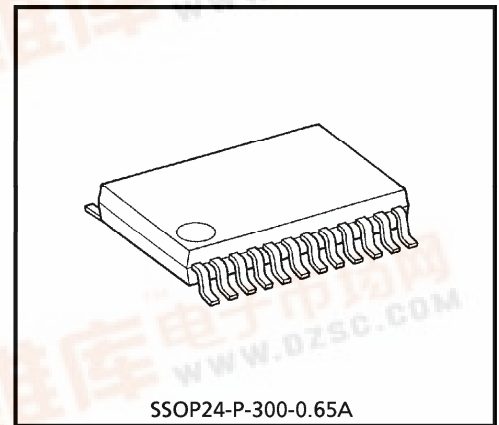


TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT SILICON MONOLITHIC

TA31149FNG

4-LEVEL FSK IF DETECTOR IC FOR PAGER

TA31149FN is a 4-level frequency-shift keying (FSK) compatible IF detector IC for pagers. The IC contains a 4-level FSK comparator and a bit rate filter switch. The device, which operates at low voltage, incorporates a battery alarm and RF regulator, reducing the number of external components.

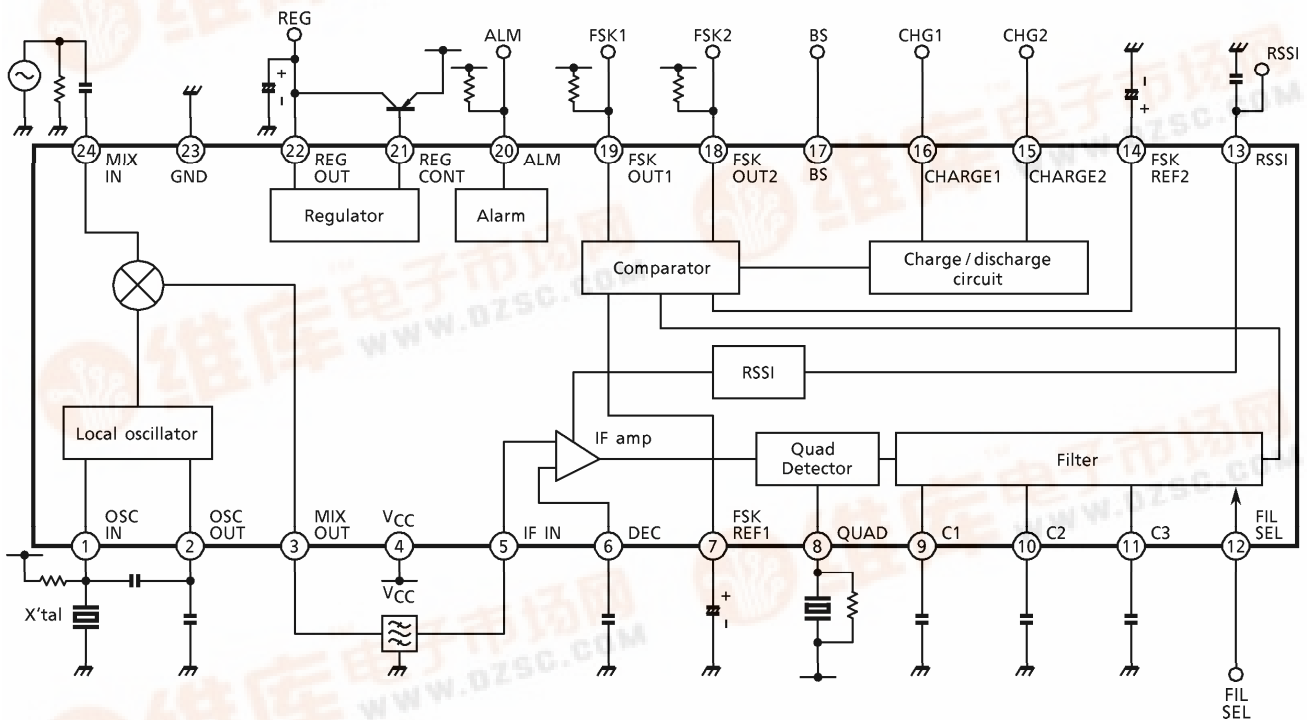


SSOP24-P-300-0.65A

Weight : 0.14g (Typ.)

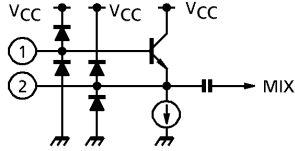
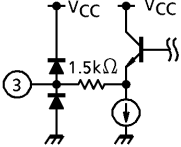
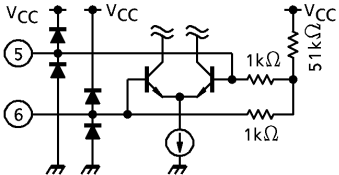
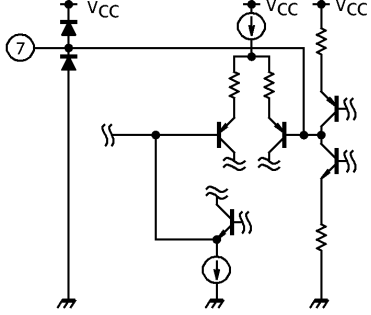
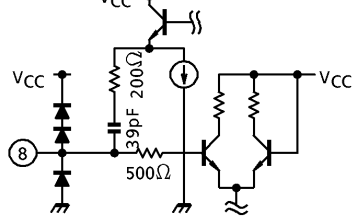
FEATURES

- Mixer operating frequency range : 10~50MHz
- Operating voltage range : 1.1~3.5V
- Current dissipation : 1.5mA (Typ.)
- Current dissipation at BS : 0 μ A (Typ.)
- Small package : SSOP 24PIN (0.65mm pitch)

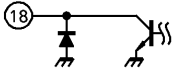
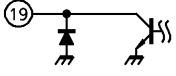
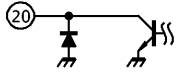
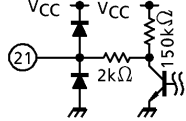
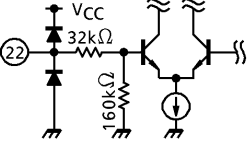
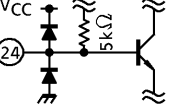


Handle with care to prevent devices from deterioration by static electricity.

PINS

PIN No.	PIN NAME	FUNCTION	INTERNAL EQUIVALENT CIRCUIT (RESISTANCES AND CAPACITANCES ARE TYP. VALUES.)
1	OSC IN	Local oscillator input terminal. In case of oscillating by X'tal, connect to this terminal.	
2	OSC OUT	Local oscillator output terminal. In case of input external source, input to this terminal.	
3	MIX OUT	Mixer output terminal. Output impedance is 2kΩ (Typ.).	
4	VCC	Power supply terminal.	—
5	IF IN	IF amp input terminal (pin 5) and bias decoupling terminal (pin 6). Input impedance is 2kΩ (Typ.).	
6	DEC		
7	FSK REF1	Threshold input terminal for 2-Level. Connect a capacitor externally. Built-in a charge / discharge circuit with push-pull output.	
8	QUAD	Phase-shift input terminal for the FM demodulator. Connect to the discriminator.	

PIN No.	PIN NAME	FUNCTION	INTERNAL EQUIVALENT CIRCUIT (RESISTANCES AND CAPACITANCES ARE TYP. VALUES.)				
9	C1	Capacitor connecting terminals for the bit rate filter.					
10	C2						
11	C3						
12	FIL SEL	Data input terminal to control the bit rate filter.					
13	RSSI	RSSI output terminal.					
14	FSK REF2	Threshold input terminal for 4-Level. Connect a capacitor externally. Built-in a charge / discharge circuit with push-pull output.					
15	CHARGE2	Control terminal for charge / discharge circuit of FSK REF2 (pin 14). <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>"H"</td> <td>Charge / discharge ON</td> </tr> <tr> <td>"L"</td> <td>Charge / discharge OFF</td> </tr> </table>	"H"	Charge / discharge ON	"L"	Charge / discharge OFF	
"H"	Charge / discharge ON						
"L"	Charge / discharge OFF						
16	CHARGE1	Control terminal for charge / discharge circuit of FSK REF1 (pin 7). <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>"H"</td> <td>Charge / discharge ON</td> </tr> <tr> <td>"L"</td> <td>Charge / discharge OFF</td> </tr> </table>	"H"	Charge / discharge ON	"L"	Charge / discharge OFF	
"H"	Charge / discharge ON						
"L"	Charge / discharge OFF						
17	BS	Battery saving control terminal. <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>"H"</td> <td>Battery saving OFF</td> </tr> <tr> <td>"L"</td> <td>Battery saving ON</td> </tr> </table>	"H"	Battery saving OFF	"L"	Battery saving ON	
"H"	Battery saving OFF						
"L"	Battery saving ON						

PIN No.	PIN NAME	FUNCTION	INTERNAL EQUIVALENT CIRCUIT (RESISTANCES AND CAPACITANCES ARE TYP. VALUES.)
18	FSK OUT2	Output terminal for 4-Level waveform shaping. Outputs a wave-shaped FSK signal from the demodulator as an inverted signal with respect to the IF signal. Connect a pull-up resistor, because it is an open-collector output.	
19	FSK OUT1	Output terminal for 2-Level waveform shaping. Outputs a wave-shaped FSK signal from the demodulator as an inverted signal with respect to the IF signal. Connect a pull-up resistor, because it is an open-collector output.	
20	ALM	Output terminal for ALARM. At $V_{CC} \approx 1.1V$, this terminal output becomes "H" ($\approx V_{CC}$) and can indicate deterioration of battery. Connect a pull-up resistor, because it is an open-collector output.	
21	REG CONT	External transistor control terminal for regulator of external power supply. Connect the PNP transistor externally.	
22	REG OUT	Output voltage monitoring terminal for regulator of external power supply.	
23	GND	GND terminal.	—
24	MIX IN	Input terminal for the MIX section. The input impedance is $5k\Omega$ (Typ.).	

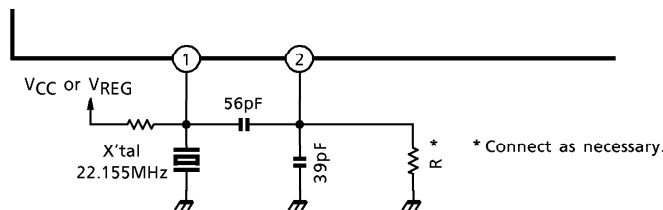
FUNCTIONS

1. Local oscillation circuit

Local oscillation circuit is Colpitts type oscillator composed by internal emitter follower circuit and external X'tal. Connect as shown in the figure below.

Connect a base bias resistor between pin1 and V_{CC} or REG OUT terminal (pin22).

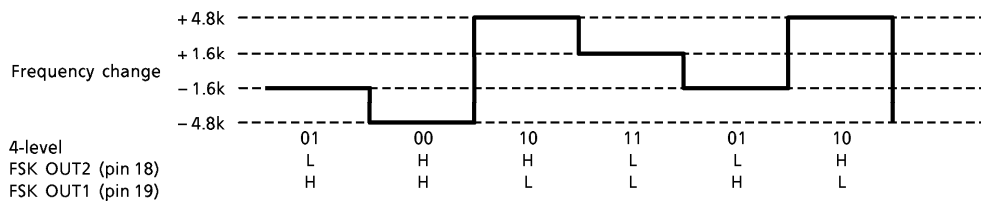
In case of need to increase the current of local oscillation circuit in order to compose the overtone oscillation and improve the stability of oscillation, connect a resistor between pin2 and GND. In such a case we recommend connecting a base bias resistor between pin1 and pin22, or the external regulator (is under the control of the battery-saving). (If a base bias resistor is connected between pin1 and V_{CC}, the current flows across a resistor connected between pin2 and GND during battery saving.)



2. Waveform shaping circuit

The FM detected signal is converted into 2-bit digital signal by the waveform shaping circuit (configured with comparator). Thus, accurate signal digitization can be achieved when this IC is in a weak electric field or there is noise in the FSK signal. Therefore reading errors of the microprocessor are reduced.

When 4-level FSK : Handled as 2-bit output

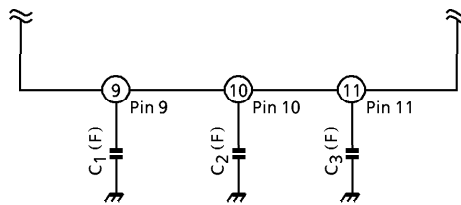


3. Charge / discharge circuit

While the Charge-discharge circuit is ON, charges / discharges the capacitors connected to the FSK REF terminals (pin7 and pin14). Also threshold-voltage for waveform shaping is determined. Threshold-voltage is automatically adjusted with FM detection waveform. Turn on the charge / discharge circuit only when the FM detection waveform is at full swing (2-level : consecutive signal of 1·0 ; 4-level : consecutive signal of 10·00). Threshold-voltage may fluctuate depending on the circuit leakage. Thus, in order to refresh with turn on the charge-discharge circuit. Charge-discharge circuit is active mode only when the CHARGE terminals (pin15 and pin16) is high.

4. Cut-off frequency switching of bit rate (low pass) filter

Cut-off frequency of low pass filter can be selected 2 kinds of frequency by controlling the FIL SEL terminal (pin12).



When using the above circuit as a three-stage Bessel filter, select the desired cut-off frequency, f_C (Hz). Where, $C_2 = C_3$, $f_1 = 1.325f_C$, $f_2 = 1.450f_C$,

$$C_1 = \frac{1}{2\pi R \cdot f_1} \quad C_2 = \frac{1}{\sqrt{2}\pi R \cdot f_2}$$

Note that : $R = 100 \text{ (k}\Omega\text{)}$ when FIL SEL = H
 $R = 50 \text{ (k}\Omega\text{)}$ when FIL SEL = L

Setting $C_2 \neq C_3$ can increase the range in which f_C can be set.

5. Battery-saving function

This IC incorporates a battery-saving function. Using this function reduces current consumption and helps preserve battery life. As the BS terminal (pin17) is base input of the NPN transistor, its input impedance is high and it can be driven with low power. Therefore, this function can be directly driven by CMOS output of microcontroller.

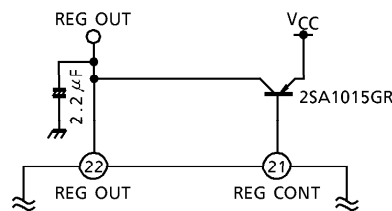
BS TERMINAL (PIN 17) STATE	BATTERY-SAVING FUNCTION	OTHER IC INTERNAL CIRCUIT OPERATION STATES	QUIESCENT CURRENT CONSUMPTION OF IC
L	Battery-saving ON	Operation stop	0 μ A (Typ.)
H	Battery-saving OFF	Normal operation	1.5mA (Typ.)

6. Battery alarm function

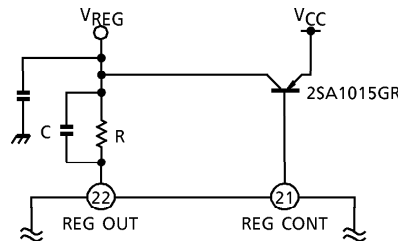
When the V_{CC} terminal (pin 4) is 1.1V (Typ.), the output of the ALM terminal (pin 20) rises to around the V_{CC} voltage to show that the battery charge is low. The output is open collector type.

7. 1V constant supply voltage

As shown in the following diagram, connecting the PNP transistor to the REG CONT terminal (pin 21) allows the REG OUT terminal (pin 22) to be used for high-output constant voltage : $V_{REG} = 1.0V$ (Typ.). During battery-saving, the constant voltage output is OFF.

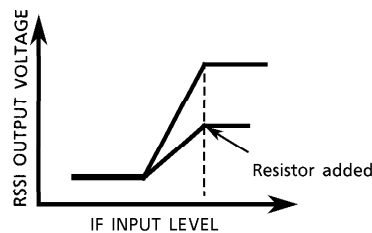
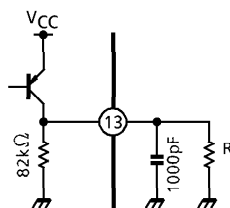


When connecting an external resistor "R" to the REG OUT terminal (pin 22) to raise the output voltage, oscillation may occur in the regulator output. To avoid this, connect a capacitor as shown in the following diagram.



8. RSSI function

The RSSI terminal (pin13) outputs a DC potential corresponding to the IF IN terminal (pin5) input level. As the RSSI output is converted into voltage by an internal resistance ($82k\Omega$), its characteristics can be changed as shown in the following diagram. In this case, note that owing to displacement of temperature coefficient between external resistance and internal resistance, the temperature characteristics of the RSSI output may change. Because of the internal circuit structure, do not connect the RSSI terminal (pin13) directly to GND.



MAXIMUM RATINGS (Ta = 25°C)

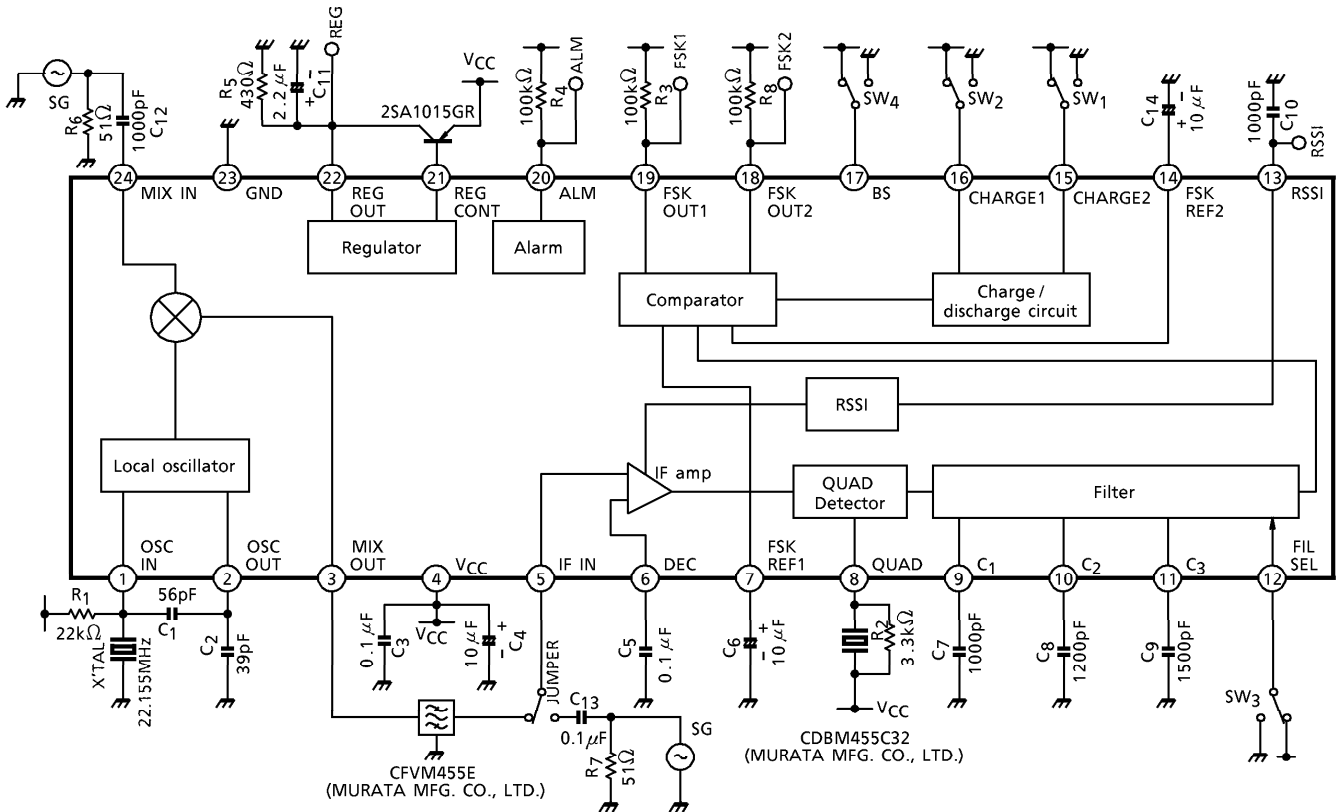
CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Supply Voltage	V _{CC}	4	V
Power Dissipation	P _D	760	mW
Operating Temperature	T _{opr}	-30~85	°C
Storage Temperature	V _{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Ta = 25°C, unless otherwise specified V_{CC} = 1.4V, f_m = 800Hz (sine wave), Dev = ± 4.8kHz, FIL SEL = "L")

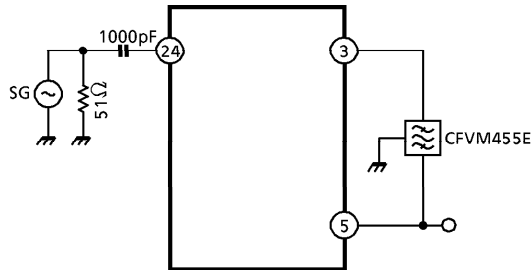
CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Operating Voltage Range	V _{CC}	—	—	1.1	1.4	3.5	V
Quiescent Current Consumption	I _{CCq}	2	—	—	1.5	1.9	mA
Current Consumption at BS	I _{CCo}	3	—	—	0	5	μA
Mixer Conversion Gain	GM _v	1 (1)	After ceramic filter	7.5	11	14	dB
Mixer Intercept Point	I _p	—	—	—	96	—	dBμV
Mixer Input Resistance	R _{(MIX) IN}	—	—	—	5	—	kΩ
Mixer Output Resistance	R _{(MIX) OUT}	—	—	—	2	—	kΩ
IF Amp Input Resistance	R _{(IF) IN}	—	—	—	2	—	kΩ
Signal to Noise Ratio 1	S/N1	1 (3)	V _{IN} (MIX) = 60dBμVEMF	—	60	—	dB
Signal to Noise Ratio 2	S/N2	1 (2)	V _{IN} (IF) = 60dBμVEMF	45	60	—	dB
Signal to Noise Ratio 3	S/N3	1 (2)	V _{IN} (IF) = 25dBμVEMF	22	28	—	dB
Limiting Sensitivity	V _i (LIM)	1 (2)	IF input	—	24	27	dBμVEMF
Demodulated Output Level	V _{OD}	1 (2)	V _{IN} (IF) = 60dBμVEMF	—	50	—	mV _{rms}
AM Rejection Ratio	AMR	1 (2)	V _{IN} (IF) = 60dBμVEMF, AM = 30%	—	45	—	dB
FSK Output Duty Ratio	D _R	1 (4)	V _{IN} (IF) = 60dBμVEMF	40	50	60	%
Alarm Detection Voltage	V _{ALM}	1 (5)	—	1.05	1.1	1.15	V
"L" Level Output Voltage (ALM)	V _{ALM L}	1 (6)	I _L = 100μA	—	—	0.4	V
"H" Level Leak Current (ALM)	I _{ALM H}	1 (7)	—	—	—	2	μA
"L" Level Output Voltage (FSK OUT)	V _{FSK L}	1 (8)	I _L = 100μA	—	—	0.4	V
"H" Level Leak Current (FSK OUT)	I _{FSK H}	1 (9)	—	—	—	2	μA

CHARACTERISTIC	SYMBOL	TEST CIRCUIT	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Regulator Output Voltage	V _{REG}	1 (10)	R _L = 430Ω	0.95	1	1.05	V
RSSI Output Voltage	V _{RSSI}	1 (12)	V _{IN} (IF) = 65dBμVEMF	0.45	0.6	0.8	V
RSSI Output Resistance	R _{RSSI}	—	—	—	82	—	kΩ
Charge / discharge Current1 (FSK REF1, FSK REF2)	I _{CH1}	4	FSK REF = GND FIL SEL = "H"	85	150	230	μA
Charge / discharge Current2 (FSK REF1, FSK REF2)	I _{CH2}	—	FSK REF = GND FIL SEL = "L"	45	80	120	μA
"H" Level Input Voltage (BS, CHARGE, FIL SEL)	—	—	—	1.1	1.4	—	V
"L" Level Input Voltage (BS, CHARGE, FIL SEL)	—	—	—	0	—	0.2	V
"L" Level Output Voltage (REG CONT)	REG L	1 (11)	I _L = 100μA	—	—	0.6	V

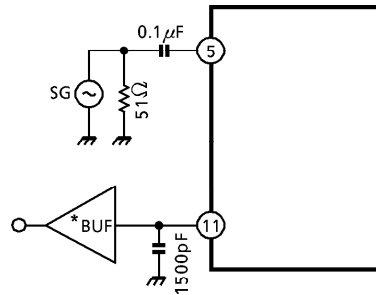
TEST CIRCUIT 1



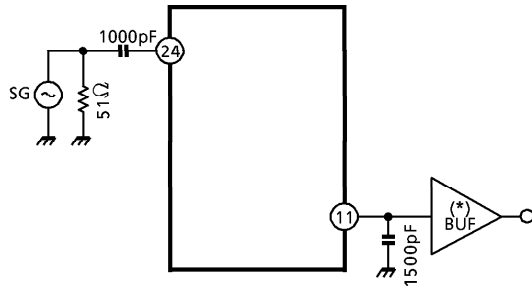
(1) GMv



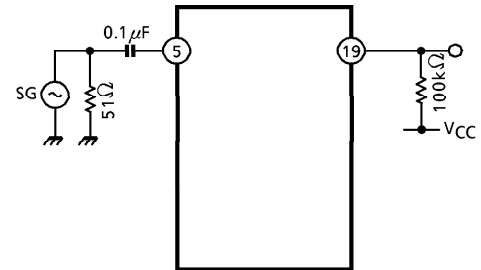
(2) S/N2, S/N3, V_i (LIM), V_{OD} , AMR



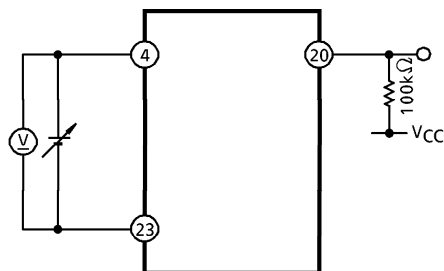
(3) S/N1



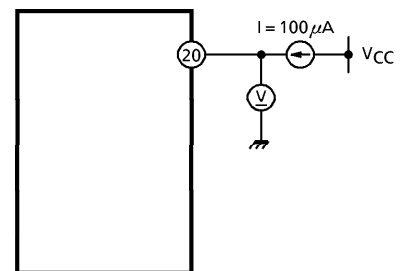
(4) DR



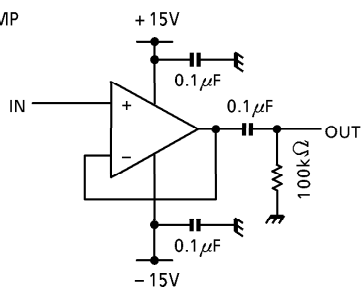
(5) V_{ALM}



(6) $V_{ALM L}$

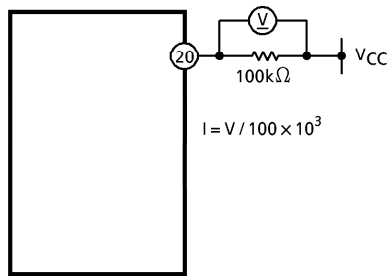


* BUF AMP

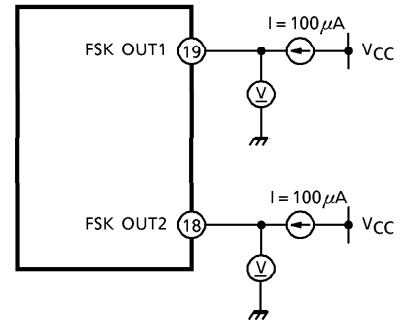


TA75559P

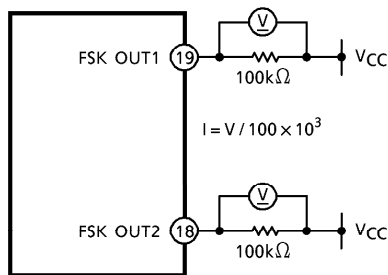
(7) I_{ALM}



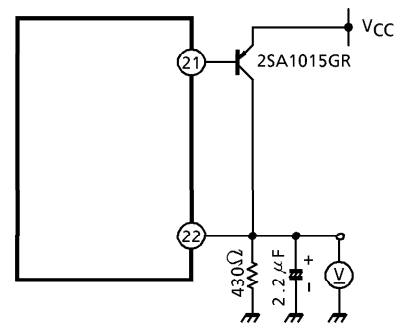
(8) $V_{FSK L}$



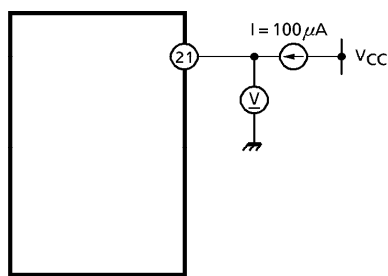
(9) I_{FSK}



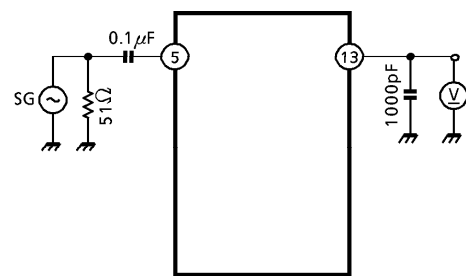
(10) V_{REG}



(11) $REG L$

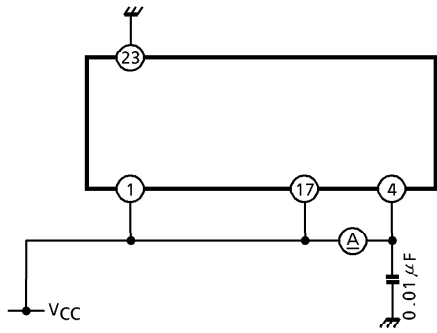


(12) V_{RSSI}



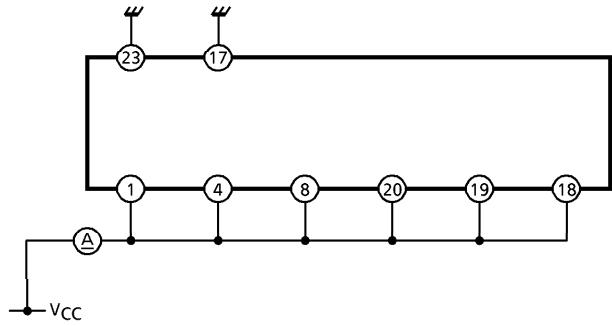
TEST CIRCUIT 2

I_{CCq}



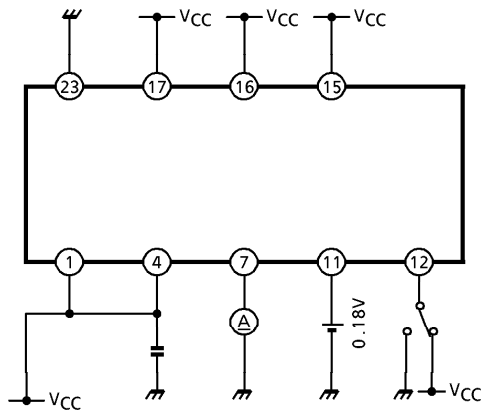
TEST CIRCUIT 3

I_{CCo}

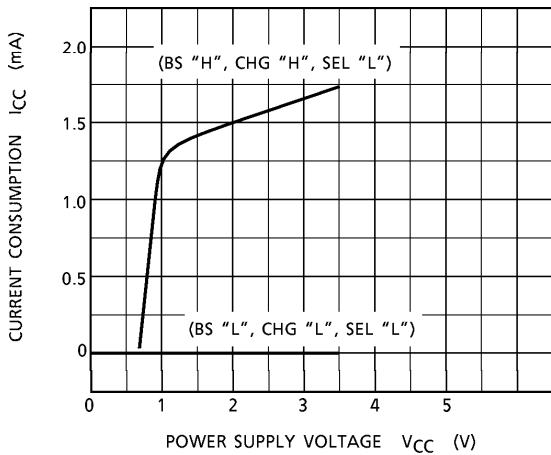


TEST CIRCUIT 4

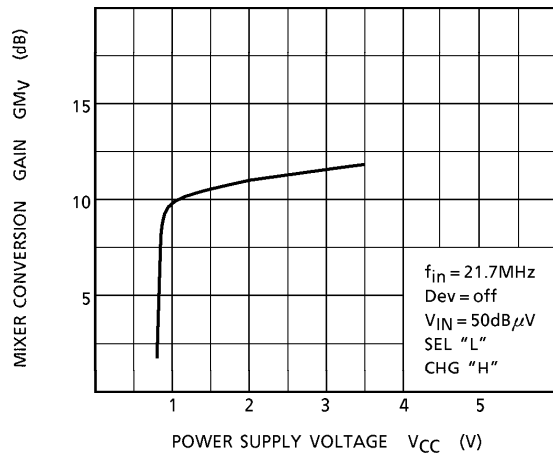
I_{CH1} (FSK REF1)



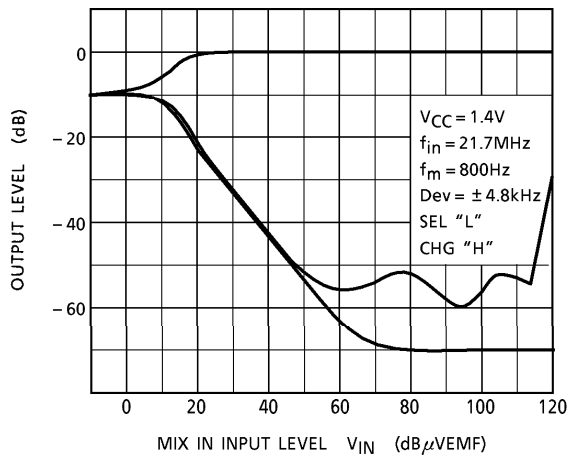
CURRENT CONSUMPTION –
POWER SUPPLY VOLTAGE



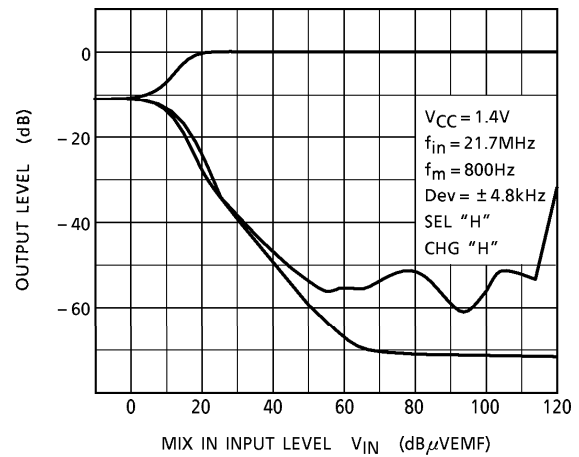
MIXER CONVERSION GAIN –
POWER SUPPLY VOLTAGE



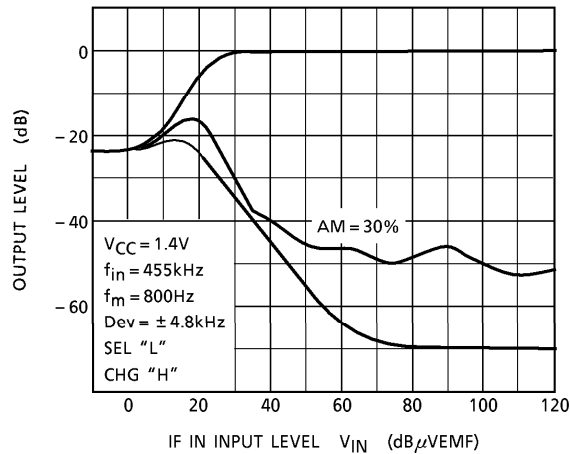
S/N, AMR INPUT / OUTPUT CHARACTERISTICS
(MIX, SEL "L")



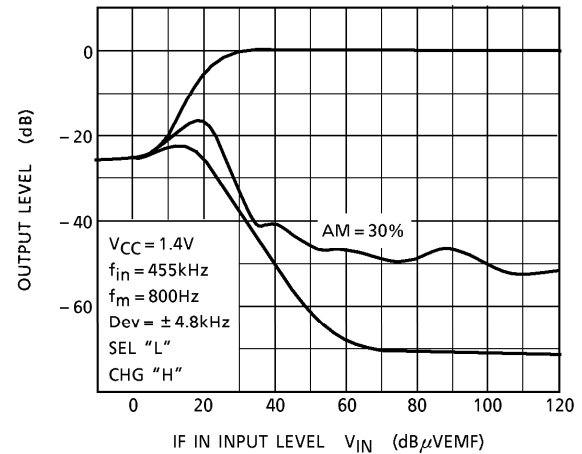
S/N, AMR INPUT / OUTPUT CHARACTERISTICS
(MIX, SEL "H")



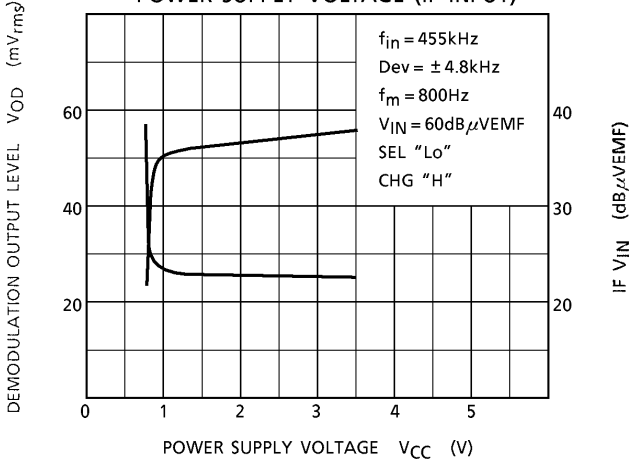
S/N, AMR INPUT / OUTPUT CHARACTERISTICS
(IF, SEL "L")



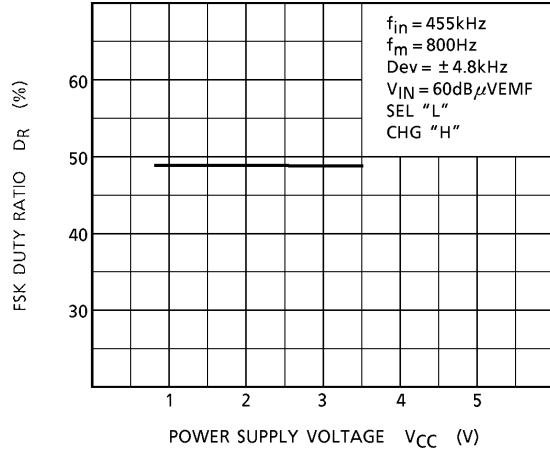
S/N, AMR INPUT / OUTPUT CHARACTERISTICS
(IF, SEL "H")



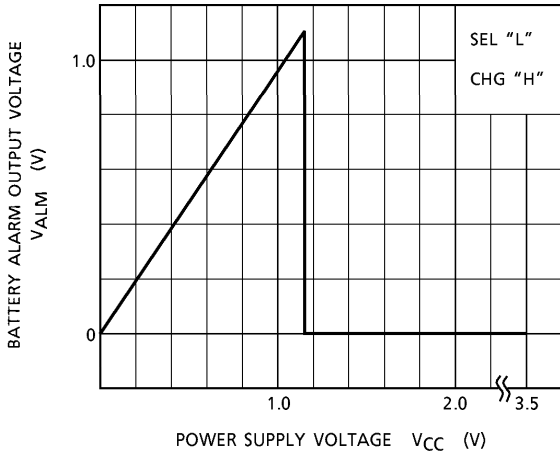
DEMODULATION OUTPUT, LIMITING SENSITIVITY
- POWER SUPPLY VOLTAGE (IF INPUT)



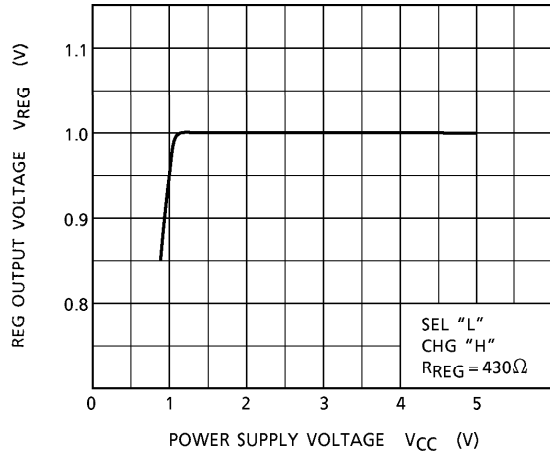
FSK DUTY RATIO -
POWER SUPPLY VOLTAGE



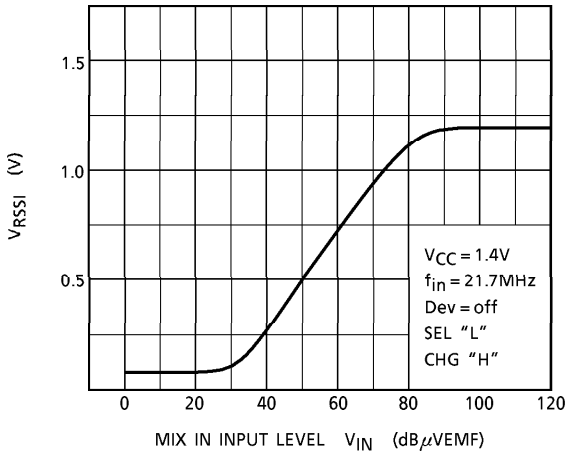
BATTERY ALARM OUTPUT VOLTAGE -
POWER SUPPLY VOLTAGE



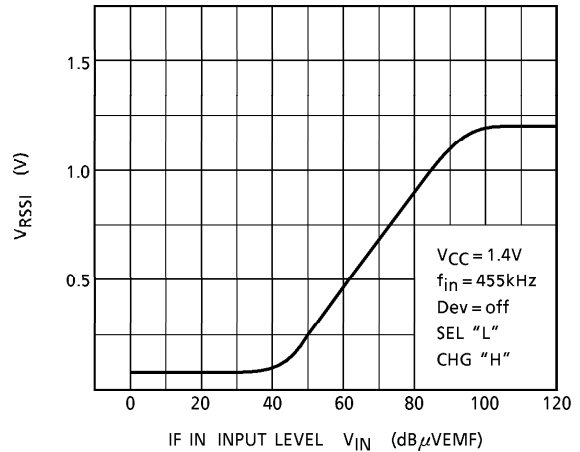
REG OUTPUT VOLTAGE -
POWER SUPPLY VOLTAGE



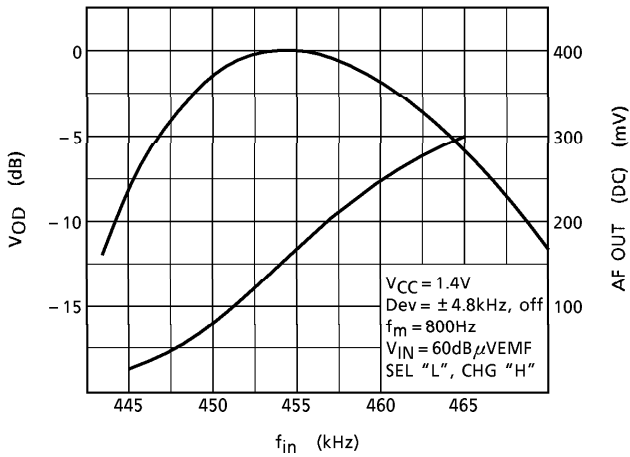
RSSI OUTPUT VOLTAGE CHARACTERISTICS
(MIX INPUT)



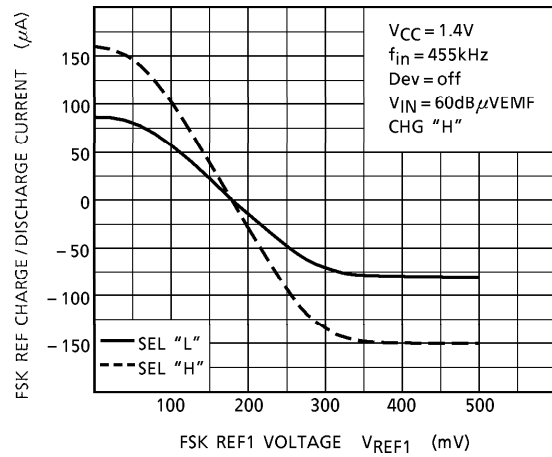
RSSI OUTPUT VOLTAGE CHARACTERISTICS
(IF INPUT)



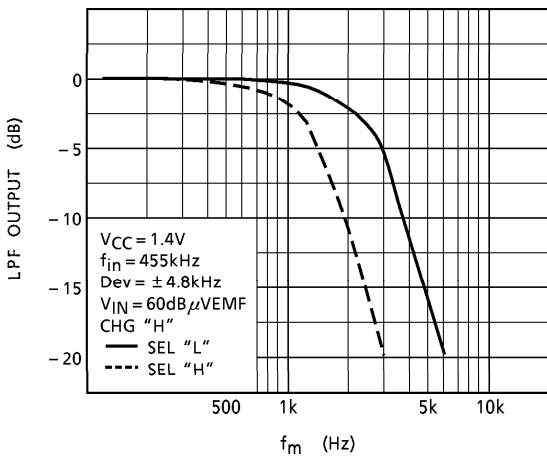
DETUNING, S-CURVE CHARACTERISTICS (IF INPUT)



CHARGE / DISCHARGE CURRENT - FSK REF1 VOLTAGE

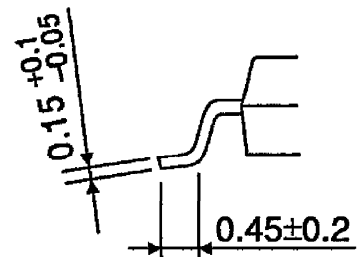
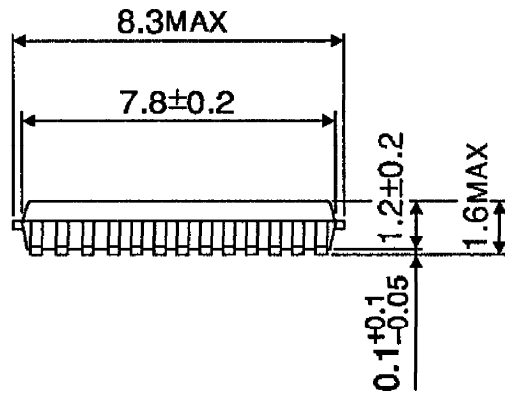
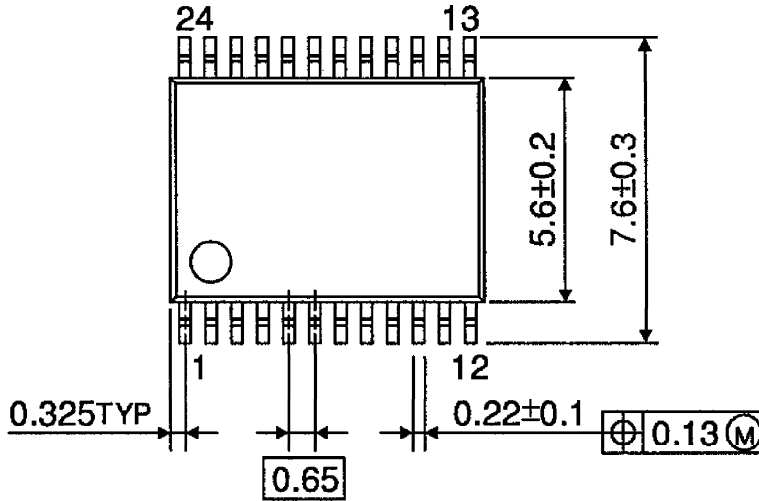


LPF CHARACTERISTICS



PACKAGE DIMENSIONS
SSOP24-P-300-0.65A

Unit : mm



Weight : 0.14g (Typ.)

Notice for Pb free product

About solderability, following conditions were confirmed

Solderability

- (1) Use of Sn-36Pb solder bath
 - solder bath temperature = 230
 - dipping time = 5seconds
 - the number of times = once
 - use of R-type flux
- (2) Use of Sn-3.0Ag-0.5Cu solder bath
 - solder bath temperature = 245
 - dipping time = 5seconds
 - the number of times = once
 - use of R-type flux

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000707EBA

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