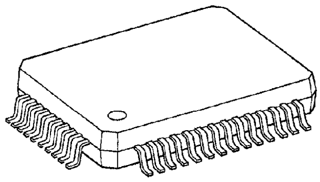
TOSHIBA Bi-CMOS INTEGRATED CIRCUIT SILICON MONOLITHIC

TB31224F

RF 1CHIP IC FOR 46 / 49MHz CORDLESS TELEPHONE

One packaging three systems PLL, IF detector, Compander.
It is possible to reduce many external parts. This IC is suitable for cordless telephone base set, hand set radio section.



QFP48-P-1014-0.80

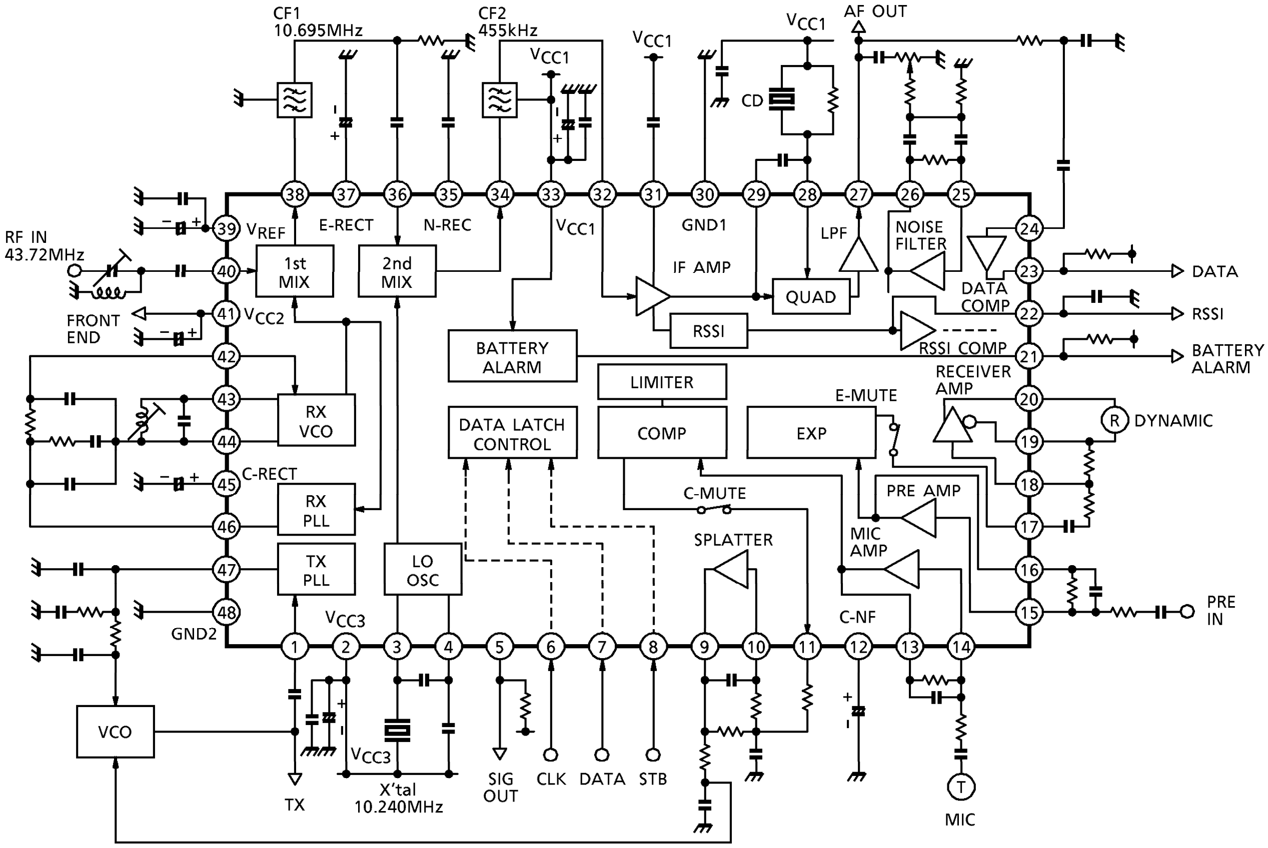
Weight : 0.83g (Typ.)

FEATURES

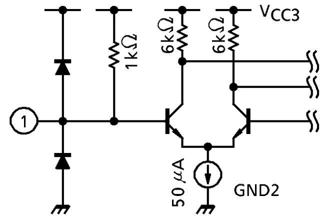
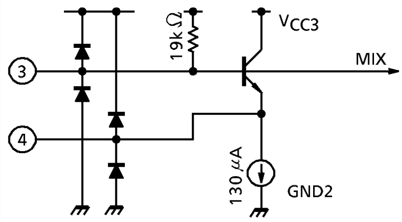
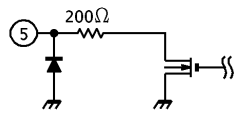
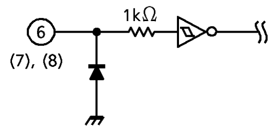
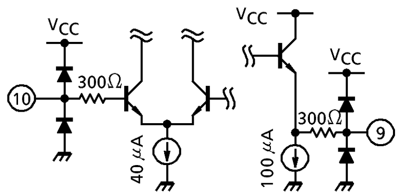
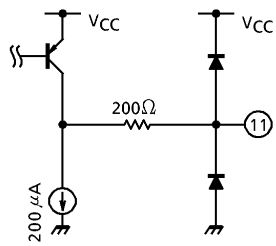
- Low operating voltage $V_{CC} = 2.0 \sim 6.0V$
- PLL operating frequency~60MHz
- Serial control for all status
- Built-in 1st Mixer : Operating frequency~60MHz
- Built-in RECEIVER AMP
- Battery-Saving function for intermittent receiving
- Variable BATTERY ALARM (5 threshold setting)
- Extremely low consumption current
  - $I_{CC} = 50\mu A$ (Typ.) at battery-saving
  - $I_{CC} = 7.5mA$ (Typ.) at stand-by
  - $I_{CC} = 12.5mA$ (Typ.) communication
- Regulator for RX front end : 2.0V
- High speed and stable CH search system by combination of NOISE DETECTION and RSSI
- Small Package
  - QFP 48Pin (0.8mm pitch)

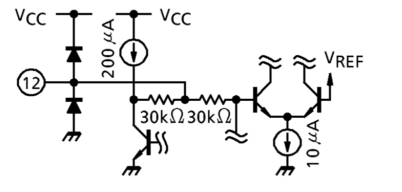
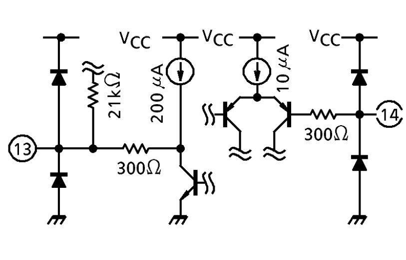
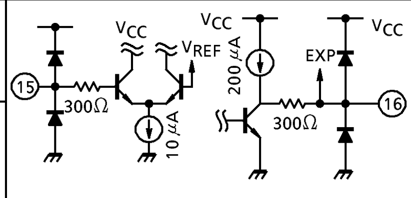
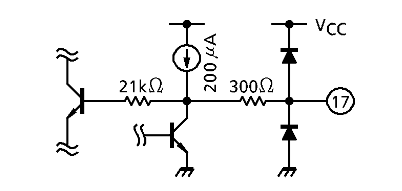
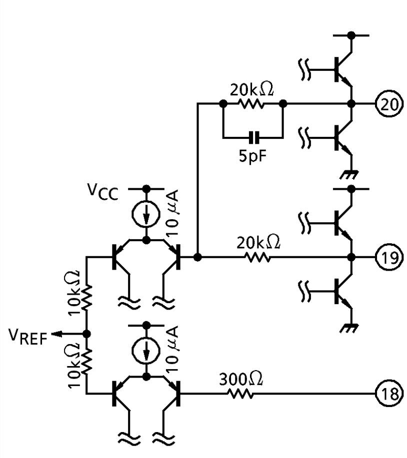
Handle with care to prevent devices from deterioration by static electricity.

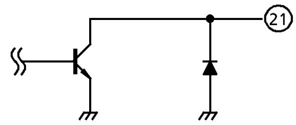
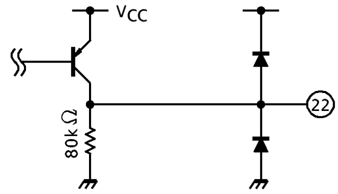
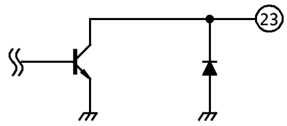
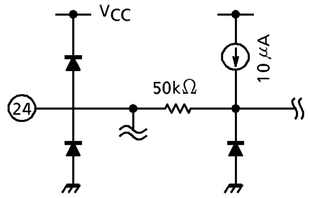
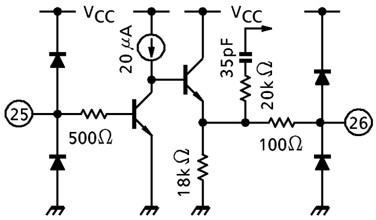
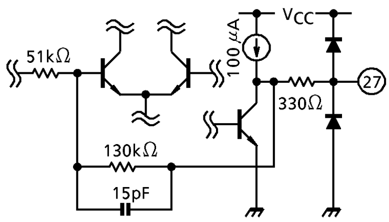
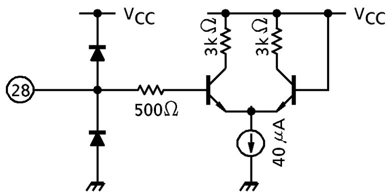
BLOCK DIAGRAM

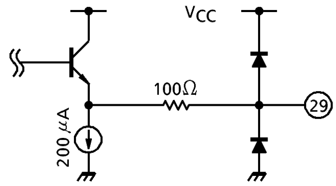
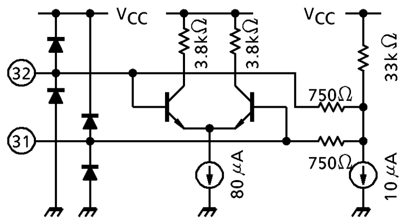
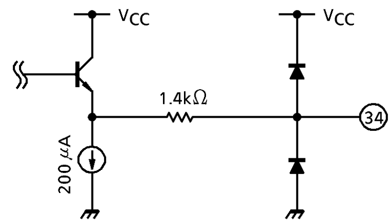
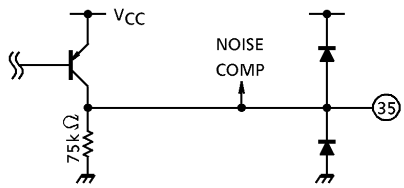
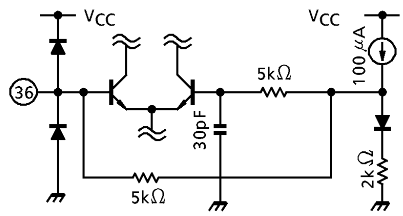


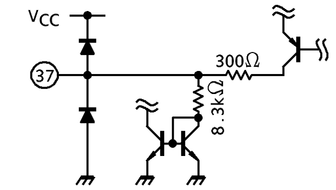
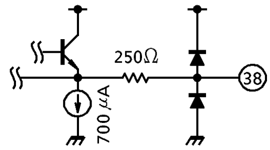
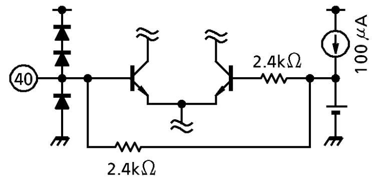
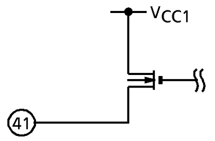
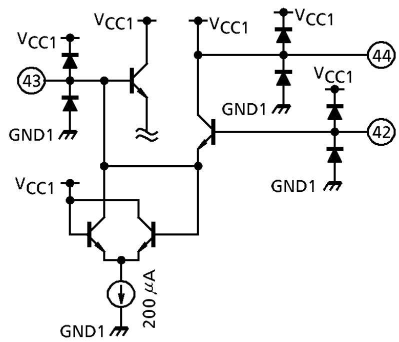
PIN FUNCTION (The values of resistor and capacitor are typical.)

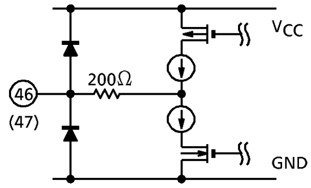
PIN No.	PIN NAME	FUNCTION		INTERNAL EQUIVALENT CIRCUIT
1	TX-IN	Input terminal of TX-VCO oscillation signal.		
2	V_{CC3}	Power supply terminal.		—
3	LO-1	LOCAL OSCILLATOR input and output terminals. Colpitts oscillator is formed by internal emitter follower and external X'tal. And external injection is possible from pin 3.		
4	LO-2			
5	SIG OUT	Output terminal of detection signal. It is the open drain output.		
6	CLK	Input terminal of clock.	Input the serial data for controlling IC.	
7	DATA	Input terminal of serial data.		
8	STB	Input terminal of strobe signal.		
9	FIL-OUT	Output of FILTER AMP.		
10	FIL-IN	Input of FILTER AMP.		
11	COMP-OUT	Output of COMPRESSOR.		

PIN No.	PIN NAME	FUNCTION	INTERNAL EQUIVALENT CIRCUIT
12	C-NF	Feedback circuit of T type is formed by external capacitor with SUM AMP.	
13	MIC-OUT	Output of MIC AMP and connected directly to input of SUM AMP.	
14	MIC-IN	Input terminal of MIC AMP.	
15	PRE-IN	Inverted input of PRE AMP.	
16	PRE-OUT	Output of PRE AMP. Connected directly to EXPANDER.	
17	EXP-OUT	Output of SUM AMP at EXPANDER. The signal from gain cell is gained by inverted amp.	
18	RECE-IN	Inverted input of RECEIVER AMP.	
19	RO1	Receiving output for a dynamic receiver. Used for BTL output type, RO1 terminal and RO2 terminal.	
20	RO2		

PIN No.	PIN NAME	FUNCTION	INTERNAL EQUIVALENT CIRCUIT
21	BAT-ALM	BATTERY ALARM terminals. When V_{CC} decrease V_{BAT-L}, This terminal outputs "H" level. Detection voltage is controled by data bit. This terminal is open collector output.	
22	RSSI	This terminal outputs DC level according to input signal level to IF AMP. Dynamic range is around 70dB.	
23	DATA-OUT	Output terminal for wave form shaping. This terminal is open collector output.	
24	D-COMP-IN	DATA COMPARATOR input terminal. This terminal input demodulation signal of DATA.	
25	N FIL-IN	NOISE FILTER input and output terminals. BPF is composed of external capacitors and resistors. Connected internally to rectifier circuit by coupling capacitor.	
26	N FIL-OUT		
27	AF-OUT	Demodulated signal output terminal. Carrier leak is small as LPF is built-in. Output impedance is around 360Ω.	
28	QUAD	Phase shift signal input terminal of FM demodulator.	

PIN No.	PIN NAME	FUNCTION	INTERNAL EQUIVALENT CIRCUIT
29	IF-OUT	Output terminal of IF AMP.	
30	GND1	GND terminal.	—
31	DEC	2nd IF input and decoupling for bias. Input impedance is around 1.5kΩ.	
32	IF-IN		
33	$V_{CC}1$	Power supply terminal.	—
34	2nd MIX-OUT	MIX output terminal. Output impedance is around 1.5kΩ.	
35	N-REC	After output of NOISE FILTER amplified around 20dB, noise signal is rectified by external capacitor.	
36	2nd MIX-IN	1st IF signal input terminal. Input impedance is around 4.7kΩ at 10.695MHz.	

PIN No.	PIN NAME	FUNCTION	INTERNAL EQUIVALENT CIRCUIT
37	E-RECT	Connected capacitor for full-wave rectifier circuit of EXPANDER.	
38	1st MIX-OUT	MIX output terminal. Externally connects filters. Output impedance is 330Ω (Typ.)	
39	V_{REF}	Reference terminal through internal buffer of compander block.	—
40	1st MIX-IN	MIX input terminal. Double-balance MIX.	
41	V_{CC2}	Regulator terminal. Output voltage is 2.0V.	
42	VCO-CONT	Voltage control terminal of RX-VCO.	
43	VCO-1	They are resonance terminals of RX-VCO.	
44	VCO-2		
45	C-RECT	Terminal for rectifier of COMPRESSOR. Almost the same circuit as E-RECT terminal.	—

PIN No.	PIN NAME	FUNCTION	INTERNAL EQUIVALENT CIRCUIT
46	RX-OUT	Output terminal of CHARGE PUMP. CHARGE PUMP is constant current output circuit, and output current is varied by input serial data.	
47	TX-OUT		
48	GND2	GND terminal.	—

1. General description

TB31224F is controlled by serial parts pin 6, 7, 8, and makes all situations by these serial bits for RF part in 46 / 49MHz cordless telephone such as intermittent receiving state.
Not only 46 / 49MHz cordless telephone but CT0 cordless phone that has frequency spec. between about 20MHz and 60MHz can be also set up TB31224F.

POWER SUPPLY BLOCK ASSIGN

V_{CC1}	GND1	1st MIX, 2nd MIX, IF AMP, QUAD, NOISE DET, RX-VCO, V_{CC2}, DATA COMP, COMPANDER, RECEIVER AMP, SPLATTER
V_{CC3}	GND2	RX-PLL, TX-PLL, LO OSC, DATA LATCH CONTROL

Fig.1 shows power supply connections for each terminal, V_{CC1}, V_{CC3} is directly connected to battery.
In case of base set battery might be replaced with 5V regulator.
V_{CC1} and V_{CC3} are not joined internally.

(Note) Bypass capacitors at V_{CC1}, V_{CC2}, V_{CC3} should be layoutted very close to each terminal and enough appropriate capacitance value and kind of capacitor for frequency should be applied.

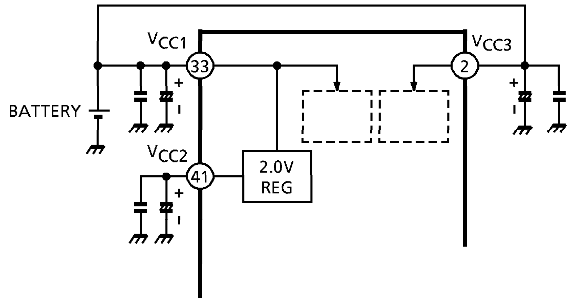


Fig.1

2. PLL

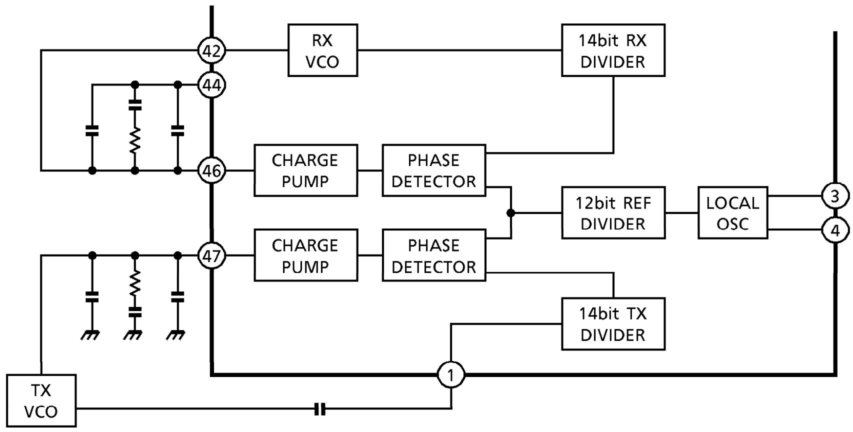


Fig.2

PLL counting number in RX DIVIDER, TX DIVIDER and REF DIVIDER are all programmable by serial data control.
CHARGE PUMP doesn't have voltage output but current output, therefore loop gain can show good linearity and external resister can be reduced. (Fig.3)

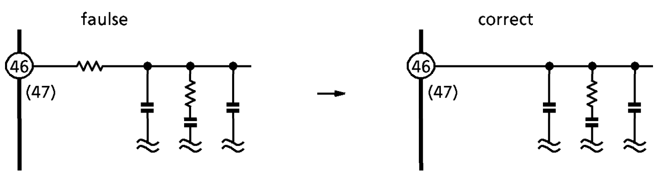


Fig.3

3. Data latch control

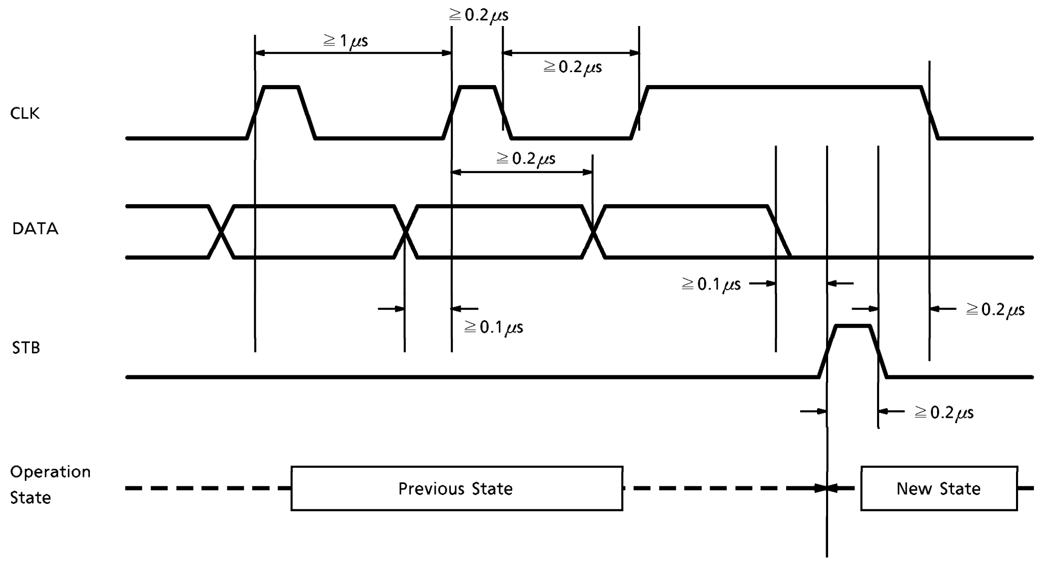
This block has 4 registers assigned by 2 bits CODE. DATA is read on the time of up edge of CLK. When STB receives high signal, DATA in shift register is sent into LATCH to control block which CODE indicates and the operation starts.

CODE ASSIGN

CODE		CONTROL BLOCK	FUNCTION
1	0	14bit TX DIVIDER	Setting Frequency for TX-VCO
0	1	14bit RX DIVIDER	Setting Frequency for RX-VCO
1	1	12bit REF DIVIDER	Setting Phase Comparate Frequency
0	0	14bit OPTIONAL CONTROL	Battery Save or MUTE Control etc.

INPUT TIMING FOR SERIAL DATA

When both CLK "H" and DATA "L", STB "H" leads data active.



4. Serial data format

(1) TX DIVIDER、RX DIVIDER

Dividing number range is 5 to 16383.

DON' T CARE					14bit N COUNTER														CODE	
					N0	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12	N13		

← 1st

1 0 ··· TX DIVIDER
0 1 ··· RX DIVIDER

Dividing number

$$N = N0 + N1 \times 2 \times N2 \times 2^2 + N3 \times 2^3 + \cdots + N12 \times 2^{12} + N13 \times 2^{13}$$

(2) REF DIVIDER

Dividing number range is 5 to 4095.
And this register includes TEST bits which must be set 0 in customer side.

DON' T CARE				TEST		12bit R COUNTER												CODE	
				0	BC	R0	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	1	1

← 1st ↑ STB

$$R = R0 + R1 \times 2 \times R2 \times 2^2 + R3 \times 2^3 + \cdots + R11 \times 2^{11}$$

BC bit is BATTERY ALARM detection setting.

◎ Example of divider setting

When LOCAL OSC frequency is 10.240MHz, how to make RX-VCO oscillate some frequencies from 35.915MHz by 20kHz or 25kHz step.

① Reference frequency at PHASE DETECTOR should be set 5kHz

10.240MHz ÷ 5kHz = 2048 ∴ R = 2048

② Calculate dividing number N for RX DIVIDER

35.915MHz ÷ 5kHz = 7183 ∴ N (CH16) = 7183
35.935MHz ÷ 5kHz = 7187 ∴ N (CH17) = 7187

⋮ ⋮ ⋮

③ Finally you get the following registers.

RX DIVIDER for N = 7183

N														CODE	
1	1	1	1	0	0	0	0	0	0	1	1	1	0	0	1

← 1st ↑ STB

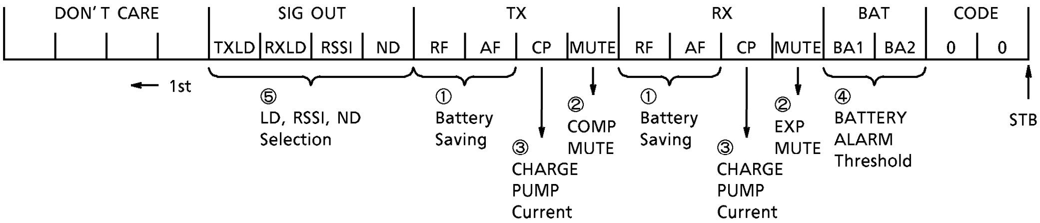
REF DIVIDER for R = 2048

TEST	BC	R												CODE	
0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1

← 1st ↑ STB

(3) CONTROL

This register indicates battery saving controls for some blocks or MUTE controls for compander block or changing threshold level for BATTERY ALARM.



① Battery saving control

0 ····· Operation 1 ····· Battery saving

BIT	CONTROL BLOCK
TX-RF	TX-PLL
TX-AF	MIC AMP, COMPRESSOR, SPLATTER
RX-RF	RX-VCO, RX-PLL, 1st MIX, 2nd MIX, V_{CC2}, IF AMP, NOISE DET, DATA COMP, RSSI
RX-AF	PRE AMP, EXPANDER, RECEIVER AMP

LOCAL OSC = OFF at TX-RF = 1 and RX-RF = 1

② MUTE control

0 ····· normal 1 ····· MUTE

TX-MUT controls MUTE for COMPRESSOR output (pin 11).
RX-MUT controls MUTE for EXPANDER output (pin 17).
These bits don't let compander block go battery saving mode, therefore current consumption doesn't decrease.

③ CHARGE PUMP current control

You can change PLL loop performance such as lock up time by these control bits.

BIT	CONTROL OUTPUT	0	1
TX-CP	TX-PLL CHARGE PUMP Output Current	200 μA	400 μA
RX-CP	RX-PLL CHARGE PUMP Output Current	200 μA	400 μA

④ BATTERY ALARM detection setting

This IC has 5 threshold levels for detection of battery dropping. These threshold levels are given by below table.

BC (*1)	BA1	BA2	V_{BAT-L}
1	1	0	2.25V
0	0	0	3.00V
0	0	1	3.25 V
0	1	0	3.30V
0	1	1	3.45 V
1	0	0	Battery (*2) Saving
1	1	1	

(*1) BC bit in REF DIVIDER.
(*2) Only for BATTERY ALARM block.

⑤ SIG OUT selection

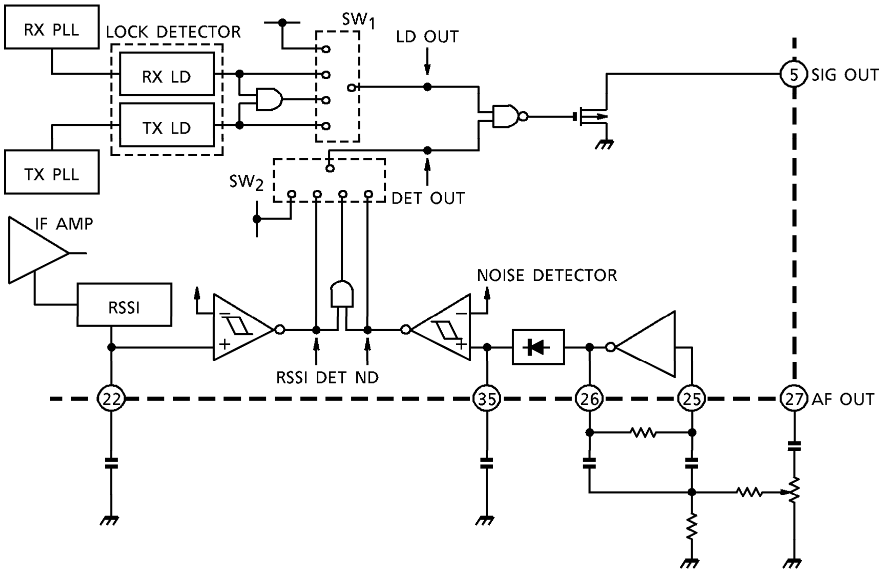


Fig.4

SIG OUT terminal (Pin 5) generates combination states of RX and TX LOCK DETECTOR, RSSI and NOISE DETECTOR as shown in Fig.4.
SW_1 and SW_2 in Fig.4 are indicated by SIG OUT selection bits in CONTROL register according to below Fig.5.

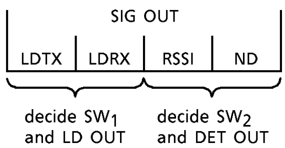


Fig.5 SIG OUT bits

EX.TX-LOCK DETECTOR Operation.

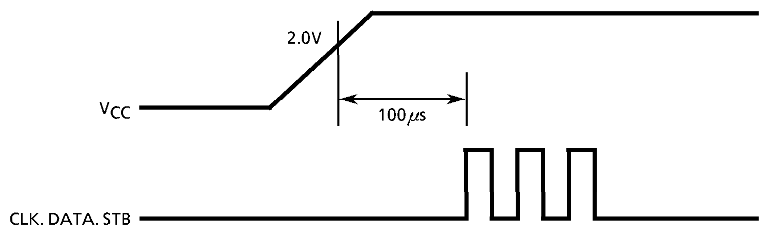
LDTX	LDRX	RSSI	ND
1	0	0	0

5. Default function

- POWER ON DATA SETTING

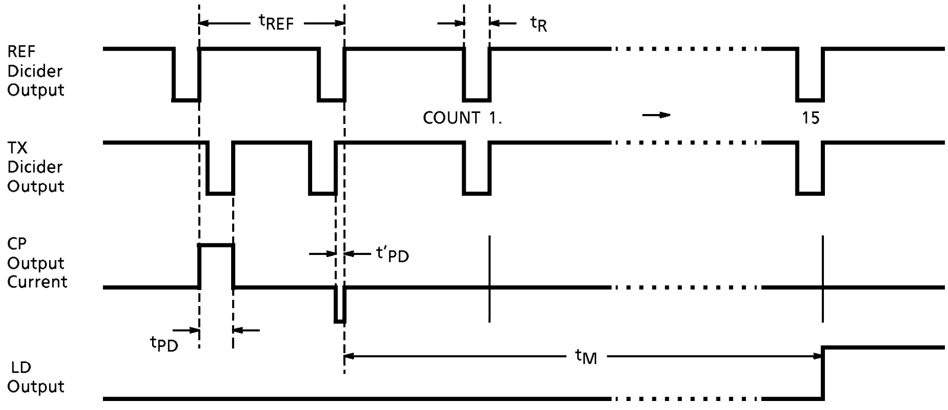
	14 bit														CODE		SETTING
REF	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	f = 10.240MHz
TX	1	1	1	0	1	1	1	1	0	1	1	0	0	1	1	0	f = 49.875MHz
RX	1	1	1	0	0	1	0	0	0	0	1	1	1	0	0	1	f = 36.035MHz
CONT	0	1	0	0	1	1	1	1	0	1	1	1	1	0	0	0	Stand by mode

- TIMING CHART



6. LOCK DETECTOR function

When difference of phase in to PHASE DETECTOR goes with in 2 / 10.24MHz = 195ns and state continues more than 15 / 5kHz = 3ms, LOCK DETECTOR output (refer to Fig.5) changes to H state from L state.



$t_{REF} = \frac{R}{f_{LO}} = \frac{1}{f_{REF}} = \frac{1}{5kHz} = 0.2ms$

$t_R = \frac{2}{f_{LO}} = 195ns$, $t_M = 3ms$ at $f_{LO} = 10.24MHz$

$t'_{PD} < t_R = 195ns$

(Note) When STB input goes H state in TX DIVIDER mode (code1, 0), LOCK DETECTOR always outputs L level.
Therefore you should care that you might take as unlock state in correctly. If the same number in TX DIVIDER would be inputted.

7. NOISE DETECTOR

(1) NOISE FILTER AMP

NOISE FILTER AMP can construct band pass filter as Fig.6 Center frequency f_0 in BPF should be set around 30kHz because of pre stage LPF and post stage HPF.

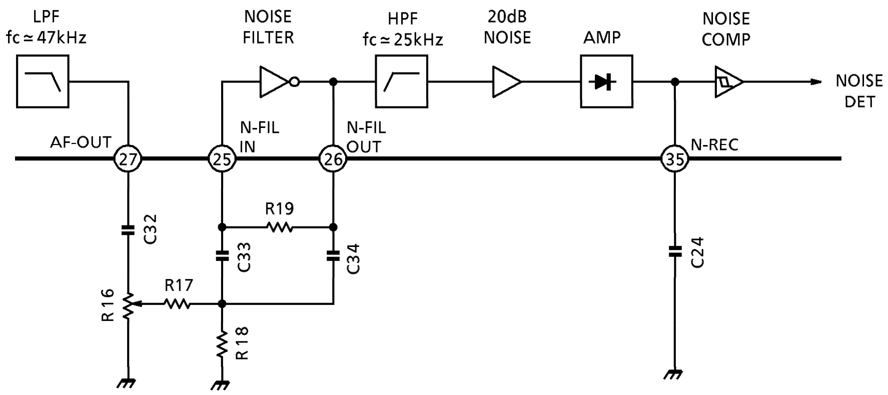


Fig.6

BPF FORMULA

$$f_0 = \frac{1}{2\pi\sqrt{R19\,(R17/\!/R18)\ C^2}} \quad \cdots\cdots (1)$$

$$G_V = R19 / 2\ R17 \quad \cdots\cdots (2)$$

$$Q^2 = \frac{R19}{4\,(R17/\!/R18)} \quad \cdots\cdots (3)$$

at C33 = C34 = C, R17 $\gg$ R16

SETTING EXAMPLE

R16 = 20kΩ (VR), R17 = 330kΩ

R18 = 3.3kΩ, R19 = 150kΩ

C = 220pF

(1), (2), (3) provide below

$f_0 \simeq 31$kHz, $G_V \simeq -13$dB

$Q^2 \simeq 12$

(Note) Please separate lines of pin 25 and pin 27 as far as possible in desiring layout. NOISE DETECTOR in this IC is so high sensitive that it might be easy to detect incorrectly by layout.

(2) NOISE COMPARATOR

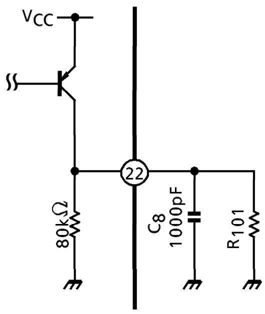
When the direct voltage at pin 35 drops under 0.4V, NOISE COMP outputs L level at point ND in Fig.4. NOISE COMP has around 100mV hysterisis at pin 35.
Rising time in NOISE DETECTOR is in direct proportion to time constant 7.5ms of C24 = 0.1μF and internal 75kΩ. Decreasing the value of C24 makes the response faster but might increase misdetection by vibration at pin 35.

8. RSSI

(1) RSSI function

A DC voltage corresponding to the input level of IF input pins (pin 32) is output to the RSSI (Pin22). While the linear range is about 70dB when $V_{CC} = 3.6V$, the range can be expanded to 80dB as in Fig.7.

However, in such a case, note that the temperature characteristics of the RSSI output may alter due to a disparity between the temperature coefficient of the external resistor and the internal resistance of the IC.



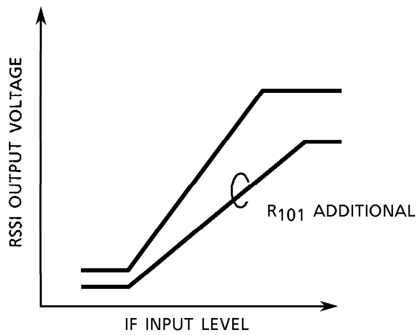


Fig.7

(2) RSSI COMPARATOR

The result of RSSI COMPARATOR is output by comparing output voltage of RSSI terminal with around 0.8V. Hysteresis range is about 65mV. When 0.8V < RSSI voltage, RSSI COMPARATOR is "L" level.

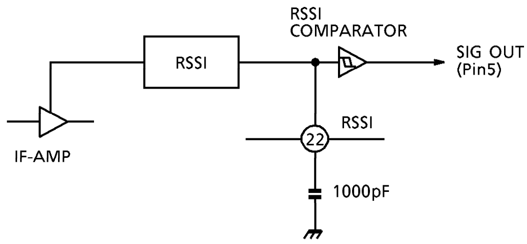


Fig.8

9. 1st MIX

Produces 1st IF signal (10.695MHz) by mixing RF signal with RX-VCO signal. Fig.9 shows input matching for 1st MIX IN (pin 40). Input matching gain is around 15dB.

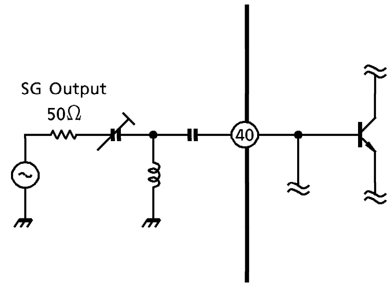
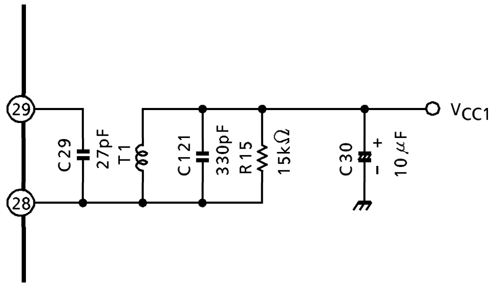


Fig.9

10. IF detector

1st IF is transformed to 2nd IF signal (455 or 450kHz) in 2nd MIX by mixing LOCAL OSC signal which also provides PLL reference frequency. Output impedance in 2nd MIX OUT (pin 34) is adjusted to that of standard ceramic filter, therefore you can reduce matching resister.
Operating frequency of 2nd MIX is restricted to around 30MHz because of preventing interference for other block. IF AMP has about 75dB gain. IF IN (pin 32) is also matched to ceramic filter impedance (1.8kΩ).
Quadrature detection with external discriminator demodulates audio signal from AF OUT (pin 27). Both ceramic and coil are useful as discriminator. We chose ceramic discriminator in main application diagram and measurement circuit but when you use coil, the connection in Fig.10 is recommended.



T1 : 4164-JPS-032
(SUMIDA ELECTRIC CO., LTD)

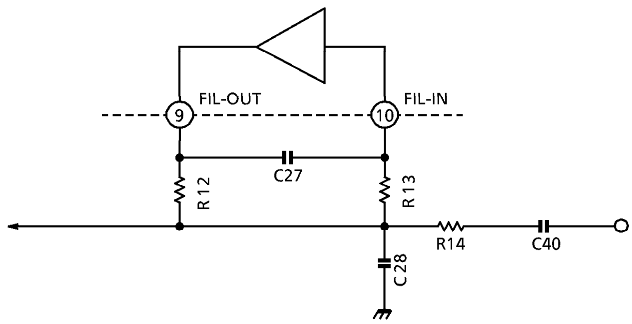
Fig.10

Damping resister R15 decides audio output level V_{OD}. You can boost V_{OD} by increasing the value of R15, but at that time temperature slope of V_{OD} level has increased. Center frequency f_0 and V_{OD} also depend on C29 and discriminator. Good temperature character should be required as C29. Especially in case of coil used. C121 is required good temperature character as well.

	DISCRIMINATER		
	Ceramic CDBM455C24	Coil at Fig.10	
V_{OD} level	$220mV_{rms}$	$190mV_{rms}$	(Typ.)

AF OUT (pin 27) includes 3 stage low pass filter with cut off frequency $f_C \simeq 47kHz$ to reduce output carrier leak which quadrature mixing produces.

11. SPLATTER FILTER AMP adjustment



(1) $f_0 = \dfrac{1}{2\pi\sqrt{C28 \cdot C27 \cdot R12 \cdot R14}}$

(2) $Q = \dfrac{1}{3}\sqrt{\dfrac{C28}{C27}}$

(3) $G_V = 20\log\dfrac{R12}{R14} = 0$

at R12 = R13 = R14

• EXAMPLE

R12 = R13 = R14 = 39kΩ, C27 = 430pF, C28 = 3900pF

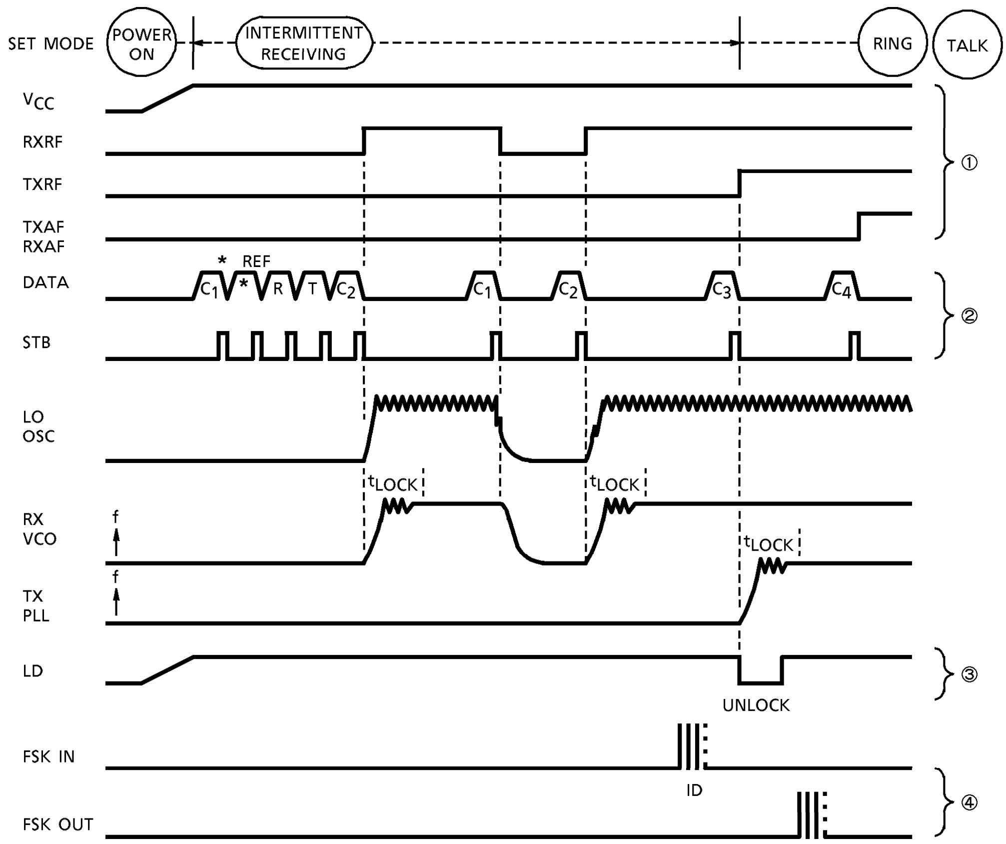
(1) $f_0 = 3.14kHz$

(2) $Q = 1.0$

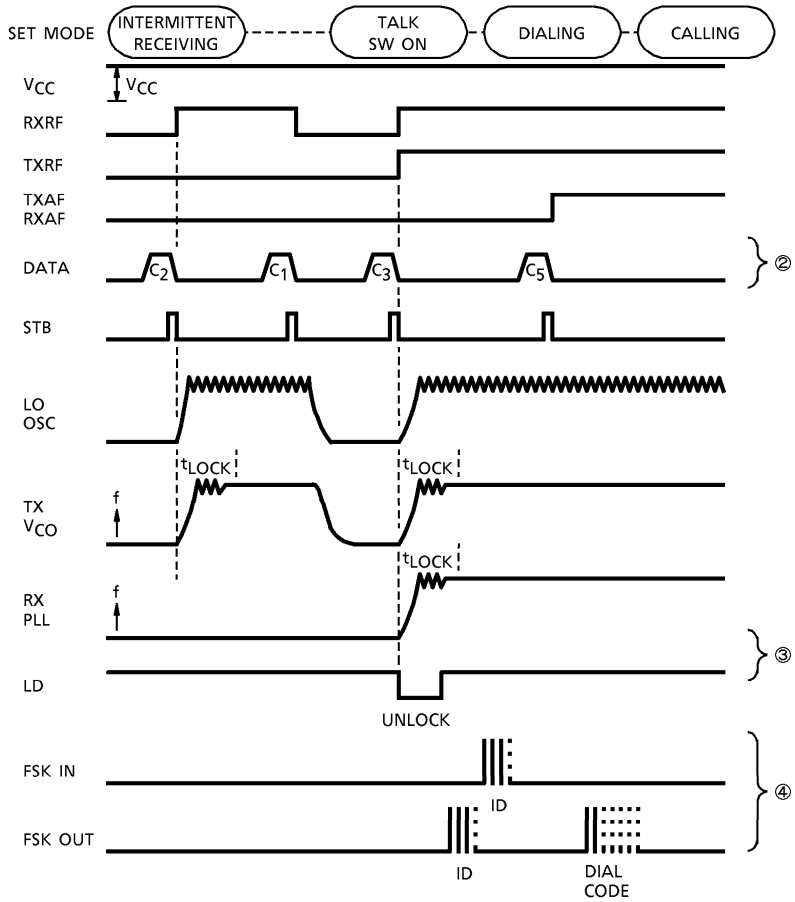
(3) $G_V = 0$

CONTROL TIMING CHART

Receiving



Transmitting



DESCRIPTION FOR CONTROL TIMING

① Stand for internal power supply motion controlled by each bit in CONTROL resister.

② Serial data input. CLK input is omitted in this chart.

REF : REF DIVIDER
R : RX PLL DIVIDER
T : TX PLL DIVIDER
C_1~C_5 : CONTROL

	SIG OUT				TX				RX				BAT		CODE	
C_1	0	0	0	0	1	1	1	1	1	1	1	1	*	*	0	0
C_2	0	0	0	0	1	1	1	1	0	1	1	1	*	*	0	0
C_3	0	0	0	0	0	1	1	1	0	1	1	1	*	*	0	0
C_4	0	0	0	0	0	0	1	0	0	0	1	0	*	*	0	0
C_5	0	0	0	0	0	1	1	1	0	0	1	0	*	*	0	0

Symble * means to be set by user according to battery.

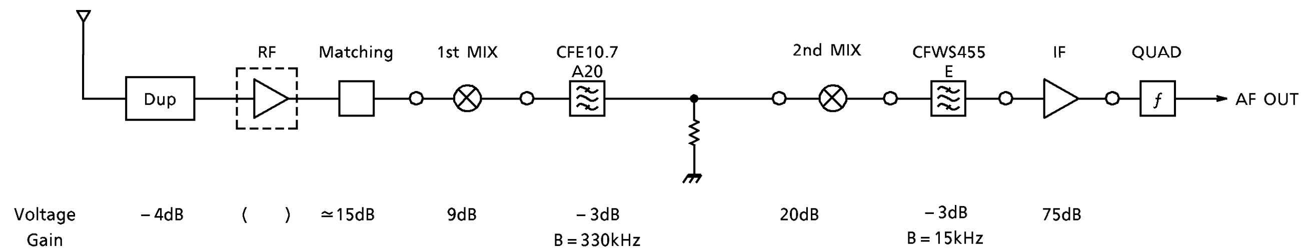
③ LD output

LOCK DETECTOR outputs L level when phase detector is unlock.

④ FSK IN, FSK OUT

FSK IN is not terminal in this IC, which is normally input to TX-VCO.
FSK OUT stands for output of DATA COMP.

GAIN DISTRIBUTION FOR RECEIVING



MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	6	V
Power Dissipation	P_D	890	mW
Operating Temperature	T_{opr}	−20~70	°C
Storage Temperature	T_{stg}	−55~150	°C

ELECTRICAL CHARACTERISTICS
TOTAL (Unless Otherwise Specified, V_{CC} = 3.6V, Ta = 25°C)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Power Supply Voltage		$V_{CC\,(opr.)}$	—	—	2.0	3.6	6.0	V
Consumption Current 1		I_{CC1}	1	ALL ON	7.5	12.5	19.5	mA
Consumption Current 2		I_{CC2}	1	RX-RF ON	5.8	7.5	12.3	mA
Consumption Current 3		I_{CC3}	1	RX-AF ON	2.0	2.5	4.7	mA
Consumption Current 4		I_{CC4}	1	TX-RF ON	0.8	1.7	3.5	mA
Consumption Current 5		I_{CC5}	1	TX-AF ON	1.0	2.0	3.1	mA
Alarm Supply Current		$I_{CC\,(A)}$	1	R_L = 100kΩ, $V_{BAT\text{-}L}$ = 3.30V MODE	—	200	300	μA
Supply Current At Battery Saving		$I_{CC\,(BS)}$	1	ALL OFF	—	50	100	μA
REF Voltage		V_{REF}	1	—	1.2	1.4	1.7	V
Data Input Threshold		V_{IH}	—	—	0.8 × V_{CC}	V_{CC}	6.0	V
		V_{IL}	—	—	−0.2	0	0.2 × V_{CC}	V
Data Input Current		I_{IH}	—	V_{IH} = V_{CC}	—	0	1	μA
		I_{IL}	—	V_{IL} = GND	—	0	1	μA
CK Input Frequency		f_{CK}	—	—	—	38	1000	kHz

REGULATOR SECTION

Output Voltage	V_{REG}	—	I_{OUT} = 1mA	1.75	2.0	2.30	V
Minimum Load Current	$I_{OUT\,(MIN)}$	1	V_{OUT} = $V_{REG\,(OPEN)}$ − 0.05V	1	3	—	mA

DETECTOR SECTION
(Unless Otherwise Specified, V_{CC} = 3.6V, Ta = 25°C)

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
BATTERY ALARM							
Detection Voltage 1	V_{BAT-L}	1	—	2.13	2.25	2.37	V
	V_{BAT-H}		—	—	2.32	2.44	V
Detection Voltage 2	V_{BAT-L}	1	—	2.85	3.00	3.15	V
	V_{BAT-H}		—	—	3.08	3.23	V
Detection Voltage 3	V_{BAT-L}	1	—	3.10	3.25	3.40	V
	V_{BAT-H}		—	—	3.35	3.50	V
Detection Voltage 4	V_{BAT-L}	1	—	3.15	3.30	3.45	V
	V_{BAT-H}		—	—	3.40	3.55	V
Detection Voltage 5	V_{BAT-L}	1	—	3.30	3.45	3.60	V
	V_{BAT-H}		—	—	3.55	3.70	V
Output Low Level Voltage	V_{OL}	1	I_{SINK} = 0.1mA	—	0.1	0.3	V
Output Leak Current	I_{LEAK}	1	V_{ALM} = 3.6V	—	0	5	μA
DATA COMPARATOR							
Minimum Detection Level	V_{TH}	—	f = 500Hz	—	—	50	mV_{rms}
Output Low Level Voltage	V_{OL}	1	I_{SINK} = 0.2mA	—	0.1	0.3	V
Output Leak Current	I_{LEAK}	1	V_{DATA} = 3.6V	—	0	5	μA
SIG OUT DETECTION							
Noise Detection Level	V_{TH-H}	1	—	—	0.5	0.7	V
	V_{TH-L}		—	0.3	0.4	—	V
Noise Detection Level Voltage	V_{OL}	1	I_{SINK} = 0.2mA	—	0.1	0.3	V
Output Leak Current	I_{LEAK}	1	V_{SIG} = 3.6V	—	0	5	μA
RSSI COMPARATOR Detection Voltage	V_{TH-L}	1	COMPARATOR OUTPUT L → H	0.59	0.74	—	V
	V_{TH-H}		COMPARATOR OUTPUT H → L	—	0.8	0.95	V
RSSI COMPARATOR Hysteresis	V_{HYS}	—	—	—	65	—	mV

PLL SECTION
(Unless Otherwise Specified V_{CC} = 3.6V, dBμV = dBμV EMF (OPEN), Ta = 25°C)

Operating Frequency	f_{IN}	1	—	20	43.72	60	MHz
TX-PLL Input Sensitivity	V_{IN}	1	—	93	103	113	dBμV
LOCAL OSCILLATOR Input Sensitivity	V_{LO}	1	f_{LO} = 10.240MHz	104	110	120	dBμV
CHARGE PUMP Output Current	I_{CP1}	—	V_{CP} = 1.8V	—	±200	—	μA
	I_{CP2}		V_{CP} = 1.8V	—	±400	—	μA
CHARGE PUMP Leak Current	I_{LEAK}	1	—	—	0	5	μA
LOCAL OSCILLATOR Operating Frequency	f_{LO}	1	V_{LO} = 112dBμV	9	10.24	12	MHz

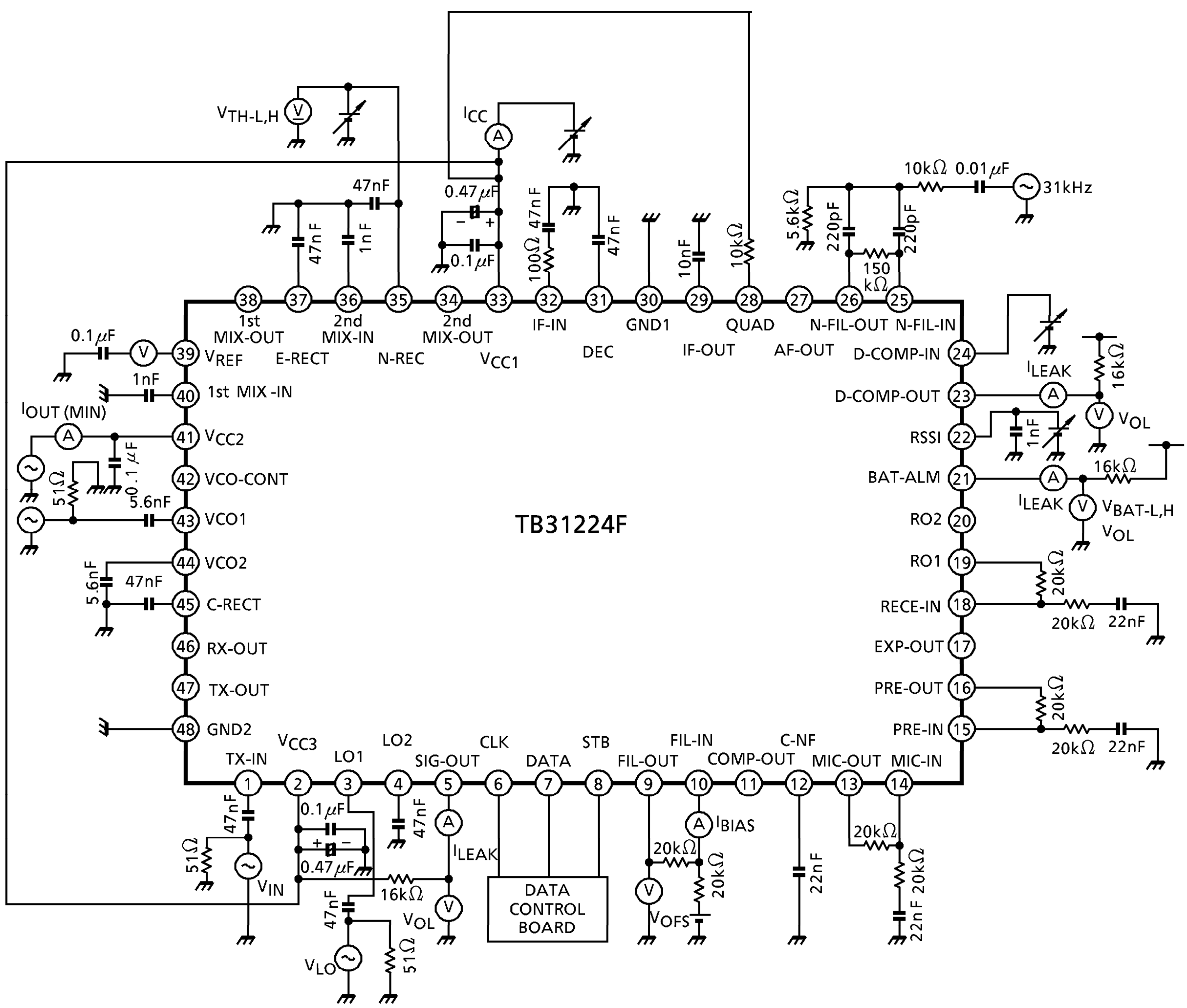
RX-VCO IF + MIX SECTION
(Unless Otherwise Specified, V_{CC} = 3.6V, f_{IN} (MIX1) = 43.72MHz, $f_{IN\ (IF)}$ = 455kHz, Δ f = 3.0kHz, f_m = 1kHz, dBμV = dBμV EMF (OPEN), Ta = 25°C)

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
RX-VCO							
Conversion Gain	K_V	—	—	—	2.2	—	MHz / V
RX-VCO Oscillation Level	V_{VCO}	—	f_{VCO} = 25~55MHz At VCO-1~GND	—	110	—	dBμV
1st AND 2nd MIXER, IF AMP							
12dBSINAD Sensitivity	12dBSINAD	—	Input 50Ω	—	20	—	dBμV
MIXER Operating Frequency	f_{MIX1}	—	1st MIXER	20	43.72	60	MHz
	f_{MIX2}		2nd MIXER	—	10.7	20	MHz
Conversion Gain	G_{VC}	2	Excluding Filter Loss	20	26	30	dB
Intercept Point	P_{IM1}	—	1st MIXER	—	107	—	dBμV
IF AMP Gain	G_{IF}	—	—	—	75	—	dB
Demodulated Output	V_{OD}	2	$V_{IN\ (MIX1)}$ = 70dBμV	170	220	270	mV_{rms}
S / N Ratio	S / N	2	$V_{IN\ (MIX1)}$ = 70dBμV	45	55	—	dB
AM Rejection Ratio	AMR	2	$V_{IN\ (MIX1)}$ = 70dBμV	—	40	—	dB
Input Inpedanse	R_{IN1}	—	1stMIX IN	—	2.2	—	kΩ
	C_{IN1}			—	3.0	—	pF
	R_{IN2}		2ndMIX IN	—	4.5	—	kΩ
	C_{IN2}			—	2.7	—	pF
Input Resistance	R_{IN}	—	IF IN	—	1.5	—	kΩ
Output Resistance	R_{01}	—	1stMIX OUT	—	330	—	Ω
	R_{02}		2ndMIX OUT	—	1.5	—	kΩ
RSSI Output Voltage	V_{RSSI1}	2	$V_{IN\ (MIX1)}$ = 20dBμV	0.60	0.85	1.10	V
	V_{RSSI2}		$V_{IN\ (MIX1)}$ = 60dBμV	1.75	2.20	2.65	V

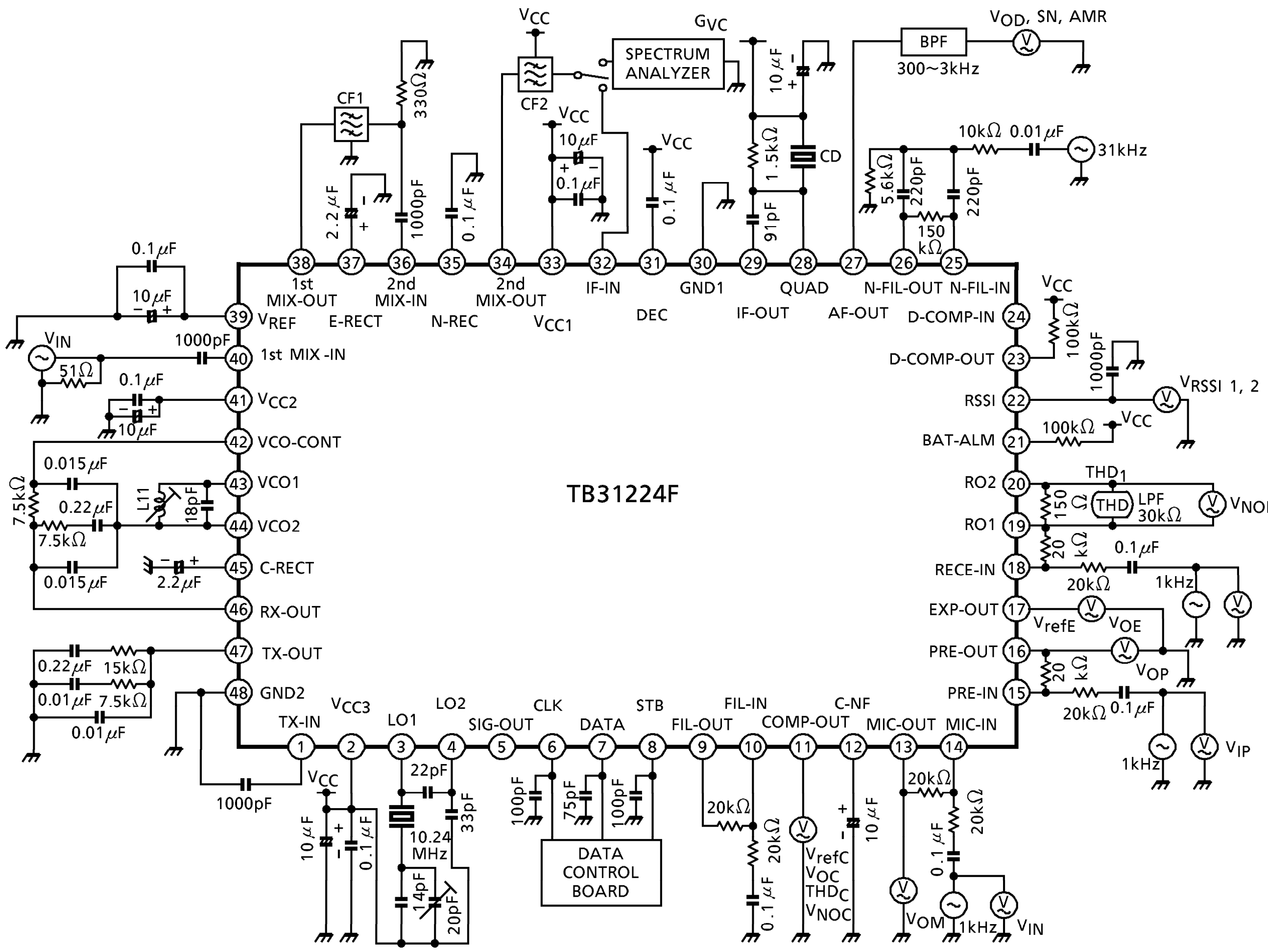
AUDIO SECTION
(Unless Otherwise Specified, $V_{CC}=3.6V$, $f_{IN}=1kHz$, Ta = 25°C)

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
COMPRESSOR + MIC AMP							
Input Reference Level	V_{refC}	2	$V_{OM}=-10dBV$	−12.5	−10.5	−8.5	dBV
Output Deviation	V_{OC}	2	$V_{OM}=-30dBV$	−0.7	0	0.7	dB
MIC AMP Voltage Gain	V_4	—	—	—	0	—	dB
Total Hormonic Distortion	THDC	2	$V_{OM}=-10dBV$	—	0.3	1	%
Output Noise Level	V_{NOC}	2	Input-GND Short	—	−61	−48	dBV
Limitting Level	V_{lim1}	—	COMP OUT, $V_{IM}=0dBV$	—	1.3	—	V_{p-p}
	V_{lim2}		MIC OUT, $V_{IM}=0dBV$	—	2.6	—	V_{p-p}
MUTE Output Level	V_{MUTE}	—	—	—	−96	—	dBV
MIC AMP Voltage Gain Setting Range	GR_4	—	—	0	20	30	dB
Crosstalk EC	CT_{EC}	—	$V_{IP}=0dBV$	—	−60	—	dB
Attack Time	T_{AC}	—	$V_{IM}=-46\rightarrow-34dBV$	—	3	—	ms
Recovery Time	T_{RC}	—	$V_{IM}=-34\rightarrow-46dBV$	—	12	—	ms
EXPANDER + PRE AMP + RECEIVER AMP							
Input Reference Level	V_{refE}	2	$V_{OP}=-10dBV$	−12.8	−10.0	−7.2	dBV
Output Deviation	V_{OE}	2	$V_{OP}=-35dBV$	−1.0	0.4	1.8	dB
PRE AMP Voltage Gain	G_{P3}	—	—	—	0	—	dB
RO1 Voltage Gain	G_{RO1}	—	$R_L=150\Omega$	—	6	—	dB
Total Hormonic Distortion	THD_1	2	$R_L=150\Omega$ $V_{RI}=-15dBV$	—	0.7	1.5	%
Output Noise Level	V_{NOR}	2	Input-GND Short	—	−100	−88	dBV
Maximum Output Level	DR_R	—	$R_L=150\Omega$, THD = 3%	—	3.0	—	V_{p-p}
MUTE Output Level	V_{MUTE}	—	—	—	−75	—	dBV
PRE AMP Voltage Gain Setting Range	G_{RNG2}	—	—	0	—	20	dB
RECEIVER AMP Voltage Gain Setting Range	G_{RNG1}	—	—	6	—	20	dB
Offset Voltage	T_{OF2}	1	RO1-RO2	−50	0	50	mV
Crosstalk CE	CT_{CE}	—	$V_{IM}=-20dBV$	—	−95	—	dB
Attack Time	T_{AE}	—	$V_{IP}=-18\rightarrow-12dBV$	—	15	—	ms
Recovery Time	T_{RE}	—	$V_{IP}=-12\rightarrow-18dBV$	—	13	—	ms
FILTER AMP							
Voltage Gain	G_5	—	—	—	0	—	dB
Maximum Output Level	DR_5	—	THD = 3%	—	3	—	V_{p-p}
Input Bias Current	I_{BIAS}	1	—	—	1.5	2.5	μA
Offset Voltage	V_{OF5}	1	—	−35	0	35	mV

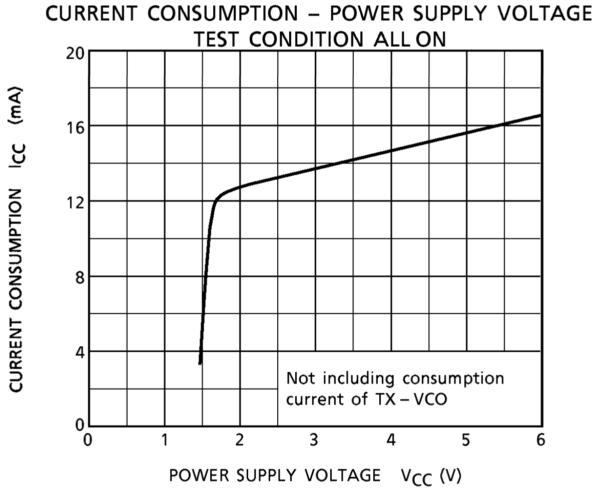
TEST CIRCUIT 1

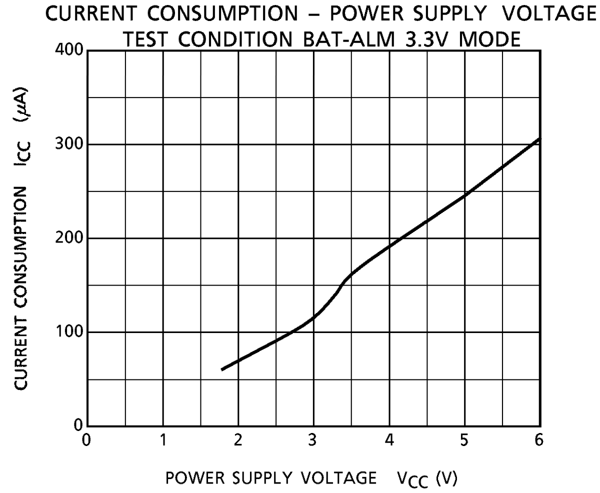


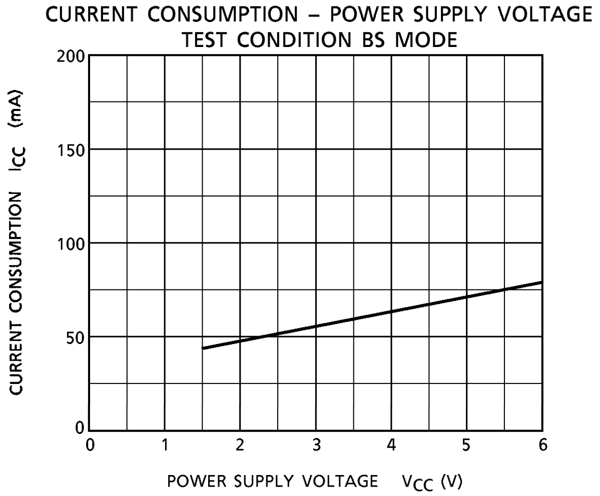
TEST CIRCUIT 2

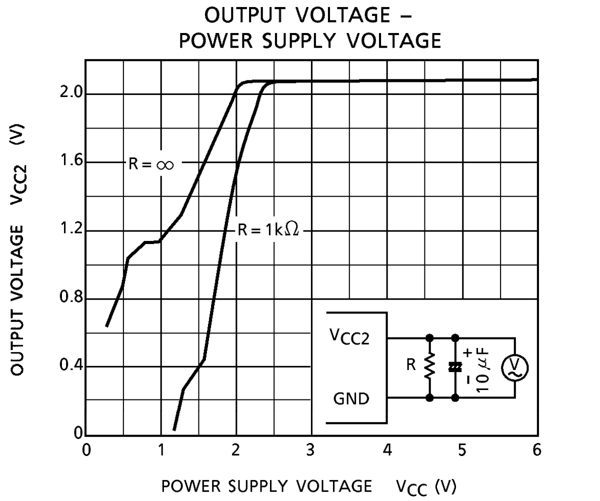


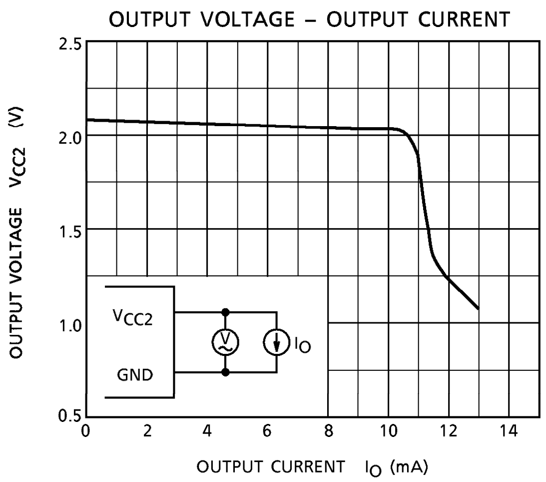
CF1. SFE10.7MA20-A
(MURATA MFG. CO., LTD.)
CF2. CFWS455E
(MURATA MFG. CO., LTD.)
CD. CDBM455C24
(MURATA MFG. CO., LTD.)
L11. 2217-1490
(SUMIDA ELECTRIC CO., LTD.)

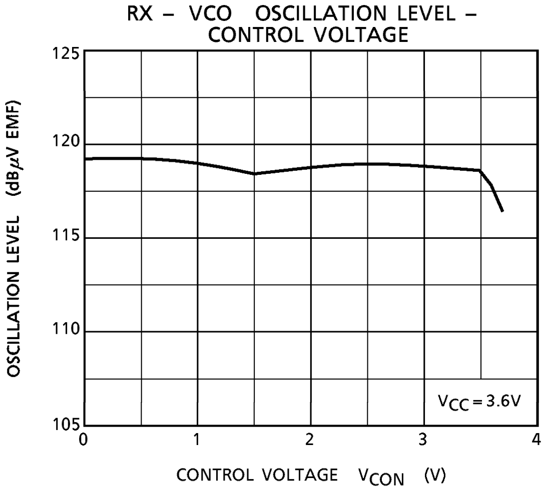

CURRENT CONSUMPTION – POWER SUPPLY VOLTAGE
TEST CONDITION ALL ON
CURRENT CONSUMPTION ICC (mA)
POWER SUPPLY VOLTAGE VCC (V)
Not including consumption current of TX – VCO

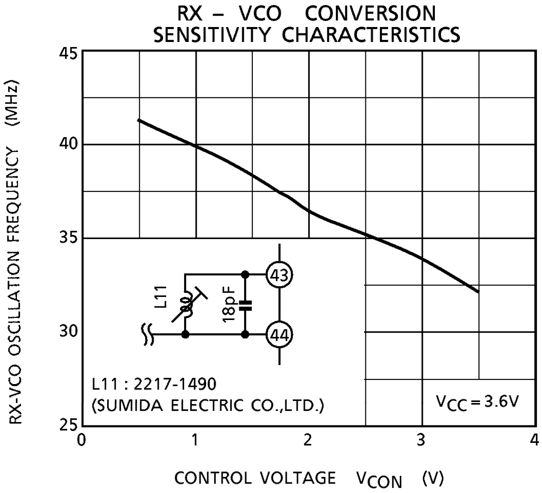

CURRENT CONSUMPTION – POWER SUPPLY VOLTAGE
TEST CONDITION BAT-ALM 3.3V MODE
CURRENT CONSUMPTION ICC (μA)
POWER SUPPLY VOLTAGE VCC (V)


CURRENT CONSUMPTION – POWER SUPPLY VOLTAGE
TEST CONDITION BS MODE
CURRENT CONSUMPTION ICC (mA)
POWER SUPPLY VOLTAGE VCC (V)

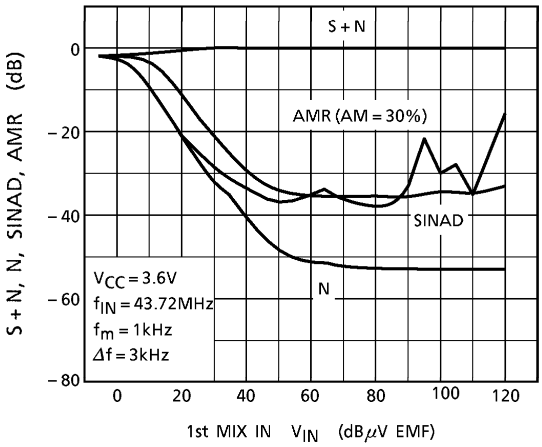

OUTPUT VOLTAGE –
POWER SUPPLY VOLTAGE
OUTPUT VOLTAGE VCC2 (V)
POWER SUPPLY VOLTAGE VCC (V)
R = ∞
R = 1kΩ
VCC2
GND
R
10 μF


OUTPUT VOLTAGE – OUTPUT CURRENT
OUTPUT VOLTAGE VCC2 (V)
OUTPUT CURRENT IO (mA)
VCC2
GND
IO

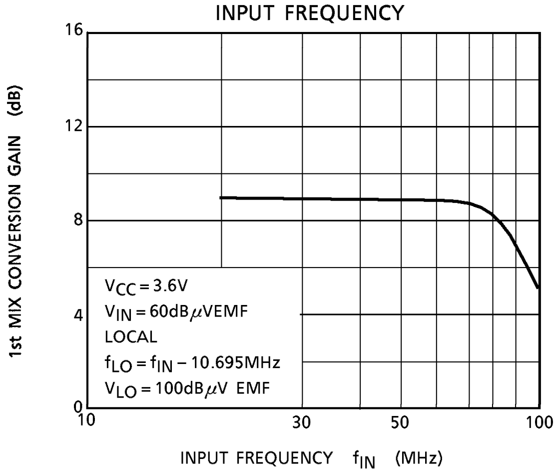

RX – VCO OSCILLATION LEVEL – CONTROL VOLTAGE
OSCILLATION LEVEL (dBμV EMF)
125
120
115
110
105
0
1
2
3
4
CONTROL VOLTAGE VCON (V)
VCC = 3.6V


RX – VCO CONVERSION SENSITIVITY CHARACTERISTICS
RX-VCO OSCILLATION FREQUENCY (MHz)
45
40
35
30
25
0
1
2
3
4
CONTROL VOLTAGE VCON (V)
L11
18pF
43
44
L11 : 2217-1490
(SUMIDA ELECTRIC CO.,LTD.)
VCC = 3.6V

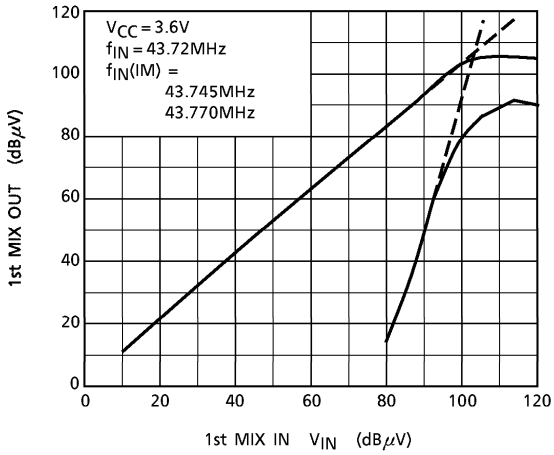
1st MIX + 2nd MIX + IF CHARACTERISTICS (INPUT 50Ω)



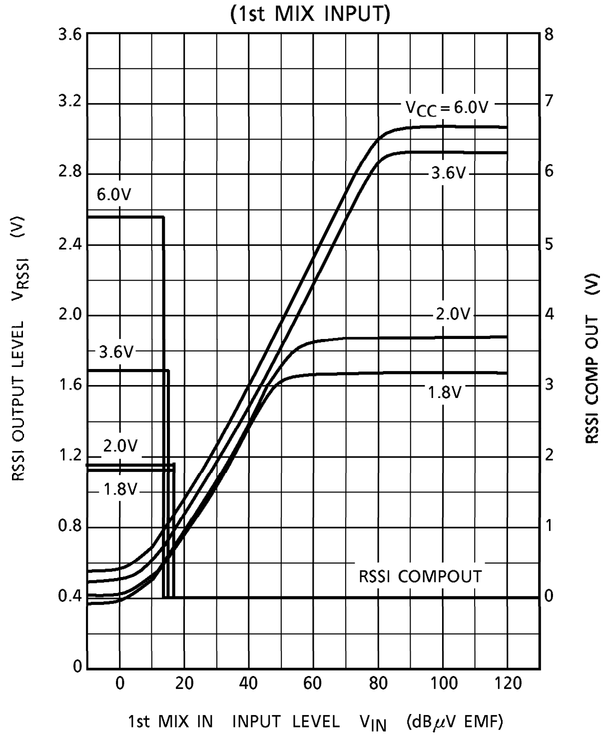
1st MIX CONVERSION GAIN – INPUT FREQUENCY



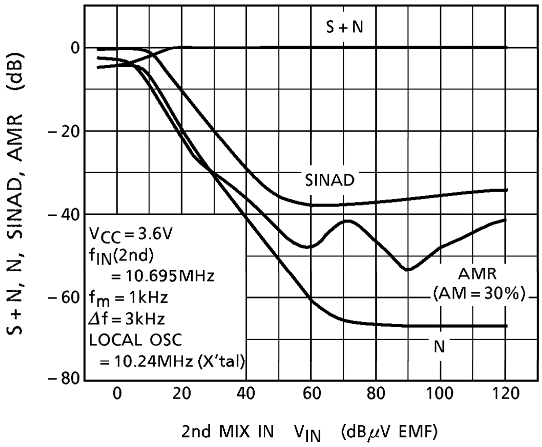
1st MIX INTERCEPT POINT CHARACTERISTICS



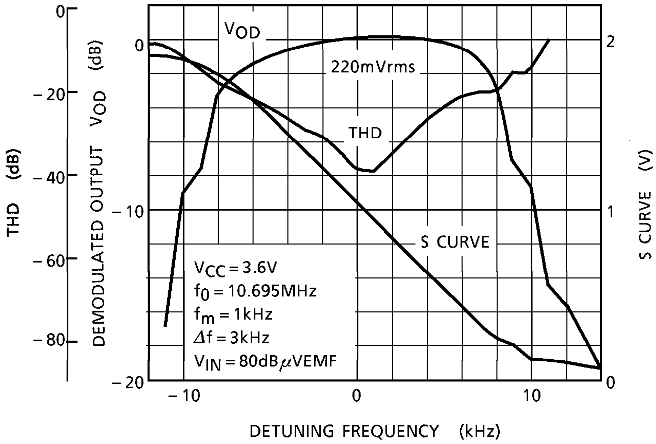
RSSI CHARACTERISTICS (1st MIX INPUT)



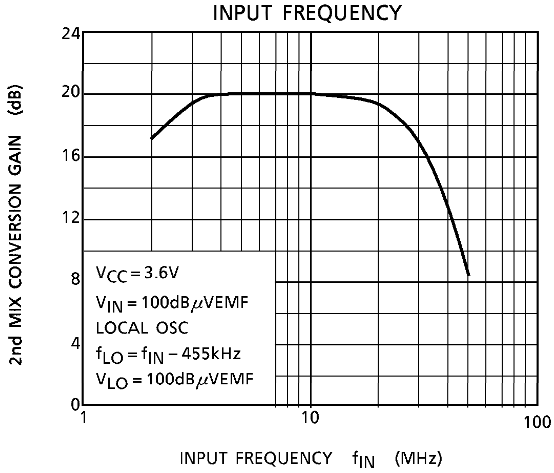
2nd MIX + IF CHARACTERISTICS (INPUT 50Ω)



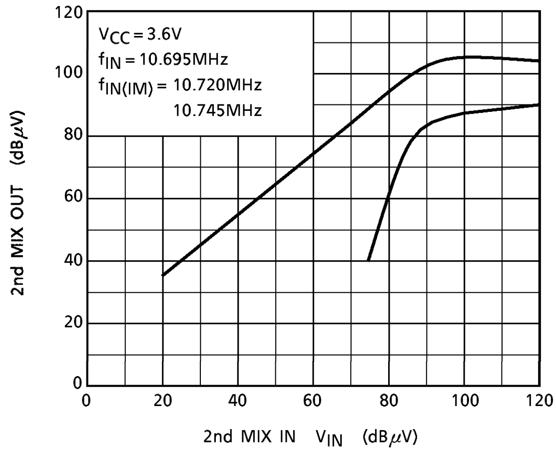
2nd MIX DETUNING CHARACTERISTICS (INPUT 50Ω)



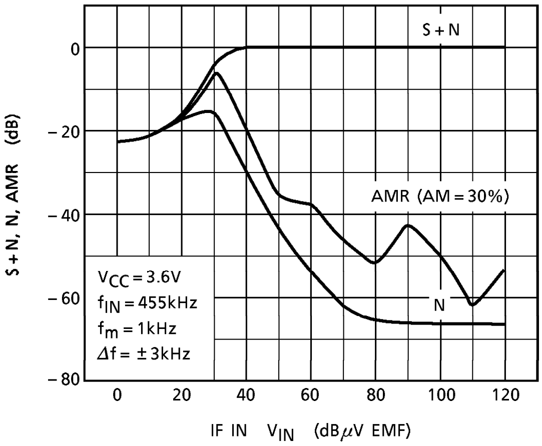
2nd MIX CONVERSION GAIN – INPUT FREQUENCY



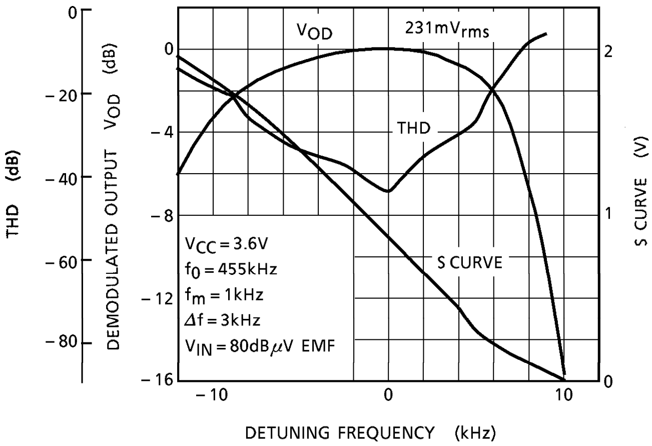
2nd MIX INTERCEPT POINT CHARACTERISTICS



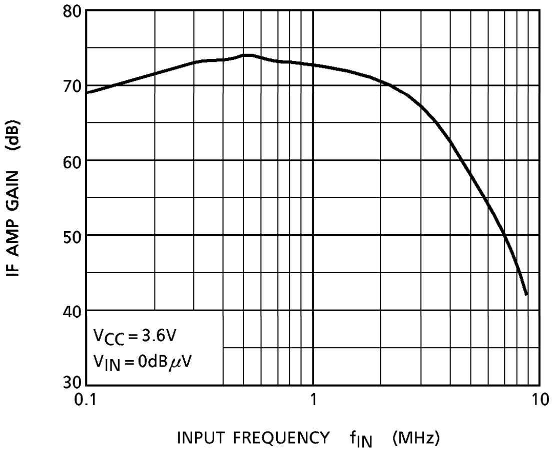
IF AMP CHARACTERISTICS (INPUT 50Ω)



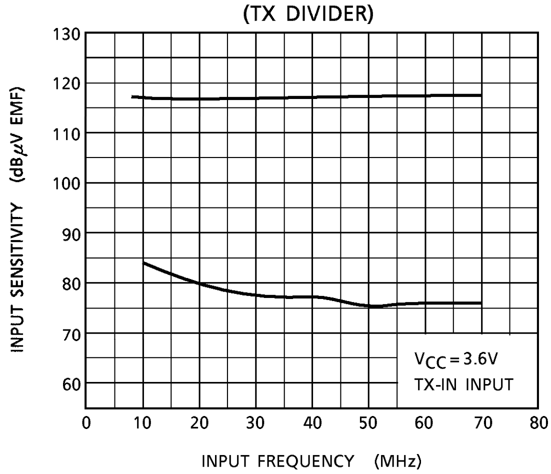
IF AMP DETUNING CHARACTERISTICS (INPUT 50Ω)



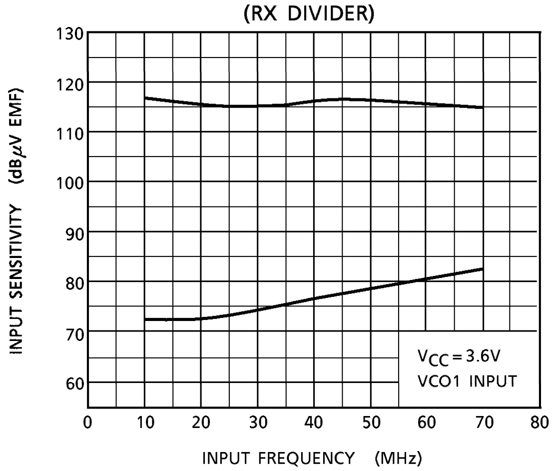
IF AMP GAIN – INPUT FREQUENCY



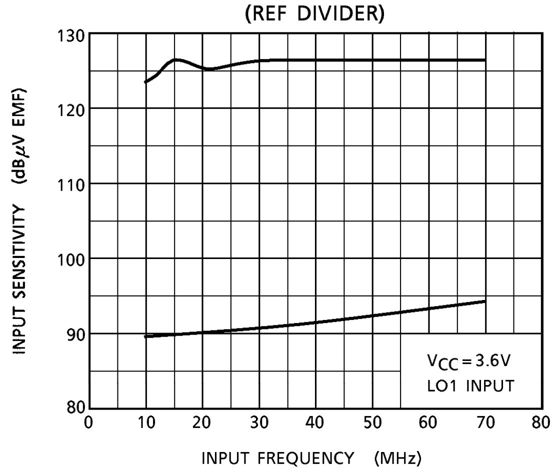
INPUT SENSITIVITY – INPUT FREQUENCY (TX DIVIDER)

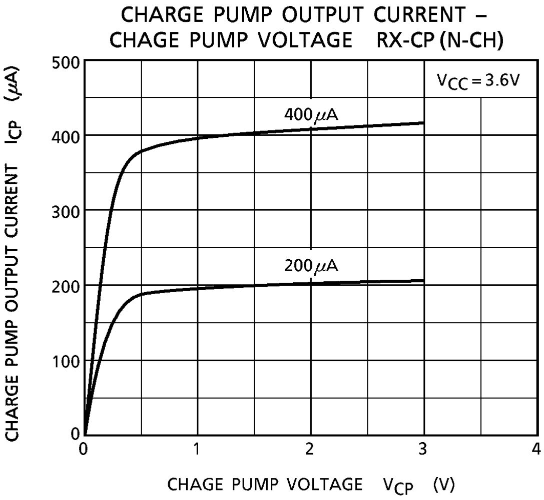


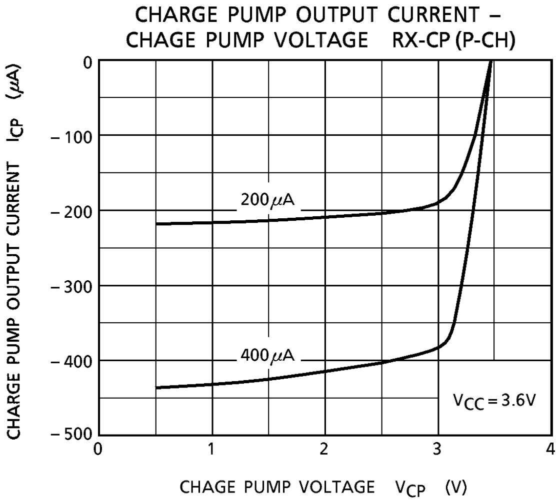
INPUT SENSITIVITY – INPUT FREQUENCY (RX DIVIDER)

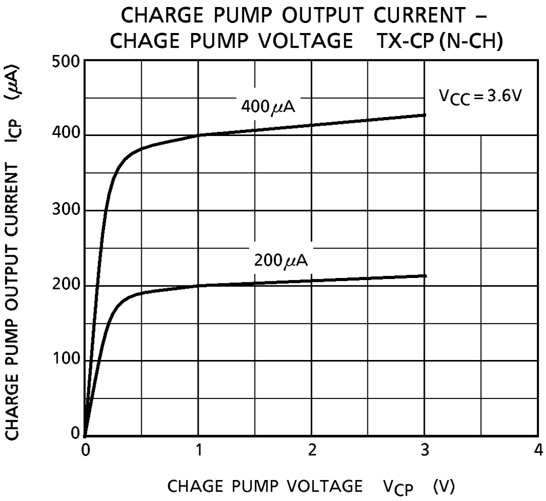


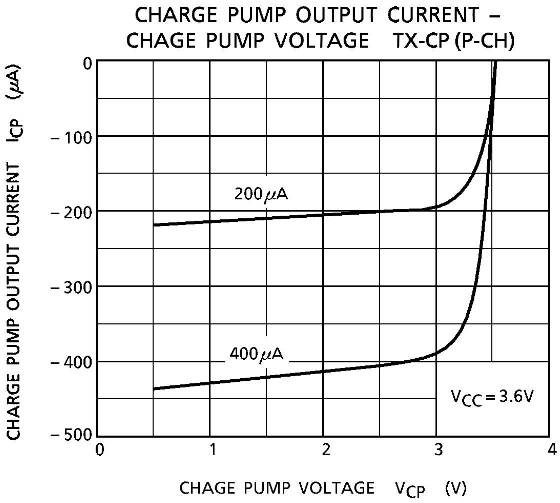
INPUT SENSITIVITY – INPUT FREQUENCY (REF DIVIDER)

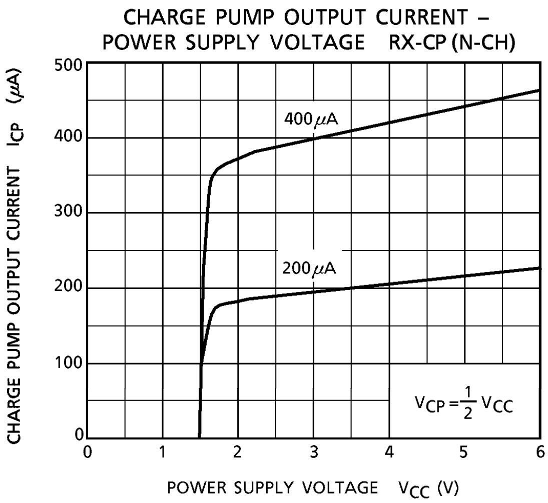


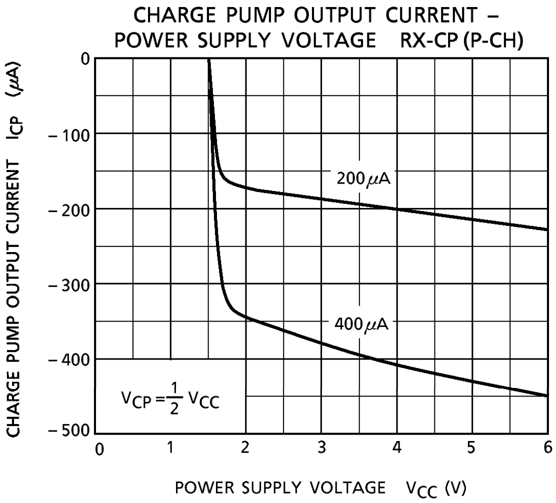

CHARGE PUMP OUTPUT CURRENT –
CHAGE PUMP VOLTAGE RX-CP (N-CH)
CHARGE PUMP OUTPUT CURRENT ICP (μA)
CHAGE PUMP VOLTAGE VCP (V)
VCC = 3.6V
400μA
200μA


CHARGE PUMP OUTPUT CURRENT –
CHAGE PUMP VOLTAGE RX-CP (P-CH)
CHARGE PUMP OUTPUT CURRENT ICP (μA)
CHAGE PUMP VOLTAGE VCP (V)
200μA
400μA
VCC = 3.6V

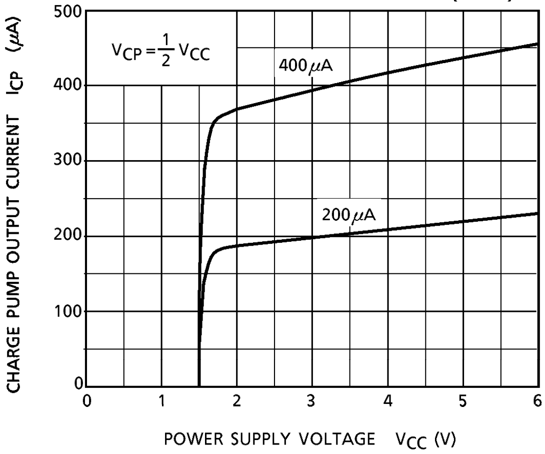

CHARGE PUMP OUTPUT CURRENT –
CHAGE PUMP VOLTAGE TX-CP (N-CH)
CHARGE PUMP OUTPUT CURRENT ICP (μA)
CHAGE PUMP VOLTAGE VCP (V)
VCC = 3.6V
400μA
200μA


CHARGE PUMP OUTPUT CURRENT –
CHAGE PUMP VOLTAGE TX-CP (P-CH)
CHARGE PUMP OUTPUT CURRENT ICP (μA)
CHAGE PUMP VOLTAGE VCP (V)
200μA
400μA
VCC = 3.6V

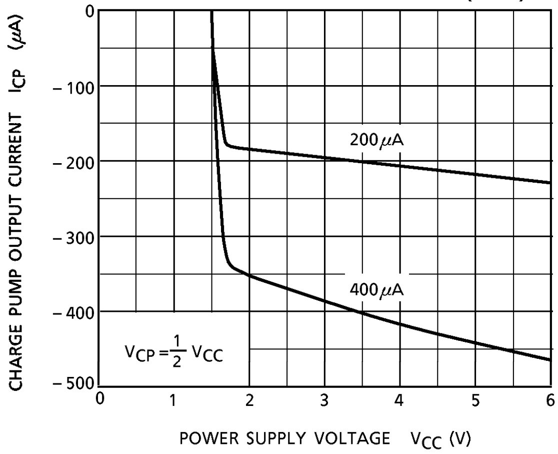

CHARGE PUMP OUTPUT CURRENT –
POWER SUPPLY VOLTAGE RX-CP (N-CH)
CHARGE PUMP OUTPUT CURRENT ICP (μA)
POWER SUPPLY VOLTAGE VCC (V)
400μA
200μA
VCP = 1/2 VCC


CHARGE PUMP OUTPUT CURRENT –
POWER SUPPLY VOLTAGE RX-CP (P-CH)
CHARGE PUMP OUTPUT CURRENT ICP (μA)
POWER SUPPLY VOLTAGE VCC (V)
200μA
400μA
VCP = 1/2 VCC

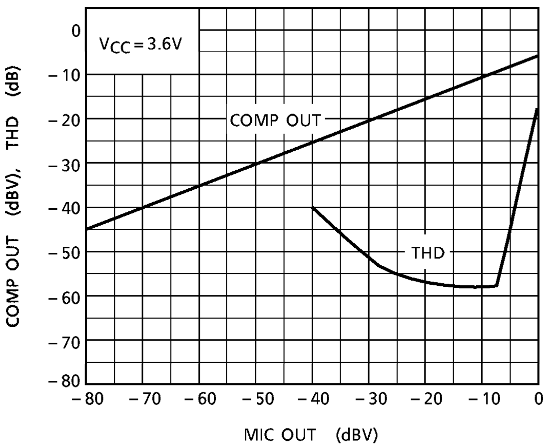
CHARGE PUMP OUTPUT CURRENT – POWER SUPPLY VOLTAGE TX-CP (N-CH)



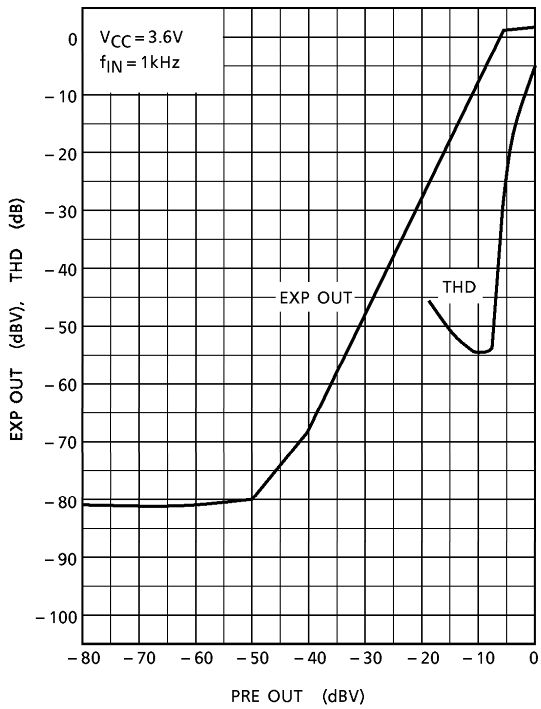
CHARGE PUMP OUTPUT CURRENT – POWER SUPPLY VOLTAGE TX-CP (P-CH)



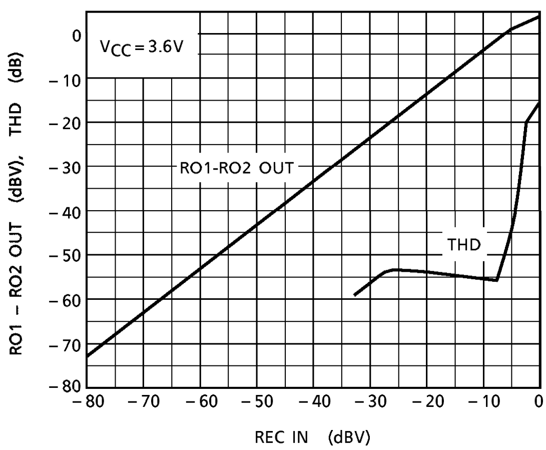
COMPRESSOR CHARACTERISTICS



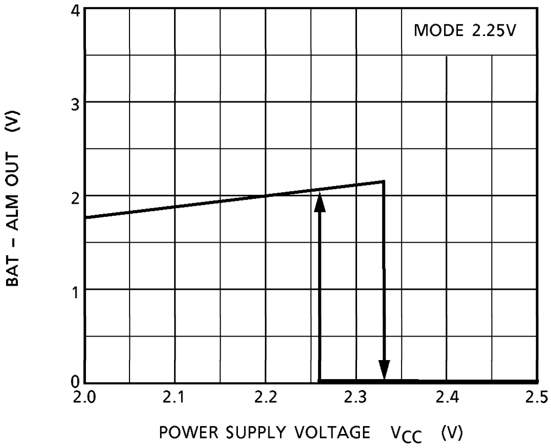
EXPANDER CHARACTERISTICS



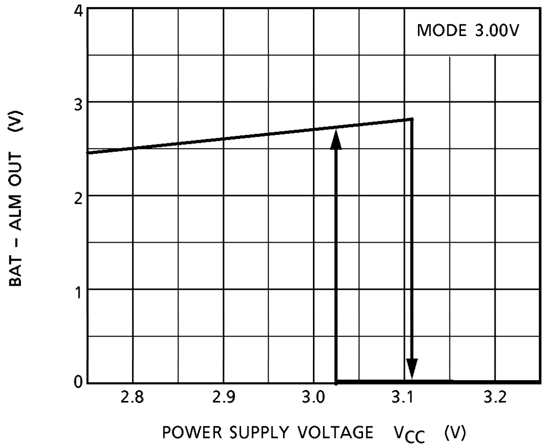
RECEIVER AMP CHARACTERISTICS



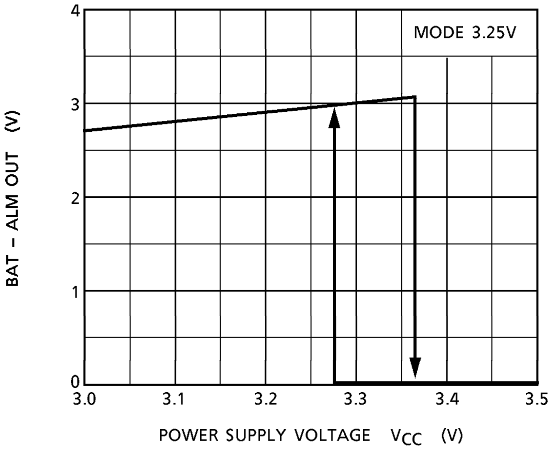
BATTERY ALARM 1 CHARACTERISTICS



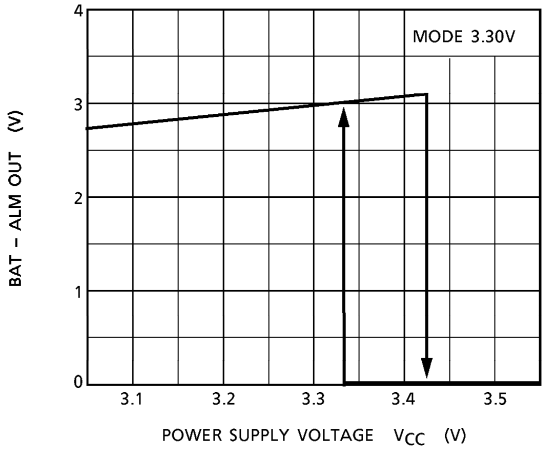
BATTERY ALARM 2 CHARACTERISTICS



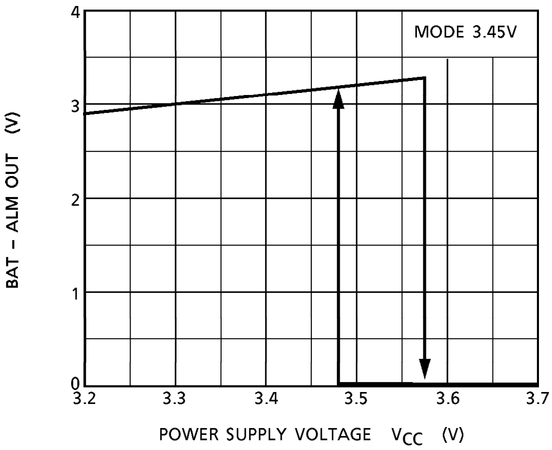
BATTERY ALARM 3 CHARACTERISTICS



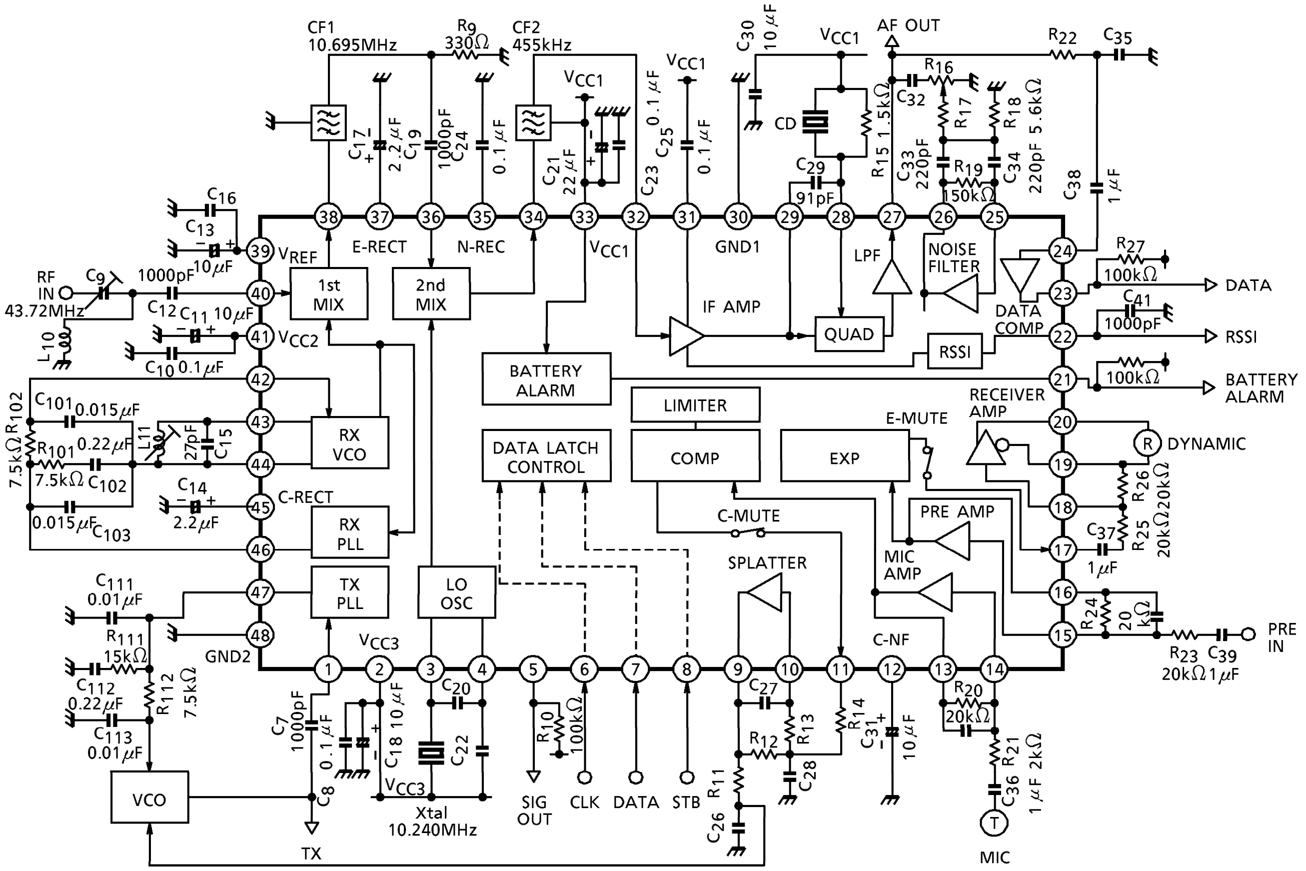
BATTERY ALARM 4 CHARACTERISTICS



BATTERY ALARM 5 CHARACTERISTICS



APPLICATION CIRCUIT

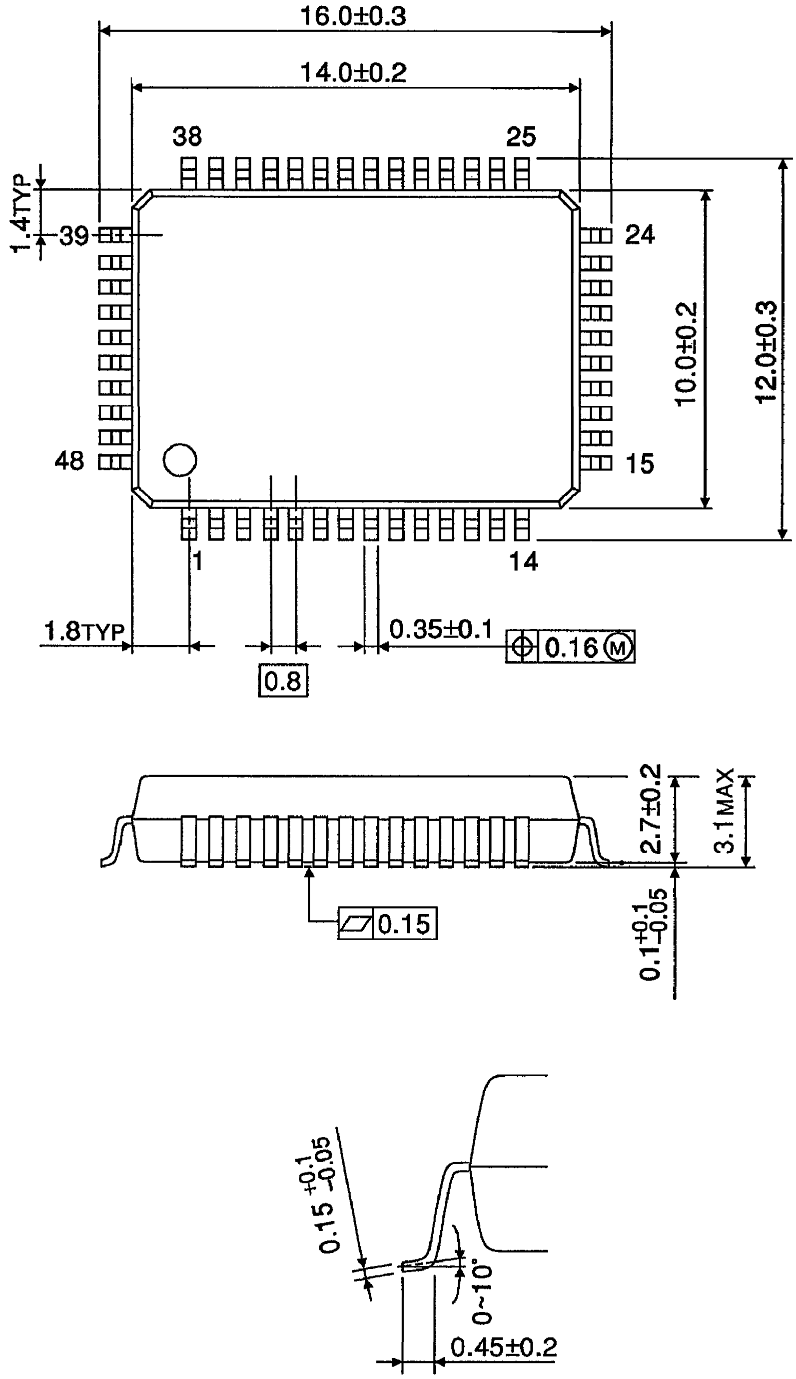


CF1. SFE10.7MA20-A
(MURATA MFG. CO., LTD.)
CF2. CFWS455E
(MURATA MFG. CO., LTD.)
CD. CDBM455C24
(MURATA MFG. CO., LTD.)
L11. 2217-1490
(SUMIDA ELECTRIC CO., LTD.)

OUTLINE DRAWING

QFP48-P-1014-0.80

Unit : mm



Weight : 0.83g (Typ.)