

TOSHIBA Bipolar Linear Integrated Circuit Silicon Monolithic

# TA2022AFN

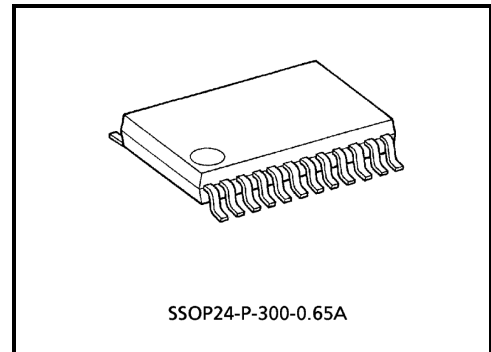
## 1.5V AM / FM IF + MPX

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.

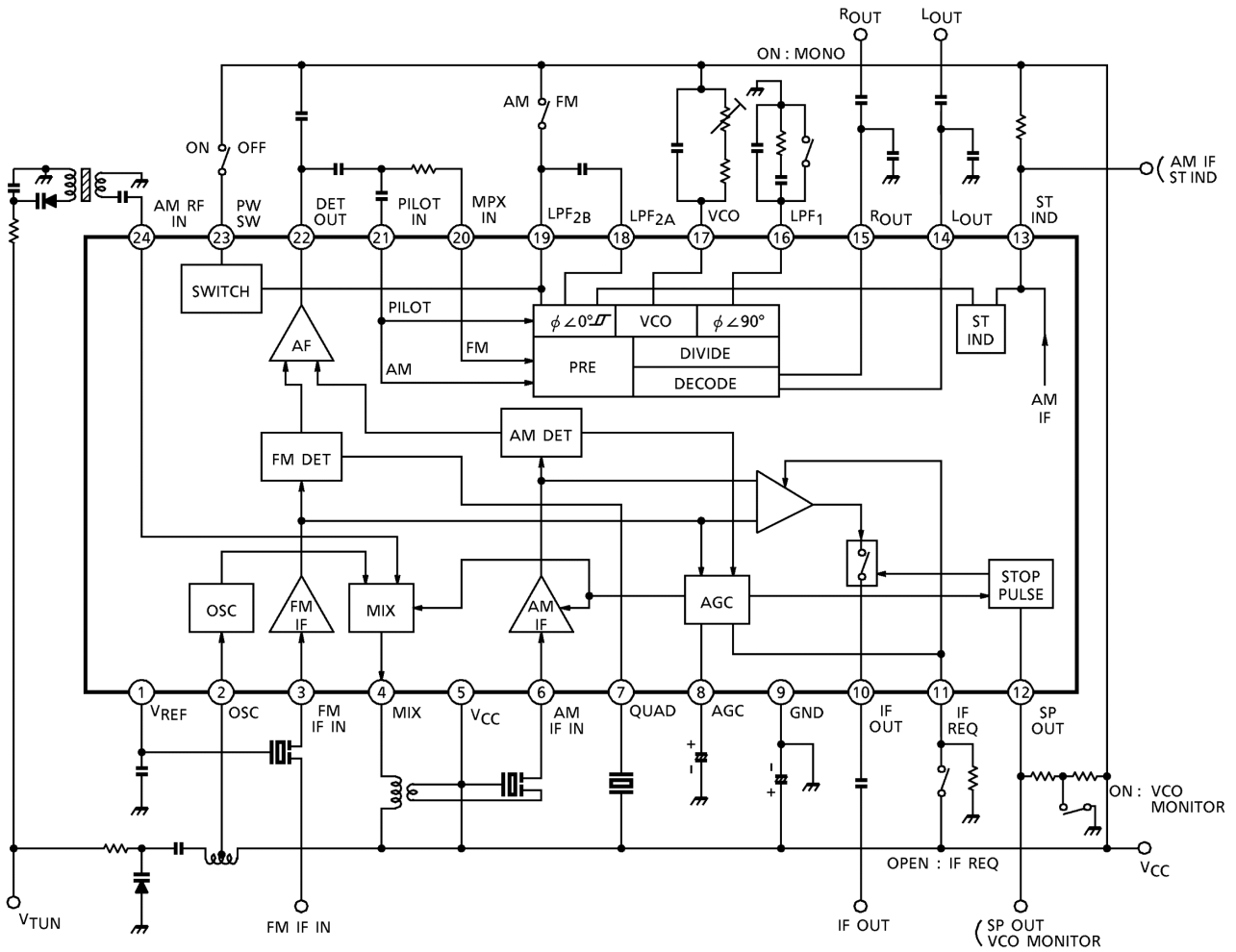
### Features

- 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 ( $T_a = 25^\circ C$ )
  - $V_{CC(opr)} = 0.95\sim 2.2V$
- Stereo operating supply voltage range ( $T_a = 25^\circ C$ )
  - $V_{CC(opr)} = 1.0\sim 2.2V$



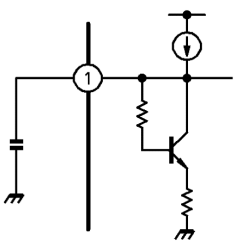
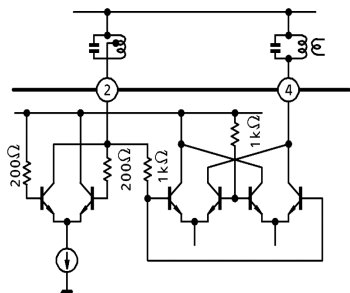
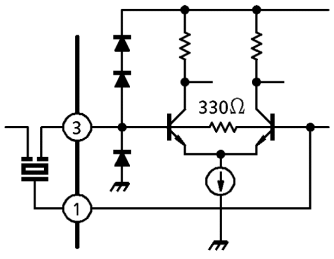
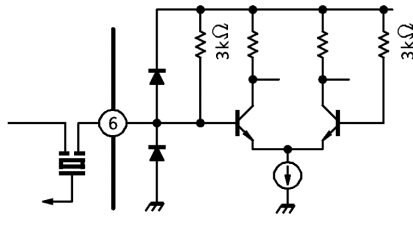
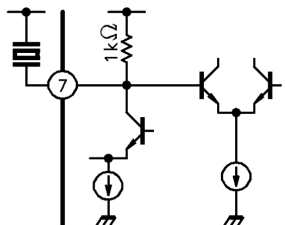
Weight: 0.14 g (typ.)

## BLOCK DIAGRAM



## Terminal Explanation

Terminal Voltage: Typical Terminal Voltage at no Signal with The Test Circuit 1  
 (V<sub>CC</sub> = 1.2V, T<sub>a</sub> = 25°C)

Terminal		Function	Internal Circuit	Terminal Voltage (V)	
No.	Name			AM	FM
1	V <sub>REF</sub>	Referential voltage 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 • Input impedance 330Ω (typ.)		0.9	0.9
5	V <sub>CC</sub>	—	—	1.2	1.2
6	AM IF IN	Input of AM IF signal • 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 AGC time constant is determined by external capacitor.</li> <li>• FM mode 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</p> <p>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.)</p> <p>AM: <math>V_{IF (AM)} = 100mV_{p-p}</math> (typ.)</p>		—	—
11	IF REQ	<p>IF request switch</p> <p><math>V_{CC}</math>: Receive mode</p> <p>Open: IF request mode</p> <p>FM stop pulse sensitivity can be changed by connecting <math>R_{SEN}</math> in IF request mode.</p> <p><math>R_{SEN}</math> should be smaller than 100kΩ</p>		—	—
12	SP OUT	<p>Output of stop pulse</p> <p>VCO frequency can be monitored, in case that this terminal is connected with GND through a resistor (<math>R_{VCO} \cong 100k\Omega</math>).</p> <p>ON : VCO monitor</p> <p>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 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 The temperature characteristic of free running frequency is +350ppm / °C. 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 V <sub>CC</sub> : AM mode 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 · Output impedance (typ.) AM: 10kΩ FM: 1kΩ		0.6	0.6
23	PW SW	Power switch V <sub>CC</sub> : IC on OPEN / GND: IC off		1.2	1.2
24	AM RF IN	Input of AM RF signal · Input impedance: 13kΩ (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 (pin (23)), in case that this IC is turned on due to external noise etc.

2. Mode switch

The terminal of AM / FM changeover is pin(19).

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

VCC : 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 VCC line independently, even through this IC is off mode (the terminal of PW SW (pin(23)) is off mode).

3. IF count output

IF count signal can be taken from IF output terminal (pin(10)), when IF request terminal (pin(11)) is connected with GND through RSEN and stop pulse sensitivity is on.

	Switch Condition		Output Frequency	Output Voltage (typ.)	Output Impedance (typ.)
	Pin(11)	Pin(19)			
FM	OPEN	OPEN	10.7MHz	80mV <sub>p-p</sub>	2 kΩ
AM	(R <sub>SEN</sub> ≤ 100kΩ)	VCC	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 RSEN between IF request terminal (pin(11)) and GND. The gain of FM IF amplifier is controlled by RSEN, and FM stop pulse sensitivity is changed.

It is advised that RSEN is 100kΩ or less.

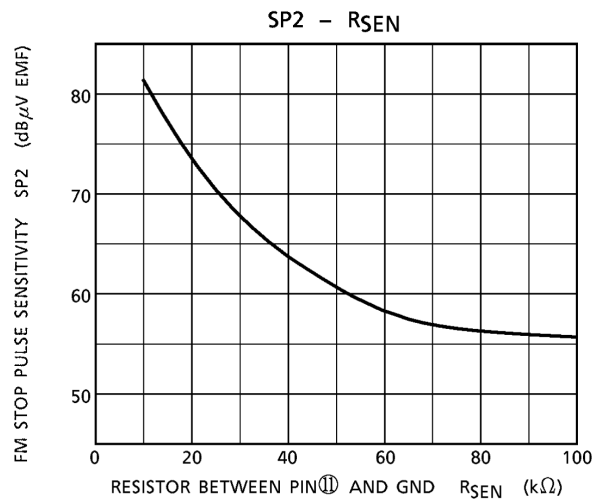


Fig.1 SP2 - RSEN

5. MPX IN

This IC can attenuate only FM stereo main signal level. Because MPX input for main signal (pin(20)) is independent of that for pilot signal (pin(21), this terminal is shared with AM input). Internal circuit of MPX in terminal (pin(20)) 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  $Q$ .

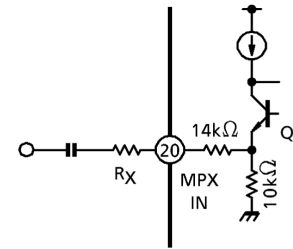


Fig.2 Internal circuit of MPX IN terminal

6. AM tweets

It is necessary to connect the capacitor  $C_t$  (about  $330pF$ ) between  $V_{CC}$  terminal (pin(6)) and DET OUT (pin(22)), in case that AM tweets occurs by pattern layout. (Fig.3) This  $C_t$  can also functions as phase compensation of MPX stage.

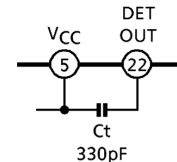


Fig.3 Countermeasures for AM tweets

7. AM AGC

It is necessary to connect a capacitor  $C$  (about  $68pF$ ) between  $V_{CC}$  terminal (pin(8)) and AM IF IN terminal (pin(6)), in case that AGC circuit doesn't operate normally. Because second harmonic of local oscillator is applied AM IF terminal (pin(6)) by pattern layout.

In case that capacitor ( $C = 68pF$ ) is connected, AM stop pulse sensitivity is delayed about 1dB. Output DC voltage of AGC terminal (pin(8)) is  $V_8 = 0.1V$  (typ., AM mode, at no signal).

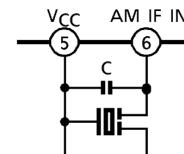


Fig.4 AM trap circuit

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

- The terminal of pin(13) 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 pin(13), or pin(13) should be connected to  $V_{CC}$  directly. (Fig.5) In case that  $R_{IF} > 3k\Omega$  or pin (13) is opened, this IC doesn't operate normally in AM mode. Because transistor  $Q_2$  is saturated.

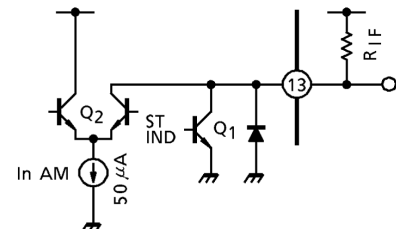


Fig.5 Internal circuit of pin⑬



- AM IF output  
 $V_{IF} (AM\ MOD) = 6mV_{rms}$  (typ.  $R_{IF} = 3k\Omega$ )  
 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.

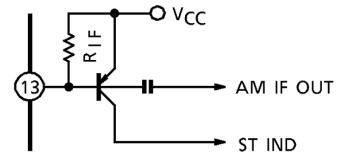


Fig.6 Method to use stereo indicator and AM IF output.

(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.

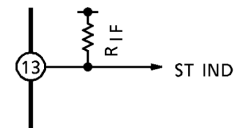


Fig.7 Method to use stereo indicator.

(c) Method to use AM IF output  
 External circuit is recommended as shown in fig.8.

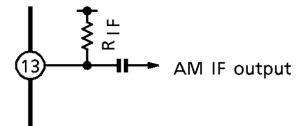
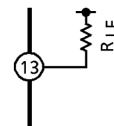


Fig.8 Method to use AM IF output.

(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.



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

**Maximum Ratings (Ta = 25°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	$T_{opr}$	-25~75	°C
Storage temperature	$T_{stg}$	-55~150	°C

(Note) Derated above Ta = 25°C in the proportion of 4mW / °C.

## Electrical Characteristics

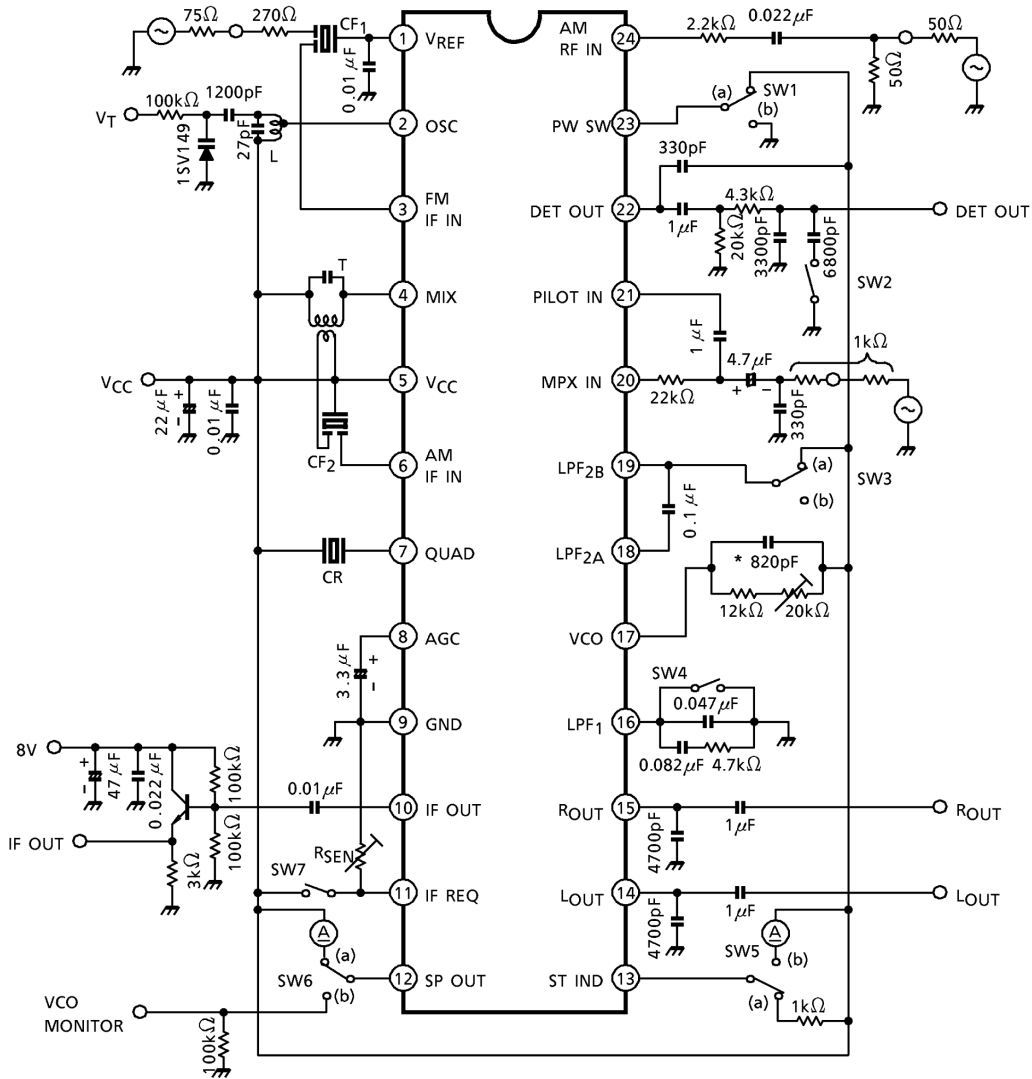
Unless Otherwise Specified

$V_{CC} = 1.2V$ ,  $T_a = 25^{\circ}C$ , SW1: a, SW4: OPEN, SW5: a, SW6: a / b, SW7: ON  
 FM IF:  $f = 10.7MHz$ ,  $f_m = 1kHz$ ,  $\Delta f = \pm 22.5kHz$ ,  $V_{in} = 80dB\mu V$ , EMF, SW2: ON, SW3: b  
 AM:  $f = 1MHz$ ,  $f_m = 1kHz$ , MOD = 30%,  $V_{in} = 60dB\mu V$ , EMF, SW2: OPEN, SW3: a  
 MPX:  $f_m = 1kHz$ ,  $f_p = 19kHz$ , 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 IF	Input limiting sensitivity	$V_{in} (lim)$	1	-3dB limiting	43	48	53	$dB\mu V$ EMF	
	Recovered output voltage 1	$V_{OD1}$			35	55	70	$mV_{rms}$	
	Signal to noise ratio 1	S / N1			—	60	—	dB	
	Total harmonic distortion 1	THD1			—	0.5	—	%	
	AM rejection ratio	AMR			MOD = 30%	—	40	—	dB
	Stop pulse sensitivity 1	SP1			$I_{12} = 0.5mA$ , SW6: a	50	55	60	$dB\mu V$ EMF
	Stop pulse sensitivity 2	SP2			$I_{12} = 0.5mA$ , $R_{SEN} = 39k\Omega$ SW6: a, SW7: OPEN	—	64	—	
IF output voltage	$V_{IF} (FM)$		$\Delta f = 0$ , SW7: OPEN	—	80	—	$mV_{p-p}$		
A M	Gain	$G_V$	1	$V_{in} = 26dB\mu V$ EMF	15	27	—	$mV_{rms}$	
	Recovered output voltage 2	$V_{OD2}$			30	45	60		
	Signal to noise ratio2	S / N2			—	38	—	dB	
	Total harmonic distortion 2	THD2			—	1.5	—	%	
	Stop pulse sensitivitiy	SP3		$I_{12} = 0.5mA$ , SW6: a	25	30	35	$dB\mu V$ EMF	
	IF output voltage	$V_{IF} (AM)$		MOD = 0, SW7: OPEN	—	100	—	$mV_{p-p}$	
	Oscillator voltage	$V_{osc}$	2		30	55	—	$mV_{rms}$	
Oscillator stop voltage	$V_{stop}$			—	—	0.95	V		

Characteristic		Symbol	Test Cir-cuit	Test Condition	Min.	Typ.	Max.	Unit		
MPX	Voltage gain 1	$G_V$ (FM)	1	$V_{in} = 100mV_{rms}$ (mono)	-1.5	+0.5	+2.5	dB		
	Voltage gain 2	$G_V$ (AM)			-0.5	+1.5	+3.5			
	Channel balance	CB			-2	—	+2			
	Maximum composite signal input level	$V_{in}$ (MAX)		L + R =90%, P = 10% THD = 3%	—	220	—	$mV_{rms}$		
	Total harmonic distortion	Mono		THD3	$V_{in} = 100mV_{rms}$ (mono)	—	0.2	0.5	%	
		Stereo		THD4	L + R =90 $mV_{rms}$ , P = 10 $mV_{rms}$	—	0.3	—		
		AM		THD5	$V_{in} = 100mV_{rms}$	—	0.2	—		
	Separation	SEP		L + R =90 $mV_{rms}$ P = 10 $mV_{rms}$	$f_m = 100Hz$	—	36	—	dB	
					$f_m = 1kHz$	25	35	—		
					$f_m = 10kHz$	—	34	—		
	Stereo indicator sensitivity	On		ST (ON)	Pilot signal input $I_{13} = 0.5mA$ , SW5: a	—	5.5	8	$mV_{rms}$	
		Off		ST (OFF)		2	4	—		
	Stereo indicator hysteresis			$V_H$	To indicator turn off from turn on	—	1.5	—	$mV_{rms}$	
	Capture range			CR	P = 10 $mV_{rms}$ , $f_p = 19kHz$	—	±7	—	%	
Signal noise ratio 3		S / N3	$V_{in} = 100mV_{rms}$ (mono)	—	65	—	dB			
Power switch	On current	$I_{23}$	2	$V_{CC} = 0.95V$	SW1: c	5	—	—	$\mu A$	
	Off voltage	$V_{23}$			SW1: d	0	—	0.3	V	
AM mode on current		$I_{19}$			SW3: c	50	—	—	$\mu A$	
FM mono mode on voltage		$V_{16}$			SW4: ON	—	0.1	—	V	
IF request off voltage		$V_{11}$			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 THD<sub>4</sub>, V<sub>in</sub> (Max.), and SEP the filter shown in Figure 10 is used.

ATT : ATT ≥ 60dB (f = 19~100kHz)

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

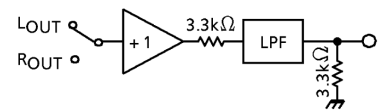
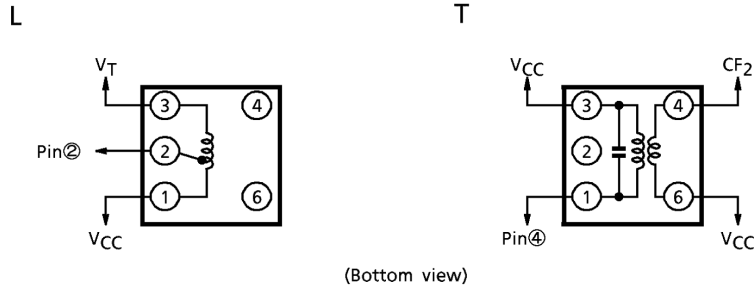


Fig.10 Filter circuit

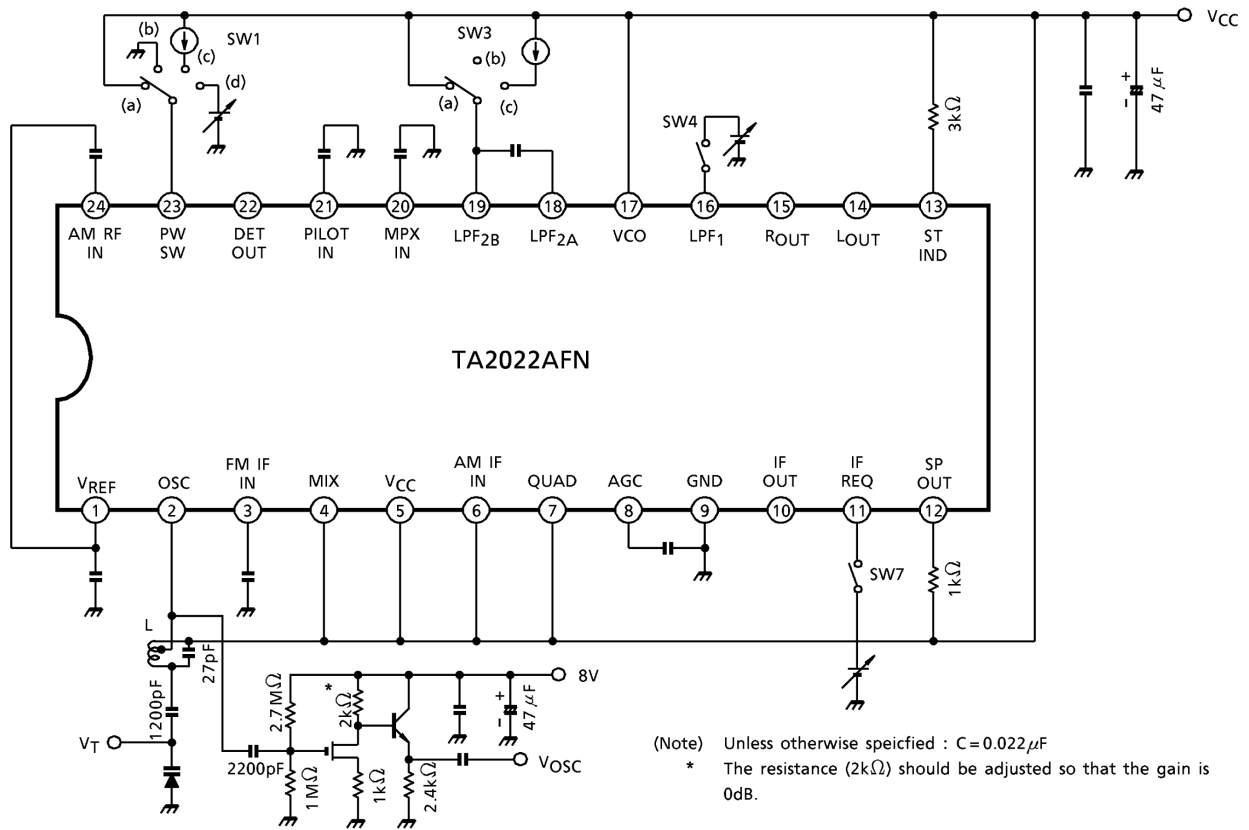
## Coil Data

Coil	Test Frequency	L (μH)	Co (pF)	Qo	Turns				Wire (mmφ)	Reference (coil no.)
					1-2	2-3	1-3	4-6		
L AM OSC	796kHz	100	—	85	13	55	—	—	0.06UEW	(S)4187-144
T AM IFT	450kHz	—	180	65	—	—	184	29	0.05UEW	(S)4161-242

(S): SUMIDA ELECTRIC Co., LTD.

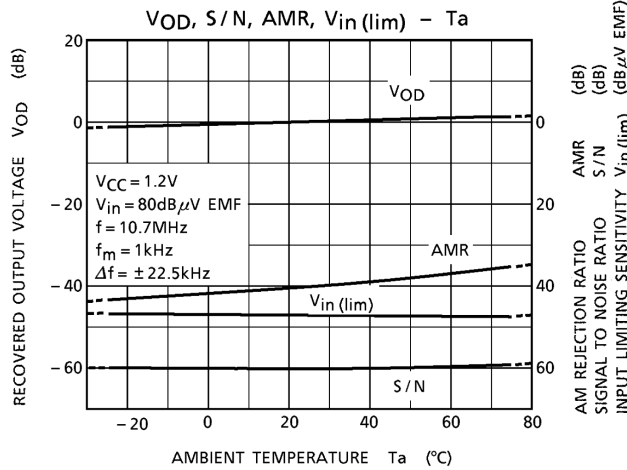
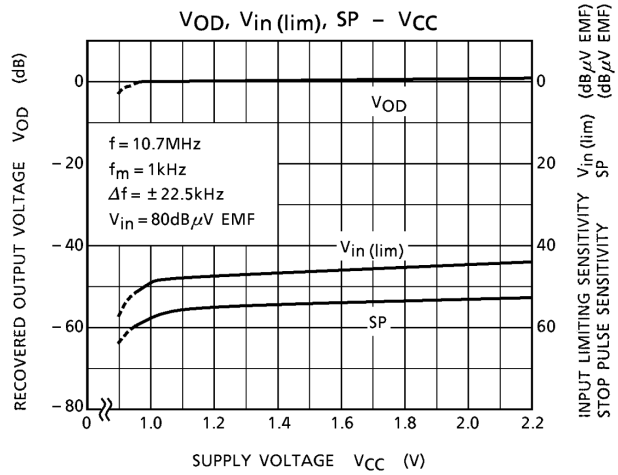
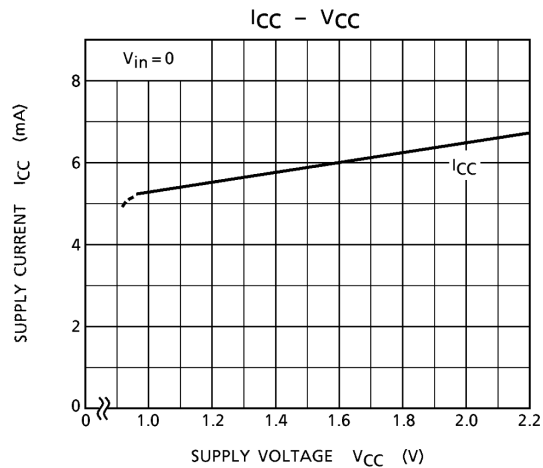
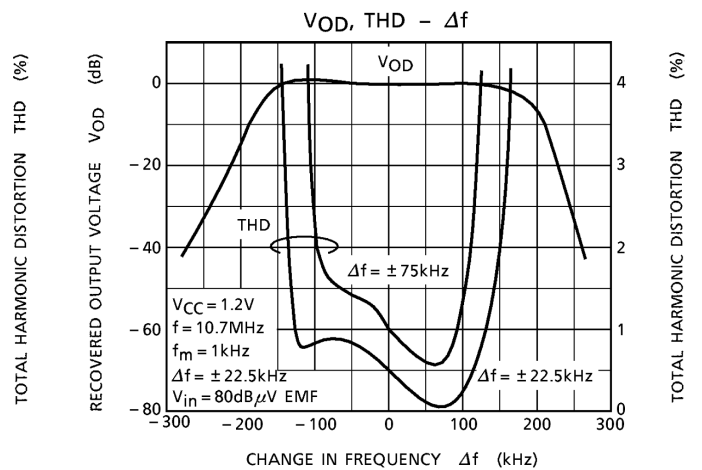
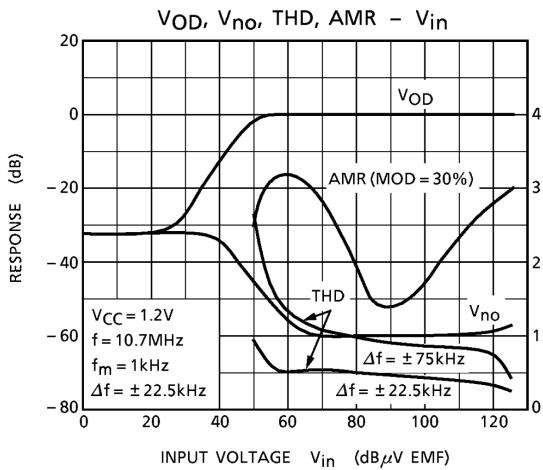


## TEST CIRCUIT 2

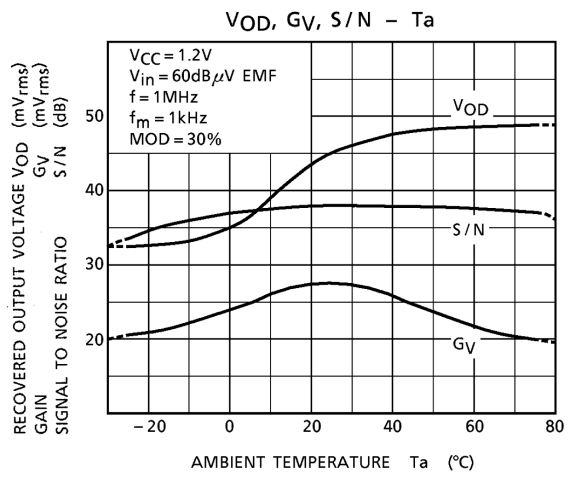
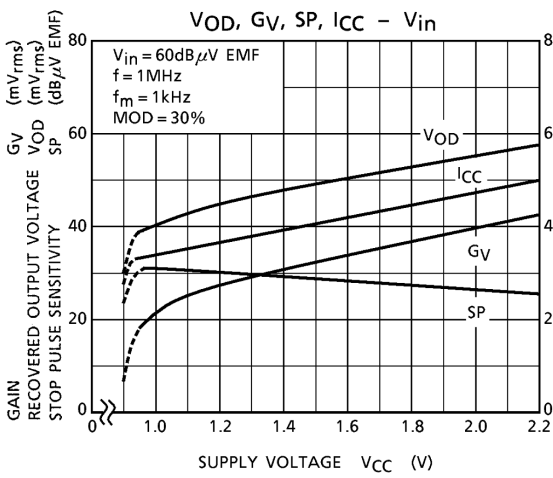
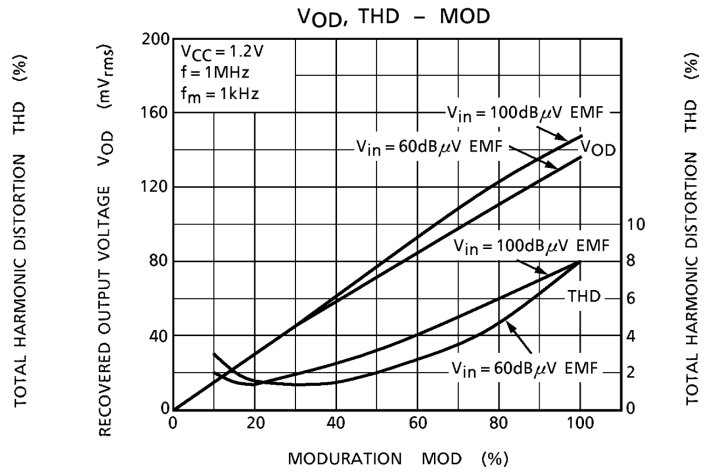
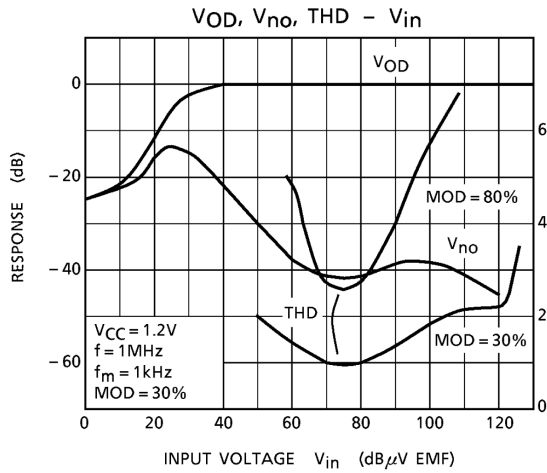


Characteristic Curve

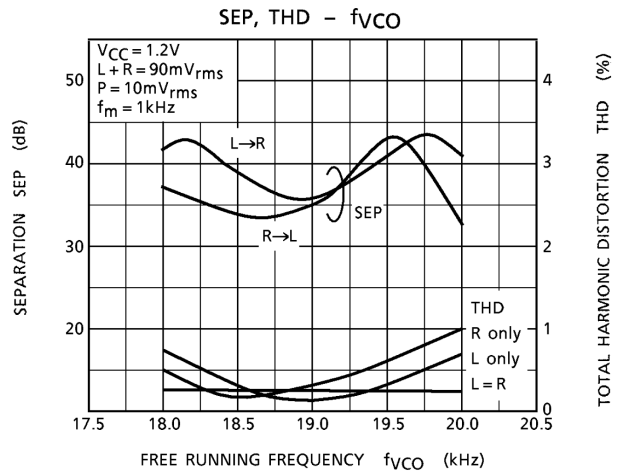
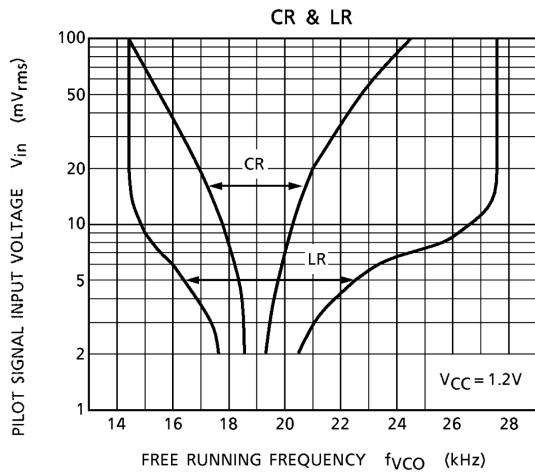
FM IF

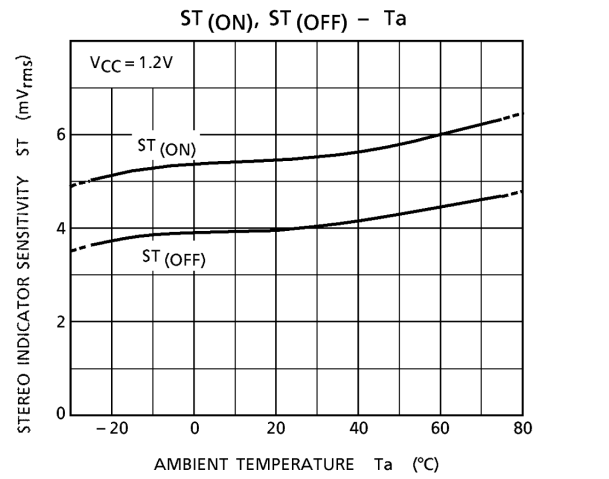
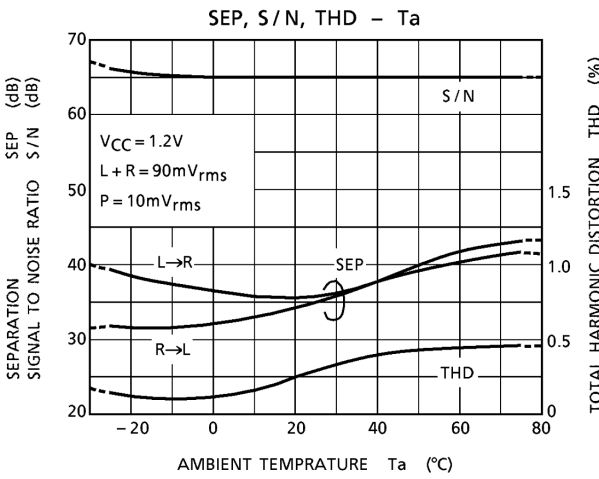
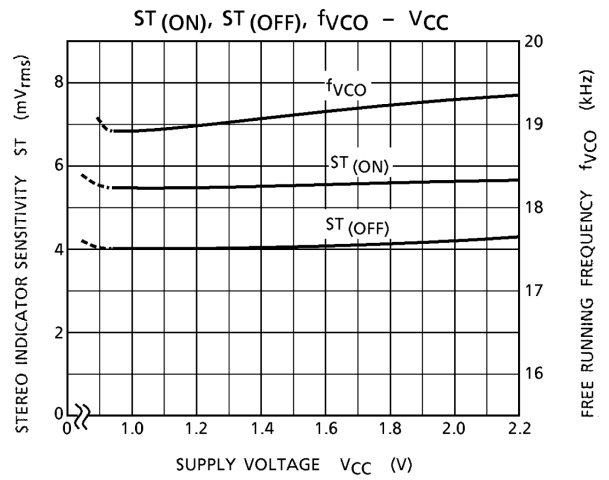
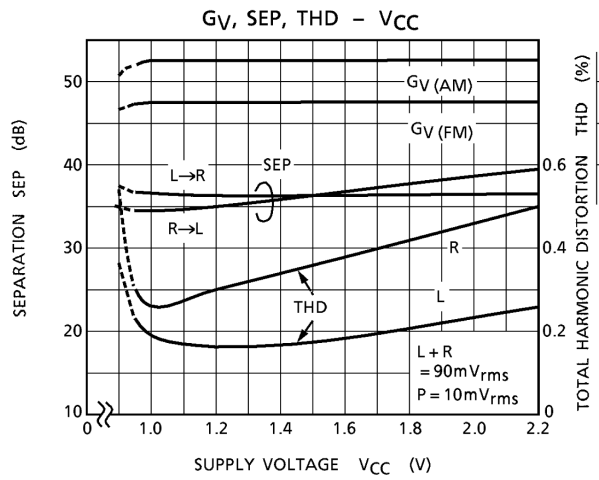
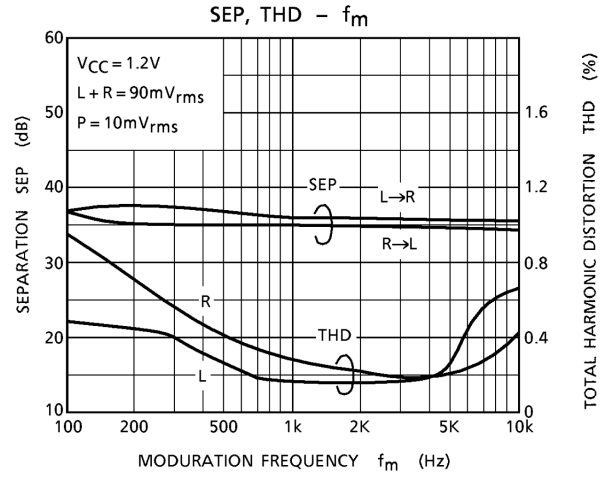
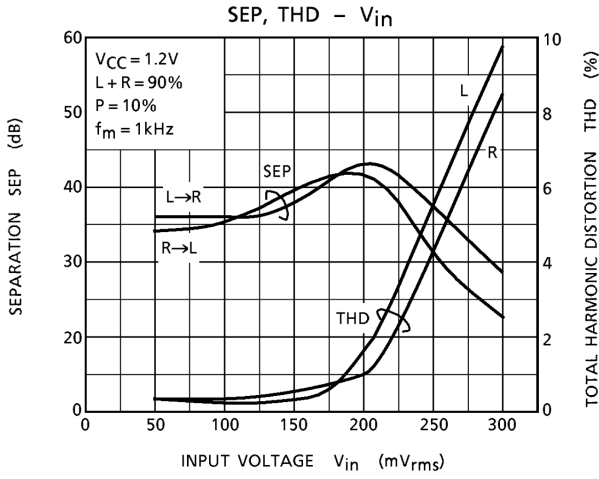


## AM



## MPX



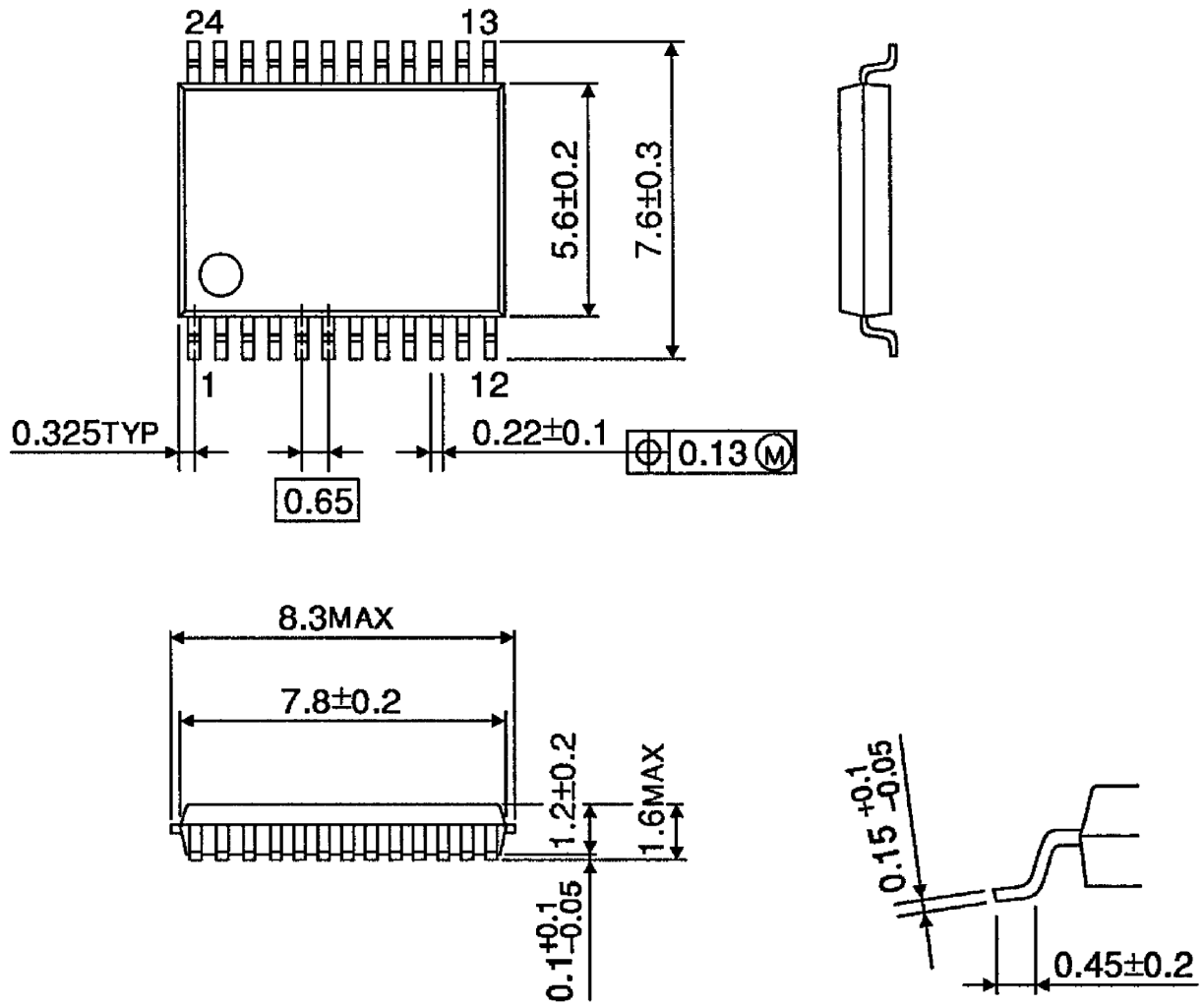




## Package Dimensions

SSOP24-P-300-0.65A

Unit : mm



Weight: 0.14g (typ.)

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