

# 1. Description

C9631 is PLL free debugging single radio chip with FM / AM / SW / LW multi-band. Thanks to its monolithic integrated frequency synthesizers, radio frequency front end and MPX decoder, this chip implements all receiver function from wireless input to audio output, eliminating the correction in the weeks of complex peripheral circuit and complex debugging correction production process.

C9631 chip integrates a high-performance low intermediate frequency digital audio DSP, so that the chip has an excellent sound quality in various receiving condition.

C9631 chip with AFC function so that make it an excellent performance and flexibility. C9631 chip can work from 2.0V to 3.6V Wide supply voltage range.

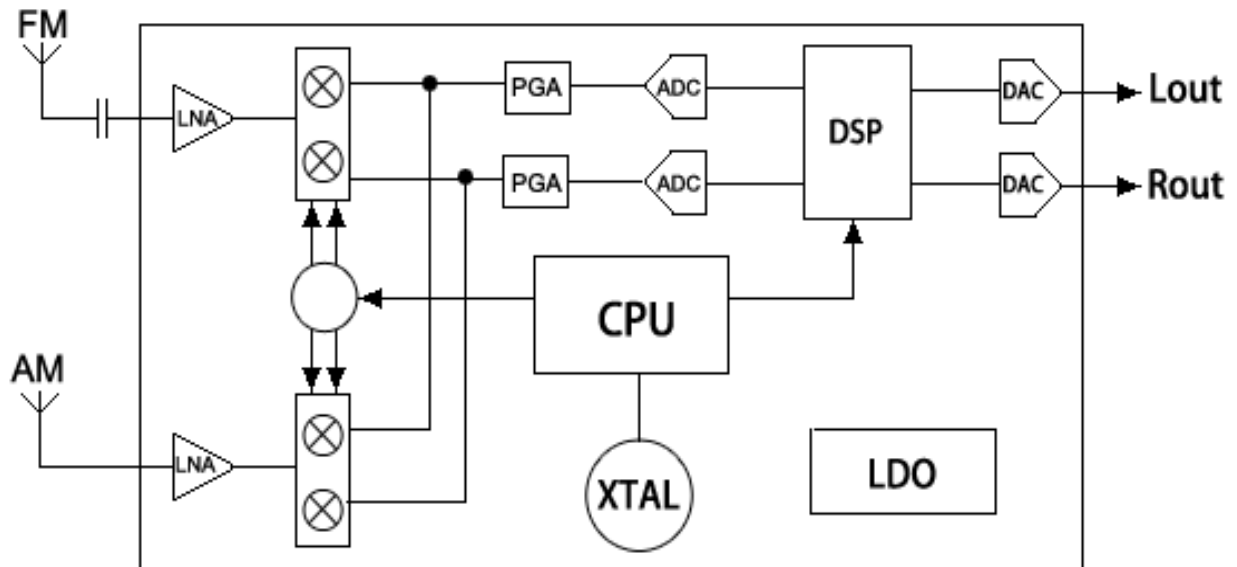
## 1.1. Features

- monolithic integrated FM/AM/SW/LW radio receiver
- & extremely low power consumption
  - power consumption in FM mode is less than 35mA
  - power consumption in AM mode is less than 25mA
- Worldwide FM/AM/SW/LW band support
  - AM band within 520 -1710KHz
  - FW band within 87 -108MHz
  - Single FW band within 64 -108MHz
  - SW band within 2.2MHz-22.85MHz
  - LW band within 153KHz-288KHz
- Integrated digital low-IF tuner
  - Transducers under the suppression of mirror
  - high performance A/D converter
- fully integrated digital frequency synthesizers
  - Fully integrated on chip RF VCO
  - fully integrated on chip loop filter
  - support manual tuning
- support 32.768KHz crystal oscillator
- automatic frequency control (AFC)
- support digital automatic gain control
- digital adaptive noise cancellation
  - mono/stereo automatic switch
- FM / AM frequency band selection for each region
- Support 1-8 shortwave mode
- support short arbitrary band selection
- package types: SSOP24(RoHS )

## 1.2. Applications

- Desktop and portable radio
- CD/DVD player
- Mini audio
- Entertainment system
- Toys or gifts

## 2. Functional diagram



( Figure 1. C9631 Functional diagram )

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## 3. Function Description

### 3.1. Overview

C9631 is a highly integrated single-chip PLL FM / AM / SW / LW receiver chip, which can realize the flexible radio receiver scheme, greatly minimizing the peripheral device chip, reducing the BOM and the cost of application, more convenient for factory production.

### 3.2. FM Receiver

C9631 chip using low-IF architecture, avoiding the image rejection problems which were brought by direct frequency conversion, reducing the cost and complexity of the applications effectively. C9631 chip integrates the FM low-noise amplifier (FM\_LNA) for which support the single-band (64 to 108MHz), a orthogonal image rejection mixer, a programmable gain amplifier (PGA), a high-resolution analog to digital converters, an audio DSP and a high-fidelity digital to analog converter (DAC).

FM\_LNA amplifying the RF signal and converting it to differential signal; the orthogonal image rejection mixer change the frequency of FM-LNA differential RF signal to low-IF signal, and complete image rejection function at the same time; PGA enlarge orthogonal image reject the IF signal which were outputted by the mixer, then changing the low-IF signal which were outputted by PGA through ADC to digital signal, sending to the audio DSP for subsequent processing.

The DSP audio complete the channel selection, FM demodulation, decoding MPX stereo and audio signal output. MPX decoder can automatically complete stereo / mono switch to reduce the output noise.

### 3.3. AM Receiver

C9631 chip using digital low-IF architecture, supports the global AM band which the frequency ranging from 520 kHz to 1710 kHz. The AM reception of C9631 chip only requires minimal external components, and does not need manual adjustment. Digital low-IF architecture enables C9631 chip having high accuracy filter, excellent selectivity and signal to noise ratio throughout the whole AM band. Similar to the FM receiver phase, the AM receiver of C9631-chip receiver optimized the sensitivity of the receiver and the suppression for strong interference signal, making the receiver of weak signal radio easier. To provide the maximum flexibility, C9631 chip supports ferrite coil magnet of wide range. C9631 chip can also increase the effective inductance of the loop antenna through a transformer.

### 3.4. SW/LW Receiver

C9631 chip supports eight shortwave bands range from 2.2MHz to 22.85 MHz . Also supports arbitrary frequency range of frequency selection. The characteristics of shortwave reception of C9631 chip has few external discrete devices and does not require factory calibration. C9631 chip also supports the application of FM antenna to receive shortwave signals. LW band supports frequency range from 153KHz to 288KHz.

### 3.5. Frequency Synthesizer

The vibration signal generated from frequency synthesizer is input to a quadrature mixer, RF signal down-conversion to low intermediate frequency signal of fixed frequency.

## 4. Electrical Specification

Table 1: Operation Condition

Parameter	Symbol	Operating Condition	Min	Typ	Max	Units
Power Supply	AVDD	Relative to GND	2.0	3.3	3.6	V
Ambient Temperature	Ta		-15		+85	°C

Table 2: DC Characteristics

Parameter		Symbol	Test/Operating Condition	Min	Typ	Max	Units
Current Consumption	FM Model	$I_{FM}$			35		mA
	AM Model	$I_{AM}$			25		mA
	SW Model	$I_{SW}$			35		mA
	LW Model	$I_{LW}$			25		mA
VDD Power Down		$I_{PD}$			30		μA

# FM/AM/SW/LW Multi Band Single Radio Chip C9631

( Table 3: FM Receiver Characteristics )

(VDD = 3.0 V, Ta = 0 to 45 °C)

ITEMS	Test/Operating Condition	TYP	Units
Frequency Coverage Range	Low	87	MHz
	High	108	MHz
Sensitivity For 30dB S/N	90 MHz	15	dB
	98 MHz	15	dB
	106 MHz	15	dB
S/N Ratio 60dB Input	98 MHz	54	dB
3dB Limiting Sensitivity	98 MHz	14	dB
AFC Holding Range	98 MHz	± 50	KHz
AM Suppression 60dB Input	98 MHz	45	dB
Distortion 60db Input	98 MHz	0.5	%
Overload THD.75 KHz Dev.	98 MHz	0.3	%
Power Output 10% T.H.D.(MOD=75KHz)	98 MHz	175	mVrms
Max.Power Output (MOD=75KHz)	98 MHz	175	mVrms
No Signal Current		13	uA
Current Drain Current at OutPut		35	mA
Modulation Hum. ( 100dB )		1.5	mV
Frequency Response 1mV Input with 1KHz=0dB (-6dB)	High	5	KHz
	Low	80	Hz
Level Difference Mono/Stereo	98 MHz	0	dB
Sens.For Stereo Indicator On	98 MHz	22	dB
Channel Balance	98 MHz	0.2	dB
Separation 1KHz	98 MHz	50	dB
<b>NOTE:</b> <ol style="list-style-type: none"> <li>1. Frequency is 87~108 MHz.</li> <li>2. <math>V_{EMF} = 1</math> mV.</li> <li>3. FMOD = 1 kHz, MONO, and L = R unless noted otherwise.</li> <li>4. <math>\Delta f = 22.5</math> kHz.</li> <li>5. <math> f_2 - f_1  &gt; 2</math> MHz, <math>f_0 = 2 \times f_1 - f_2</math>.</li> <li>6. BAF = 300 Hz to 15 kHz, A-weighted.</li> <li>7. At LOUT and ROUT pins.</li> <li>8. <math>f = 75</math> kHz.</li> </ol>			

( Table 4: AM Receiver Characteristics )

(VDD = 3.0 V, Ta = 0 to 45 °C)

ITEMS	Test/Operating Condition	TYP	Units
Frequency Coverage Range	Low	520	KHz
	High	1710	KHz
Sensitivity For 20dB S/N	600 KHz	83	dB/m
	1000 KHz	83	dB/m
	1400 KHz	83	dB/m
S/N Ratio (5mV/m)	1000 KHz	40	dB/m
A.G.C -10dB (100mV/m)	1000 KHz	50	dB/m
Selectivity ±9KHz	1000 KHz	18	dB/m
Band width (-6dB)	1000 KHz	12	KHz
Power Output 10% T.H.D. (Mod=80%)	1000 KHz	170	mVrms
Max. Power Output (Mod=80%)	1000 KHz	170	mVrms
Distortion 30% MOD.74dB INPUT	1000 KHz	0.5	%
Frequency Response -6dB 5mV/m Input 1KHz=0dB	Low	2.8	KHz
	High	80	Hz
Min. Volume Output		0.2	mV
Modulation Hum. ( 100dB )		4	mV
No Signal Current		10	uA
Current Drain Current at MAX. Output		23	mA
NOTE: 1. Volume = maximum, for all tests. Tested at RF = 520 kHz. 2. FMOD = 1 kHz, 30% modulation, 2 kHz channel filter. 3. BAF = 300 Hz to 15 kHz, A-weighted. 4. VIN = 5mVrms. 5. Stray capacitance on antenna and board must be < 10 pF to achieve full tuning range at higher inductance levels.			

# FM/AM/SW/LW Multi Band Single Radio Chip C9631

( Table 5.SW Receiver Characteristics )

(VDD = 3.0 V, Ta = 0 to 45 °C)

ITEMS	Test/Operating Condition	TYP	Units
Frequency Coverage Range	Low	9.0	MHz
	High	22	MHz
Sensitivity For 20dB S/N	9.5 MHz	13	dB
	15MHz	13	dB
	20 MHz	13	dB
S/N Ratio 74dB Input	15 MHz	>35	dB
A.G.C -10dB (100mV/m)	15 MHz	40	dB
Selectivity ± 9KHz	15 MHz	± 10	dB
Band width (-6dB)	15 MHz	3- 6	KHz
Power Output 10% T.H.D. (Mod=80%)	15 MHz	50 ~ 100	mVrms
Max. Power Output (Mod=80%)	15 MHz	50 ~ 100	mVrms
Distortion 30% MOD.74dB INPUT	15MHz	< 1	%
Modulation Hum. ( 100dB )		< 5	mv
Max Volume output		30	mv
Min. Volume Output		0.5	mv
Frequency Response -6dB 5mV/m Input 1KHz=0dB	High	2.8	KHz
	Low	80	Hz
No Signal Current		< 20	uA
Current Drain Current at MAX. Output		20~30	uA
Spurious Frequency Rejection Ratio		9 ~ 18	dB
NOTE:			

# FM/AM/SW/LW Multi Band Single Radio Chip C9631

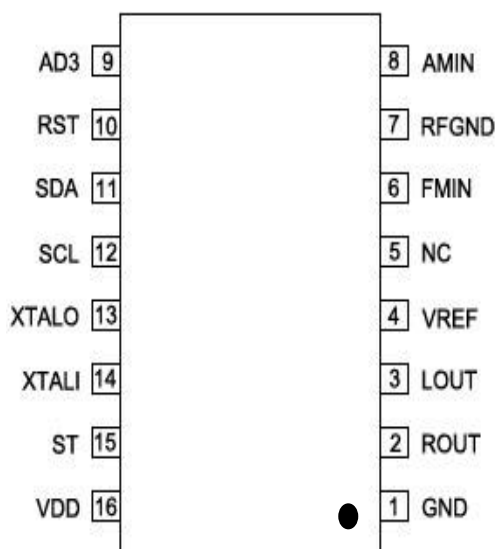
( Table 6.LW Receiver Characteristics )

(VDD = 3.0 V, Ta = 0 to 45 °C)

ITEMS	Test/Operating Condition	TYP	Units
Frequency Coverage Range	Low	153	KHz
	High	288	KHz
Sensitivity For 20dB S/N	162 KHz	92	dB/u
	216 KHz	92	dB/u
	279 KHz	92	dB/u
S/N Ratio (74dB/m)	216 KHz	40	dB
A.G.C -10dB (100mV/m)	216 KHz	40	dB
Selectivity ±9KHz	216 KHz	±10	dB
Band width (-6dB)	216 KHz	3 - 6	KHz
Power Output 10% T.H.D. (Mod=80%)	216 KHz	50 ~ 100	mVrms
Max. Power Output (Mod=80%)	216 KHz	50 ~ 100	mVrms
Distortion 30% MOD.74dB INPUT	216 KHz	<1	%
Frequency Response -6dB 5mV/m Input 1KHz=0dB	Low	2.8	KHz
	High	80	Hz
Min. Volume Output		0.5 ~ 2.0	mV
Current Drain Current at MAX. Output		23	mA
NOTE:			



## 5. Chip pin description



(Table 7. C9631 Chip pin description )

Pin	Pin Name	Description
1	GND	GND
2	ROUT	Right output
3	LOUT	Left output
4	VREF	Voltage Detection
5	NC	NC
6	FMIN	FM RF input
7	RFGND	RFGND
8	AMIN	AM RF input
9	AD3	State detection
10	RST	Reset
11	SDA	IIC SDA
12	SCL	IIC SCL
13	XTALO	crystal oscillator output
14	XTALI	crystal oscillator input
15	STEREO	stereo
16	VDD	VDD

( Table 8. Regional frequency range selection table )

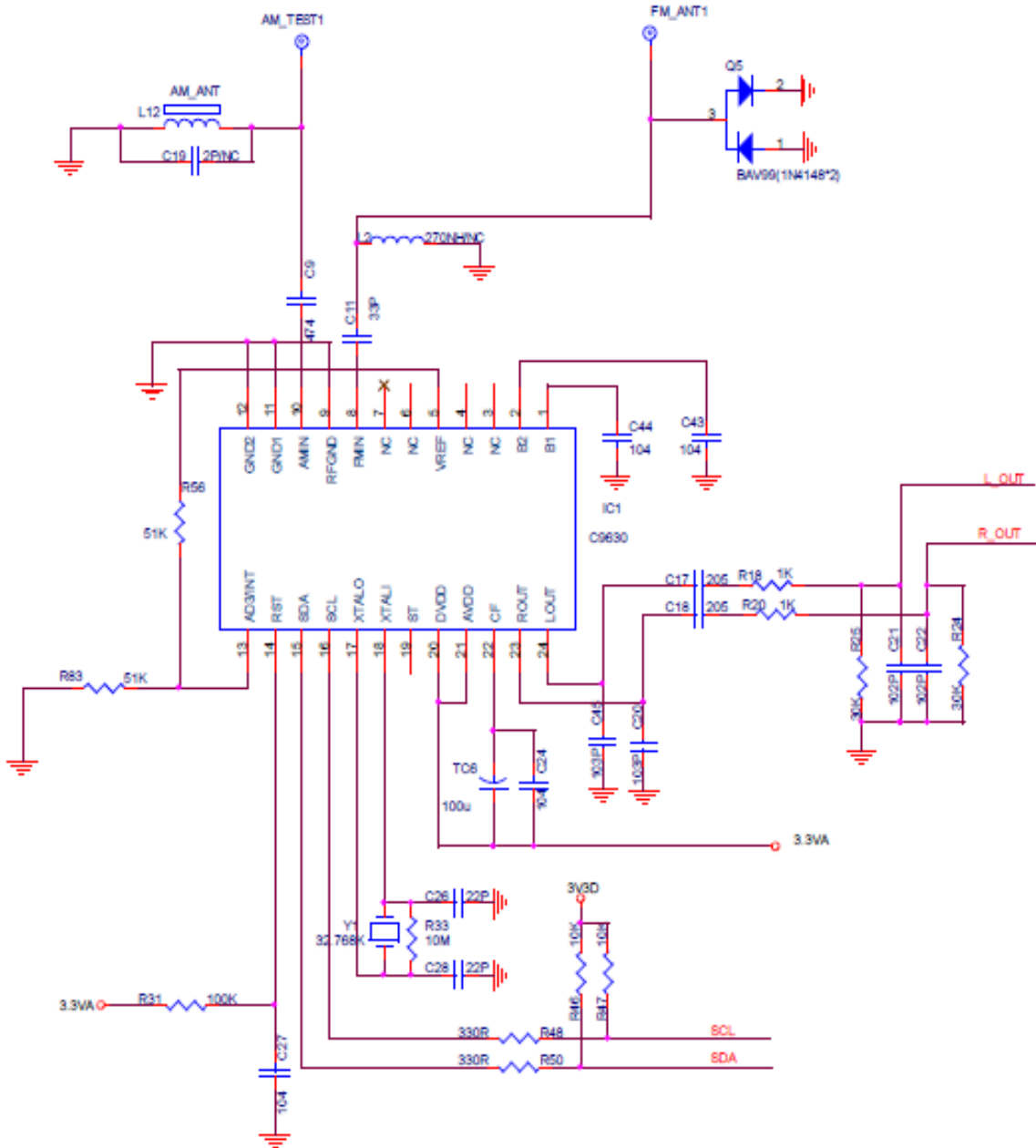
Radio station area	Countries or regions	Hand tuning frequency width limit
EUR	Europe / Korea / Taiwan	AM Lower : 522 KHz ; AM Upper : 1620 KHz
		FM Lower : 87.0MHz ; FM Upper : 108.0 MHz
USA	U.S.A. , Canada & Latin America	AM Lower : 520 KHz ; AM Upper : 1710 KHz
		FM Lower : 87.0 MHz ; FM Upper : 108.0 MHz
JPN	Japan (without TV-Band)	AM Lower : 522 KHz ; AM Upper : 1629 KHz
		FM Lower : 76.0 MHz ; FM Upper : 90.0 MHz
JTV	Japan (with TV-Band TV1, TV2 & TV3)	AM Lower : 522 KHz ; AM Upper : 1629KHz
		FM Lower : 76.0 MHz ; FM Upper : 108.0 MHz
RUS	Russia	AM Lower : 522 KHz ; AM Upper : 1620 KHz
		FM Lower : 64.0 MHz ; FM Upper : 108.0 MHz
AUS	Australia, New Zealand & S. Africa	AM Lower : 531 KHz ; AM Upper : 1602KHz
		FM Lower : 87.5 MHz ; FM Upper : 108.0 MHz
EUR2	UNUSED(Global)	AM Lower : 522 KHz ; AM Upper : 1620KHz
		FM Lower : 87.5 MHz ; FM Upper : 108.0 MHz

**SW frequency range selection:**

SW1	2.20 - 4.36 MHz	SW5	11.60 - 13.85 MHz
SW2	4.50 - 6.25 MHz	SW6	15.05 - 15.65 MHz
SW3	6.75 - 7.65 MHz	SW7	17.50 - 19.98 MHz
SW4	9.50 - 10.50 MHz	SW8	21.40 - 22.85 MHz

Note: Customers can choose frequency range randomly according to their own requirements.

## 6. Typical application circuit of AM/FM two band

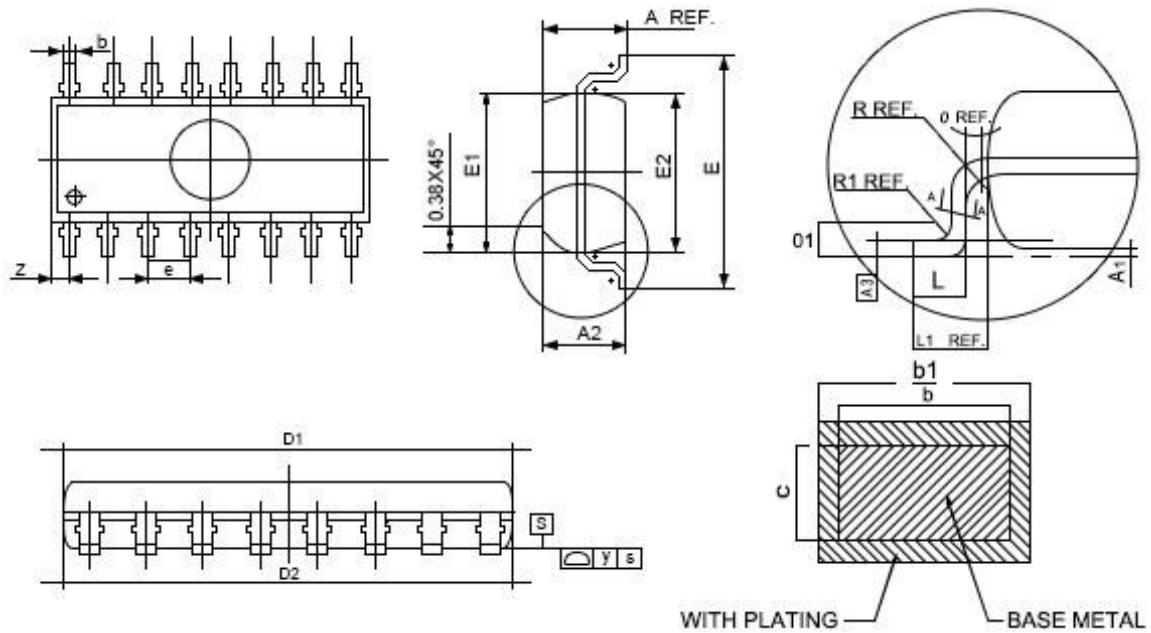


( Table 9. Typical application schematic diagram )

Note: The above demonstration circuit is for the C9631 chip reference design circuit, Our company reserves the right to modify the circuit. When entering the normal product design, please obtain the latest information from our engineering staff.

## 7. Package

Package dimensions: SOP 16



Symbol	Min	Nom	Max
A	1.500	1.600	1.700
A1	0.100	0.150	0.200
A2	1.400	1.450	1.500
A3	-----	0.223	-----
b	0.356	0.406	0.456
b1	0.366	0.426	0.486
c	-----	0.203	-----
D1	9.700	9.900	10.10
D2	9.750	9.950	10.15
E	5.900	6.000	6.100
E1	3.800	3.900	4.000
E2	3.850	3.950	4.050
e	-----	1.270	-----
L	0.600	0.660	0.700
L1	0.950	1.050	1.150
R	-----	0.200	-----
R1	-----	0.300	-----
$\theta$	0	-----	8°
$\theta 1$	0	-----	10°
y	-----	-----	0.1
Z	-----	0.505	-----

SECTION "A" - "A"

**Note:**

1. All dimension are in mm;
2. Dim D1/D2 & E1/E2 does not include plastic flash; flash: Plastic residual around body edge after dejuik/singulation.
3. Dim b does not include dambar protrusion/intrusion.
4. Plating thickness 0.005-0.015 mm.

( Table 10.SOP 16 package dimension )