

TOSHIBA Bipolar Linear Integrated Circuit Silicon Monolithic

TA32305FN/TA32305FNG*

RF 1chip Receiver and Transmitter for low power wireless

The TA32305FN is an RF 1 chip receiver and transmitter IC.

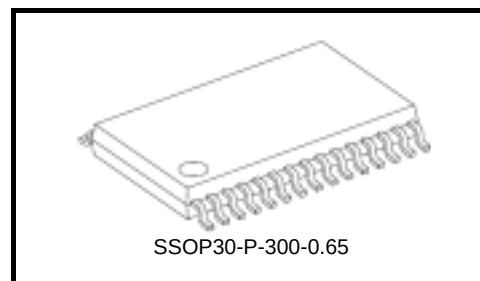
Receiver is for AM/FM radio.

The IC incorporates an RF amp, 2-level comparator, and local $\times 8$ circuit.

This IC's main use is remote control.

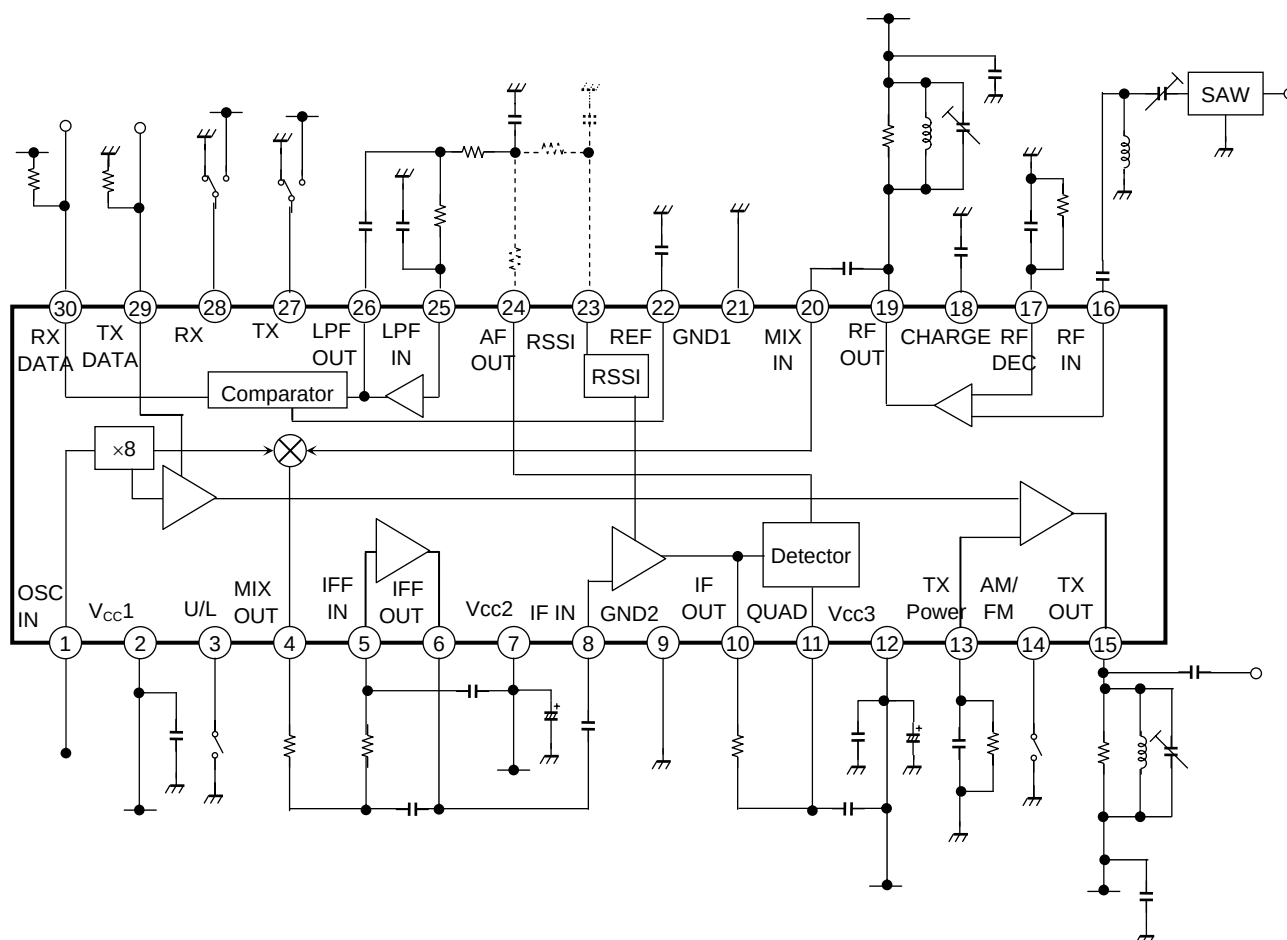
Features

- RF frequency: 240 to 450 MHz (multiplication is used)
- IF frequency: 80 kHz
- Operating voltage range: 2.2 to 5.5 V
- Current dissipation: TX 4.3 mA/ RX 5.6 mA (FM), 5.3 mA (AM)
(except current at oscillator circuit)
- Current dissipation at BS: 0 μ A (typ.)
- Small package: 30-pin SSOP (0.65 mm pitch)



Weight: 0.17 g (typ)

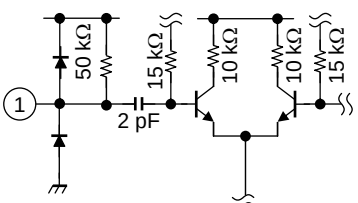
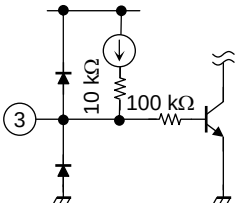
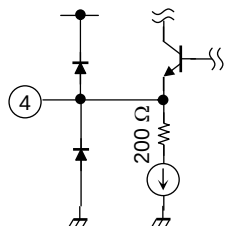
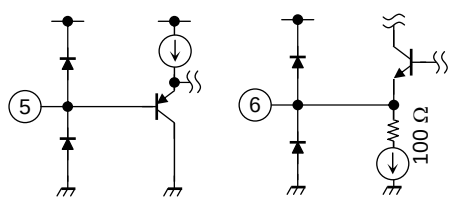
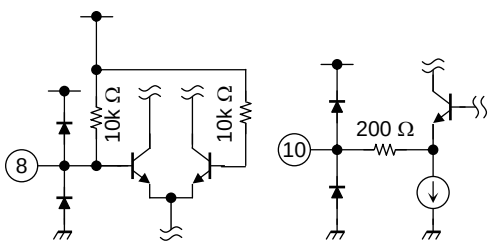
Block Diagram



*: TA32305FNG Package is Pb-Free.

Pin Description

(the values of resistor and capacitor in the internal equivalent circuit are typical.)

Pin No.	Pin Name	Function	Internal Equivalent Circuit
1	OSC IN	Local oscillator input pin.	
2	V _{CC} 1	Local power supply pin.	—
3	U/L	U/L switch pin. OPEN : Upper Local L : Lower Local Do not connect V _{cc} .	
4	MIX OUT	Mixer output pin. The output impedance of the pin is typically 225 Ω.	
5	IFF IN	IF filter input pin.	
6	IFF OUT	IF filter output pin.	
7	V _{CC} 2	Power supply pin 2.	—
8	IF IN	IF amp input pin.	
10	IF OUT	IF amp output pin.	
9	GND2	GND pin 2.	—

Pin No.	Pin Name	Function	Internal Equivalent Circuit
11	QUAD	Phase-shift input terminal for the FSK Demodulator.	
12	Vcc3	Power supply pin 3.	—
13	TX Power	Regulating TX output power pin.	
15	TX OUT	TX signal output pin.	
14	AM/FM	Changeover switch for AM/ FM. OPEN : AM L : FM Do not connect Vcc.	
16	RF IN	RF signal input pin.	
17	RF DEC	Emitter pin for internal transistor.	
19	RF OUT	RF amp output pin.	
18	CHARGE	Control terminal for quick charge circuit. To use the quick charge circuit, attach a capacitor.	

Pin No.	Pin Name	Function	Internal Equivalent Circuit
20	MIX IN	Mixer input pin.	
21	GND1	GND pin 1.	—
22	REF	Threshold input terminal for 2-level FM/AM comparator.	
23	RSSI	RSSI output pin. This pin is connected internal circuit. MONI pin during transmitting.	
24	AF OUT	Output terminal for FM demodulator.	
25	LPF IN	FM/AM LPF input pin.	
26	LPF OUT	FM/AM LPF output pin.	
27	TX	Battery saving pin for transmitter.	

Pin No.	Pin Name	Function	Internal Equivalent Circuit
28	RX	Battery saving pin for receiver.	
29	TX DATA	AM modulation switch for transmitter. L : Output ON H : Output FF	
30	RX DATA	FM/AM waveform shaping output pin for receiver. Open collector output. Connect a pull-up resistor.	

Equivalent circuits are given to help understand design of the external circuits to be connected. They do not accurately represent the internal circuits.

Functions

1. Waveform Shaper Circuit (comparator)

The output data (pin 30) are inverted.

2. RSSI Function

DC potential corresponding to the input level of IF IN (pin 8) is output to RSSI (pin 23). Output to RSSI (pin 23) is converted to a voltage by the internal resistance. Thus, connecting external resistance R to pin 21 varies the gradient of the RSSI output as shown below. Note that due to the displacement of temperature coefficients between external resistor R and the internal IC resistor R_{IC} , the temperature characteristic of the RSSI output may change. Also, the maximum RSSI value should be $V_{CC} - 0.8\text{ V}$ or less.

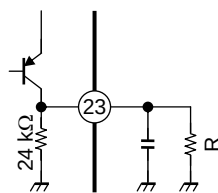


Figure 1

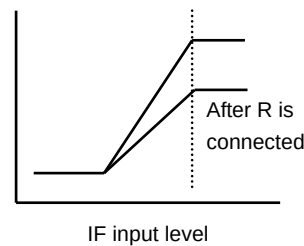


Figure 2

3. S Curve Characteristics

Changing external capacitance C27 varies the gradient of the S curve characteristics as shown below. In case of widening the detection range, heightening IF frequency or lowering demodulation output, make the gradient of the S curve characteristics gentle less than typical (120pF).

When using this IC by about 2.2V (low supply), set the constant of C27 100pF or add attenuator to AF OUT (24 pin).

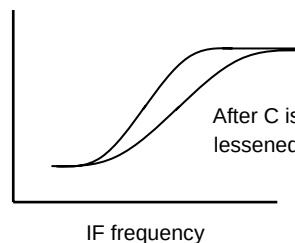


Figure 3

4. V_{CC} Pin and GND Pin

Use the same voltage supply for V_{CC1} (2 pin) and V_{CC2} (7 pin) and V_{CC3} (12 pin) (or connect them). Also, use the same voltage supply source for GND1 (21 pin) and GND2 (9 pin) (or connect them).

5. Local Oscillator Circuit

The local oscillator circuit is external-input-only. The device incorporates no transistor for oscillation. Input to pin 1 at a level from 92 to 105dBμV.

Adjust the values of constants C shown in the application circuit diagram so that the input level will become approximately 100dBμV.

6. U/L switch pin

It is possible to switch Mixer output frequency to upper local or lower local comparing RF input frequency.

7. RF Amp Current Adjustment

The RF amp current dissipation can be regulated by varying resistor R as shown in the figure below. When $R = 560\ \Omega$, the current dissipation is approximately $600\ \mu\text{A}$.

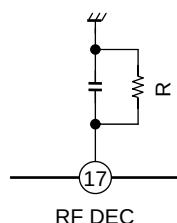


Figure 4

8. Battery-Saving (BS) Function

The IC incorporates a battery-saving function. These functions offer the following selection.

Receiver

FM Mode (FM/AM pin: GND)

RX Pin	Circuit Status in the IC	IC Current Dissipation (at no signal)
H	Circuits in operation: •x8 circuit •Mixer •RF amp •Comparator •IF amp •Detector circuit •RSSI •Comparator capacitor charger circuit	5.6 mA (typ.)
L	All circuits	0 mA (typ.)

AM Mode (FM/AM pin: OPEN)

RX Pin	Circuit Status in the IC	IC Current Dissipation (at no signal)
H	Circuits in operation: •x8 circuit •Mixer •RF amp •Comparator •IF amp •RSSI •Comparator capacitor charger circuit	5.3 mA (typ)
L	All circuits	0 mA (typ)

Transmitter

TX Pin	Circuit Status in the IC	IC Current Dissipation (at no signal)
H	Circuits in operation: •x8 circuit •TX amp	4.3 mA (typ)
L	All circuits	0 mA (typ)

9. RF Amp Gain 2

RF amp gain 2 ($G_V(\text{RF})_2$) is a reference value calculated as follows. Measure G_{RF} in the following figure.

$G_V(\text{RF})_2$ is calculated as follows:

$$G_V(\text{RF})_2 = G_{\text{RF}} - G_V(\text{MIX})$$

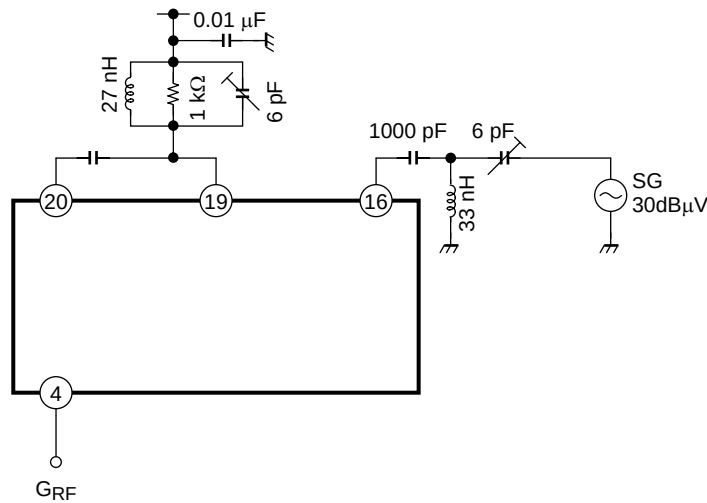


Figure 5

10. Waveform-Shaping Output Duty Cycle

The specified range of electrical characteristics is only available for single-tone.

11. Treatment of FM Terminal when Using AM

When using AM, it is not necessary to treat the QUAD pin (pin 11). Leave it open or connected to an FM external circuit. To use the bit rate filter, connect the RSSI pin (pin 23) to the bit rate filter through a resistor. The AF-OUT pin (pin 24) should be left open.

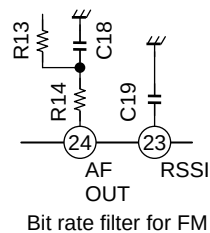


Figure 6

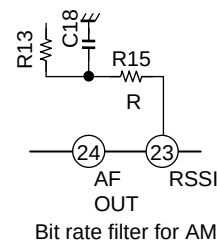


Figure 7

12. Control Terminal for Quick Charge Circuit (CHARGE)

CHARGE (18 pin) is control terminal for quick charge circuit. REF (22 pin) control terminal for quick charge a given period by time constant of internal resistance and outside capacitance. Enabling the CHARGE pin requires an external capacitor. In normal operation, connect a capacitor having the same capacitance as that of the capacitor connected to the REF pin (pin 22).

If the connected external capacitor (C30) is 0.1 μF , the quick charge time is 7 ms (typically).

13. Bit Rate Filter for FM

The current FM bit rate filter is used as a tertiary filter.

If the filter is to be used at a rate other than 1200 bps, please change the filter constant.

Quadratic Filter (NRZ)

	R12	R13	R14	C14	C15	C18
1200 bps	68 k Ω	68 k Ω	68 k Ω	0.01 μF	560 pF	3300 pF
2400 bps	68 k Ω	68 k Ω	68 k Ω	4700 pF	270 pF	1500 pF
4800 bps	68 k Ω	68 k Ω	68 k Ω	2200 pF	150 pF	680 pF
9600 bps	68 k Ω	68 k Ω	68 k Ω	1200 pF	68 pF	390 pF

14. Bit Rate Filter for AM

The current AM bit rate filter is used as a quadratic filter.

If the filter is to be used at a rate other than 1200 bps, please change the filter constant.

Quadratic Filter (NRZ)

(the bit rate filter time constant takes into account the internal resistance RSSI (24 k Ω))

	R15	R12	C14	C15
1200 bps	43 k Ω	68 k Ω	4700 pF	1500 pF
2400 bps	43 k Ω	68 k Ω	2200 pF	680 pF
4800 bps	43 k Ω	68 k Ω	1000 pF	390 pF
9600 bps	43 k Ω	68 k Ω	470 pF	180 pF

In addition, the current AM bit rate filter can be used as a tertiary filter.

If the filter is to be used at a rate other than 1200 bps, please change the filter constant.

Quadratic Filter (NRZ)

(the bit rate filter time constant takes into account the internal resistance RSSI (24 k Ω))

	R15	R13	R12	C14	C15	C18
1200 bps	43 k Ω	68 k Ω	68 k Ω	0.01 μF	560 pF	3300 pF
2400 bps	43 k Ω	68 k Ω	68 k Ω	4700 pF	270 pF	1500 pF
4800 bps	43 k Ω	68 k Ω	68 k Ω	2200 pF	150 pF	680 pF
9600 bps	68 k Ω	68 k Ω	68 k Ω	1200 pF	68 pF	390 pF

For the cutoff frequency of the bit rate filter, specify a sufficiently high value for the bit rate to be used.

Specifying a relatively high cutoff frequency for the bit rate filter enables a low capacitor to be used at the REF pin, therefore making the pulse rise quickly.

When AM is used, the internal resistance of RSSI is used. So, take the output resistance into account when specifying a cutoff frequency.

15. Simple Image Cancel Mixer for Receiver

The IC incorporates simple image cancel mixer for receiver.

16. TX Amp Current Adjustment

The RF amp current dissipation can be regulated by varying resistor R as shown in the figure below. When $R = 560\ \Omega$, the current dissipation is approximately $680\ \mu\text{A}$.

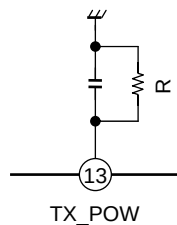


Figure 8

Cautions for Designing Circuit Board Patterns

Observe the following cautions when designing circuit patterns for this product.

Local Oscillator Circuit (pin 1)

Isolate the local oscillator circuit block sufficiently from the RF amp block.

Isolate the local oscillator circuit block securely so that its output will not get in the IF input, IF filter, or mixer input.

Do not place the local oscillator circuit block too close to the ceramic filter.

Subdivide the ground pattern for the local oscillator circuit block, and connect the subdivisions with thin lines.

IF Input and Output Block (pin 8, 10)

Isolate the input from output patterns of the IF filter and detector block securely from each other.

Demodulator Circuit Block (pin 11)

Isolate the demodulator circuit block sufficiently from the IF input block (pin 8).

Do not place the LC too close to the IC device.

Data Output Block (pin 30)

Isolate the data output block sufficiently from the IF input block (pin 8).

Isolate the output pattern of the data output block from other circuits as much as possible, so any noise from a stage subsequent to the output will not affect them.

RF Amp Circuit Block

1) Preventing RF amp oscillation

Do not place the patterns connected to pins 16 and 17 too close to each other.

Isolate the patterns connected to the input block (pin 16) and output block (pin 19) from each other.

Make the RF input signal line relatively thin.

Place a relatively wide ground pattern between the RF-IN pin (pin 16) and RF-DEC pin (pin 17).

Connect the RF-OUT pin (pin 19) and MIX-IN pin (pin 20) with the shortest possible pattern.

2) Attaining a sufficient gain

To attain a sufficient RF amp gain, select an optimum value for the input matching circuit block (pin 16) according to the board circuit pattern.

3) Sharing antenna with receiver and transmitter

Using hi power application, place the patterns connected to SAW filter and pin 15 close.

IC Mounting Area

Provide a ground pattern under the IC device, and prepare relatively many through holes.

Cautions for mounting

Mount better accurate constants of capacitance in IF filter block and detector block.

Maximum Ratings

(unless otherwise specified, Ta = 25°C. the voltage is with reference to the ground level.)

Characteristics	Symbol	Rating	Unit
Supply voltage	V _{CC}	6	V
Power dissipation	P _D	860	mW
Operating temperature range	T _{opr}	-40~85	°C
Storage temperature range	T _{stg}	-55~150	°C

The maximum ratings must not be exceeded at any time. Do not operate the device under conditions outside the above ratings.

Operable Range

(unless otherwise specified, Ta = 25°C. the voltage is with reference to the ground level.)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Operating voltage range	V _{CC}	—	—	2.2	3.0	5.5	V
RF operating frequency	f _{RF}	—	—	250	—	450	MHz

Operating ranges indicate the conditions for which the device is intended to be functional even with the electrical changes.

Electrical Characteristics (unless otherwise specified: Ta = 25°C, V_{CC} = 3 V, U/I = OPEN, fin (RF) = fin (MIX) = 314.96 MHz, fin (IF) = 80 kHz)

Receiver Block

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Current dissipation at battery saving	I _{CCO}	3	RX = "L", TX = "L"	—	0	5	μA
RF amp gain 1	G _V (RF) 1	1 (5)	The input and output impedances are 50 Ω.	-9.0	-6.5	-4.0	dB
Mixer conversion gain	G _V (MIX)	—	—	18	21	24	dB
RSSI output voltage 1	V _{RSSI1}	—	V _{in} (MIX) = 25dBμVEMF in AM mode	0.25	0.5	0.75	V
RSSI output voltage 2	V _{RSSI2}	—	V _{in} (MIX) = 50dBμVEMF in AM mode	0.7	1.0	1.3	V
RSSI output voltage 3	V _{RSSI3}	—	V _{in} (MIX) = 80dBμVEMF in AM mode	1.35	1.7	2.05	V
RSSI output resistance	R _{RSSI}	—	—	18	24	30	kΩ
Comparator input resistance	R _{COMP}	—	—	75	100	125	kΩ
RX data output voltage (L level)	V _{RXDATAL}	1 (3)	I _{RXDATAL} = 200 μA	—	0.04	0.4	V
RX data output leakage current (H level)	I _{RXDATAH}	1 (4)	—	—	0	2	μA
RX pin H-level input voltage	V _{RXH}	—	—	2.0	—	5.5	V
RX pin L-level input voltage	V _{RXL}	—	—	0	—	0.2	V

FM Mode ($T_a = 25^\circ\text{C}$, $V_{cc} = 3.0\text{ V}$, $f_{in}(\text{RF}) = f_{in}(\text{MIX}) = 314.96\text{ MHz}$, $U/L = \text{OPEN}$,
 $f_{in}(\text{IF}) = 80\text{ kHz}$, $\text{dev} = \pm 8\text{ kHz}$, $f_{\text{mod}} = 600\text{ Hz}$ ((single wave))

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Quiescent current consumption (for FM)	Iccqfm	2 (1)	RX/FMAM = "H/ L" Fin (Lo) = 39.38 MHz	4.2	5.6	7.0	mA
Demodulated output level	Vod	—	V _{in} (MIX) = 60dBμVEMF	95	130	165	mVrms
Waveform shaping duty ratio	DRfm	1 (2)	V _{in} (MIX) = 60dBμVEMF For single tone	45	50	55	%

AM Mode ($T_a = 25^\circ\text{C}$, $V_{cc} = 3.0\text{ V}$, $f_{in}(\text{RF}) = f_{in}(\text{MIX}) = 314.96\text{ MHz}$, $U/L = \text{OPEN}$,
 $f_{in}(\text{IF}) = 80\text{ kHz}$, $\text{AM} = 90\%$, $f_{\text{mod}} = 600\text{ Hz}$ (square wave))

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Quiescent current consumption (for AM)	Iccqam	2 (2)	RX/FMAM = "H/ OPEN" Fin (Lo) = 39.38 MHz	3.9	5.3	6.7	mA
Reference characteristic data	Dram	1 (2)	V _{in} (MIX) = 60dBμVEMF For single tone	45	50	55	%

Transmitter Block

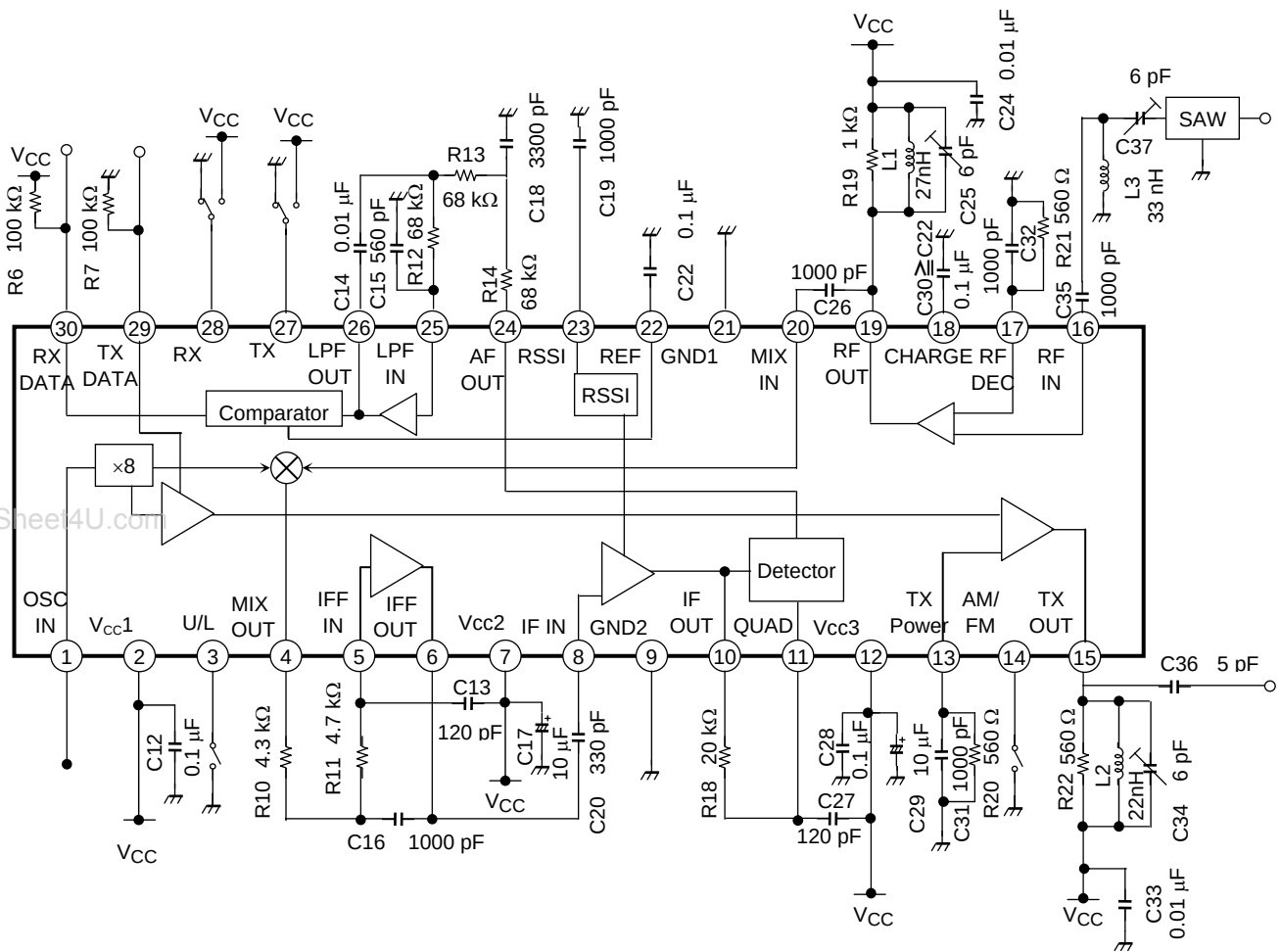
Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Quiescent current consumption (for Transmitter Mode)	Iccqtx	2 (3)	TX= "H"	3.0	4.3	5.6	mA
TXDATA pin H-level input voltage	V _{TXDATAH}	—	—	2.0	—	5.5	V
TXDATA pin L-level input voltage	V _{TXDATA L}	—	—	0	—	0.2	V
TX pin H-level input voltage	V _{TXBSH}	—	—	2.0	—	5.5	V
TX pin L-level input voltage	V _{TXBSL}	—	—	0	—	0.2	V
TXoutput signal level 1	V _{TX1}	—	The output impedances are 50 Ω	-25.5	-22.5	-19.5	dBm

Reference Characteristic Data *

Characteristics	Symbol	Test Circuit	Test Condition	Typ.	Unit
RF amp gain 2	G _v (RF) 2	—	—	30	dB
RF amp input resistance	R (RF) IN	—	—	1.0	kΩ
RF amp input capacitance	C (RF) IN	—	—	2.0	pF
RF amp output capacitance	C (RF) OUT	—	—	2.0	pF
Mixer input resistance	R (MIX) IN	—	—	1.2	kΩ
Mixer input capacitance	C (MIX) IN	—	—	1.6	pF
Mixer intercept point	IP3	—	—	96	dBμV
IFamp gain	G _v (RF)	—	—	65	dB
Signal-to-noise ratio 1	S/N1	1 (8)	V _{in} (MIX) = 20dBμVEMF	19	dB
Signal-to-noise ratio 2	S/N2	1 (8)	V _{in} (MIX) = 60dBμVEMF	56	dB
TX amp output capacitance	C (TX) OUT	—	—	2.0	pF
TX output signal level 2	V _{TX2}	—	—	-14	dBm

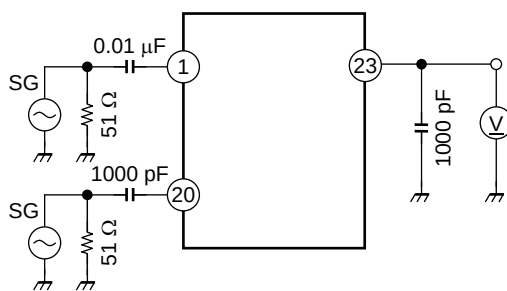
* : These characteristic data values are listed just for reference purposes. They are not guaranteed values.

Typical Test Circuit (FSK)

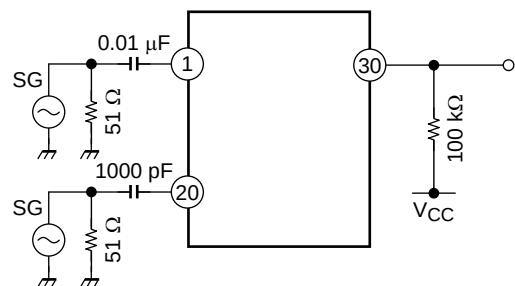


Test Circuit 1

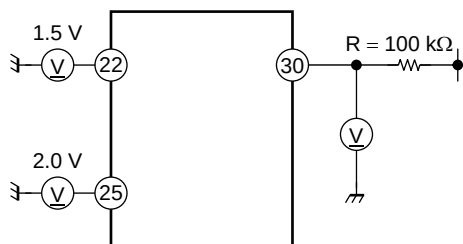
(1) VRSSI



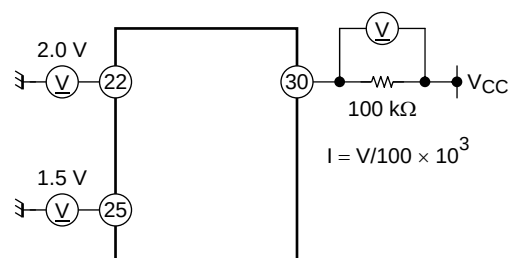
(2) DR



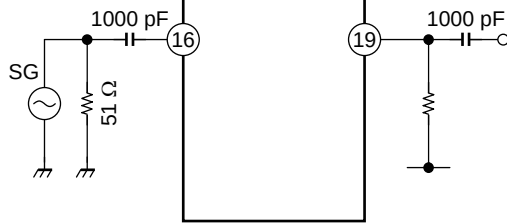
(3) VDATA L



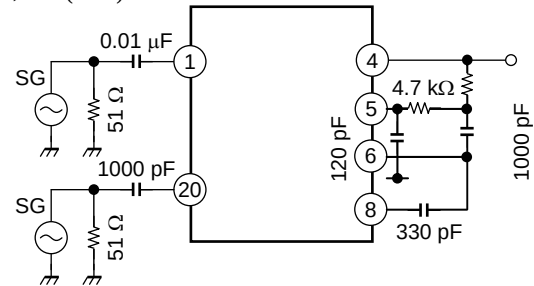
(4) IDATA H



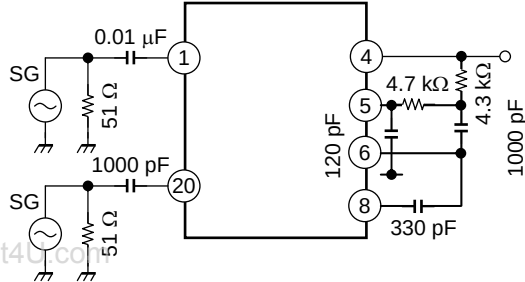
(5) G_V (RF) 1



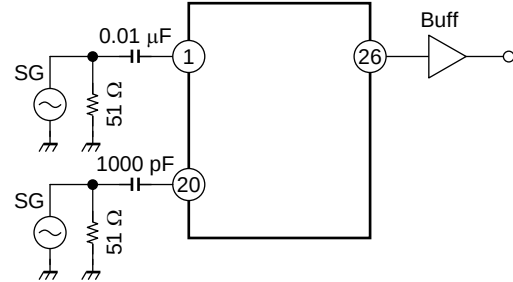
(6) G_V (MIX)



(7) G_V (MIX) vs V_{LO}

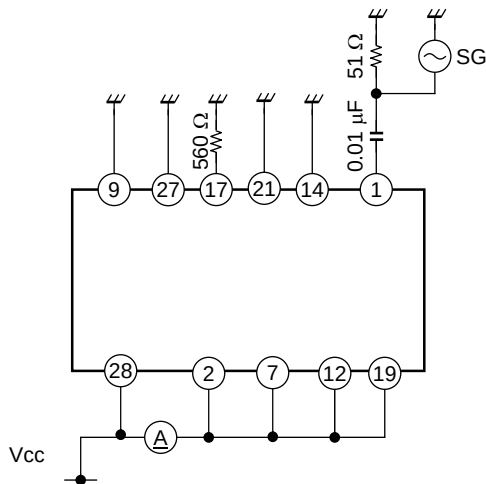


(8) $S/N_{1, 2}$

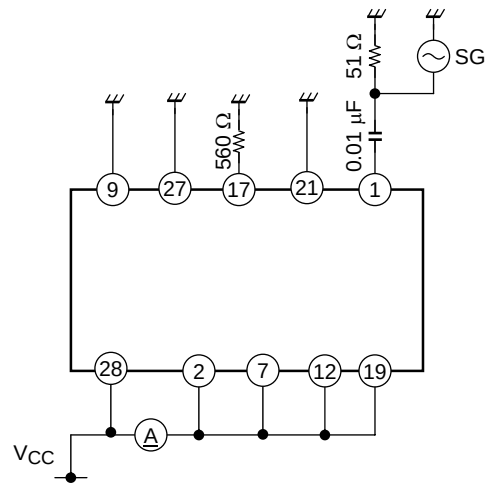


Test Circuit 2

(1) I_{ccqfm}

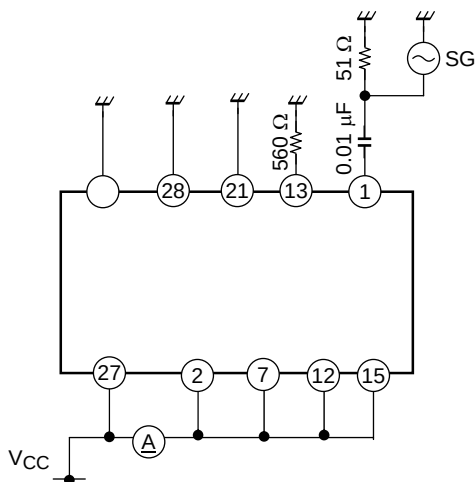


(2) I_{ccqam}

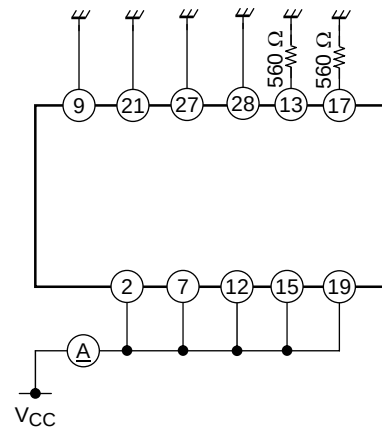


Test Circuit 3

(3) I_{cctx}

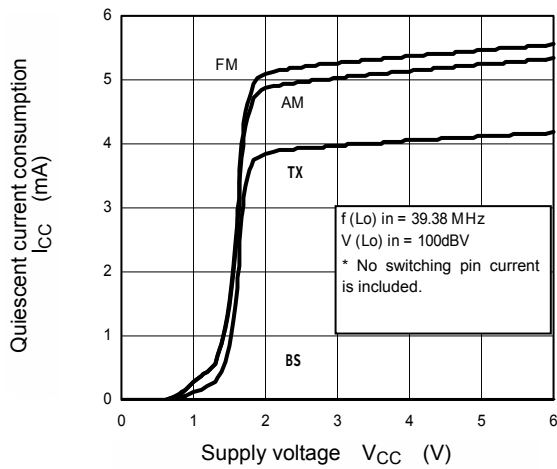


I_{cco}

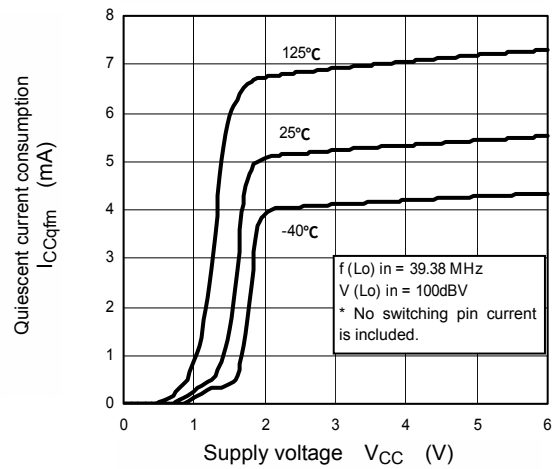


Reference Data (This is characteristics data when it used evaluation boards. This is not guarantee on condition that it is stating except electrical characteristics.)

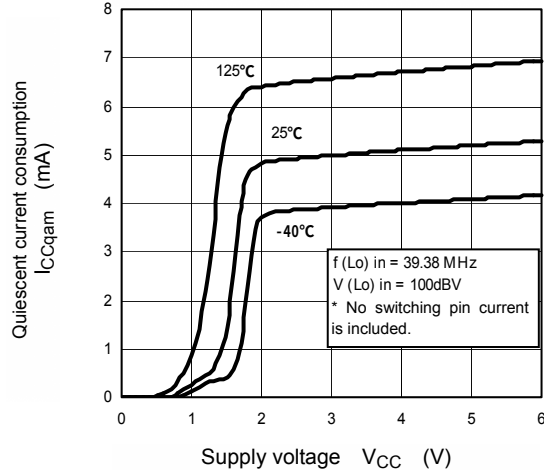
Quiescent Current Consumption –
Supply Voltage Characteristics



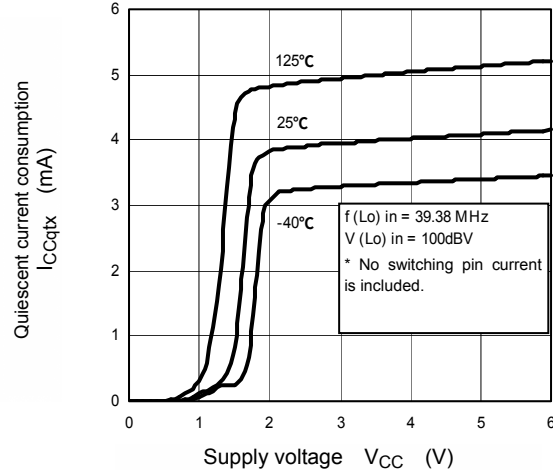
Quiescent Current Consumption –
Supply Voltage Characteristics FM Mode



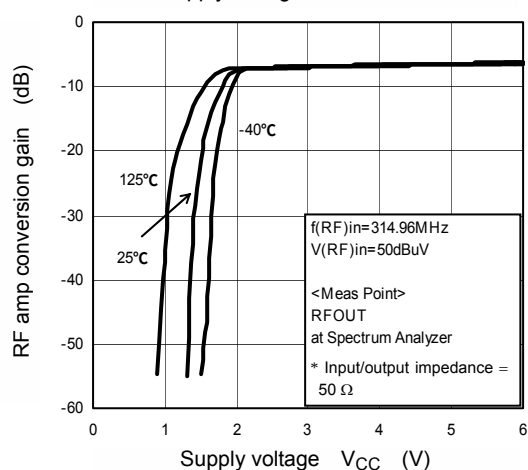
Quiescent Current Consumption –
Supply Voltage Characteristics AM Mode



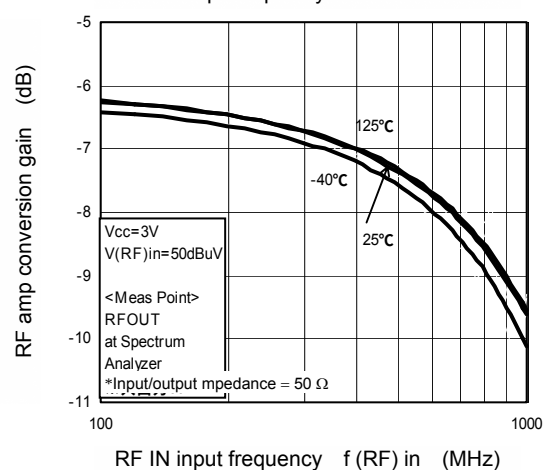
Quiescent Current Consumption –
Supply Voltage Characteristics TX Mode



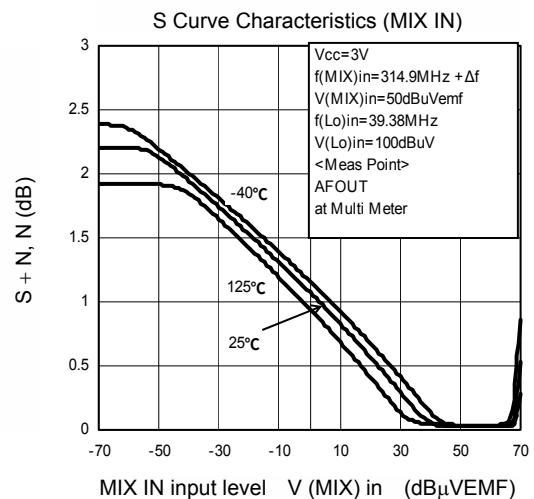
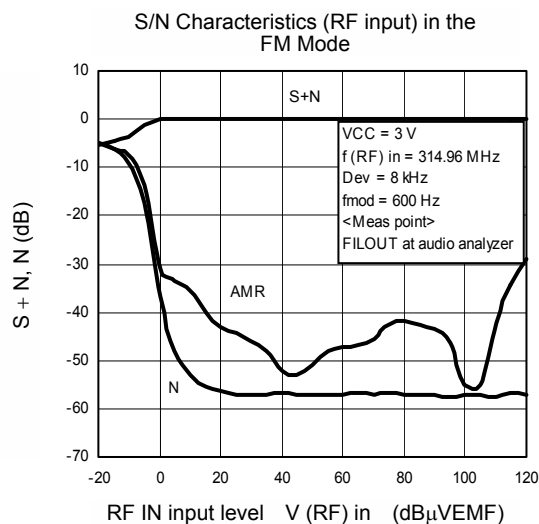
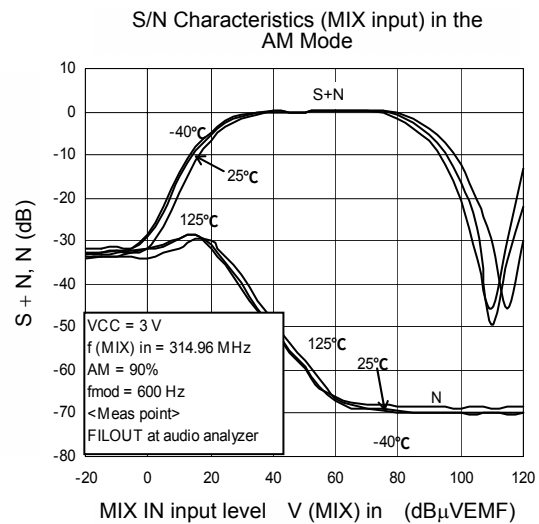
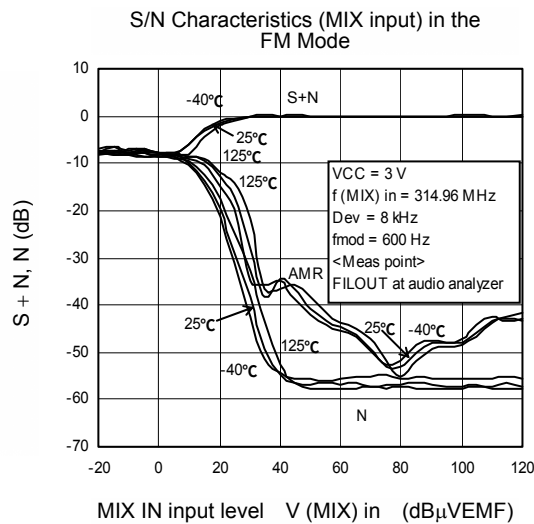
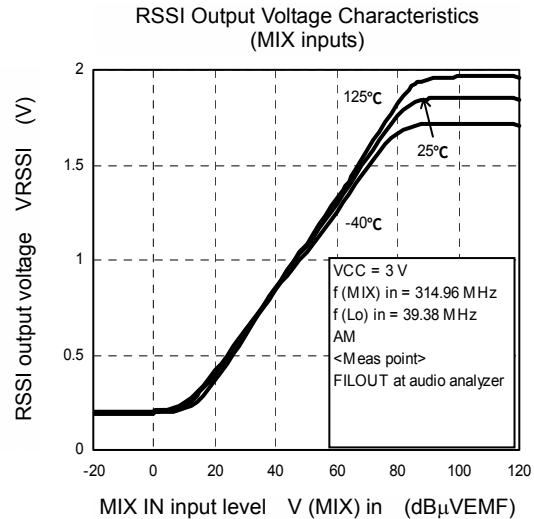
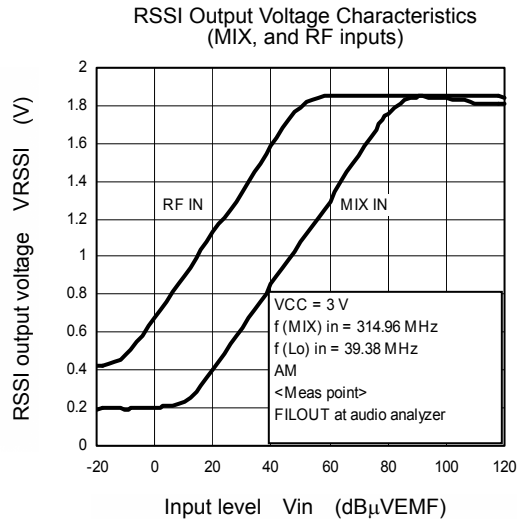
RF Amp Gain –
Supply Voltage Characteristics



RF Amp Frequency Characteristics

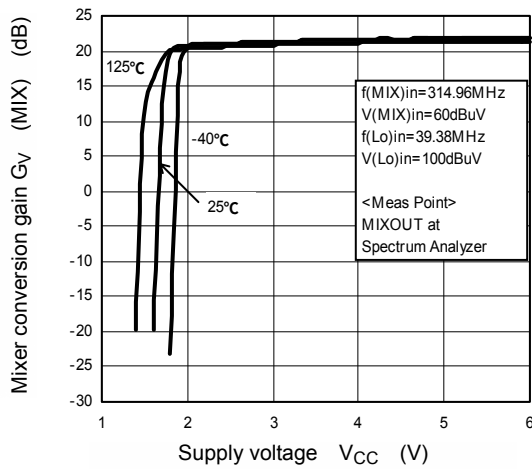


Reference Data (This is characteristics data when it used evaluation boards. This is not guarantee on condition that it is stating except electrical characteristics.)

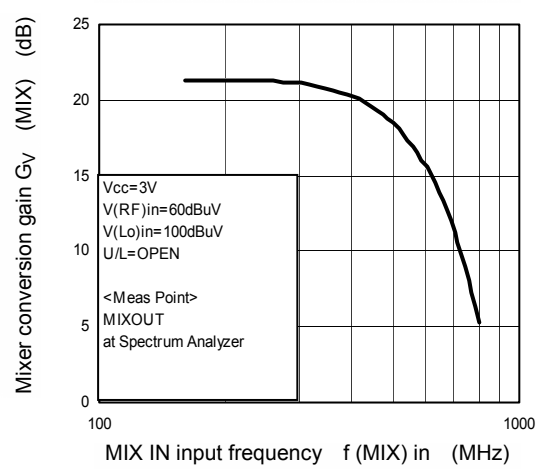


Reference Data (This is characteristics data when it used evaluation boards. This is not guarantee on condition that it is stating except electrical characteristics.)

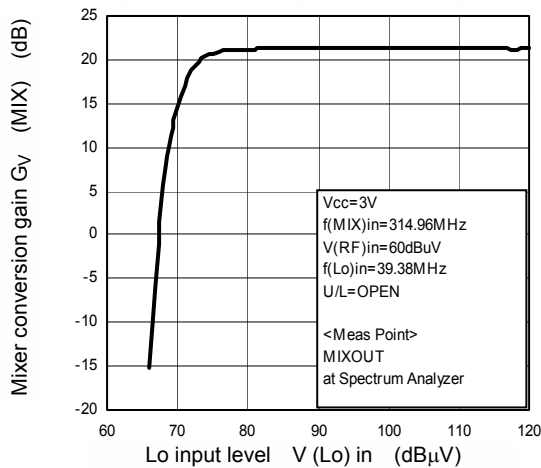
Mixer Conversion Gain –
Supply Voltage Characteristics



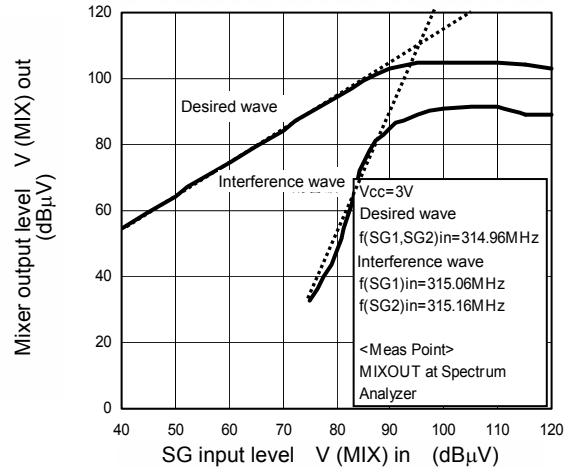
Mixer Conversion Gain Frequency
Characteristics



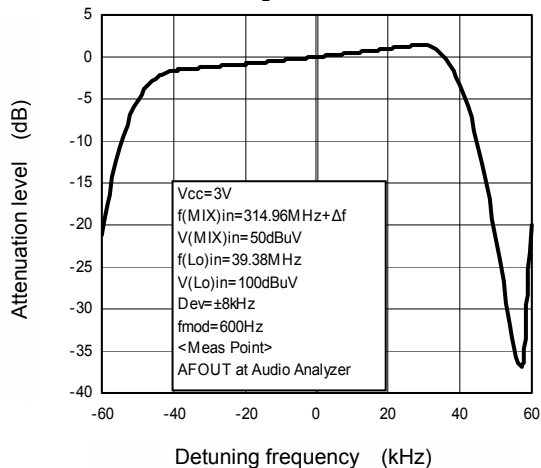
Mixer Conversion Gain –
Local Input Level Characteristics



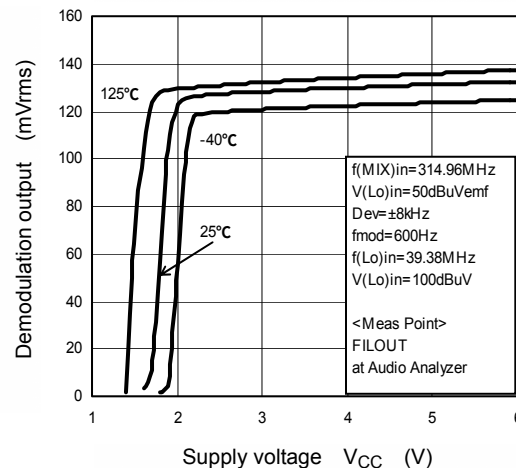
Mixer Intercept Point



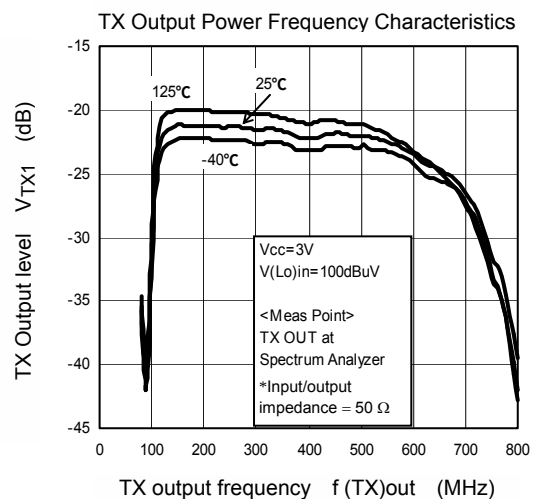
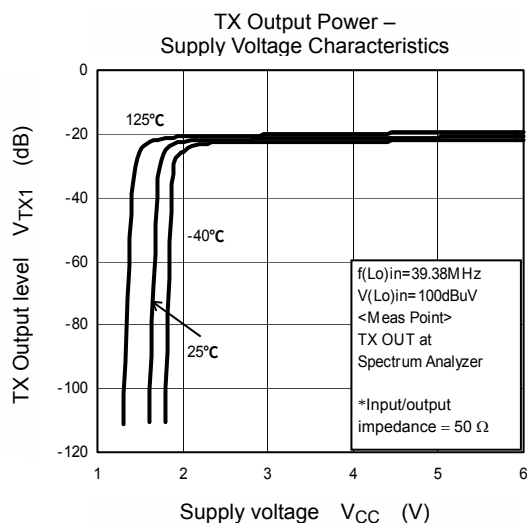
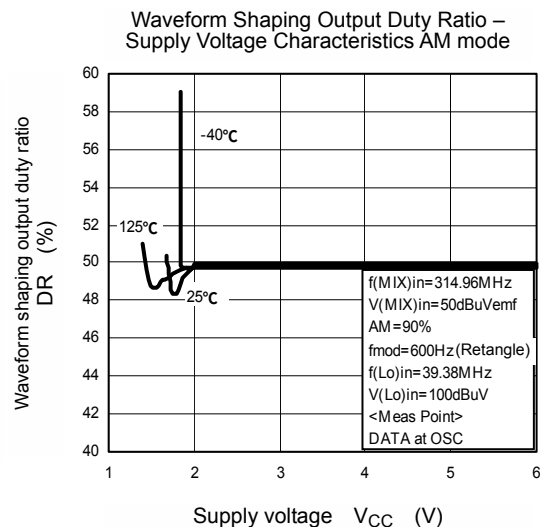
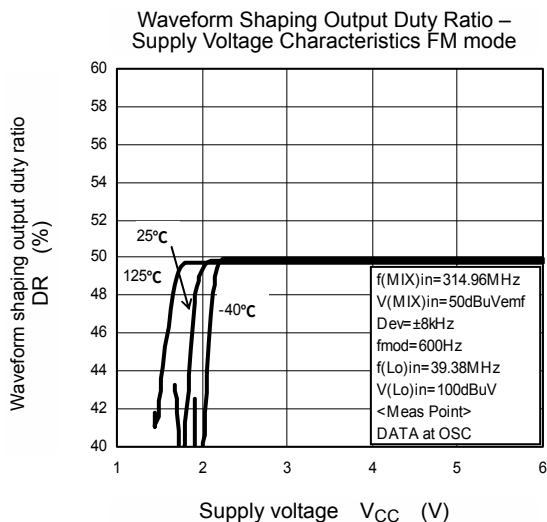
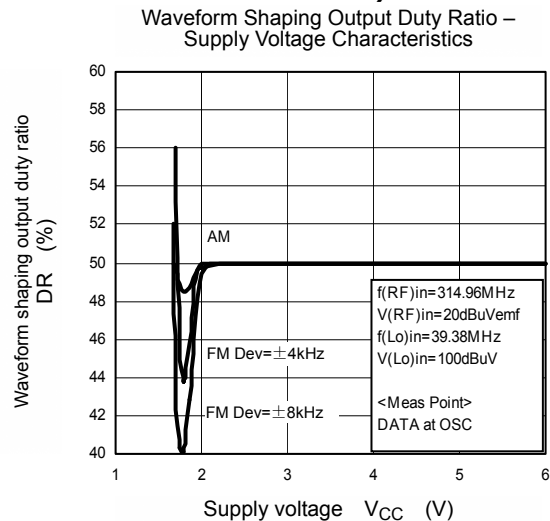
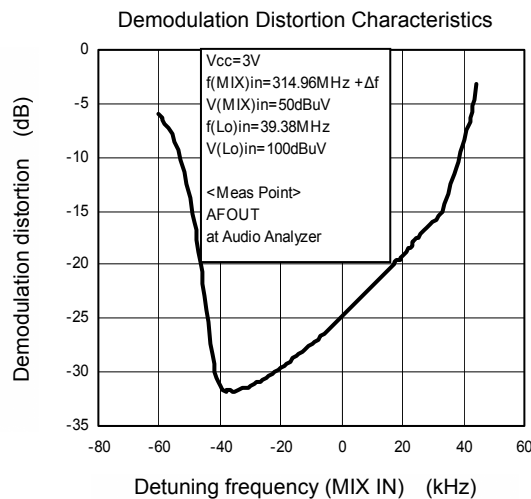
Detuning Characteristics



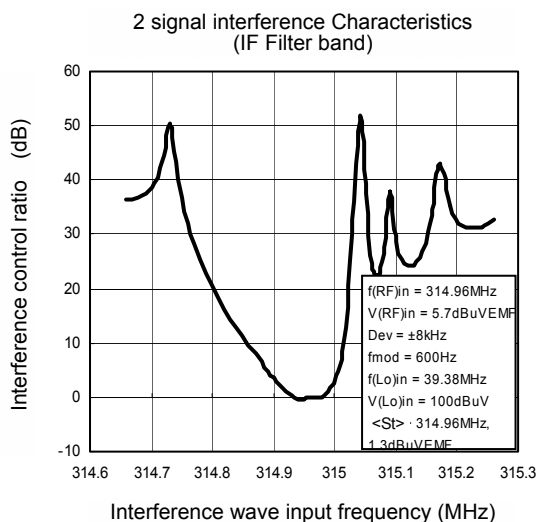
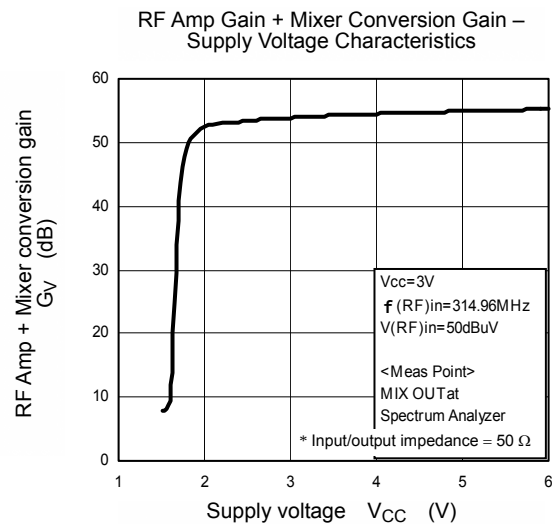
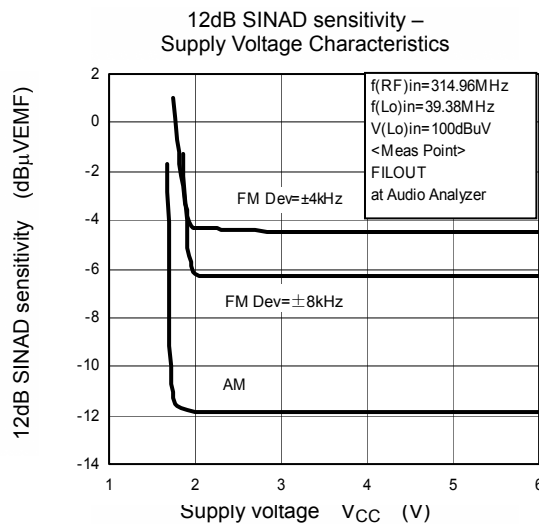
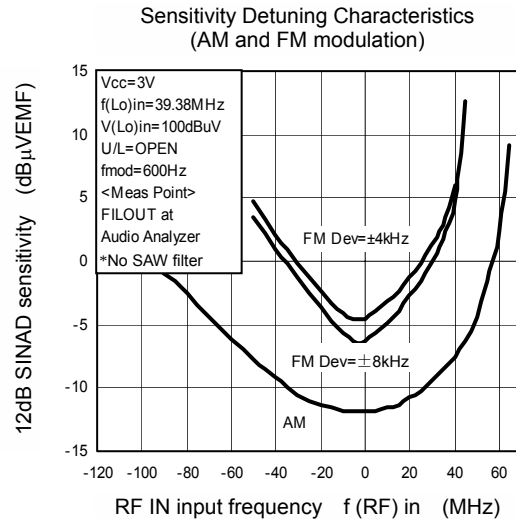
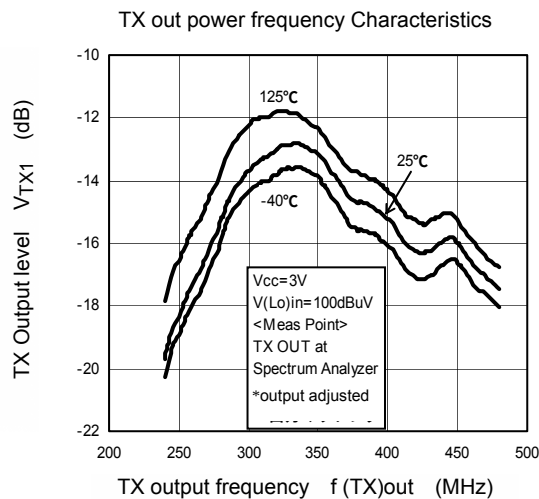
Demodulation Output –
Supply Voltage Characteristics (FM)



Reference Data (This is characteristics data when it used evaluation boards. This is not guarantee on condition that it is stating except electrical characteristics.)

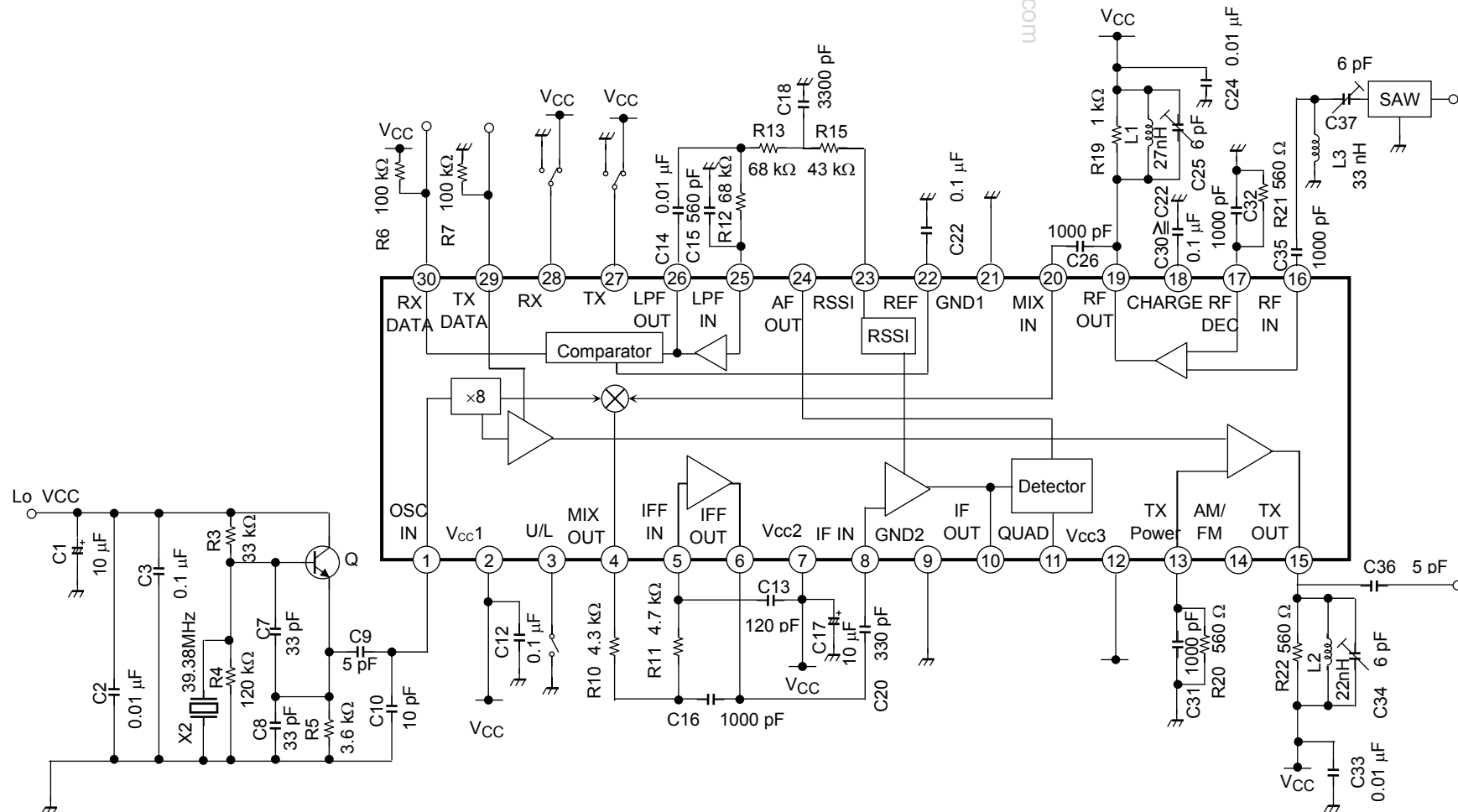


Reference Data (This is characteristics data when it used evaluation boards. This is not guarantee on condition that it is stating except electrical characteristics.)



Application Circuit (ASK) *This circuit is not guaranteed for mass product design. Please evaluate the circuit for mass product design well.

For Receiver and Transceiver



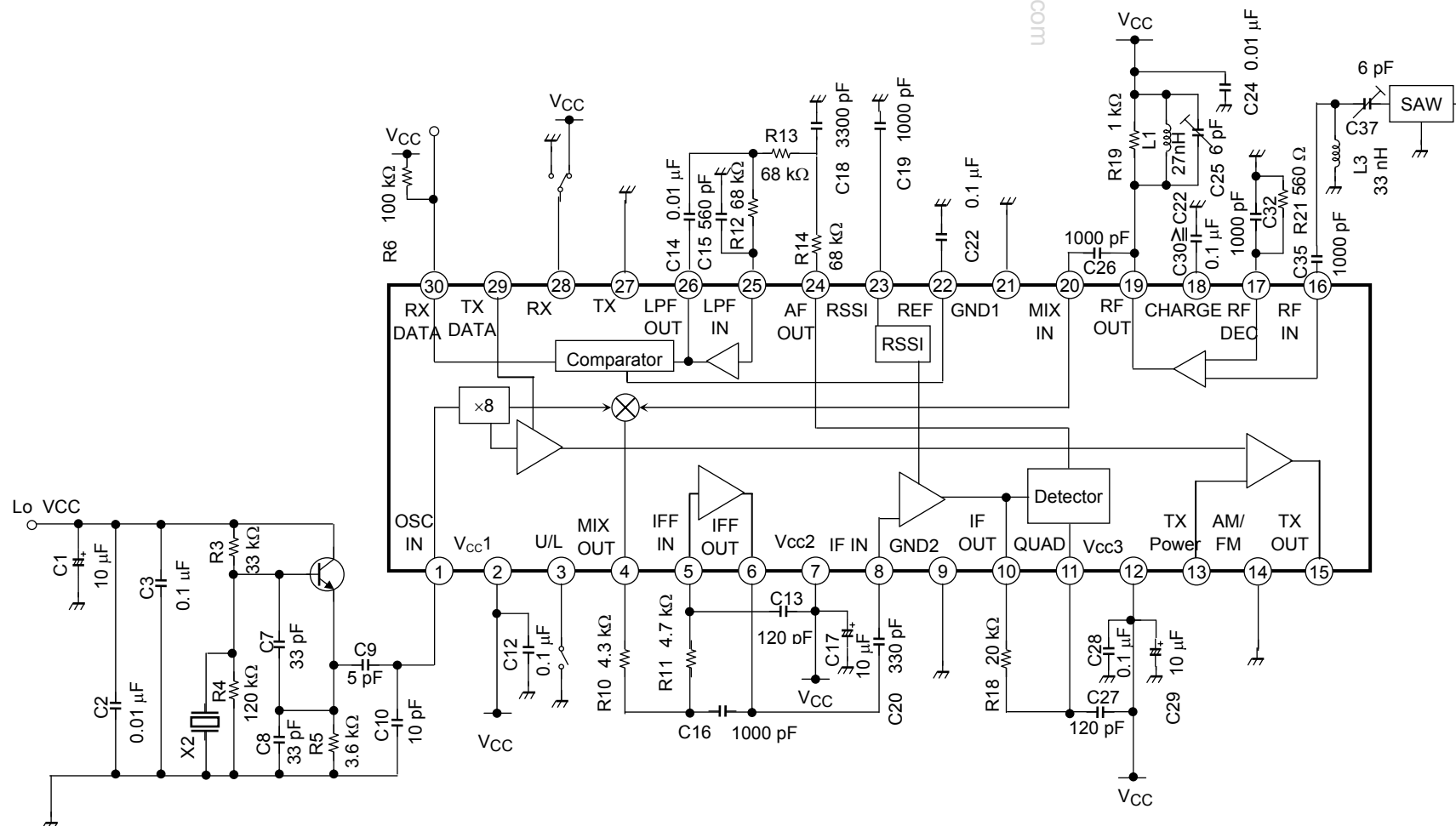
SAW: SAFCH315MAM0T00 (Murata Manufacturing)

X2: TR-1 (TEW)

Q: 2SC2499 (TOSHIBA)

Application Circuit (FSK) *This circuit is not guaranteed for mass product design. Please evaluate the circuit for mass product design well.

For Receiver only

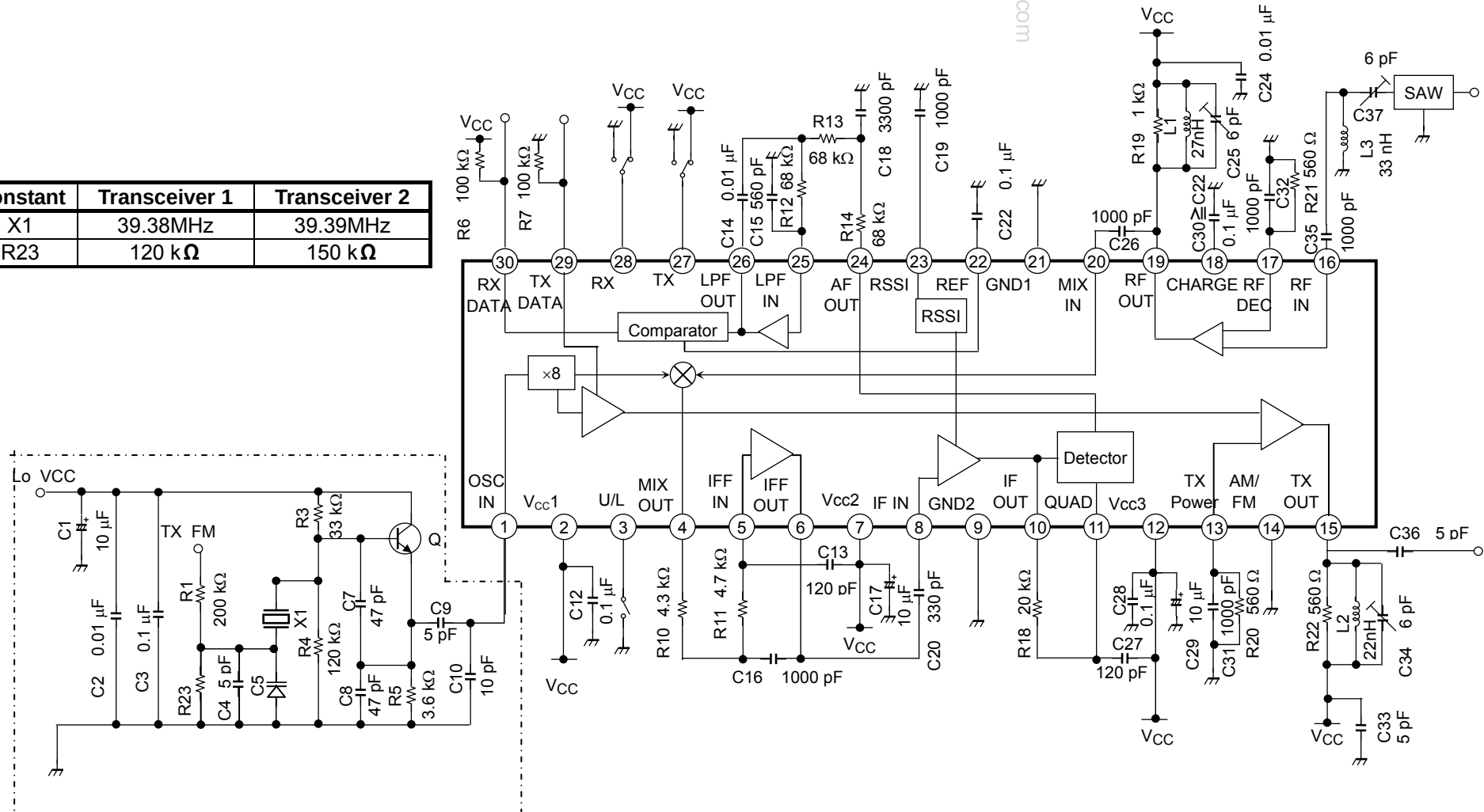


SAW: SAFCH315MAM0T00 (Murata Manufacturing)
X2: TR-1 (TEW)
Q: 2SC2499 (TOSHIBA)

Application Circuit (FSK) *This circuit is not guaranteed for mass product design. Please evaluate the circuit for mass product design well.

For Transceiver only: Change the constants (X1 and R23) at oscillator circuit like the table below to be shifted oscillator frequency 10 kHz.

Constant	Transceiver 1	Transceiver 2
X1	39.38MHz	39.39MHz
R23	120 k Ω	150 k Ω



SAW: SAFCH315MAM0T00 (Murata Manufacturing)

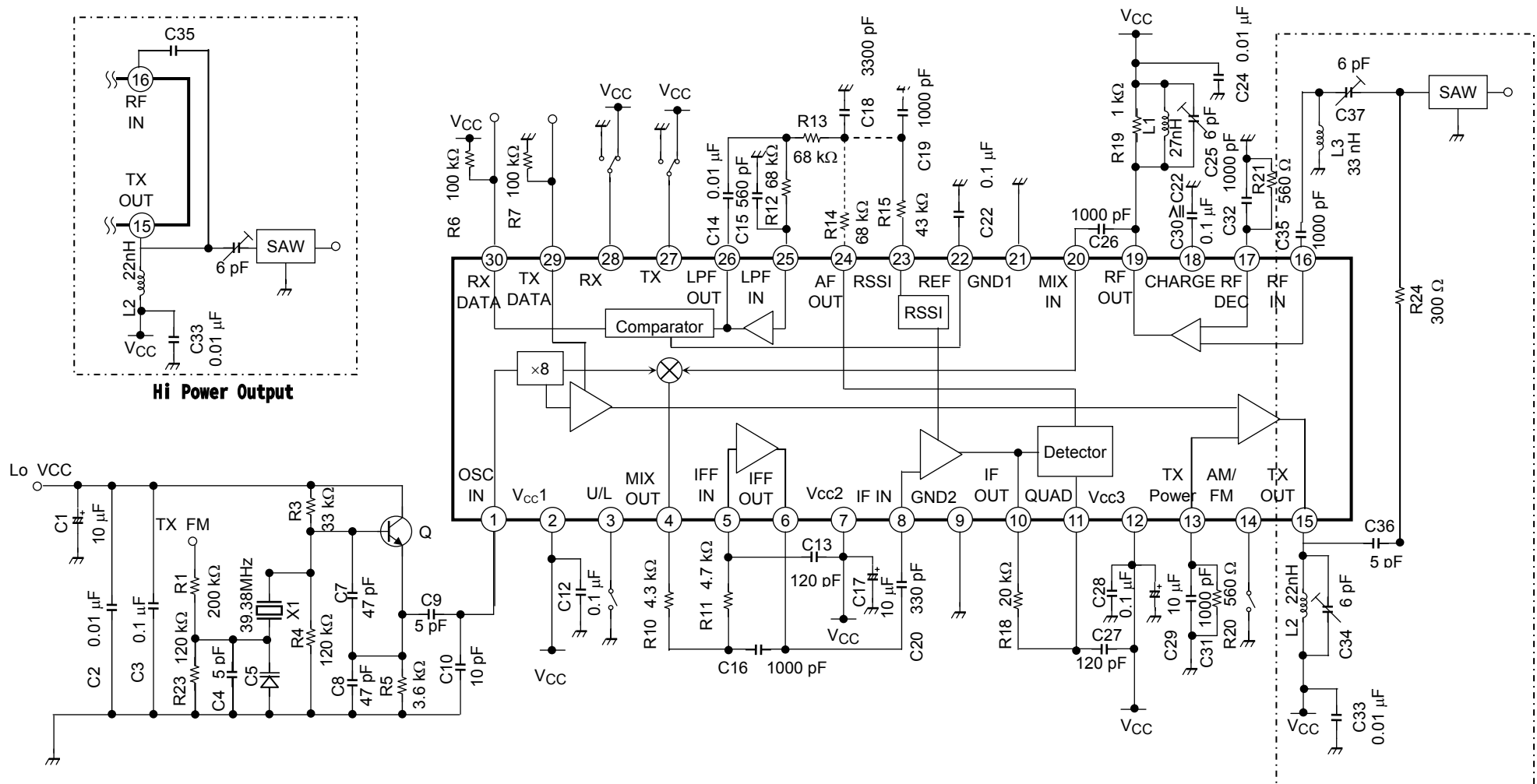
X2: TR-1 (TEW)

Q: 2SC2499 (TOSHIBA)

C5: 1SV325 (TOSHIBA)

Application Circuit *This circuit is not guaranteed for mass product design. Please evaluate the circuit for mass product design well.

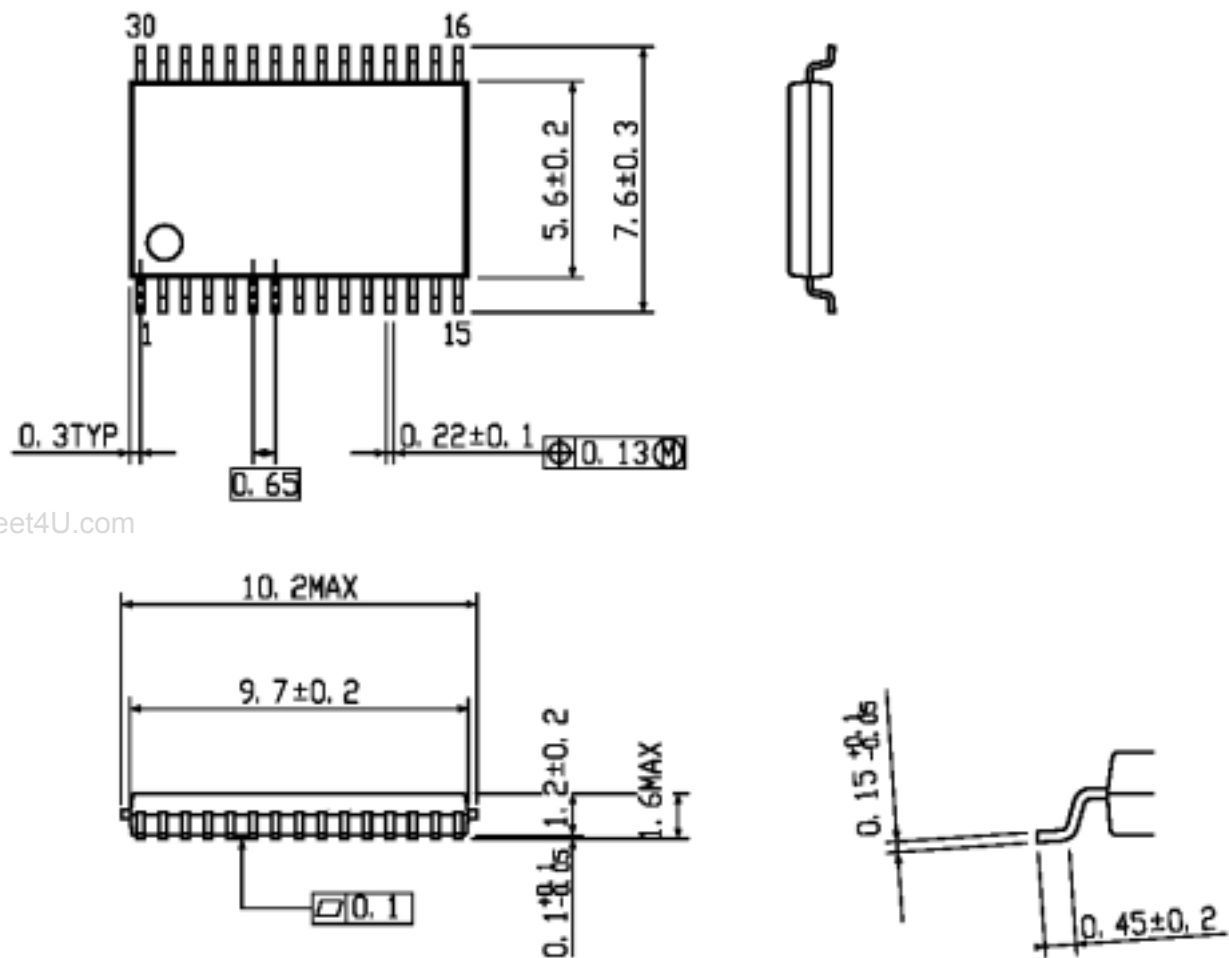
For Transceiver, one antenna version: Adjust the circuit expect antenna block. In case of Hi power output application, set the circuit like left figure.



Package Dimensions

SSOP30-P-300-0.65A

Unit::mm



Weight: 0.17 g (typ)

Notice for Pb free product

About solderability, following conditions were confirmed

➤ Solderability

- (1) Use of Sn-36Pb solder bath
 - solder bath temperature = 230°C
 - 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°C
 - dipping time = 5seconds
 - the number of times = once
 - use of R-type flux

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000707EBA

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