# SONY

# CXA1741Q

## IF Amplifier for Analog Cellular Communications

### Description

The CXA1741Q is an analog cellular(TACS/NTACS) FM IF IC which incorporates an IF filter.

### Features

- Incorporates a ceramic filter function, which is normally mounted externally.
- Quadrature detection discriminator function.
- This IC has almost all IF functions and is ideal for reduction in set size because of few external parts required.
- The built-in filter permits mode changeover between TACS and NTACS.
- Wide operating voltage range (2.7 V to 3.6 V) and low current consumption (Icc=10 mA (typ.) when Vcc= 3 V).
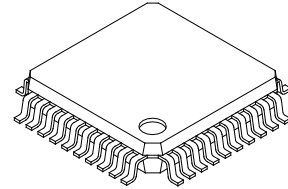- Wide range and excellent temperature characteristics for the RSSI (receiving signal strength indicator).

### Applications

Ideally suited for cellular phones, particularly hand-held sets.

### Structure

Bipolar silicon monolithic IC



40 pin QFP (Plastic)

### Absolute Maximum Ratings (Ta = 25°C)

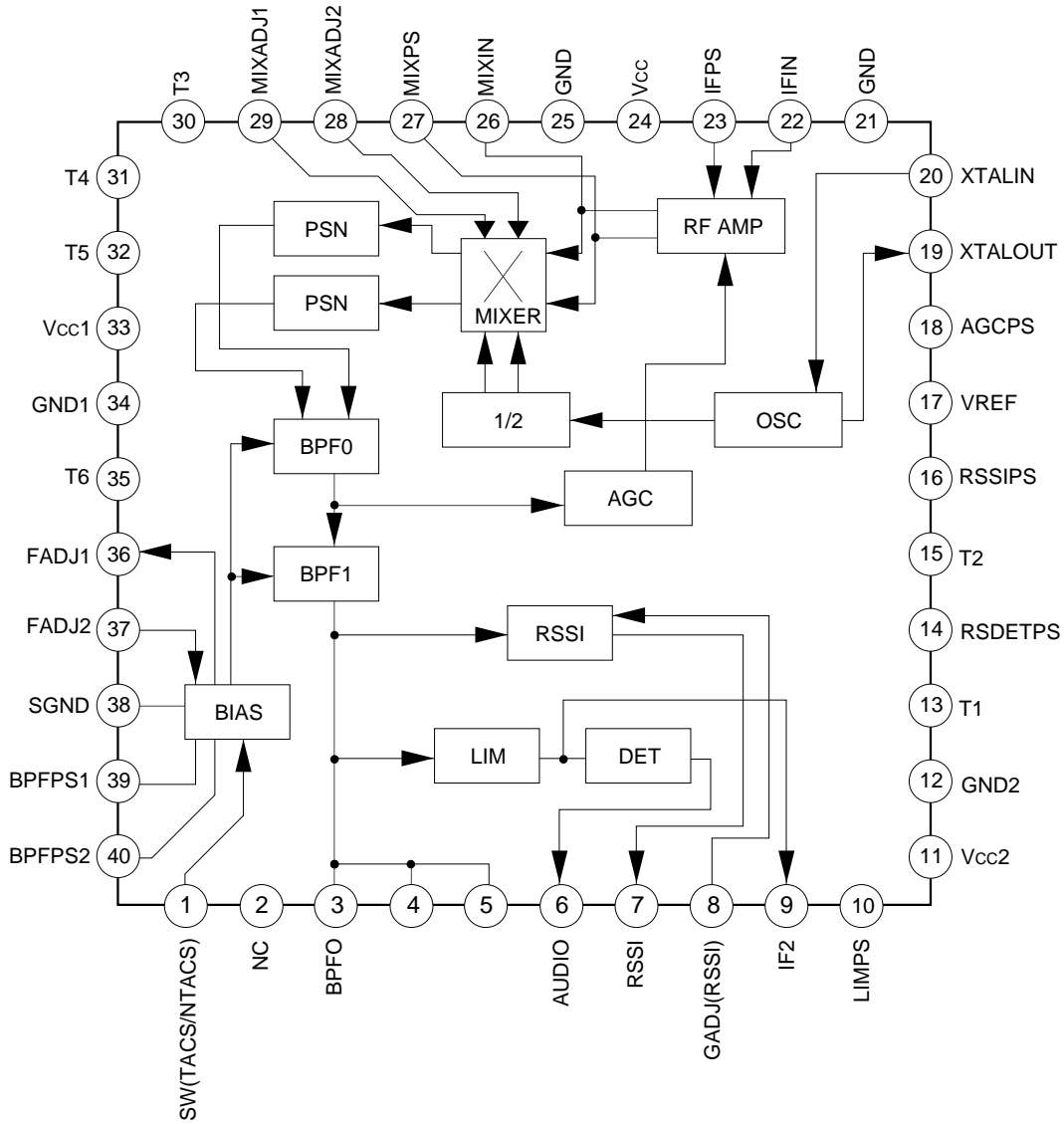- Supply voltage            $V_{CC}$      5           V
- Operating temperature   Topr    −35 to +85    °C
- Storage temperature     Tstg    −65 to +150   °C
- Allowable power dissipation
                          $P_D$       500         mW

### Operating Conditions

Supply voltage            $V_{CC}$    2.7 to 3.6    V

E94245-TE

## Block Diagram and Pin Configuration

(Top View)



Note) Pins 21 and 25 are connected via the IC internal wiring.

Pins 12, 21 and Pins 25, 34 are connected via IC internal resistors.

When designing a PCB, ensure that all GND pins of IC are connected to the GND on PCB with its connection wiring distance minimized.

| Pin No. | Symbol | Pin voltage | | I/O resistance | Equivalent circuit | Description |
|---|---|---|---|---|---|---|
| | | DC | AC | | | |
| 1 | SW $\left(\begin{matrix} TACS \\ NTACS \end{matrix}\right)$ | 0V OPEN HIGH (3 V) | | |  | Changeover switch for built-in filter. TACS for Low; NTACS for High. |
| 2 | NC | | | | | Not internally connected. |
| 3 4 5 | BPFO | 1.8 V | | |  | BPF output monitor. Not used normally. Connected to the LIM and RSSI inputs in the IC. |
| 6 | AUDIO | 2.1 V | | |  | Outputs an AUDIO signal which is FM-detected. |

| Pin No. | Symbol | Pin voltage | | I/O resistance | Equivalent circuit | Description |
|---|---|---|---|---|---|---|
| | | DC | AC | | | |
| 7 | RSSI | 1.2 V | | |  | RSSI output. Outputs a DC voltage in accordance with the signal input to the RF amplifier. |
| 8 | GADJ | 0.2 V | | |  | Adjusts the RSSI amplifier gain (varies the resistance so as to obtain a linear RSSI output). |
| 9 | IF2 | 0.9 V | | |  | Limiter operation monitor. Not used normally. |
| 10 | LIMPS | 1.8 V | | |  | Connects a limiter integrating capacitor. |

| Pin No. | Symbol | Pin voltage | | I/O resistance | Equivalent circuit | Description |
|---------|--------|------|------|------|------|------|
| | | DC | AC | | | |
| 11 | Vcc2 | 3.0 V | | | | Power supply. Supplies current to the LIM, DET, and RSSI circuits. |
| 12 | GND2 | 0 V | | | | Ground. |
| 13 | T1 | | | | | IC operation check. |
| 14 | RSDETPS | 1.4 V | | |  | Connects an RSSI detector integrating capacitor. |
| 15 | T2 | | | | | IC operation check. |
| 16 | RSSIPS | 1.8 V | | |  | Connects an RSSI integrating capacitor. |
| 17 | VREF | 1.3 V | | |  | Monitor for the reference voltage used in the internal circuit. When connected to an external capacitor, this pin also functions to lower the reference voltage dynamic impedance. |

| Pin No. | Symbol | Pin voltage | | I/O resistance | Equivalent circuit | Description |
|---|---|---|---|---|---|---|
| | | DC | AC | | | |
| 18 | AGCPS | 0.2 V | | | | Connects an AGC integrating capacitor. |
| 19 | XTALOUT | 2.9 V | | | | Connect a crystal oscillator to form a Colpitts-type oscillator circuit. When an external oscillator is used, its input must be connected to Pin 20. |
| 20 | XTALIN | 2.9 V | | | | |
| 21 | GND | 0 V | | | | Ground. |
| 22 | IFIN | 1.3 V | | | | RF amplifier input. The relationship between IFIN (Pin 22) and IFPS (Pin 23) is designed so that the IC internal stray capacitance is small. Therefore, if Pins 22 and 23 are used for balance input, the common-mode rejection deteriorates. |
| 23 | IFPS | 1.3 V | | | | |
| 24 | Vcc | 3.0 V | | | | Power supply. Supplies current to the RF AMP, MIXER, OSC, and 1/2 DIVIDER circuits. |
| 25 | GND | 0 V | | | | Ground. |

| Pin No. | Symbol | Pin voltage | | I/O resistance | Equivalent circuit | Description |
|---|---|---|---|---|---|---|
| | | DC | AC | | | |
| 26 | MIXIN | 1.3 V | | |  | RF AMP output monitor. Connected to the MIXER input in the IC. |
| 27 | MIXPS | 1.3 V | | | | |
| 28 | MIX ADJ2 | 0.1 V | | |  | Balance adjustment for mixers 1 and 2. |
| 29 | MIX ADJ1 | 0.1 V | | | | |
| 30 | T3 | | | | | IC operational check. |
| 31 | T4 | | | | | |
| 32 | T5 | | | | | |
| 33 | Vcc1 | 3.0 V | | | | Power supply. Supplies current to the PSN, BPF, and BIAS circuits. |
| 34 | GND1 | 0 V | | | | Ground. |
| 35 | T6 | | | | | IC operational check. |
| 36 | FADJ1 | 2.2 V | | |  | When the resistance value of an external resistor connected between Pins 36 and 37 is varied, the center frequency of the BPF in the IC changes accordingly. |
| 37 | FADJ2 | 1.5 V | | | | |

| Pin No. | Symbol | Pin voltage | | I/O resistance | Equivalent circuit | Description |
|---------|--------|------|------|----------------|--------------------|-------------|
| | | DC | AC | | | |
| 38 | SGND | 1.8 V | | | <br>B.P.F signal reference voltage | Monitor for the pseud-ground voltage used in the internal circuits.<br>When connected to an external capacitor, this pin also functions to lower the reference voltage dynamic impedance. |
| 39 | BPFPS1 | 1.1 V | | | <br>reference voltage used for B.P.F | Monitor for the reference voltage used by the BPF. When connected to an external capacitor, these pins also function to lower the reference voltage dynamic impedance. |
| 40 | BPFPS2 | 1.2 V | | | | |

**Electrical Characteristics**

0dBm = 50Ω, 1mW

$V_{CC}$ = 3V, Ta = 25°C

$F_{OSC}$ = 89.9 MHz

| Item | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Current consumption - 1 | $I_{CC-11}$ | fin = 45 MHz, -30 dBm<br>Pin 11 | 0.8 | 1.1 | 1.5 | mA |
| Current consumption - 2 | $I_{CC-24}$ | fin = 45 MHz, -30 dBm<br>Pin 24 | 2 | 2.9 | 3.8 | mA |
| Current consumption - 3 | $I_{CC-33}$ | fin = 45 MHz, -30 dBm<br>Pin 33 | 3.8 | 5.3 | 7 | mA |
| Pin current<br>Pin 1 - Low | $I_{IL}$ | 0 V | -14 | -10 | -7 | μA |
| Pin current<br>Pin 1 - High | $I_{IH}$ | 3 V | 15 | 23 | 30 | μA |
| Pin current<br>Pin 19 | $I_{19}$ | Crystal osc. 89.9 MHz | | 0.4 | 0.6 | mA |
| Pin voltage - Pin 17 | $V_{17}$ | | 1.2 | 1.25 | 1.3 | V |
| Pin voltage - Pin 38 | $V_{38}$ | | 1.6 | 1.8 | 2 | V |
| Pin voltage - Pin 39 | $V_{39}$ | | 1 | 1.17 | 1.4 | V |
| Pin voltage - Pin 40 | $V_{40}$ | | 1 | 1.2 | 1.4 | V |
| OSC output swing<br>Pin 19 | $V_{OSC}$ | Crystal osc. 89.9 MHz | 70 | 93 | 130 | mV rms |
| Wide BPF; TACS mode (Pin 1=Low) | | | | | | |
| BPF output voltage - 1 | $V_{TG1}$ | fin = 45 MHz, -50 dBm | 100 | 162 | 220 | mV rms |
| BPF output voltage - 2 | $V_{TG2}$ | fin = 45 MHz, -20 dBm | 220 | 291 | 360 | mV rms |
| IF1 output voltage | $V_{TIF}$ | fin = 45 MHz, -20 dBm | 80 | 89 | 100 | mV rms |
| Mixer image rejection level | $V_{IMAG}$ | fin = 44.9 MHz, -30 dBm | | 30 | 100 | mV rms |
| BPF 6 dB bandwidth | $BW_{6dB}$ | Vin = -50 dBm, Swept with fin = 45 MHz regarded as the center | | 26 | 30 | kHz |
| BPF 40 dB bandwidth | $BW_{40dB}$ | Vin = -50 dBm, Swept with fin = 45 MHz regarded as the center | | 47 | | kHz |
| BPF extraband attenuation | $ATT_{40K}$ | fo ±40 kHz | | 56 | | dB |
| FM detection level | $FM_{DET}$ | fin = 45 MHz, -30 dBm, fmod=1 kHz, Dev. = 5.6 kHz, Dev. = 5.6 kHz, used LPF 20 kHz | 150 | 194 | 250 | mV rms |
| AM rejection ratio | AMR | fin = 45 MHz, -30 dBm, fmod = 1 kHz, Mod = 80% used LPF 20 kHz | | -27 | -20 | dB |

| Item | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|------|--------|-----------|------|------|------|------|
| Audio output distortion | THD | fin = 45 MHz, -30 dBm, fmod = 1 kHz, Dev. = 8 kHz, used LPF 20 kHz | | 3.7 | 6 | % |
| RSSI output voltage - 11 | $RSSI_{11}$ | No input | 1 | 1.15 | 1.3 | V |
| RSSI output voltage - 12 | $RSSI_{12}$ | fin = 45 MHz, -60 dBm | 1.65 | 1.93 | 2.2 | V |
| RSSI output voltage - 13 | $RSSI_{13}$ | fin = 45 MHz, -20 dBm | 2.4 | 2.67 | 2.8 | V |
| Narrow BPF; NTACS mode (Pin 1=High) | | | | | | |
| Mixer 3rd inter-modulation | $IM_3$ | f1 = 45.02 MHz, -30 dBm, f2 = 45.04 MHz, -30 dBm | | 4.5 | 20 | mV rms |
| BPF 6 dB bandwidth | $BW_{6dB}$ | Vin = -50 dBm, Swept with fin = 45 MHz regarded as the center | | 13.5 | 16 | kHz |
| BPF 40 dB bandwidth | $BW_{40dB}$ | Vin = -50 dBm, Swept with fin = 45 MHz regarded as the center | | 23 | | kHz |
| BPF extraband attenuation | $ATT_{20K}$ | fo ±20 kHz | | 62 | | dB |
| FM detection level | $FM_{NDET}$ | fin = 45 Mhz, -30 dBm, fmod = 1 kHz, Dev. = 3 kHz, Used LPF 20 kHz | | 99 | | mV rms |
| AM detection level | $AMR_N$ | fin = 45 Mhz, -30 dBm, fmod = 1 kHz, Mod = 80%, Used LPF 20 kHz | | 16 | | dB |
| Audio output distortion | $THD_N$ | fin = 45 Mhz, -30 dBm, fmod = 1 kHz, Dev. = 3 kHz, Used LPF 20 kHz | | 2.8 | | % |
| RSSI output voltage - 21 | $RSSI_{21}$ | No input | | 1.09 | | V |
| RSSI output voltage - 22 | $RSSI_{22}$ | f = 45 MHz, -60 dBm | | 1.91 | | V |
| RSSI output voltage - 23 | $RSSI_{23}$ | f = 45 MHz, -20 dBm | | 2.65 | | V |
| Others | | | | | | |
| Equivalent input resistance Pin 22 | $R_{IN}$ | f = 55 MHz | | 1.4 | | kΩ |
| Equivalent input capacitance Pin 22 | $C_{IN}$ | f = 55 MHz | | 4.7 | | pF |
| BPF•fo temperature characteristics TACS mode | | Ta = -30 to + 70°C | | 1.5 | | kHz |
| BPF•fo temperature characteristics NTACS mode | | Ta = -30 to + 70°C | | 1.5 | | kHz |

**Measurement Circuit**
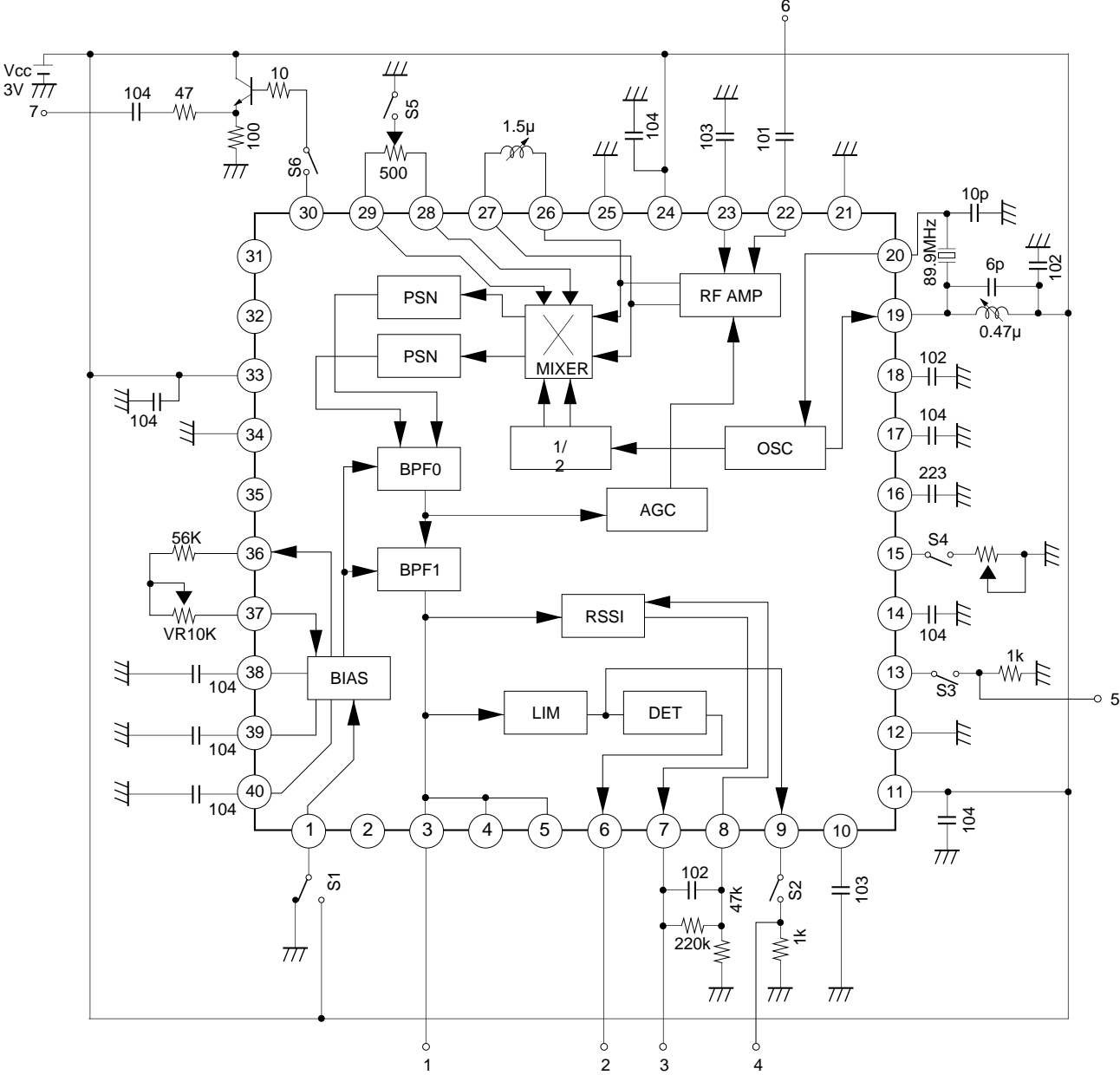
**Application Circuit**
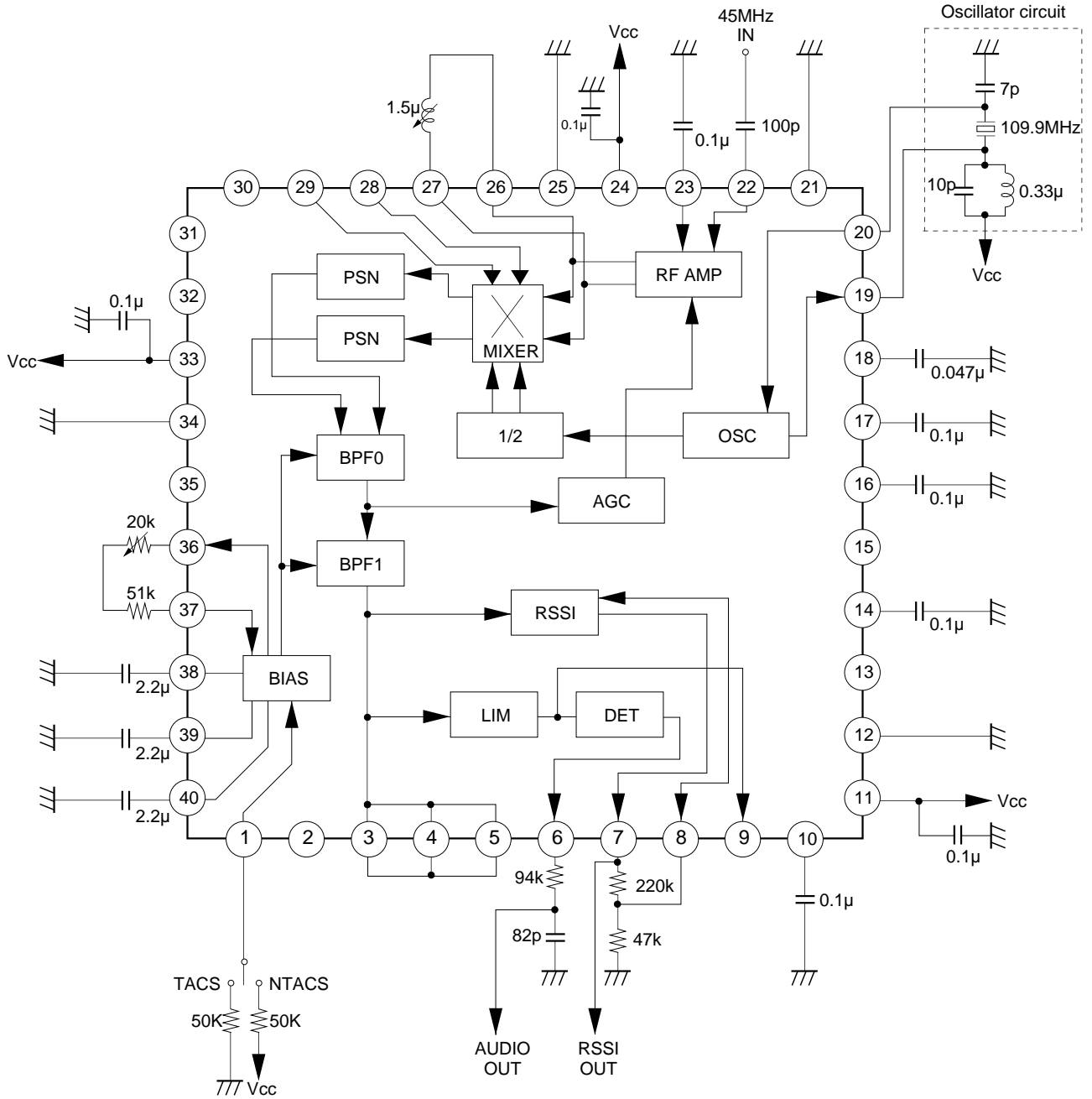


Note: Use a 0.1μF capacitor for Pin 14 decoupling.

The IC malfunctions at a capacitance of 0.047μF or lower.

The oscillator circuit must be changed according to the crystal characteristics.

When designing PCB pattern, make PCB pattern so that Pins 3, 4, and 5 are connected correlatively.

This makes IC other than TACS/NTACS standard possible to use without changing PCB pattern.

**Description of Operation**

A 45 MHz IF signal is input to Pin 22.  This input signal is amplified at the RF AMP and then mixed  with the local oscillation signals from the oscillator at the mixer to change the signal frequency to 50 kHz.  When a crystal resonator or like external circuit is connected to Pins 19 and 20, the oscillator can be self-executed by composing a Colpitts-type oscillation circuit.  It can be also used with an external local oscillation signal applied to Pin 20.

The internal BPF eliminates any interference from the converted 50 kHz signal, which is then fed to the limiter and RSSI circuit.

The limiter eliminates an amplitude component from the signal.  The resulting signal is then detected at the quadrature FM detector circuit, and Pin 6 outputs an audio signal.

The RSSI circuit detects the RF AMP input signal voltage and generates from Pin 7 the DC voltage where the detected voltage value is logarithmically compressed.

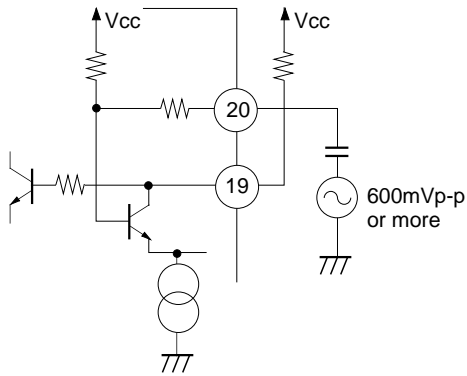SW (Pin 1) can switch the NTACS and TACS modes.
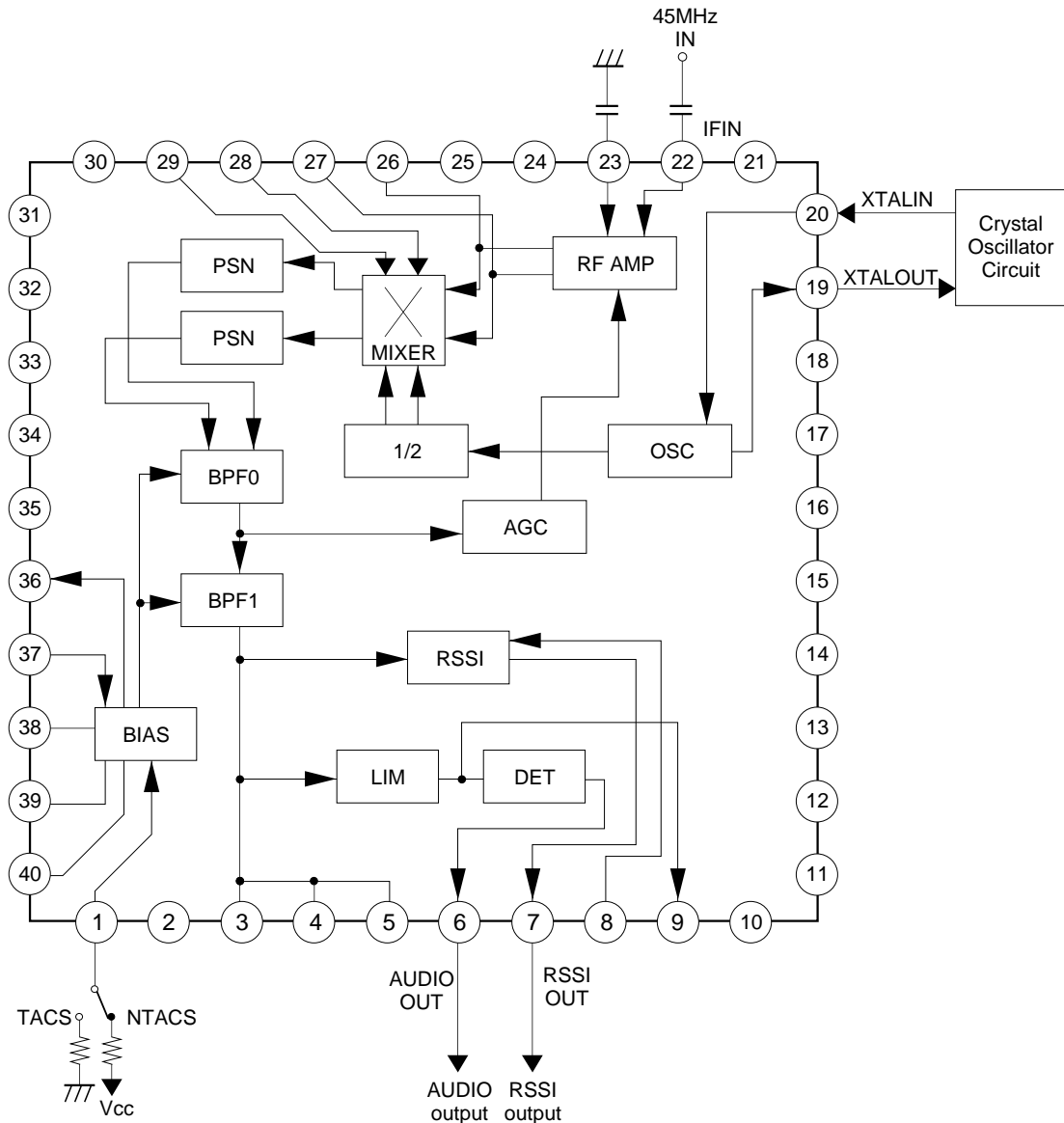
Signal Flow

1) Power supply

Power supply pins (Pins 11, 24, and 33) must be decoupled with the shortest distance.

2) Oscillator

The figures below show how to use the CXA1741Q oscillator.
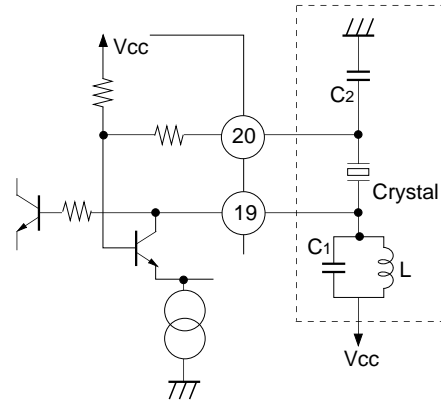


(a) Inputting a local oscillation signal from an external circuit.

The circuit current varies with the externally fed signal amplitude.

The reason is that the AGC circuit, which works to maintain the oscillation amplitude constant when a Colpitts-type oscillator circuit is formed, also operates when an external local oscillation signal is input.

(b) Configuring a Colpitts-type oscillator circuit.

The C1, C2, and L must be changed according to the crystal characteristics.

The oscillation Tr in the IC is internally subjected to AGC so that the oscillation level at Pin 19 is not likely to be affected by temperature or supply voltage fluctuations.

3) Mixers

Since the BPF in the IC has an fo value as low as 50 kHz, the IC employs an image rejection type of mixer having an enhanced interference elimination capability. Therefore, the two internal mixers must be accurately adjusted so that their gains are equal. Normally, an adequate degree of image rejection is provided without using Pins 28 and 29. However, when they are used for adjustment purposes, an increased degree of image rejection will result.
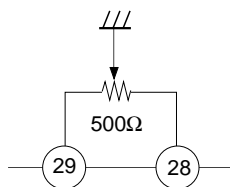
4) BPF

The passband frequency of the built-in filter should be adjusted.

For adjustment method, adjust skirt characteristics of band-pass filter to be symmetric with respect to the center frequency. Or observe the AUDIO output at Pin 7 and adjust the variable resistor between Pins 36 and 37 so as to minimize the AUDIO output distortion.
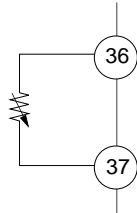
5) RSSI (receiving signal strength indicator)

RSSI detects the input signal level.

The IC generates a DC voltage output, which is nearly proportional to the logarithmic value of RF input level. The output level can be varied by adjusting GADJ (Pin 8) resistance value. Adjust the resistance value so that saturation does not occur when the input level is high.
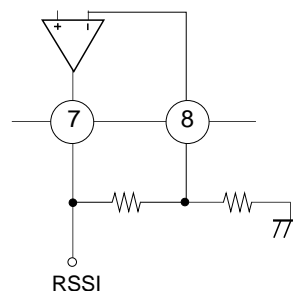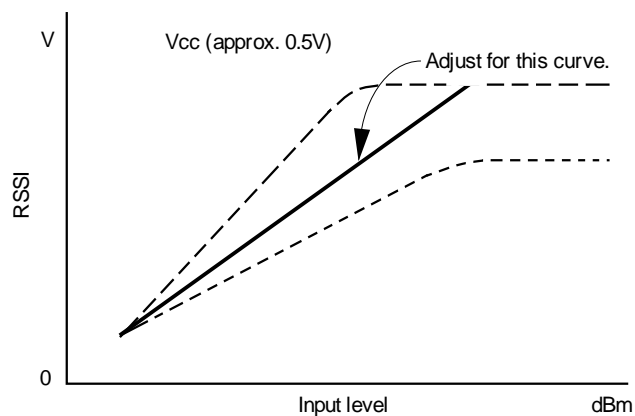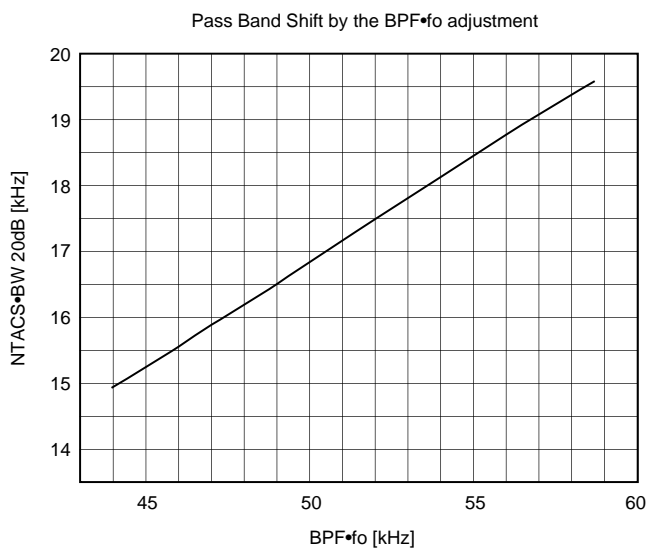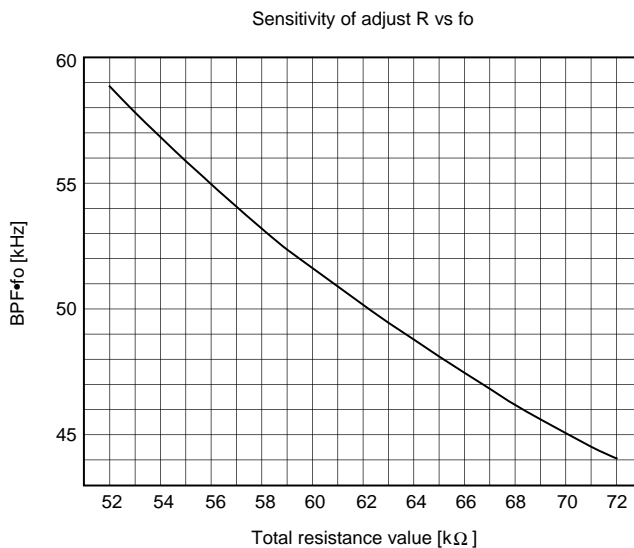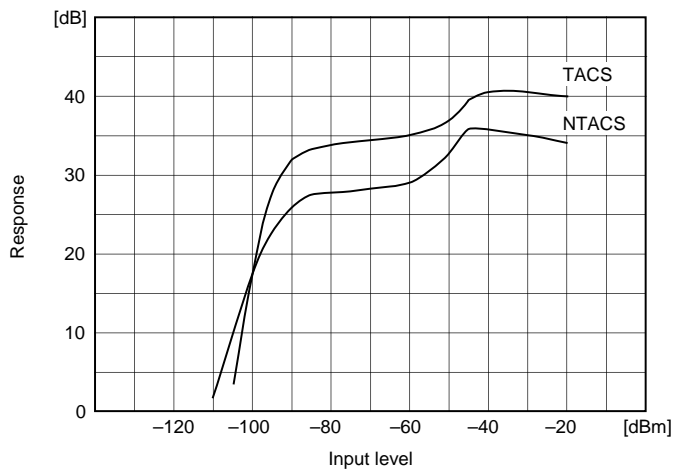
**Notes on Operation**

1. This IC must be handled with care because it is extremely susceptible to electrostatic surges.  Particularly, IFIN (Pin 22) is easily affected by electrostatic surges.

2. When the 0.1μF capacitor connected to Pin 14 has a capacitance of 0.047μF or less, the IC malfunctions. Be sure that the employed capacitor has an excellent temperature characteristics.

3. When the capacitance value of the 0.1μF capacitor connected to Pin 38 is decreased, the IC characteristics begin to slightly deteriorate.  Further, a capacitance value increase would not improve the IC characteristics accordingly.

4. When the capacitance value of the 0.1μF capacitor connected to Pin 40 is decreased, the IC characteristics slightly deteriorate.

5. Vcc1 (Pin 33) supplies the power to the reference bias voltage generator circuit which is necessary for IC operations.  If the same Vcc power supply is not provided for Vcc voltages to be applied to Pins 11, 19, 24, and 33, ensure that the Pin 33 Vcc rises first.

6. Be sure that nothing is connected to Pins 13, 15, 30, 31, 32, and 35.

7. Resistance between Pins 36 and 37
   The signal of 45 MHz, −50 dBm is input from Pin 22 (IFIN) and the level of Pin 3 (BPFOUT) is read.  After that when this frequency is varied to +8 kHz and −8 kHz respectively, resistance value between Pins 36 and 37 is varied to be the same attenuation level.

8. Inductance between Pins 26 and 27
   Adjustment must be made so that a 45 MHz parallel resonance circuit is formed by the inductor between Pins 26 and 27 and the IC stray capacitor.  This adjustment assures that an increased mixer conversion gain is provided at a low input signal level.
   Once the optimum value is obtained upon PCB conductive pattern determination, readjustment is unnecessary after sample changes.

9. Pin 19 resonance circuit
   This circuit must be adjusted for the crystal oscillation frequency. Once the optimum value is obtained upon PCB conductive pattern determination, readjustment is unnecessary after sample changes.

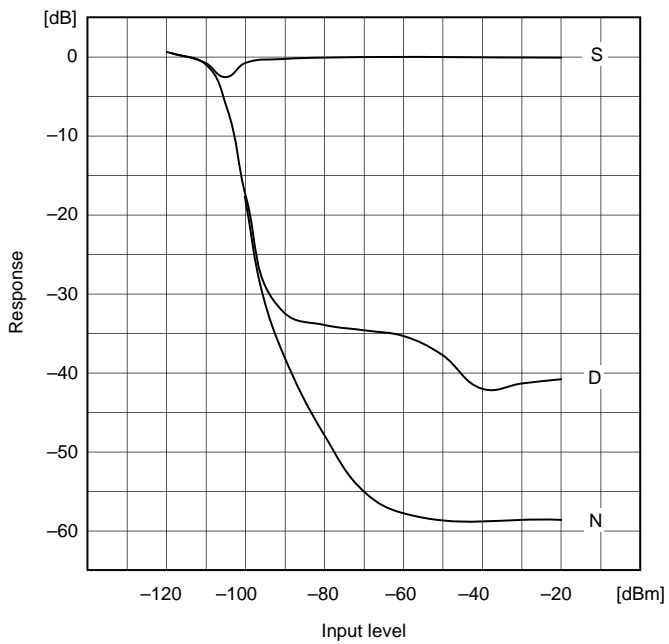**Example of Representative Characteristics**

The following characteristic curves are measured after IC adjustment. If the IC is not properly adjusted, the resulting characteristics are not close to the representative characteristics presented below. When making measurements, observe precautions 7, 8, and 9 under "Notes on Operation".
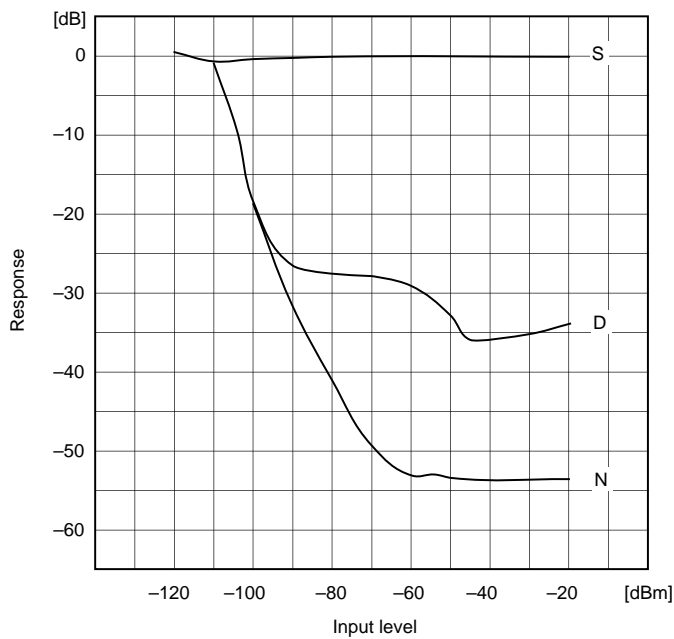
Sensitivity of adjust R vs fo



Pass Band Shift by the BPF•fo adjustment

[dB]

40 — TACS

NTACS

30

20

Response

10

0

−120    −100    −80    −60    −40    −20    [dBm]

Input level

CXA1741•SINAD
TACS
 f=45MHz, FM Modulation
 Dev. 5.7kHz
 Audio 1kHz
 CCITT weighting
NTACS
 f=45MHz, FM Modulation
 Dev. 3kHz
 Audio 1kH
 CCITT weighting

Ta=25°C
Vcc=3.3V

[dB]

0 — S

−10

−20

Response

−30

−40 — D

−50

−60 — N

−120    −100    −80    −60    −40    −20    [dBm]

Input level

CXA1741•TACS
CCITT weighting
 f=45MHz
 FM Modulation
 Dev. 5.7kHz
 Audio 1kHz

Ta=25°C
Vcc=3.3V

[dB]

0 — S

−10

−20

Response

−30 — D

−40

−50

−60 — N

−120    −100    −80    −60    −40    −20    [dBm]

Input level

CXA1741•NTACS
CCITT weighting
 f=45MHz
 FM Modulation
 Dev. 3kHz
 Audio 1kHz

Ta=25°C
Vcc=3.3V

—18—

Selectivity characteristics

D/U [dB]

Vcc=2.7V
Ta=25°C
20dB SINAD=−96dBm

NTACS
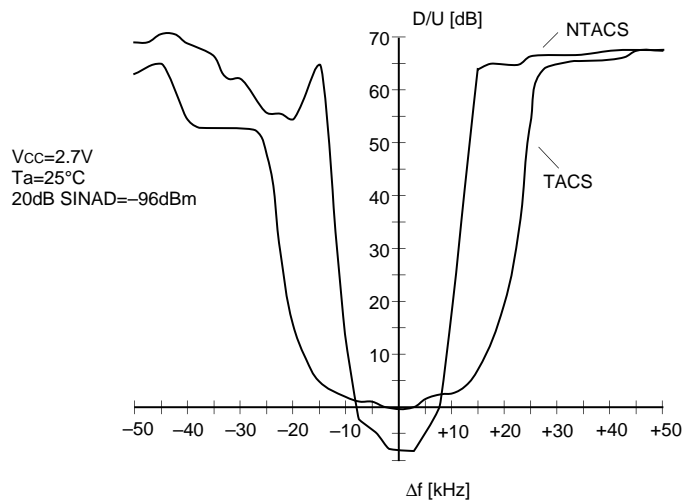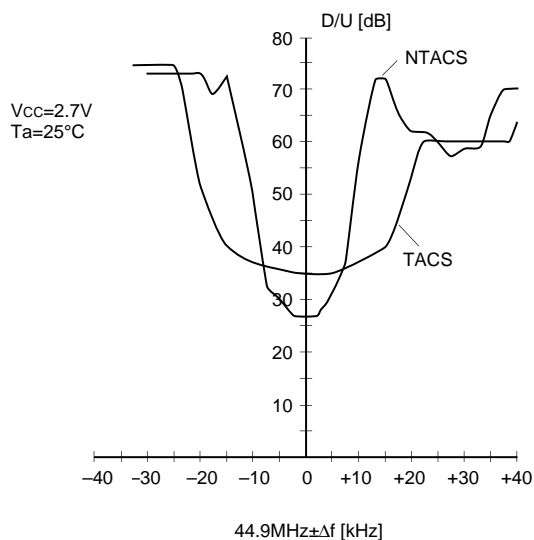
TACS

70
60
50
40
30
20
10

−50  −40  −30  −20  −10      +10  +20  +30  +40  +50

Δf [kHz]

Image rejection characteristics

D/U [dB]

Vcc=2.7V
Ta=25°C

NTACS

TACS

80
70
60
50
40
30
20
10

−40  −30  −20  −10    0   +10  +20  +30  +40

44.9MHz±Δf [kHz]

Detuning characteristics

Distortion [%]

TACS
  Deviation 5.7kHz
  Audio 1kHz
  CCITT weighting
NTACS
  Deviation 3kHz
  Audio 1kHz
CCITT weighting

Vcc=2.7V
Ta=25°C

NTACS

TACS

14
12
10
8
6
4
2

−10  −8  −6  −4  −2   0  +2  +4  +6  +8  +10

45MHz±Δf [kHz]

—19—

## RSSI characteristics-1

[V]

TACS
Vcc=2.7V

70°C
25°C
−30°C

RSSI output voltage

3.0

2.5

2.0

1.5

1.0

0.5

0

−100        −50        0
dBm

Signal input from Pin 22 (IF IN)
Voltage measurement at Pin 7

IF input voltage

## RSSI characteristics-2

[V]

NTACS
Vcc=2.7V

70°C
25°C
−30°C

RSSI output voltage

3.0

2.5

2.0

1.5

1.0

0.5

0

−100        −50        0
dBm

IF input voltage
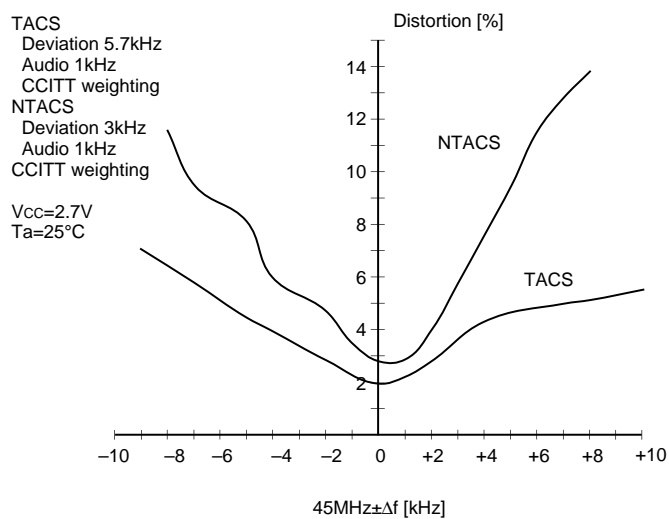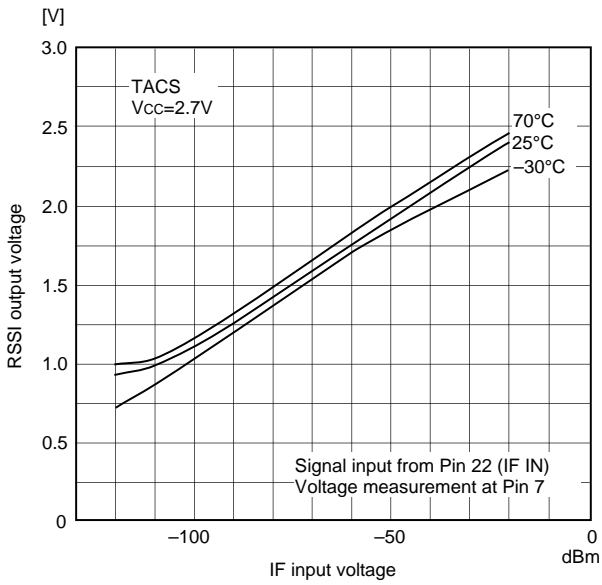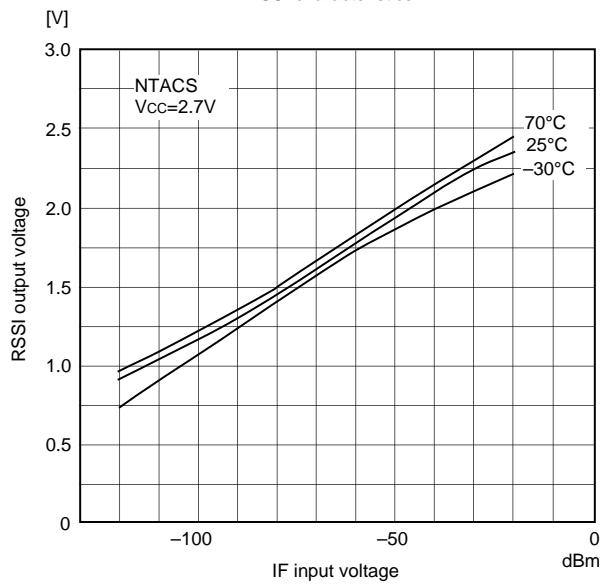
## Modulation characteristics

Distortion [dB]

−20

IFIN to Audio OUT
f=4.5Mhz, −40dBm
Audio=1kHz
CCITT weighting
Vcc=3.3V
Ta=25°C

NTACS

TACS

−30

−40

−50

2        4        6        8        10

Deviation [kHz]

## I/O characteristics

BPF output [dBV]

0

IFIN to BPF OUT
$F_0$=45MHz
$F_1$=45.02MHz
$F_2$=45.04MHz
Ta=25°C
Vcc=3.3V

−20

−40

IM3

−60

−80

−100  −90  −80  −70  −60  −50  −40  −30  −20  −10  0

IF input [dB]
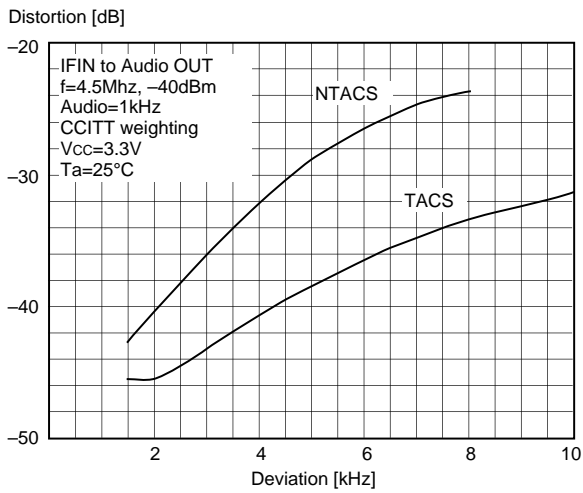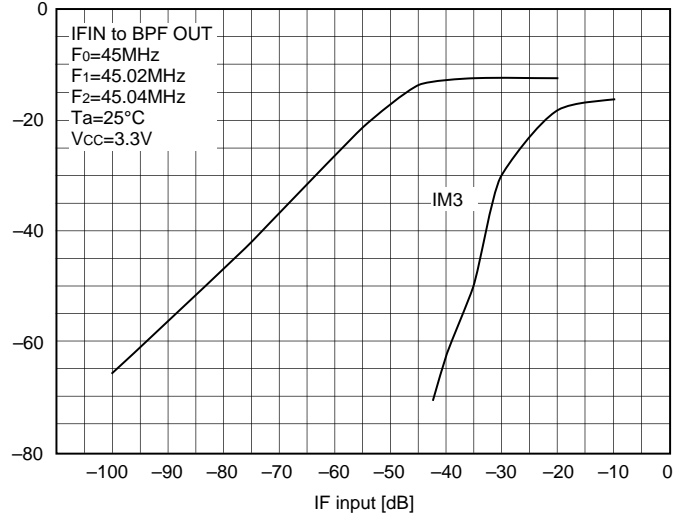
## Audio frequency response

Response [dB]

+2

0

0dB normalized at 1kHz
TACS deviation 5.7kHz
NTACS deviation 3kHz
IFIN 45MHz, −40dBm
Ta=25°C, Vcc=3.3V

NTACS

TACS

−2

−4

−6

−8

−10

−12

−14

10        100        1k        10k        100k

Frequency [Hz]
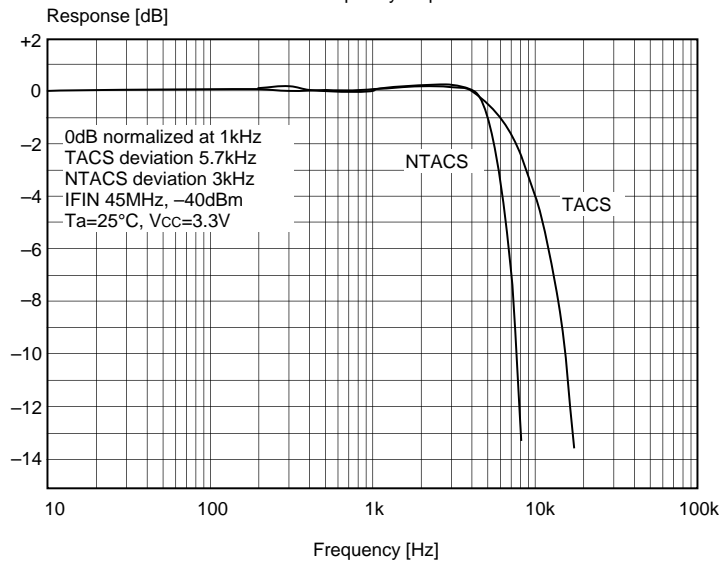
**Package Outline**   Unit : mm

40PIN QFP (PLASTIC)

□ 9.0 ± 0.4

□ 7.0 $^{+ 0.4}_{- 0.1}$

30        21

31        20

40        11

1        10

0.65        0.3 $^{+ 0.15}_{- 0.1}$

⊕ | ± 0.12 Ⓜ

1.5 $^{+ 0.35}_{- 0.15}$

0.127 $^{+ 0.1}_{- 0.05}$

△ | 0.1

A

0.1 $^{+ 0.15}_{- 0.1}$

(8.0)

0.5 ± 0.2

DETAIL **A**

| SONY CODE | QFP-40P-L01 |
|-----------|-------------|
| EIAJ CODE | ∗QFP040-P-0707 |
| JEDEC CODE | ———— |
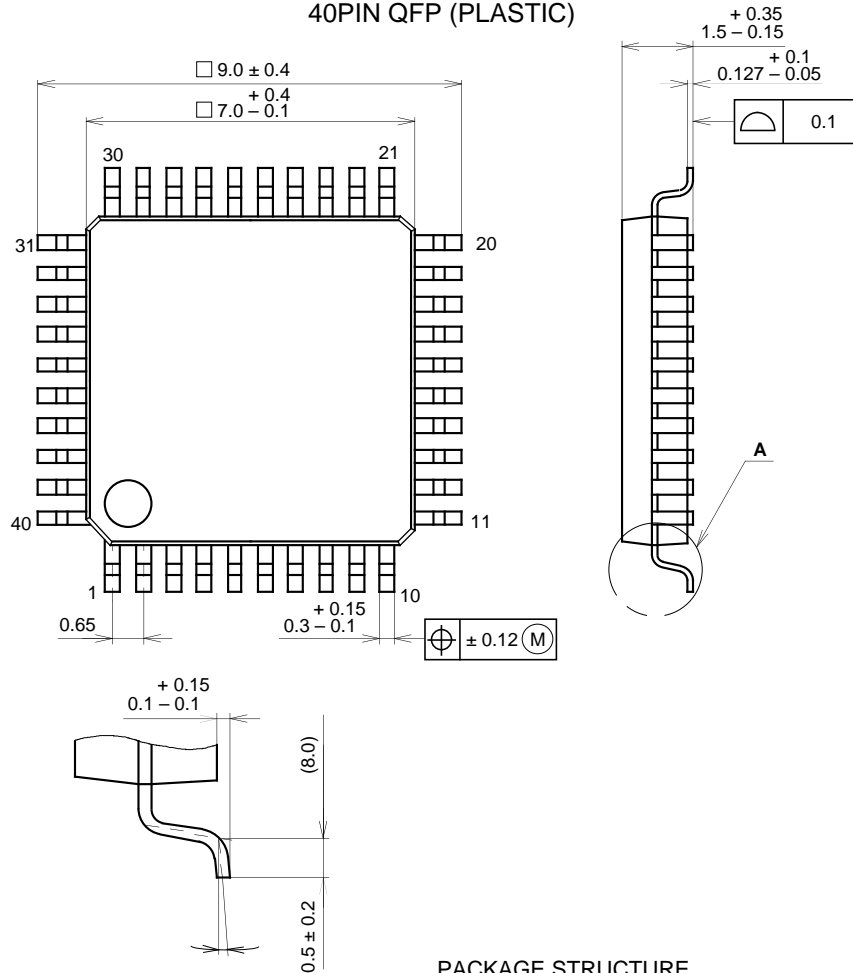
PACKAGE STRUCTURE

| PACKAGE MATERIAL | EPOXY RESIN |
|------------------|-------------|
| LEAD TREATMENT | SOLDER / PALLADIUM PLATING |
| LEAD MATERIAL | COPPER / 42 ALLOY |
| PACKAGE WEIGHT | 0.2g |