4     | —     |                   |      |  |
|                | Signal Noise Ratio 3                 |                       |                 | To indicator turn off from turn on                     | —                      | 1.5   | —     | mV <sub>rms</sub> |      |  |
|                | Power Switch                         |                       |                 | P = 10mV <sub>rms</sub> , f <sub>p</sub> = 19kHz       | —                      | ± 7   | —     | %                 |      |  |
|                | AM Mode On Current                   | On Current            | I <sub>23</sub> | V <sub>in</sub> = 100mV <sub>rms</sub> (MONO)          | —                      | 65    | —     | dB                |      |  |
|                |                                      | Off Voltage           | V <sub>23</sub> | 2  | SW1 : c                | 5     | —     | —                 | μA   |  |
|                | FM MONO Mode On Voltage              |                       | I <sub>19</sub> |  | SW1 : d                | 0     | —     | 0.3               | V    |  |
|                | IF Request Off Voltage               |                       | V <sub>16</sub> |  | SW3 : c                | 50    | —     | —                 | μA   |  |
|                |                                      |                       | V <sub>11</sub> |  | SW4 : ON               | —     | 0.1   | —                 | V    |  |
|                |                                      |                       |                 |  | SW7 : ON               | 0.9   | —     | —                 | V    |  |

## TEST CIRCUIT 1



\* Temperature coefficient : SH (-330ppm / °C)

CF<sub>1</sub> : SFE10.7MA8 (MURATA Co., Ltd.)

CF<sub>2</sub> : PFA450A (MURATA Co., Ltd.)

CR : CDA10.7MG50 (MURATA Co., Ltd.)

- For measurement of the THD4,  $V_{in}$  (Max.), and SEP the filter shown in Figure 10 is used.

ATT : ATT  $\geq$  60dB (f = 19~100kHz)

Filter : 4501-054 (SUMIDA ELECTRIC Co., LTD) with insertion loss of 0.3dB

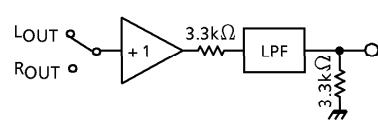


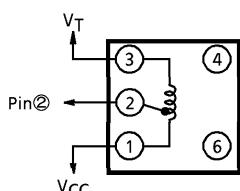
Fig.10 Filter circuit

## COIL DATA

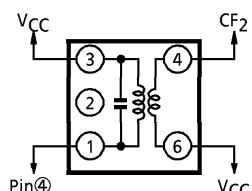
| COIL     | TEST FREQUENCY | L<br>( $\mu$ H) | Co<br>(pF) | Qo | TURNS |     |     |     | WIRE<br>(mm $\phi$ ) | REFERENCE<br>(COIL No.) |
|----------|----------------|-----------------|------------|----|-------|-----|-----|-----|----------------------|-------------------------|
|          |                |                 |            |    | 1-2   | 2-3 | 1-3 | 4-6 |                      |                         |
| L AM OSC | 796kHz         | 100             | —          | 85 | 13    | 55  | —   | —   | 0.06UEW              | ④4187-144               |
| T AM IFT | 450kHz         | —               | 180        | 65 | —     | —   | 184 | 29  | 0.05UEW              | ④4161-242               |

(④ : SUMIDA ELECTRIC Co., LTD.)

L

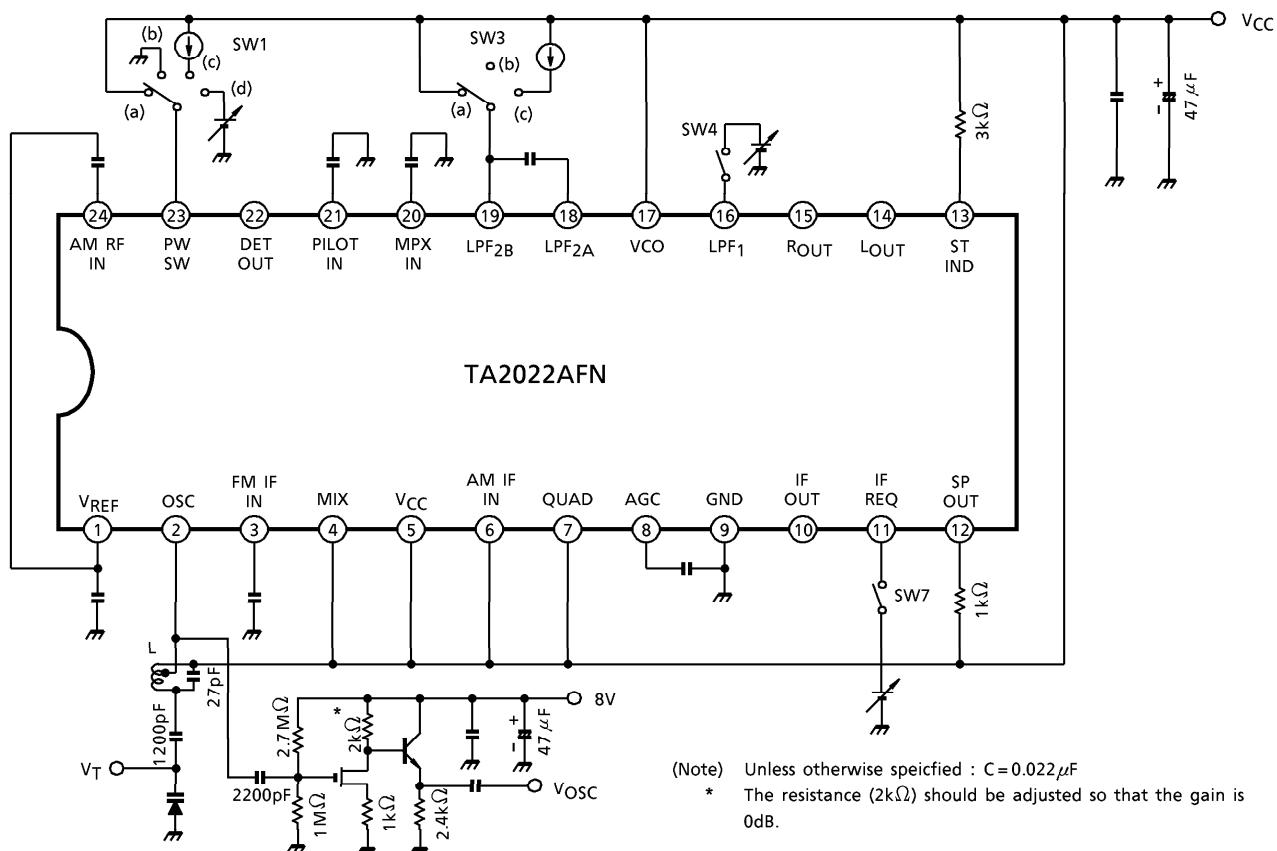


T



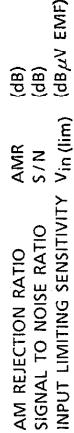
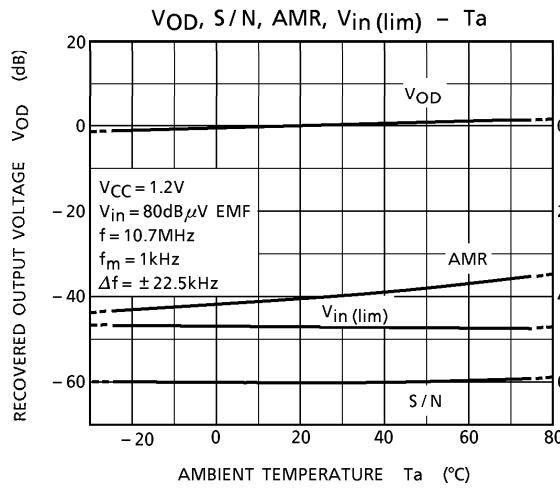
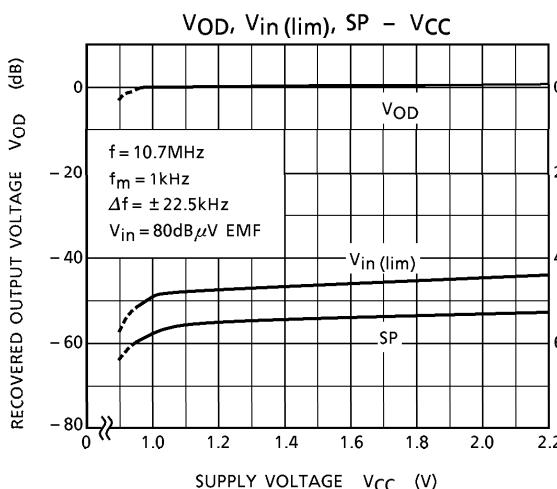
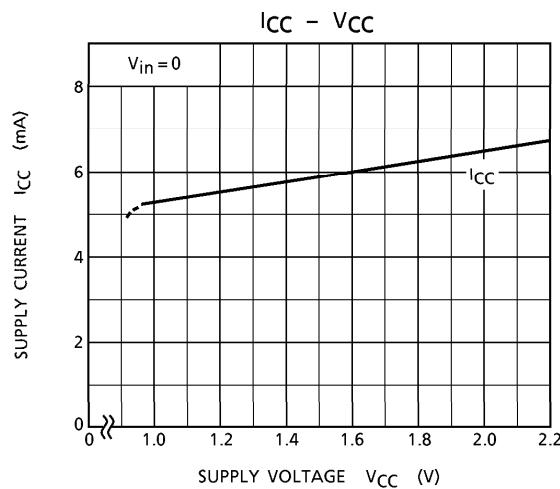
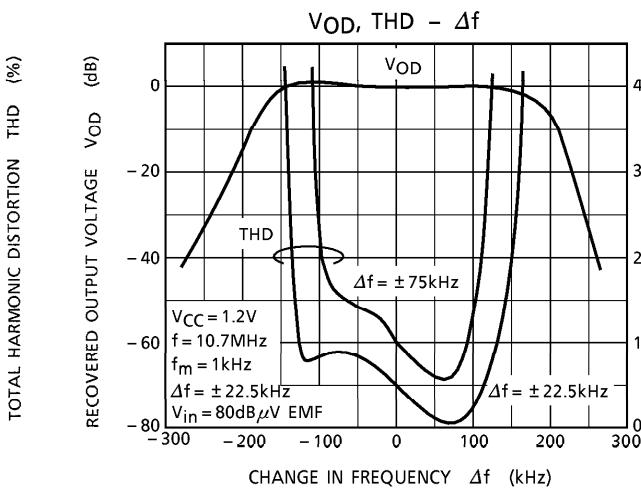
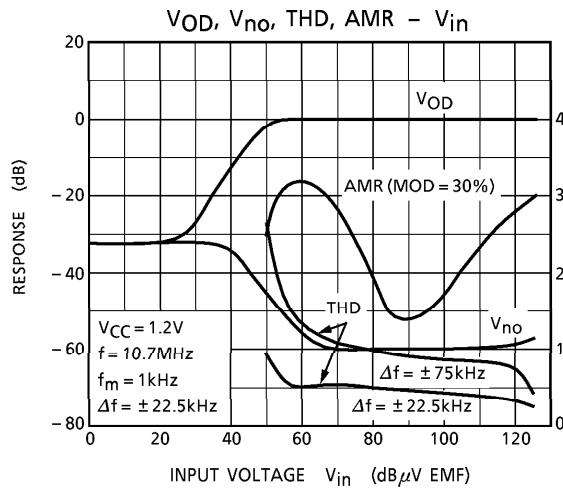
(Bottom view)

## TEST CIRCUIT 2

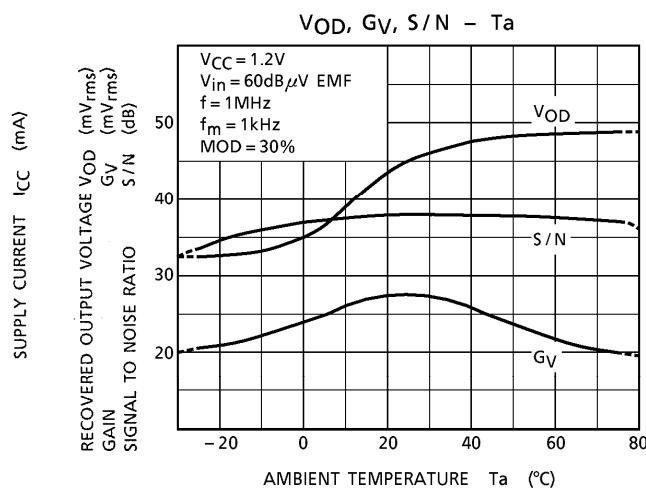
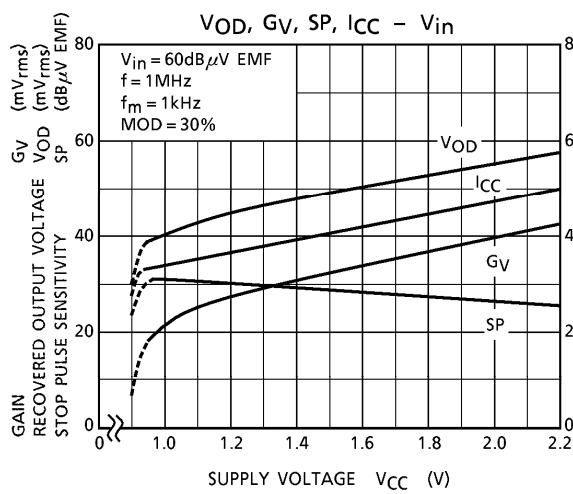
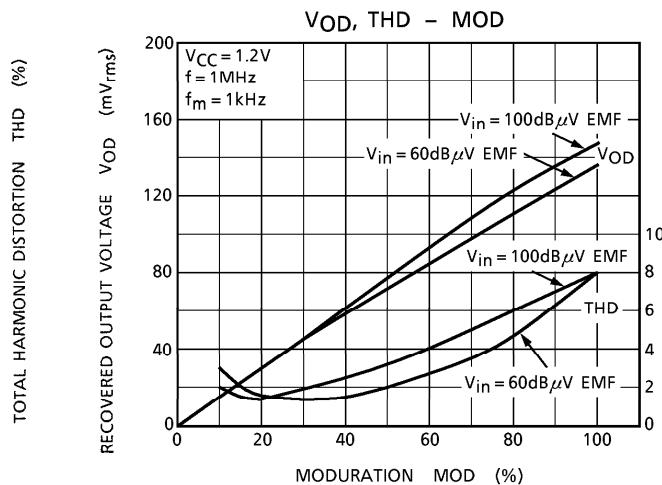
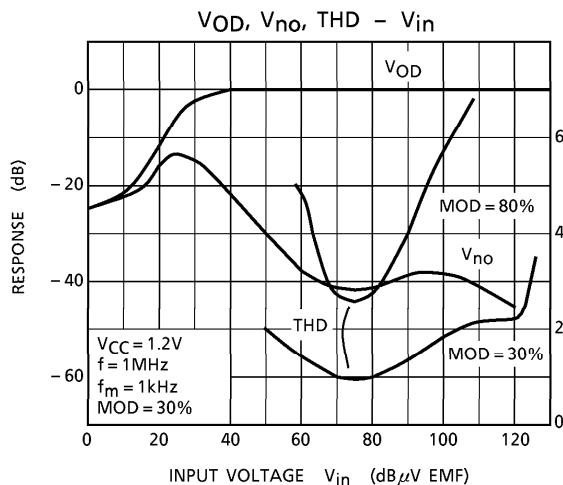


## CHARACTERISTIC CURVE

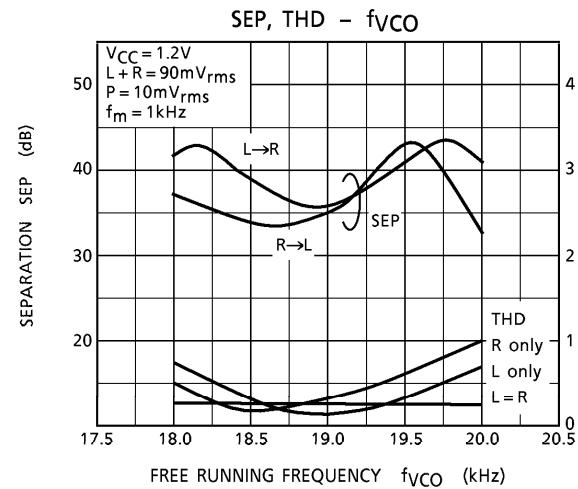
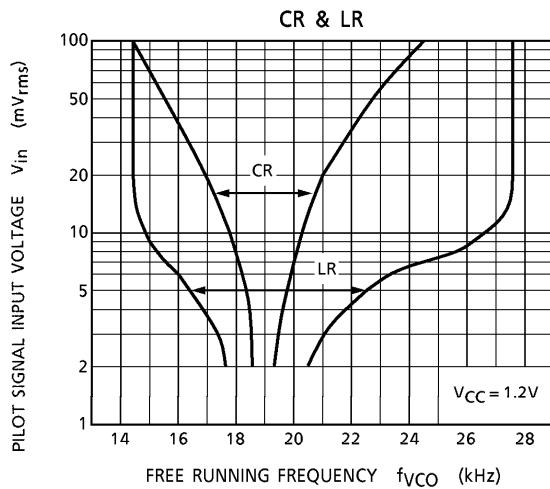
FM IF

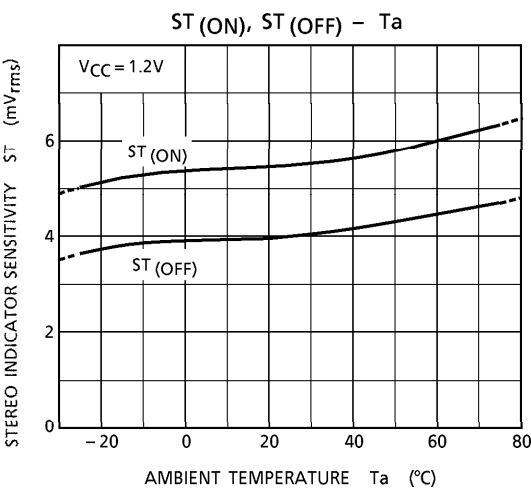
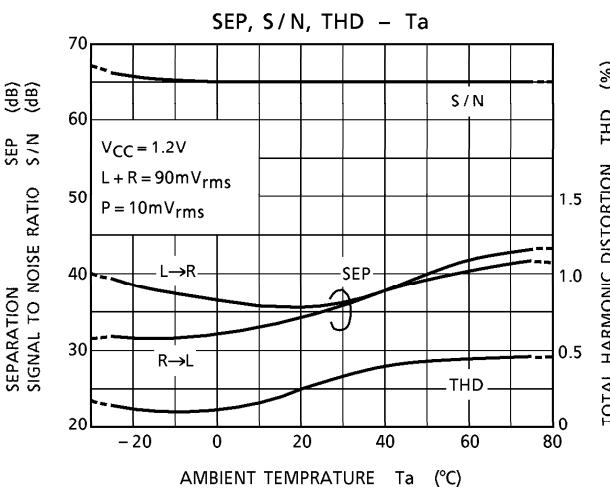
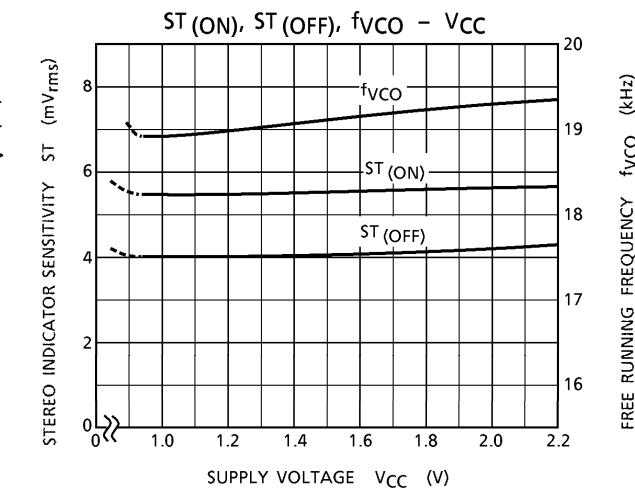
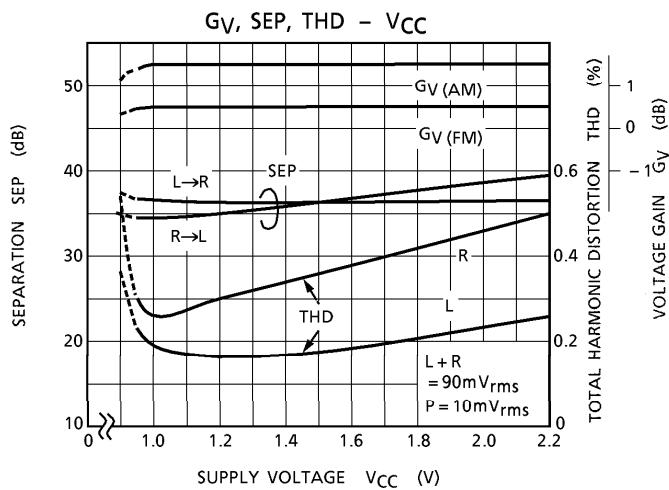
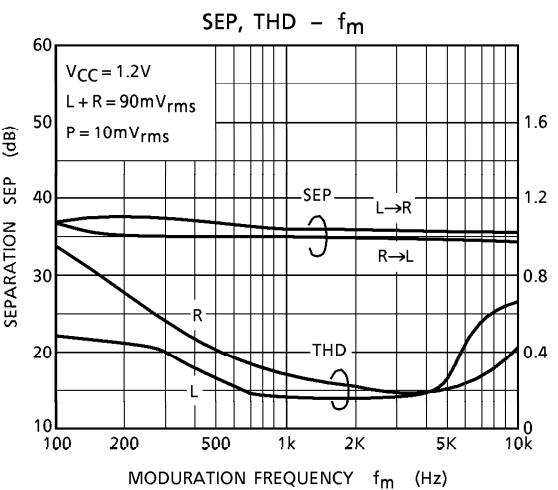
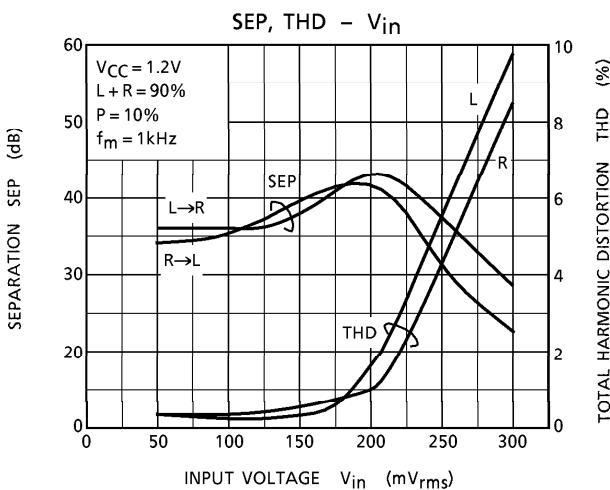


## AM



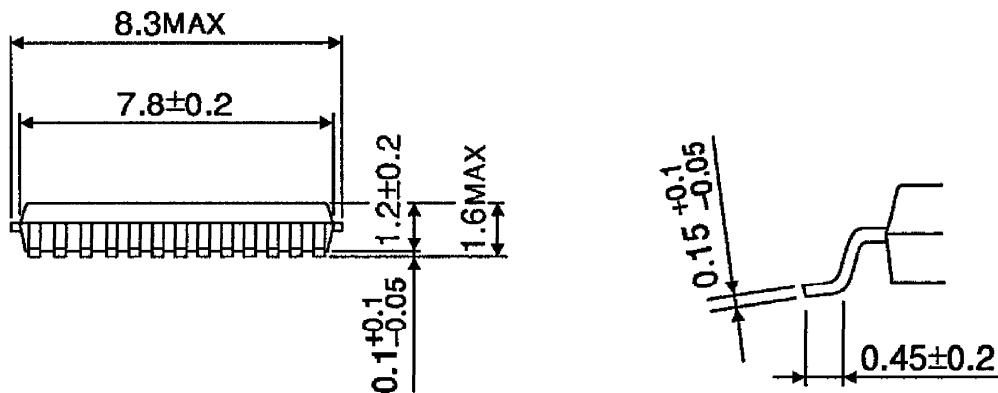
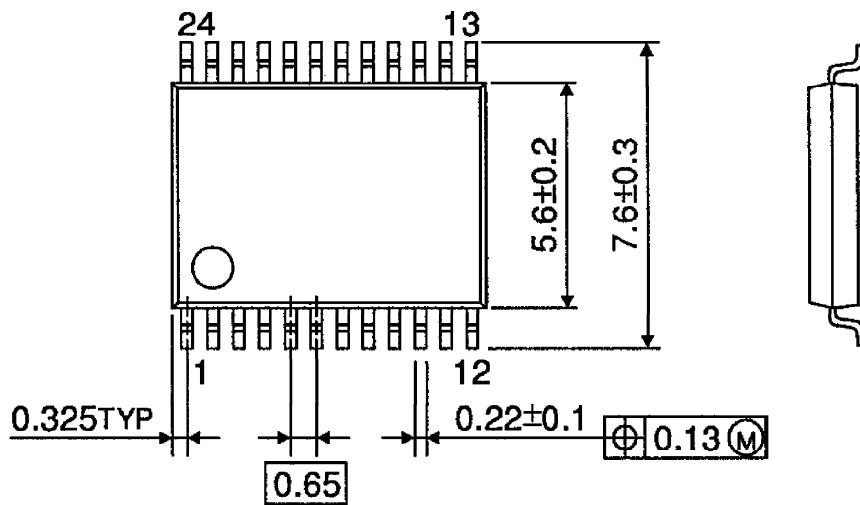
## MPX





**PACKAGE DIMENSIONS**  
SSOP24-P-300-0.65A

Unit : mm



Weight : 0.14g (Typ.)

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000707EBA

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