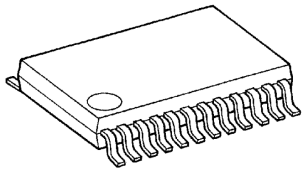
TOSHIBA Bipolar Linear Integrated Circuit Silicon Monolithic

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.



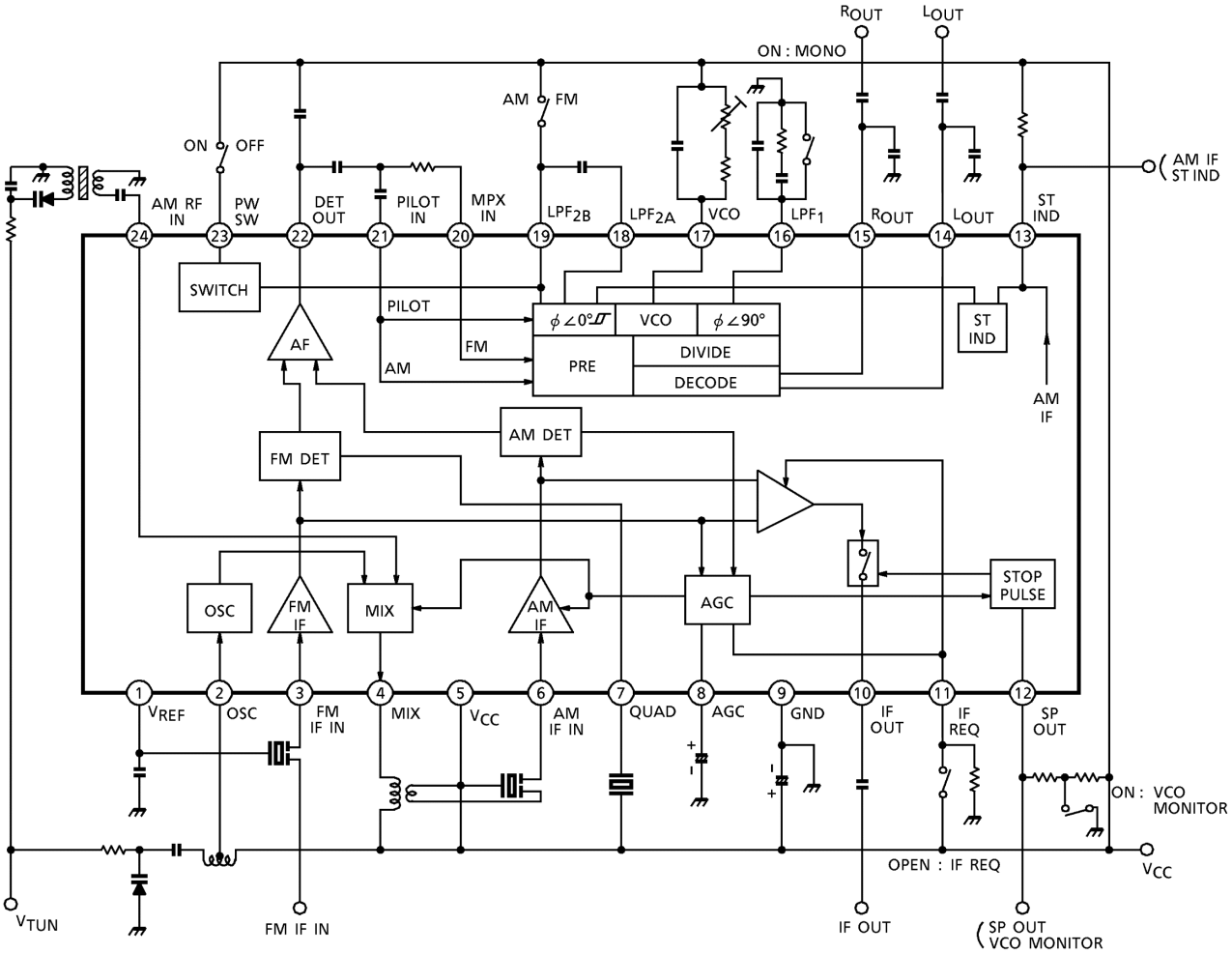
SSOP24-P-300-0.65A

Weight: 0.14 g (typ.)

Features

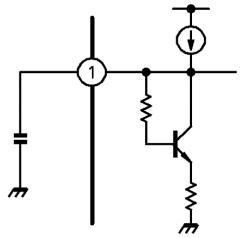
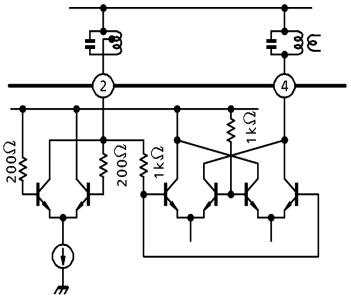
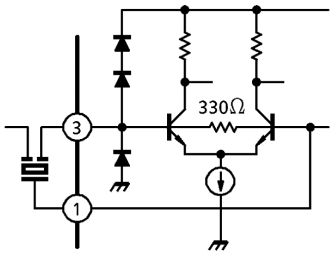
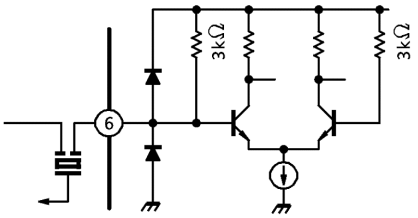
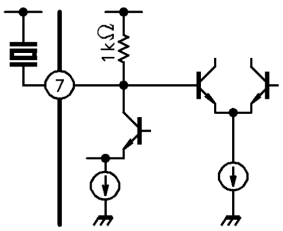
- Suitable for combination with digital tuning system which is included IF counter.
  - Built−in AM / FM IF count output for IF counter of digital tuning system.
    FM: 10.7MHz
    AM: 450kHz
  - Adjustable for stop pulse sensitivity (in FM mode)
- For adopting ceramic discriminator, it is not necessary 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, Ta = 25°C)
  FM mode: I_{CC2} = 5.5mA (typ.)
  AM mode: I_{CC3} = 3.7mA (typ.)
- Operating supply voltage range (Ta = 25°C)
  $V_{CC\ (opr)}$ = 0.95~2.2V
- Stereo operating supply voltage range (Ta = 25°C)
  $V_{CC\ (opr)}$ = 1.0~2.2V

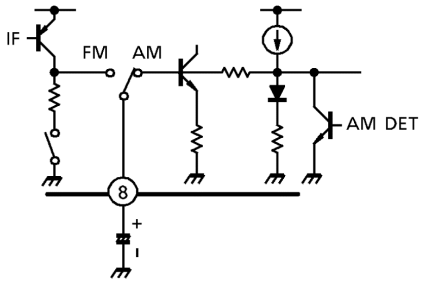
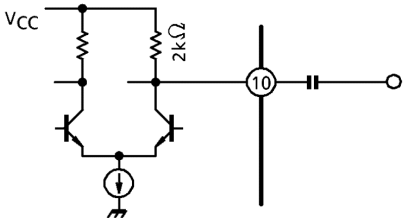
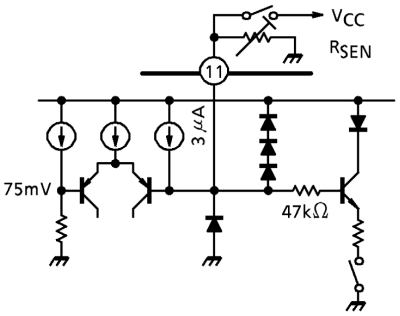
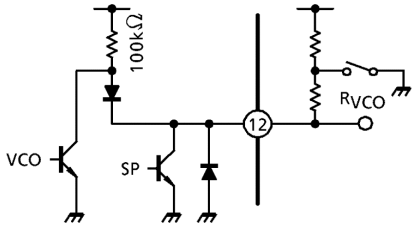
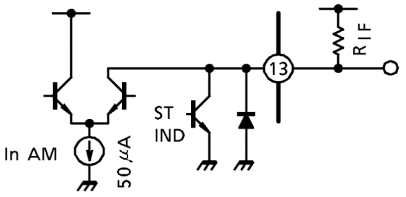
BLOCK DIAGRAM

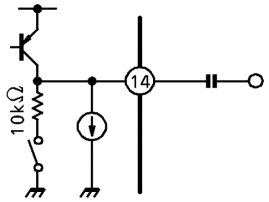
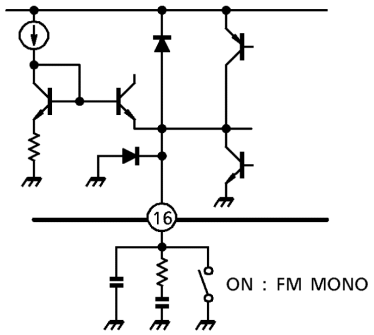
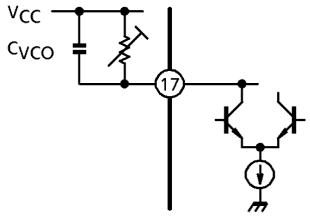
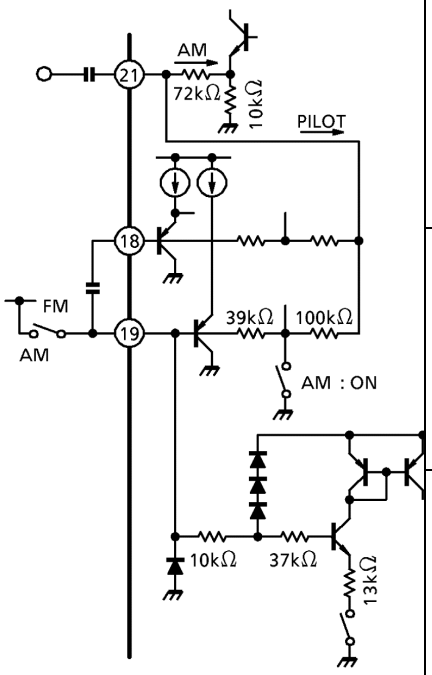


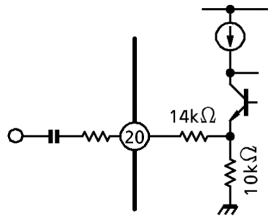
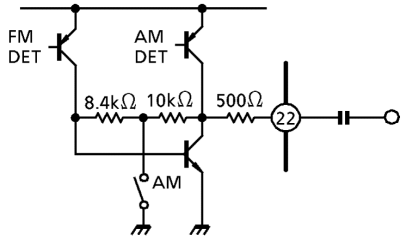
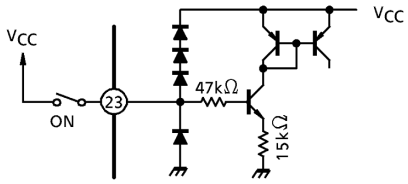
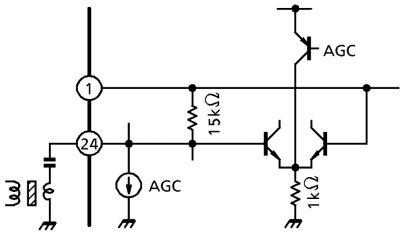
Terminal Explanation

Terminal Voltage: Typical Terminal Voltage at no Signal with The Test Circuit 1
(V_{CC} = 1.2V, Ta = 25°C)

Terminal		Function	Internal Circuit	Terminal Voltage (V)	
No.	Name			AM	FM
1	V_{REF}	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	Imput of FM IF signal ・Input impedance 330Ω (typ.)		0.9	0.9
5	V_{CC}	—	—	1.2	1.2
6	AM IF IN	Imput of AM IF signal ・Input impedance 3kΩ (typ.)		1.2	1.2
7	QUAD	FM QUAD detector		1.2	1.2

Terminal No.	Terminal Name	Function	Internal Circuit	Terminal Voltage (V) AM	Terminal Voltage (V) FM
8	AGC	・AM mode AGC time constant is determined by external capacitor. ・FM mode The sudden change of stop pulse sensitivity is held in by external capacitor.		—	—
9	GND	—	—	0	0
10	IF OUT	Output of IF count signal In case of IF request mode, IF count signal for IF counter is taken from this terminal. FM: $V_{IF\ (FM)}$ = 80mV$_{p-p}$ (typ.) AM: $V_{IF\ (AM)}$ = 100mV$_{p-p}$ (typ.)		—	—
11	IF REQ	IF request switch V_{CC}: Receive mode Open: IF request mode FM stop pulse sensitivity can be changed by connecting R_{SEN} in IF request mode. R_{SEN} should be smaller than 100kΩ		—	—
12	SP OUT	Output of stop pulse VCO frequency can be monitored, in case that this terminal is connected with GND through a resistor (R_{VCO} ≒ 100kΩ). ON : VCO monitor OPEN : SP OUT		—	—
13	ST IND	Stereo indicator terminal ・This terminal shared with output of modulated AM IF signal. ・AM IF output: 6mV$_{rms}$ (R_{IF} = 3kΩ, typ.) ・R_{IF} should be smaller than 3kΩ. In case that R_{IF} > 3kΩ, internal biasing circuit doesn't operate normally in AM mode.		—	—

Terminal No.	Terminal Name	Function	Internal Circuit	Terminal Voltage (V) AM	Terminal Voltage (V) FM
14	L_{OUT}	Output of stereo signal These terminals are high-impedance in power off mode.		0.5	0.5
15	R_{OUT}				
16	LPF_1	LPF terminar for phase detector		—	—
17	VCO	VCO The temperature characteristic of free running frequency is +350ppm / °C. Temperature coefficient: SH		—	1.2
18	LPF_{2A}	LPF terminal for synchronous detector		—	—
19	LPF_{2B}	LPF terminal for synchronous detector and AM / FM switch V_{CC}: 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_{CC} : 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.
   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 (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 R_{SEN} 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	$80mV_{p-p}$	2 kΩ
AM	(R_{SEN} ≤ 100kΩ)	V_{CC}	450kHz	$100mV_{p-p}$	

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 (pin(11)) 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 100kΩ or less.

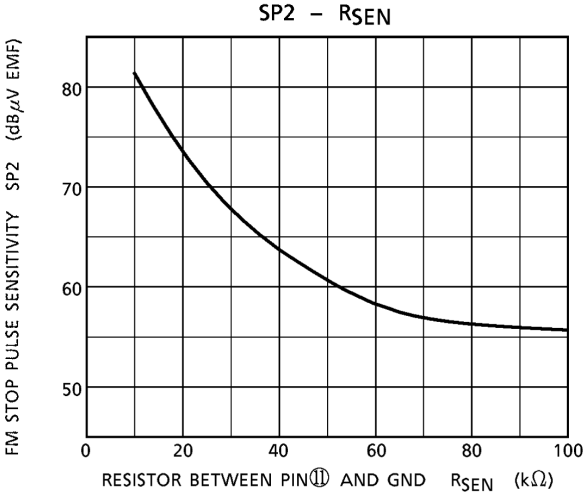


Fig.1 SP2 – R_{SEN}

5. MPX IN

This IC can attenuate only FM stereo main signal level. Because MPX input for main signal (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 (14kΩ and10kΩ) and resistor R_X. And it is applied to an emitter of transistor Q.

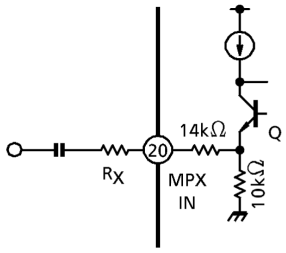


Fig.2 Internal circuit of MPX IN terminal

6. AM tweets

It is necessary to connect the capacitor Ct (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 Ct can also functions as phase compensation of MPX stage.

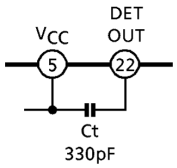


Fig.3 Countermeasures for AM tweets

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 pettern 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).

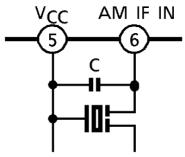


Fig.4 AM trap circuit

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} (3kΩ or less) should be connected between V_{CC} and pin(13) , or pin(13) should connected to V_{CC} directly. (Fig.5) In case that R_{IF} >3kΩ or pin (13) is opened, this IC doesn't operate normally in AM mode. Because transistor Q_2 is saturated.

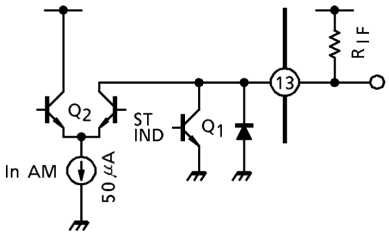


Fig.5 Internal circuit of pin⑬

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

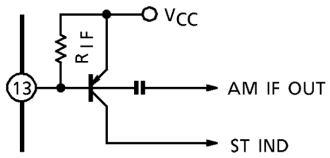


Fig.6 Method to use stereo indicator and AM IF output.

(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.

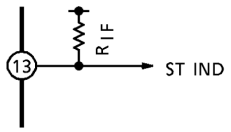


Fig.7 Method to use stereo indicator.

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

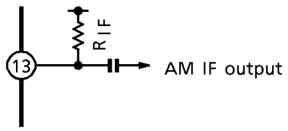
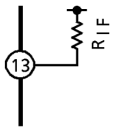


Fig.8 Method to use AM IF output.

(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

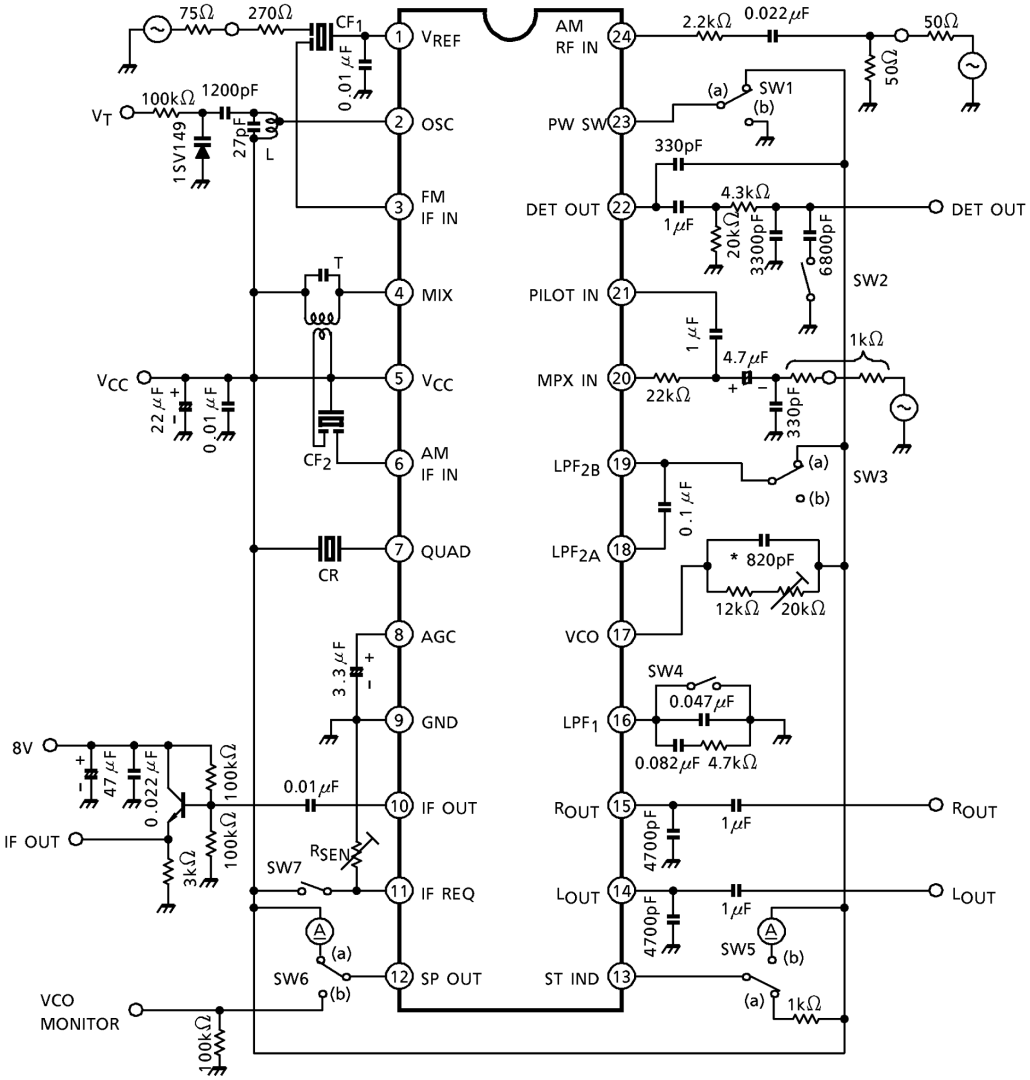
Unless Otherwise Specified

V_{CC} = 1.2V, Ta = 25°C, SW1: a, SW4: OPEN, SW5: a, SW6: a / b, SW7: ON
FM IF: f = 10.7MHz, f_m = 1kHz, Δf = ±22.5kHz, V_{in} = 80dBμV, EMF, SW2: ON, SW3: b
AM: f = 1MHz, f_m = 1kHz, MOD = 30%, V_{in} = 60dBμV, EMF, SW2: OPEN, SW3: a
MPX: f_m = 1kHz, f_p = 19kHz, SW3:b

Characteristic		Symbol	Test Circuit	Test Condition	Min.	Typ.	Max.	Unit
Supply current		I_{CC1}	1	PW off, SW1: b	—	—	5	μA
		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	dBμV 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	dBμV EMF
	Stop pulse sensitivity 2	SP2		I_{12} = 0.5mA, R_{SEN} = 39kΩ SW6: a, SW7: OPEN	—	64	—	
	IF output voltage	$V_{IF\ (FM)}$		Δf = 0, SW7: OPEN	—	80	—	mV_{p-p}
AM	Gain	G_V	1	V_{in} = 26dBμV 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	dBμV 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 =90mV$_{rms}$, P = 10mV$_{rms}$		—	0.3	—	
		AM	THD5		V_{in} = 100mV$_{rms}$		—	0.2	—	
	Separation		SEP		L + R =90mV$_{rms}$ P = 10mV$_{rms}$	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 = 10mV$_{rms}$, 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	—	—	μA
		Off voltage	V_{23}			SW1: d	0	—	0.3	V
AM mode on current			I_{19}			SW3: c	50	—	—	μA
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_1 : SFE10.7MA8 (MURATA Co., Ltd.)

CF_2 : 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≧60dB (f = 19~100kHz)
  Filter : 4501-054 (SUMIDA ELECTRIC Co., LTD) with insertion loss of 0.3dB

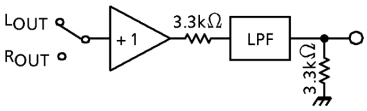
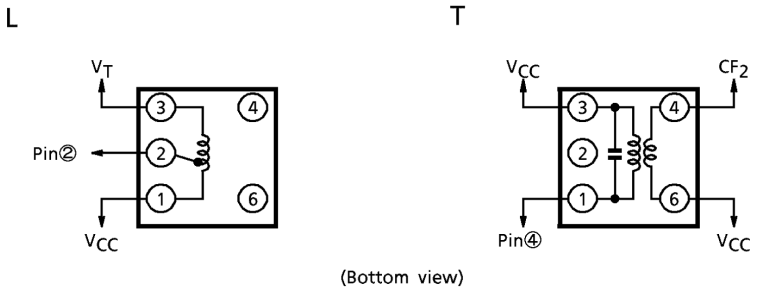


Fig.10 Filter circuit

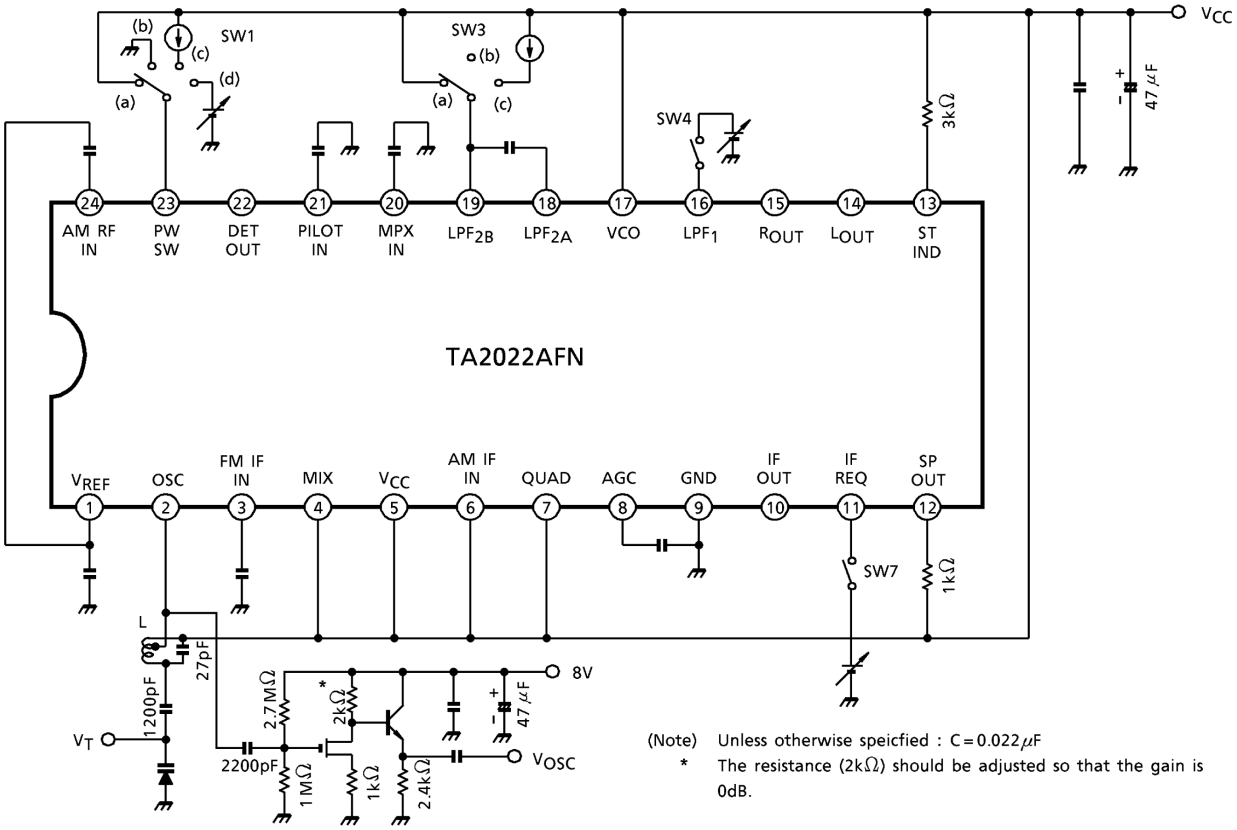
Coil Data

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.



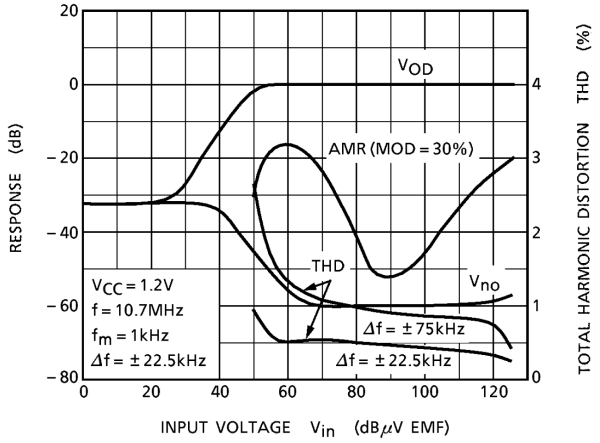
TEST CIRCUIT 2



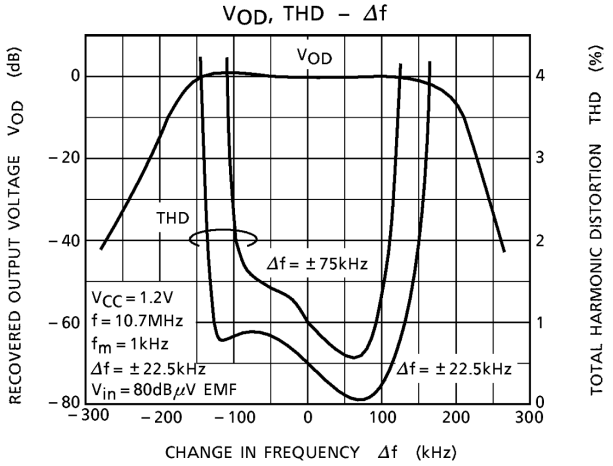
Characteristic Curve

FM IF

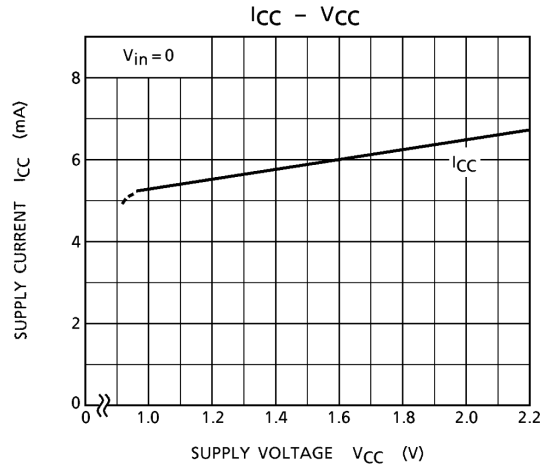
V_{OD}, V_{no}, THD, AMR – V_{in}



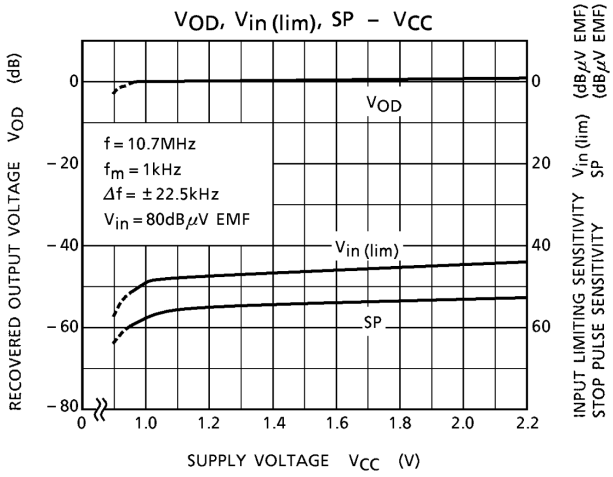
V_{OD}, THD – Δf



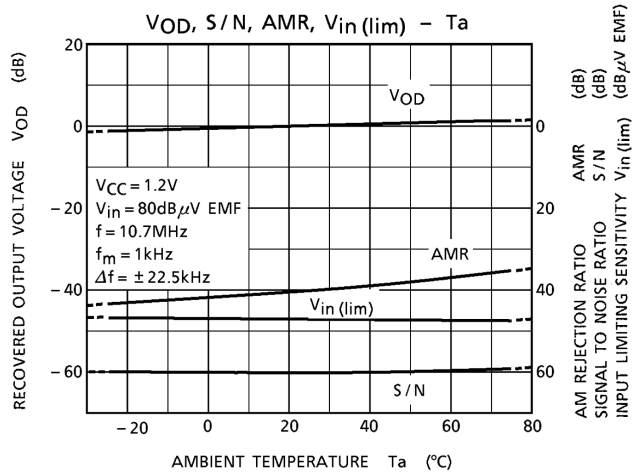
I_{CC} – V_{CC}



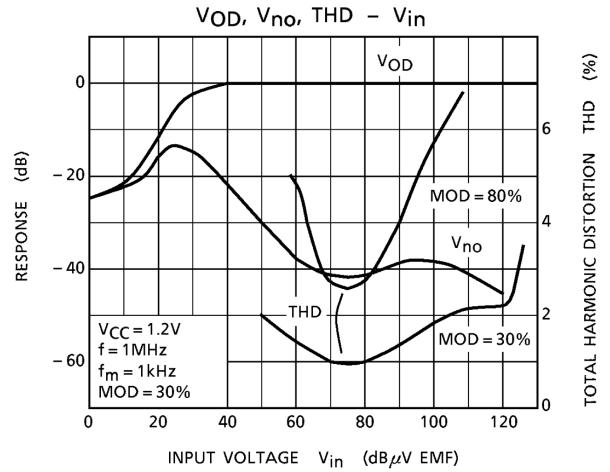
V_{OD}, $V_{in\,(lim)}$, SP – V_{CC}

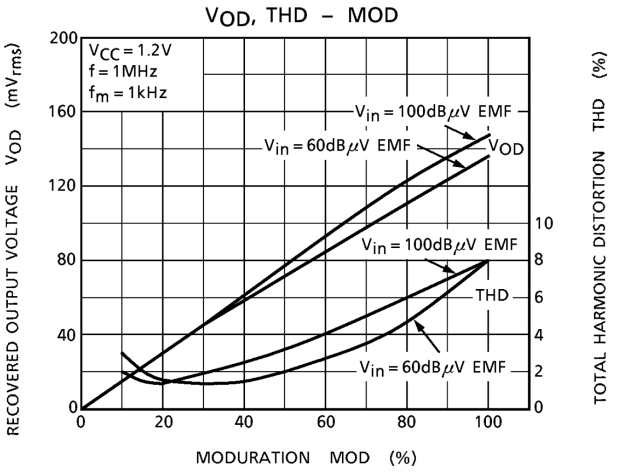


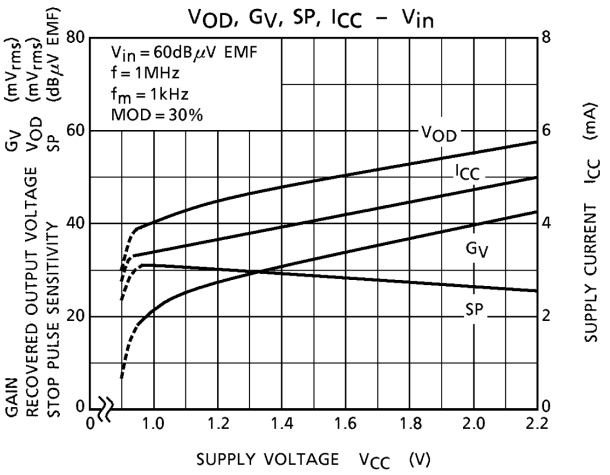
V_{OD}, S/N, AMR, $V_{in\,(lim)}$ – Ta

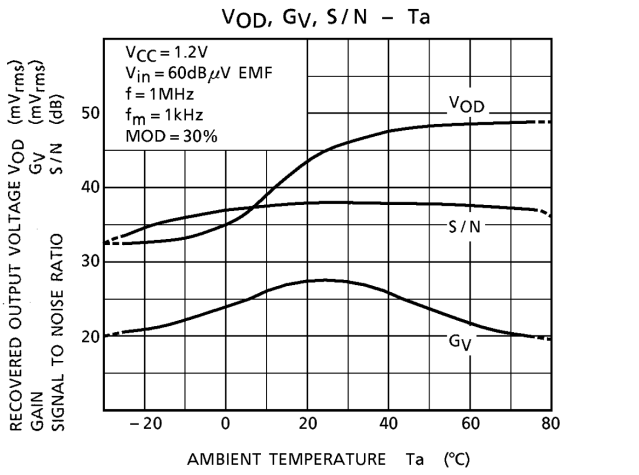


AM

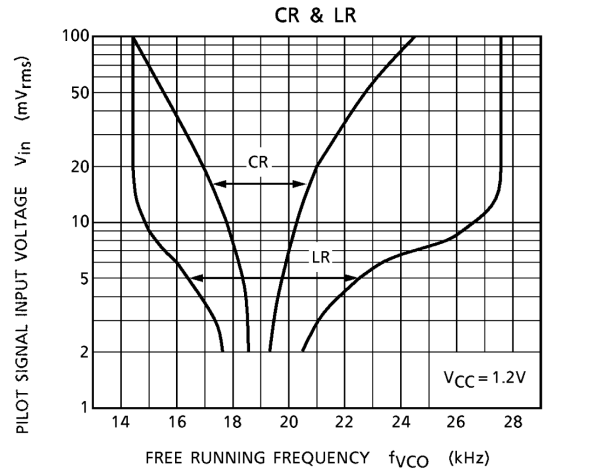

VOD, Vno, THD – Vin
VOD
MOD = 80%
Vno
THD
MOD = 30%
VCC = 1.2V
f = 1MHz
fm = 1kHz
MOD = 30%
RESPONSE (dB)
TOTAL HARMONIC DISTORTION THD (%)
INPUT VOLTAGE Vin (dBμV EMF)

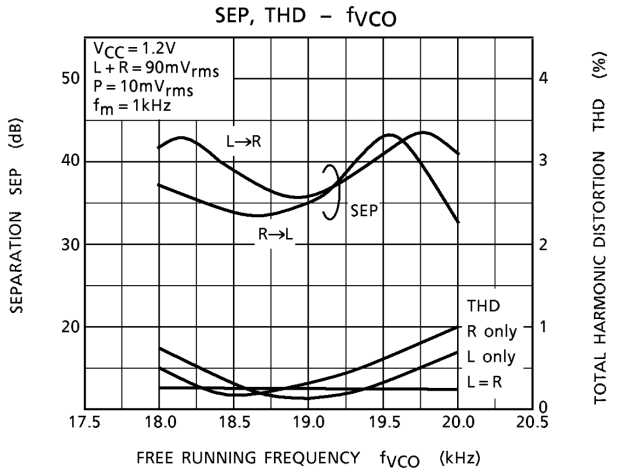

VOD, THD – MOD
VCC = 1.2V
f = 1MHz
fm = 1kHz
Vin = 100dBμV EMF
Vin = 60dBμV EMF
VOD
Vin = 100dBμV EMF
THD
Vin = 60dBμV EMF
RECOVERED OUTPUT VOLTAGE VOD (mVrms)
TOTAL HARMONIC DISTORTION THD (%)
MODURATION MOD (%)


VOD, GV, SP, ICC – Vin
Vin = 60dBμV EMF
f = 1MHz
fm = 1kHz
MOD = 30%
VOD
ICC
GV
SP
GAIN GV (mVrms)
RECOVERED OUTPUT VOLTAGE VOD (mVrms)
STOP PULSE SENSITIVITY SP (dBμV EMF)
SUPPLY CURRENT ICC (mA)
SUPPLY VOLTAGE VCC (V)

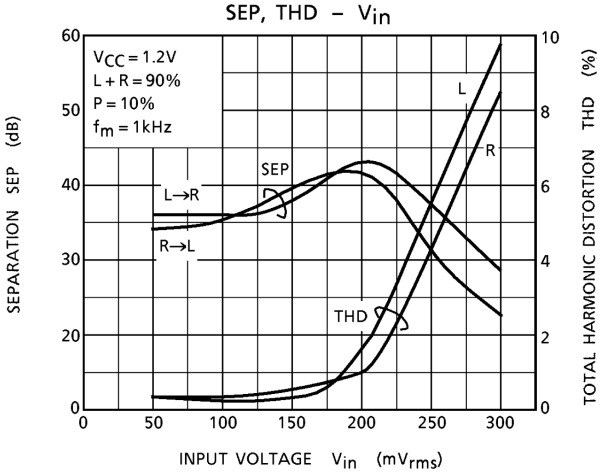

VOD, GV, S/N – Ta
VCC = 1.2V
Vin = 60dBμV EMF
f = 1MHz
fm = 1kHz
MOD = 30%
VOD
S/N
GV
RECOVERED OUTPUT VOLTAGE VOD (mVrms)
GAIN GV (dB)
SIGNAL TO NOISE RATIO S/N (dB)
AMBIENT TEMPERATURE Ta (°C)

MPX

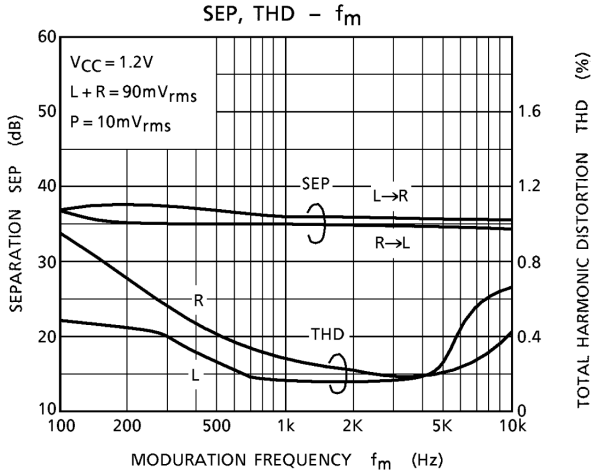

CR & LR
CR
LR
VCC = 1.2V
PILOT SIGNAL INPUT VOLTAGE Vin (mVrms)
FREE RUNNING FREQUENCY fVCO (kHz)


SEP, THD – fVCO
VCC = 1.2V
L + R = 90mVrms
P = 10mVrms
fm = 1kHz
L→R
SEP
R→L
THD
R only
L only
L = R
SEPARATION SEP (dB)
TOTAL HARMONIC DISTORTION THD (%)
FREE RUNNING FREQUENCY fVCO (kHz)

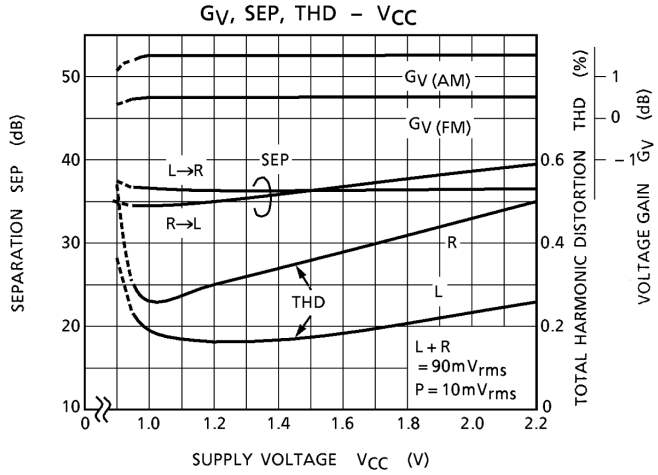
SEP, THD – V_{in}



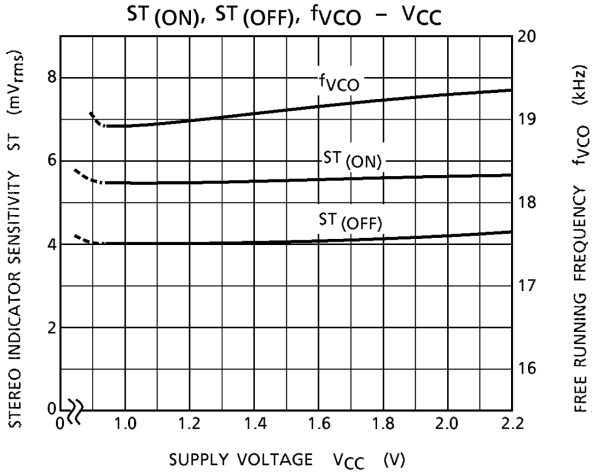
SEP, THD – f_m



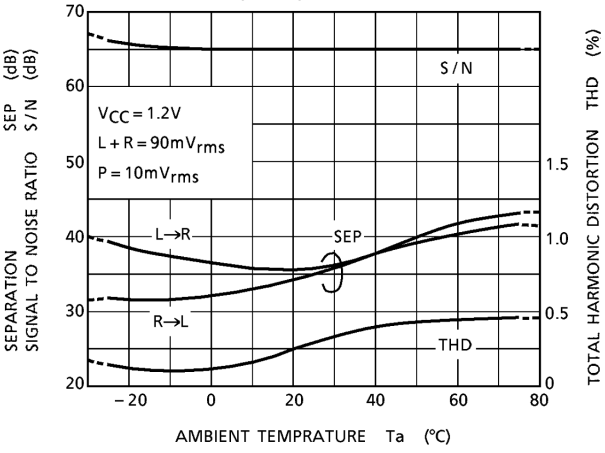
G_V, SEP, THD – V_{CC}



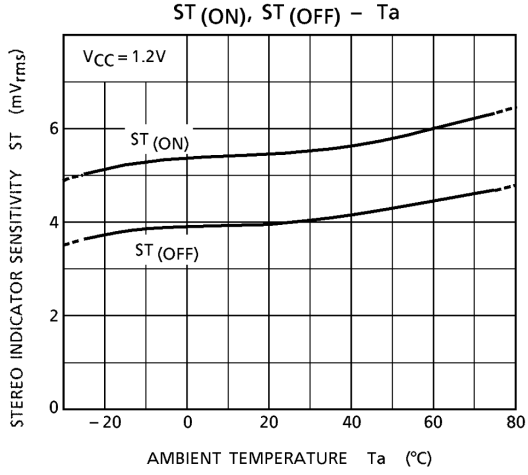
ST (ON), ST (OFF), f_{VCO} – V_{CC}



SEP, S/N, THD – Ta

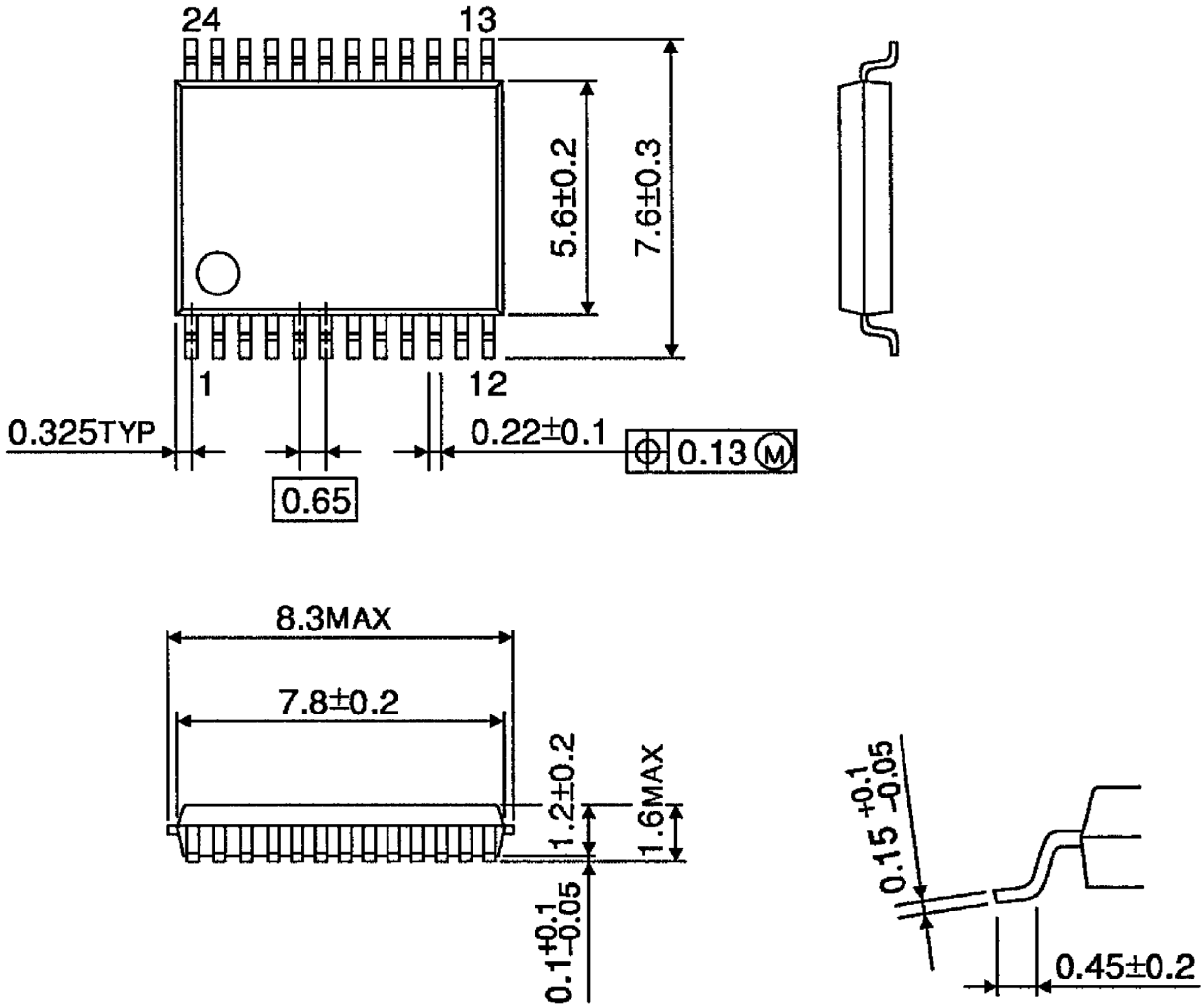


ST (ON), ST (OFF) – Ta



Package Dimensions

SSOP24-P-300-0.65A Unit : mm



Weight: 0.14g (typ.)

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