NARROW BAND FM IF IC

FEATURES

- **Wide Operating Voltage Range 2.0 to 8.0V**
- **RF Input Frequency up to 220 MHz**
- **Low Supply Current (2.8mA, squelch off, 3.8mA, squelch on)**
- **Low External Component Count**
- **Excellent Limiting Sensitivity (-3dB = 8dBμ)**

APPLICATIONS

- **Amateur Radio Transceivers**
- **Cordless Phones**
- **Remote Controls**
- **Wireless Data Transceivers**
- **Battery Powered Devices**

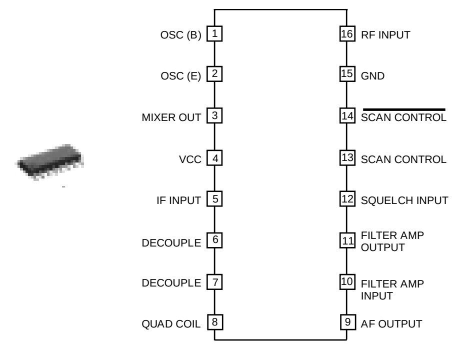
DESCRIPTION

The TK83361M is a narrow band FM IF IC designed for cordless phones, radio transceivers, remote controls, wireless data transceivers, and other communication equipment.

It integrates the mixer, oscillator, limiting amplifier, FM demodulator, filter amplifier and squelch circuit into a single surface mount SOP-16 package. The low operating current combined with a minimum operating voltage of only 2 V makes this device ideal for battery powered devices.

The TK83361M offers improved performance over the MC3361C. The operating frequency has been increased to 220MHz (vs. 60MHz) while reducing the supply current from 5.2 mA to 3.8mA (squelch on). Offered in the SOP-16 surface mount package, the TK83361M is a drop-in replacement for the MC3361C.

TK83361M



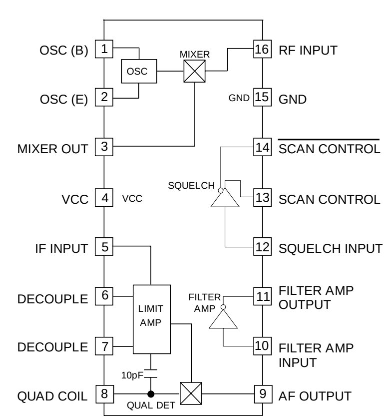
ORDERING INFORMATION

TK83361M□□

Tape/Reel Code

TAPE/REEL CODE
TL: Tape Left

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Supply Voltage .... 10 V
Operating Voltage .... 2.0 to 8.0 V
Power Dissipation (Note 1) .... 600 mW
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -30 to +70 °C
Input Frequency .... 220 MHz

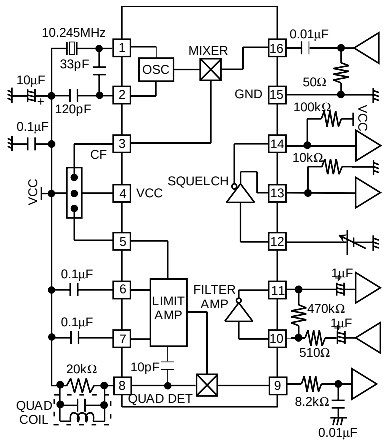
TK83361M ELECTRICAL CHARACTERISTICS

Test Conditions: V_{CC} = 4.0 V, f_{RF} = 10.7 MHz, V_{RF} = +80dBμ, f_m = 1kHz, f_{dev} = ±3kHz, f_{OSC} = 10.245MHz, Ta = 25°C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC1}	Supply Current 1	No Signal, Squelch off		2.8	3.5	mA
I_{CC2}	Supply Current 2	No Signal, Squelch on		3.8	4.9	mA
L_{imit}	-3dB Limiting Sensitivity	-3dB pt.(1kHz)		8	15	dBµ
V_O	Output Voltage	V_{RF} = +80dBµ, f_{dev} = ±3kHz	130	170		mVrms
Z_O	Output Impedance	V_{RF} = +80dBµ, f_{dev} = ±3kHz		450		Ω
THD	Total Harmonic Distortion	V_{RF} = +80dBµ, f_{dev} = ±3kHz		0.86	2.5	%
G_M	Mixer Conversion Gain	Pin 3: terminated	21	28		dB
R_{IM}	Mixer Input Impedance	DC Measurement		3.3		kΩ
G_f	Filter Amplifier Gain	f_{in} = 10kHz, V_{in} = 0.3mV	40	50		dB
f_{OC}	Filter Amplifier Output Terminal Voltage	No Signal	0.5	0.7	0.9	V
S_H	Scan Control High Level	Squelch Input V_{SQ} = 0.0V	3.0	3.9		V
S_L	Scan Control Low Level	Squelch Input V_{SQ} = 2.5V		0.0	0.4	V
$\overline{S}_H$	$\overline{\text{Scan Control}}$ High Level	Squelch Input V_{SQ} = 2.5V	3.0	3.9		V
$\overline{S}_L$	$\overline{\text{Scan Control}}$ Low Level	Squelch Input V_{SQ} = 0.0V		0.0	0.4	V
H_{YS}	Squelch Hysteresis			45	100	mV

Note 1: Power dissipation must be decreased at a rate of 4.8 mW/°C for operation above 25°C.

TEST CIRCUIT

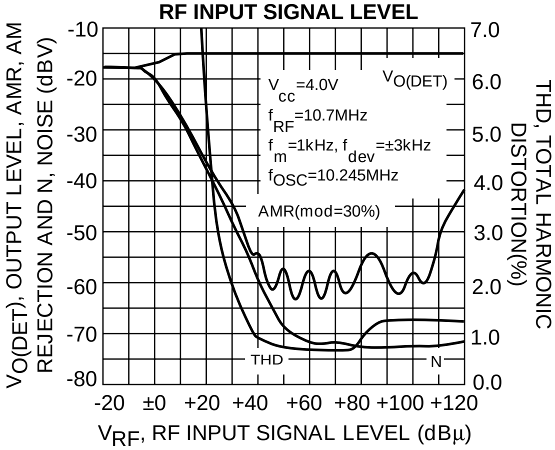


CF = BLFC455D (TOKO)
CFU455D2 (MURATA)
QUAD COIL = 7MCS-13546Z

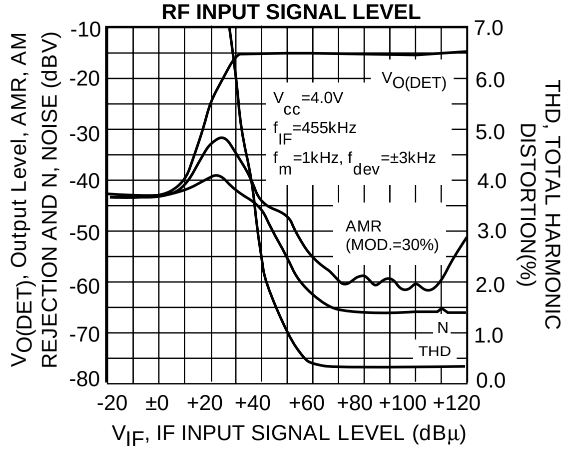
TYPICAL PERFORMANCE CHARACTERISTICS

9 - 1. Mixer + IF Section

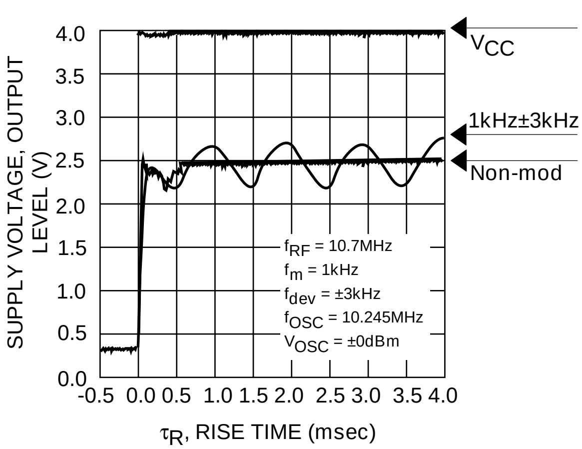
$V_{O(DET)}$, AMR, N, THD vs. RF INPUT SIGNAL LEVEL



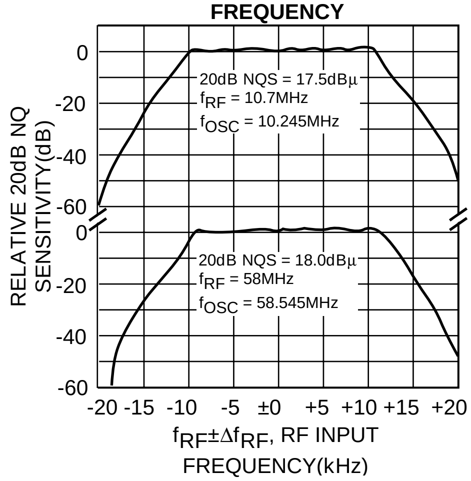
$V_{O(DET)}$, AMR, N, THD vs. RF INPUT SIGNAL LEVEL



TRANSIENT RESPONSE



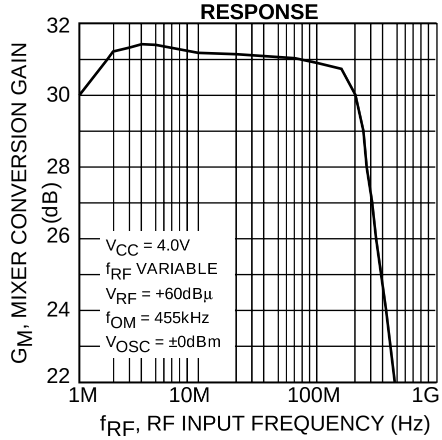
20dB NQS vs. RF INPUT FREQUENCY



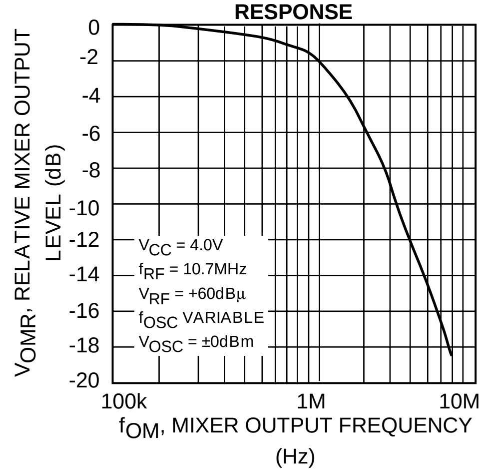
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

9 - 2. Mixer Section

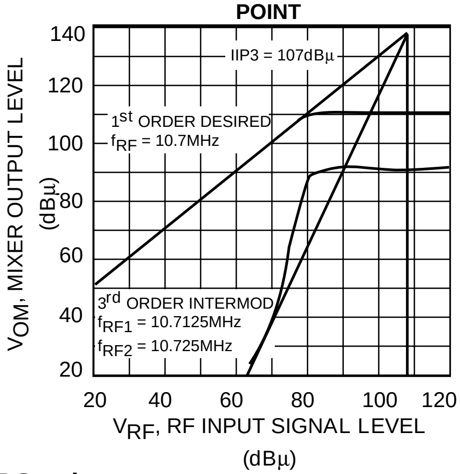
MIXER INPUT FREQUENCY RESPONSE



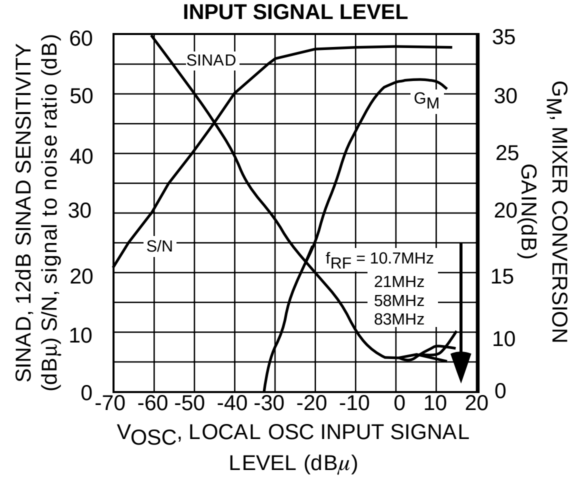
MIXER OUTPUT FREQUENCY RESPONSE



THE 3rd ORDER INTERCEPT POINT

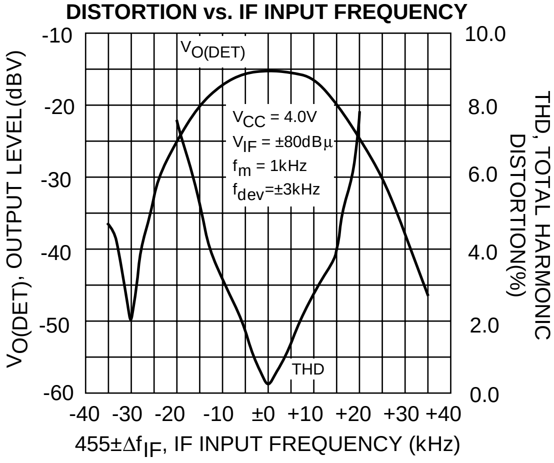


SINAD, G_M S/N vs. LOCAL OSC INPUT SIGNAL LEVEL

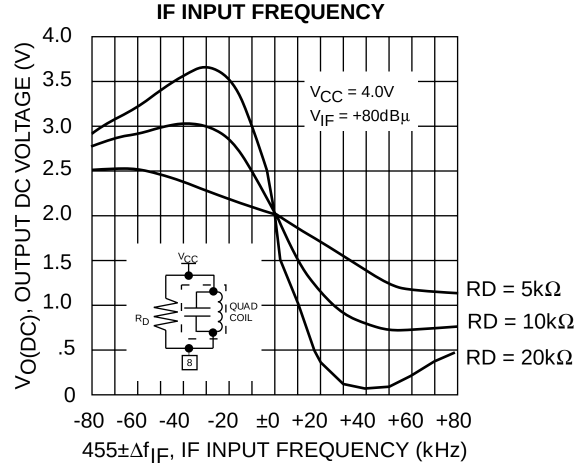


9 - 3. IF Section

OUTPUT LEVEL, TOTAL HARMONIC DISTORTION vs. IF INPUT FREQUENCY

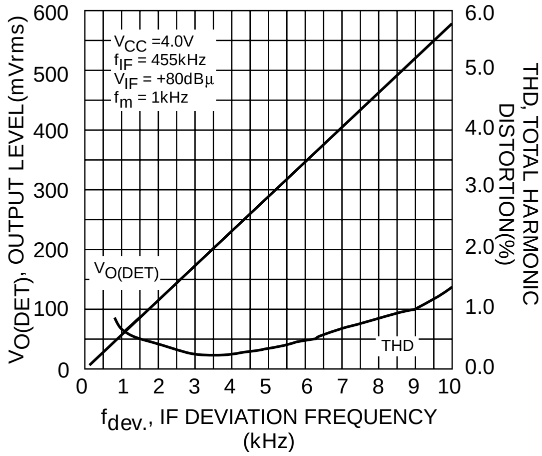


OUTPUT DC VOLTAGE vs. IF INPUT FREQUENCY

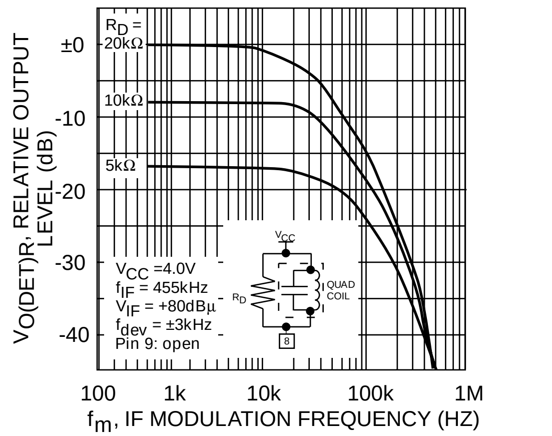


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

OUTPUT LEVEL, TOTAL HARMONIC DISTORTION vs. IF DEVIATION FREQUENCY

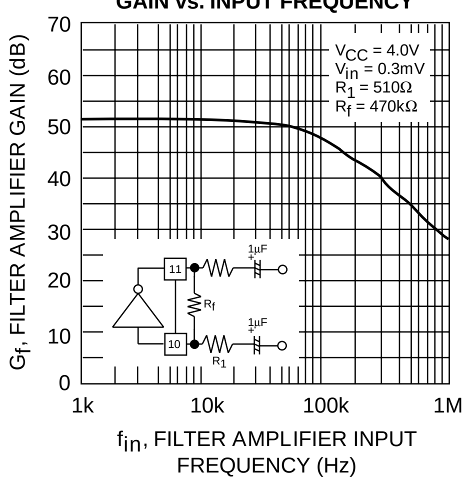


OUTPUT LEVEL vs. IF MODULATION FREQUENCY

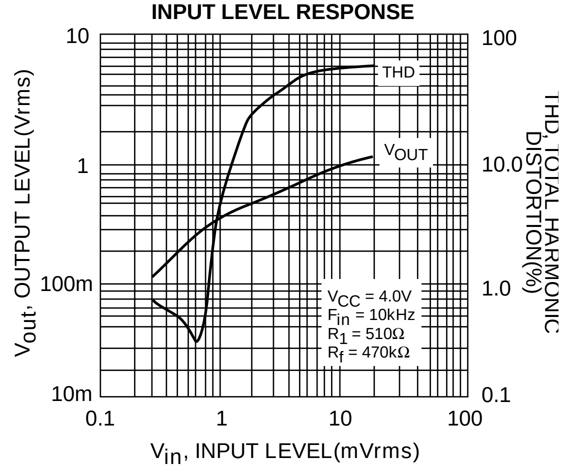


9 - 4. Filter Amplifer Section

GAIN vs. INPUT FREQUENCY

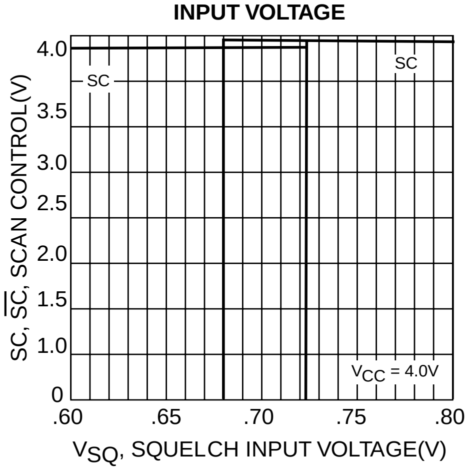


INPUT LEVEL RESPONSE



9 - 5. Squelch Section

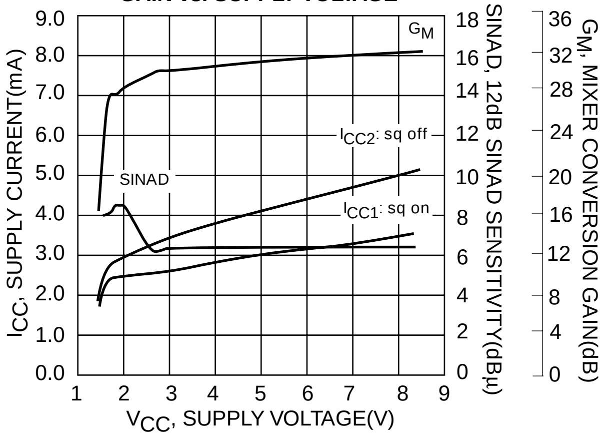
SCAN CONTROL vs. SQUELCH INPUT VOLTAGE



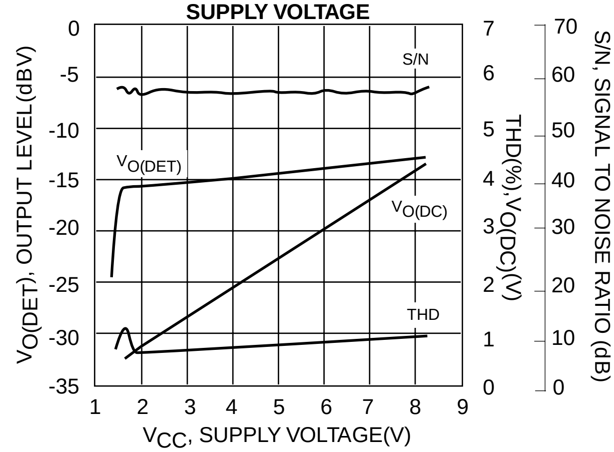
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

9 - 6. Versus Supply Voltage Characteristics

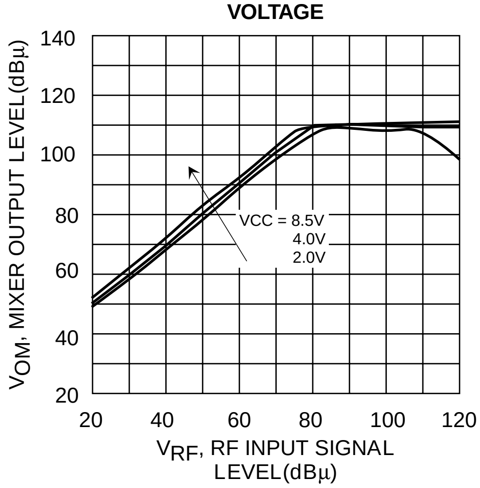
SUPPLY CURRENT, 12dB SINAD SENSITIVITY, MIXER CONVERSION GAIN vs. SUPPLY VOLTAGE



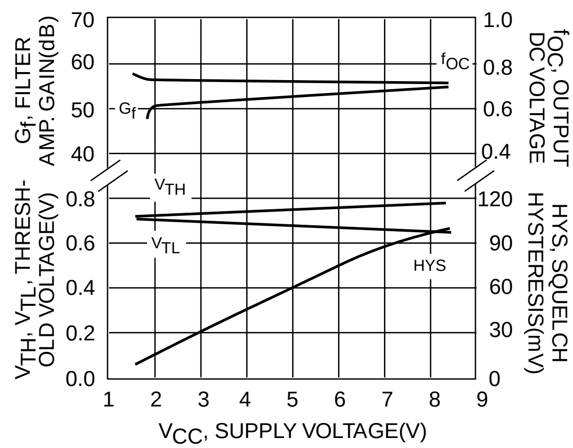
OUTPUT LEVEL, TOTAL HARMONIC DISTORTION, SIGNAL TO NOISE RATIO, OUTPUT DC VOLTAGE vs. SUPPLY VOLTAGE



MIXER OUTPUT LEVEL vs. SUPPLY VOLTAGE



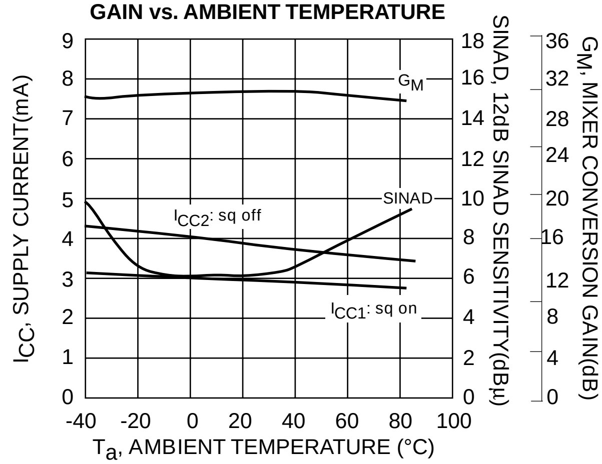
FILT. AMP. GAIN, FILT. AMP. OUTPUT DC VOLTAGE, THRESHOLD VOLTAGE, HYSTERESIS vs. SUPPLY VOLTAGE



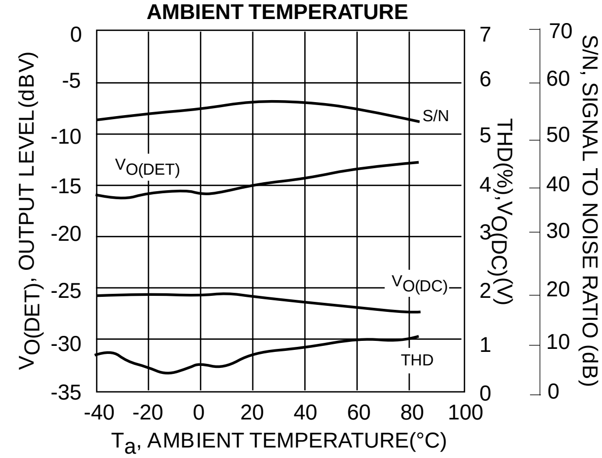
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

9 - 7. Versus Ambient Temperature Characteristics

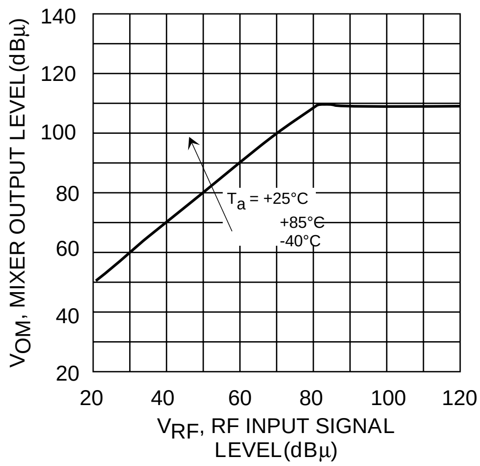
SUPPLY CURRENT, 12dB SINAD SENSITIVITY, MIXER CONVERSION GAIN vs. AMBIENT TEMPERATURE



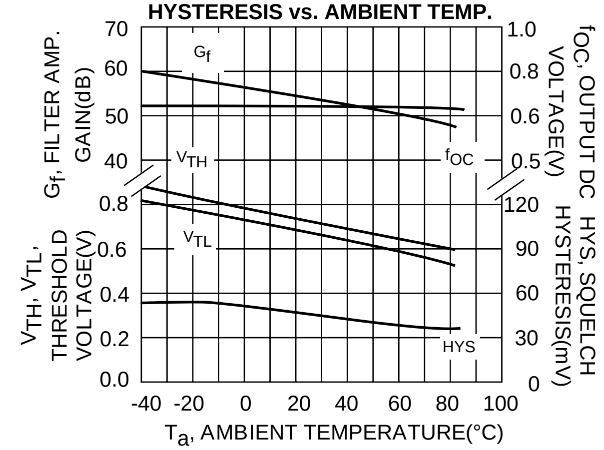
OUTPUT LEVEL, TOTAL HARMONIC DISTORTION, SIGNAL TO NOISE RATIO, OUTPUT DC VOLTAGE vs. AMBIENT TEMPERATURE



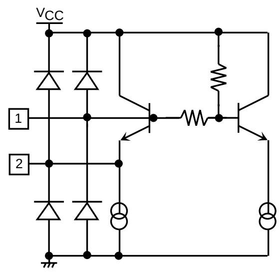
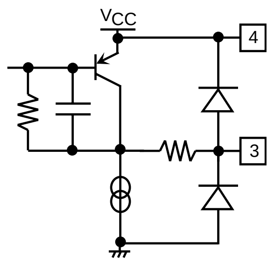
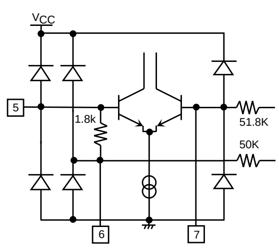
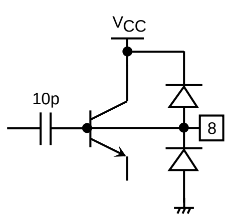
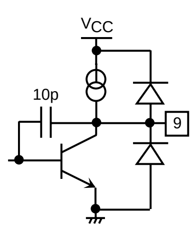
MIXER OUTPUT LEVEL vs. AMBIENT TEMPERATURE



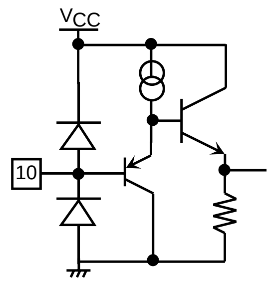
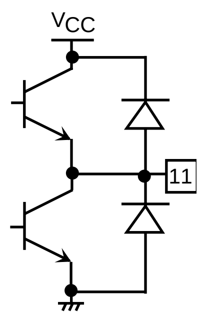
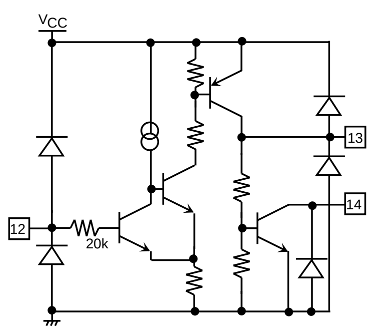
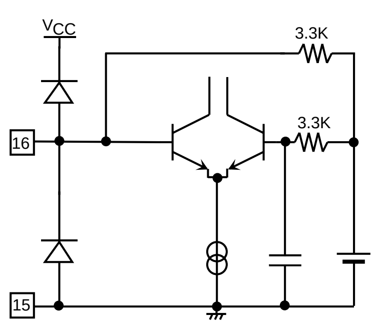
FILT. AMP. GAIN, FILT. AMP. OUTPUT DC VOLTAGE, THRESHOLD VOLTAGE, HYSTERESIS vs. AMBIENT TEMP.



PIN FUNCTION DESCRIPTION

PIN	SYMBOL	TERMINAL VOLTAGE (V)	INTERNAL EQUIVALENT CIRCUIT	DESCRIPTION
1 2	OSC(B) OSC(E)			The base of the Colpitts oscillator. The Colpitts oscillator is composed of Pin 1 and Pin 2. The emitter of the Colpitts oscillator. Using an external OSC source, local level must be injected into Pin 1, and Pin 2 must be opened.
3 4	MIXER OUT V_{CC}			Output of the Mixer. Supply Voltage.
5 6 7	IF INPUT DECOUPLE DECOUPLE			Input to the IF limiter amplifier. This pin is terminated by internal 1.8kW resistor. IF Decoupling. IF Decoupling
8	QUAD COIL			Phase Shifter.
9	AF OUTPUT			Recovered Audio Output

PIN FUNCTION DESCRIPTION (CONT.)

PIN	SYMBOL	TERMINAL VOLTAGE (V)	INTERNAL EQUIVALENT CIRCUIT	DESCRIPTION
10	FILTER AMPLIFIER INPUT			Filter Amplifier Input.
11	FILTER AMPLIFIER OUTPUT			Filter Amplifier Output.
12 13 14	SQUELCH INPUT SCAN CONTROL $\overline{\text{SCAN CONTROL}}$			Squelch Input. Scan Control. $\overline{\text{Scan Control}}$.
15 16	GND RF INPUT			Ground Mixer Input.

TEST BOARD

Figure 1: Solder Side View (Circuit Side View)

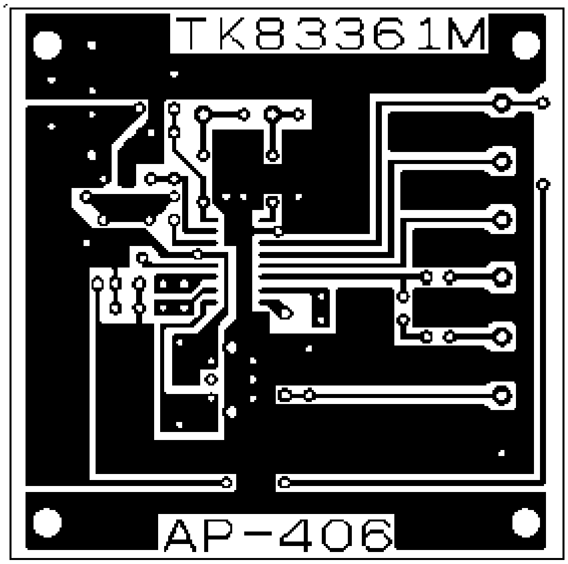
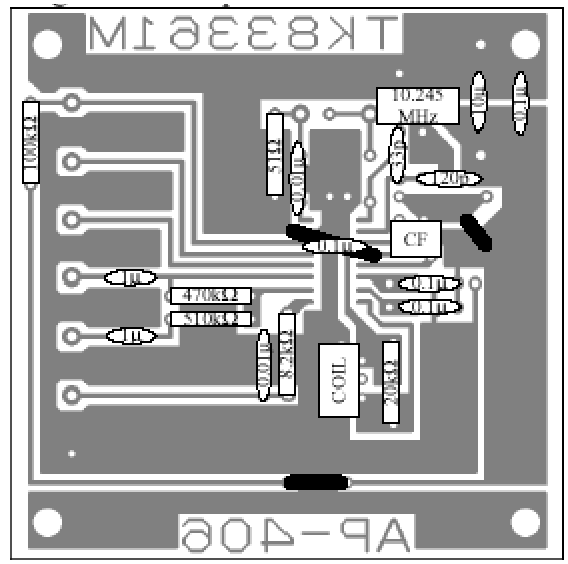


Figure 2: Component Placement View



NOTES:
1. Above test board is laid out for the TEST CIRCUIT (page 3).
2. Scale 1:1 (60mmx60mm)
3. 10.245MHz Fundamental mode crystal, about 30pF load.
4. 455kHz CF, TOKO Type BLFC455D or MURATA Type CFU455D2 or equivalent.
5. COIL, TOKO Type 7MCS-13546Z or 7MC-8128Z or equivalent.

APPLICATIONS INFORMATION

12-1. Mixer Section

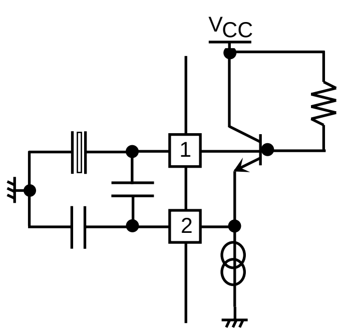
The mixer consists of a Gilbert cell and a local oscillator. The mixer conversion gain, when Pin 4 is terminated, is 28dB. The RF input is unbalanced.

12-1-1. A Local OSC

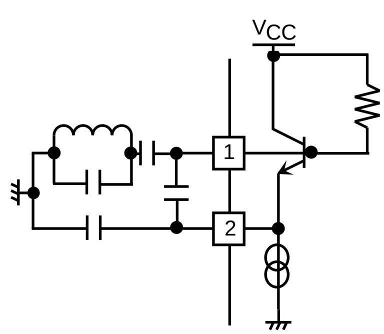
The oscillator included is a general Colpitts type OSC. The drive current of OSC is 200μA. Examples of components are shown in Fig. 3. The examples are explained in the next paragraph.

Figure 3: Oscillator Components

i) Under Crystal Control



ii) Parallel LC Components



APPLICATIONS INFORMATION (CONT.)

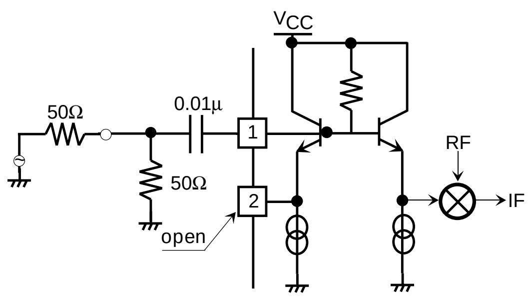
(1) Using an External Oscillator Source

The circuit composition using an external OSC source is shown in Fig. 4. When using an external OSC source instead of the internal OSC, the local level must be injected into Pin 1 by capacitor coupling.

In this case, Pin 2 must be open.

The local OSC operates as an emitter follower for a multiplier by opening Pin 2 and injecting into Pin 1.

Figure 4: External Injection

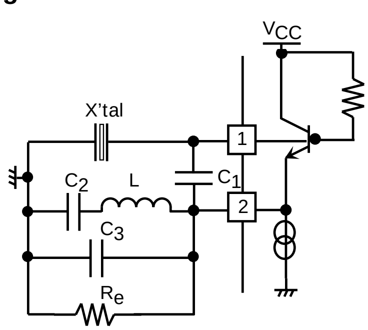


(2) For 3rd Overtone mode

In general, a crystal oscillator can oscillate in the fundamental mode and overtone mode. For example, it is easy for a 30MHz-overtone crystal to oscillate at 10MHz, fundamental mode. The reason is because the impedance of the fundamental mode is the same as the impedance of the overtone. Therefore, it is necessary for the circuit to select the overtone frequency by using a tuning coil.

How to oscillate a general 3rd overtone oscillator is explained. In the case of an overtone mode of 30MHz and higher, using a crystal oscillator, we recommend the circuit in Fig. 5 to suppress the fundamental mode oscillation.

Figure 5: Overtone Mode Circuit



The following explains how to decide the circuit constants of the overtone-crystal-oscillation fundamental circuit.

As the operating frequency increases the oscillation amplitude decreases because of a shortage of g_m of the oscillator. It is easy to increase the drive current by connecting resistor R_e between Pin 2 and GND. Being short of drive current, it makes g_m increase to increase the drive current by connecting external resistor R_e. In that case, the amount of drive current increase, Ie, is shown in Eq.(1).

$$Ie = \frac{V_{CC} - V_{BE}}{Re} = \frac{V_{CC} - 0.7}{Re} \qquad (1)$$

In order to oscillate at the 3rd overtone frequency, the values of C_2, C_3 and L (Fig.5) are selected. Fig.6 shows a 2-port impedance response of the C_2~C_3~L loop network.

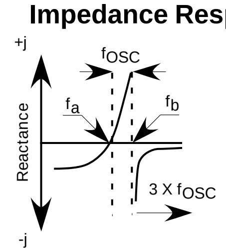
Regarding the condition of oscillation, the impedance characteristic is capacitive at the vacinity of the overtone frequency. It is reactive at the vicinity of the fundamental frequency.

The condition of oscillation is as follows:

f_{OSC} is between f_a and f_b,

3 x f_{OSC} is fb and higher. Please see Fig.6

Figure 6: 2-port Impedance Response of Resonance Network



Where:

f_a: series resonant freq.

f_b: parallel resonant freq.

f_{OSC}: fundamental mode freq.

3 x f_{OSC}: 3rd order overtone freq.

Equations of 3rd order overtone oscillation are shown below.

$$f_a = \frac{1}{2\pi\sqrt{LxC_2}}, \quad f_b = f_a\sqrt{1+\frac{C_2}{C_3}} \qquad (2)$$

The series value of the equivalent capacitance at the 3rd order overtone freq. of this network, which is decided in the above -mentioned, and the capacitance of C_1 must be equal to load capacitance C_L.

Being short of negative resistance of the circuit, increase the transistor's bias current by decreasing R_e. It is able to decide the OSC level for minute adjusting R_e. Please refer the most suitable OSC level range to 12dB SINAD sensitivity versus local OSC input signal level in TYPICAL PERFORMANCE CHARACTERISTICS. The saturating range is the most suitable OSC level range. It is comparatively easy to decide the circuit constant by examining it with a network analyzer.

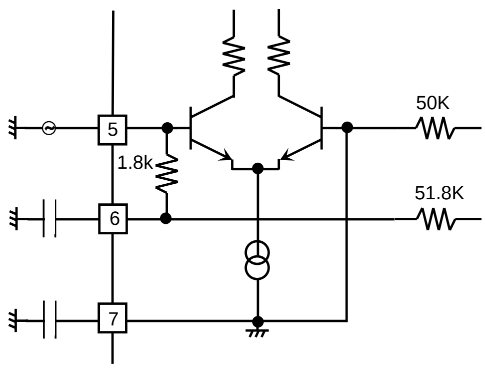
APPLICATIONS INFORMATION (CONT.)

12-2. IF Section

The IF section includes a 6 stage differential amplifier. The fixed internal input matching resistor is 1.8kΩ. The total gain of the limiting amplifier section is approximately 77dB.

The decoupling capacitors of Pin 6~7 must be connected as near as possible to the GND pin of the IC . And, make the impedance of the connecting-to-GND line to be as small as possible. If the impedance is not small enough, the sensitivities may worsen.

Figure 7: IF Limiter Amplifier Input Block



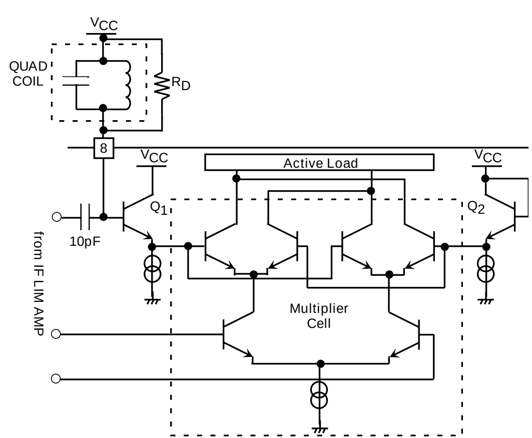
12-3. FM Demodulator

A quadrature FM demodulator using a Gilbert cell is included.

12-3-1. Internal Equivalent Circuit

The internal equivalent circuit is shown in Fig. 8.

Figure 8: Internal Equivalent Circuit of Demodulator



<u>Note at this point to add the bias voltage at Pin 8 from external source.</u>

The signal from the phase shifter is put into the multiplier cell through the emitter follower of transistor Q_1. Pin 8 is single-connected with the base terminal. And, it is necessary for Pin 8 to add the same voltage, as the base terminal of Q_2 of the opposite side of Q_1 through the multiplier is connected with the supply voltage.

If the base voltages differ between transistors Q_1 and Q_2, it alters the DC zero point or worsens the distortion of the demodulation output.

12-3-2. Phase Shifter

The IF signal from the limiter amplifier is provided with 90° phase shift and drives the quadrature detector.

The parallel RCL resonance circuit is capable of using the internal 10pF phase shift capacitor.

12-3-3. Audio Output

After quadrature detection, the audio signal is pulled out through Pin 9.

The required signal is pulled out through the LPF.

12-3-4. For Stable Operation

To prevent worsening the distortion, observe the following notes:

(1) Demodulated Output Voltage

Too large of a demodulated output voltage will worsen the distortion due to the dynamic range of the demodulator.

(2) The Signal Level in Phase Shifter (Pin 8)

If the phase shifter signal level is too small, the noise level grows worse. This will cause the distortion to grow worse.

(3) Band Width of Phase Shifter (Pin 8)

If the bandwidth of the phase shifter is narrower than IF bandwidth, including the demodulated element, the distortion will grow worse.

12-4. Filter Amplifier Section

An inverting op amp has an output at Pin 11 and the inverting input at Pin 10. The op amp, which has a wide stable operating temperature range, may be used as an active noise filter.

12-4-1. Active BPF Application

An active BPF application is shown in Fig. 9, and its Response is shown in Fig. 10.

APPLICATIONS INFORMATION (CONT.)

Figure 9. Active BPF

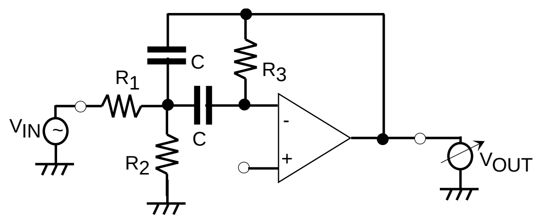
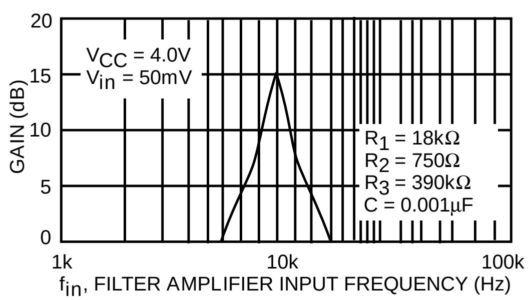


Figure 10. Frequency Response



Eq. (3) is formularized, where G_0 is the gain at center frequency f_0, and 3dB bandwidth $Q=f_0/BW$.

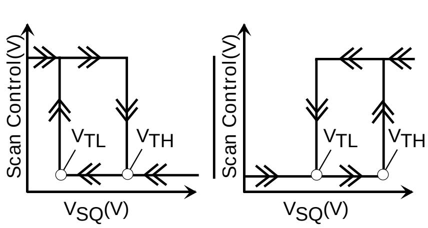
$$R_1 = \frac{R_3}{2G_0},\ R_2 = \frac{R_1R_3}{4Q^2R_1-R_3},\ R_3 = \frac{Q}{\pi f_0 C} \qquad (3)$$

12-5. Squelch Section

The output, which is controlled in accordance with the noise level from the rectifier, is injected into the squelch input pin. There is about 45mV of hysteresis at the Squelch Input to prevent jitter.

Figure 11. Squelch Output versus Squelch Input

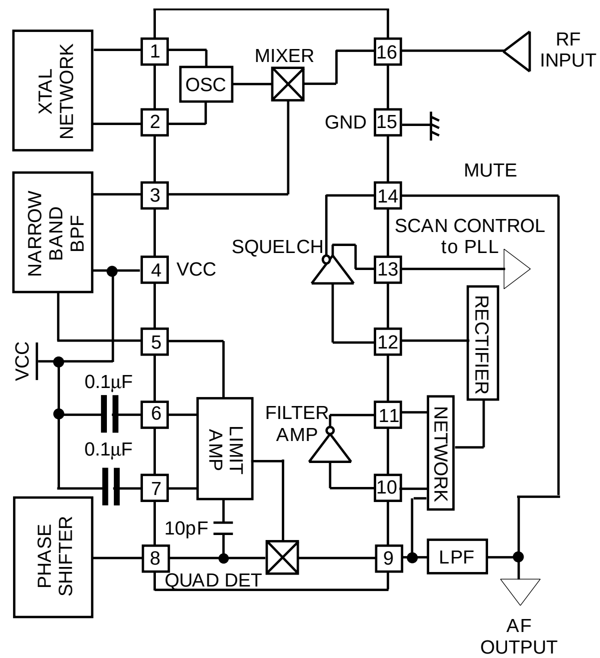
i) Pin 13 Output **ii) Pin 14 Output**



V_{TH} indicates the Hi threshold voltage, V_{TL} indicates the Lo threshold voltage in Fig. 11.

12-6. Application Example

Figure 12: Application Example Block Digram



12-7. Attentions to Layout Design

As this product is considered for stable operation, the mixer block and the other block that includes IF stage, OP amp and squelch are independent from each other. However in order to realize stable operation, please pay attention to the following, because of high frequency operation.

(1) Bypass Capacitor

A bypass capacitor must be connected with minimum distance between the V_{CC} pin and the GND pin.

(2) V_{CC}/GND Pattern

In order to make low impedance V_{CC}/GND lines, please keep the pattern as wide as possible.

(3) Pattern near Demodulator

Pattern layout around the phase shifter for demodulator: please keep as short as possible.

NOTES

WARNING - Life support applications policy.
TOKO, Inc. products shall not be used within any life support systems without the specific written consent of TOKO, Inc. A life support system is a product or system intended to support or sustain life which, if it fails, can be reasonably expected to result in a significant personal injury or death.

The contents of this application as of December 2000. The contents of this datasheet are subject to change without notice or stop manufacture.

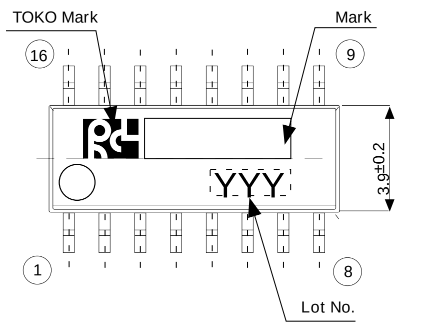
The circuits shown in this specification are intended to explain typical applications of the products concerned. Accordingly, TOKO, Inc. is not responsible for any circuit problems, or for any infringement of third party patents or any other intellectual property rights that may arise from the use of these circuits. Moreover, this specification dose not signify that TOKO, Inc. agrees implicitly or explicitly to license any patent rights or other intellectual property rights which it holds.

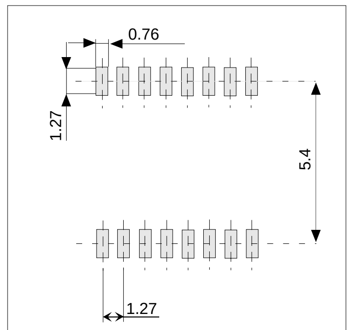
No Ozone Depleting Substances (ODS) were used in the manufacture of these parts.

Examples of characteristics given here are typical for each product and being technical data, these do not constitute a guarantee of characteristics or conditions of use.

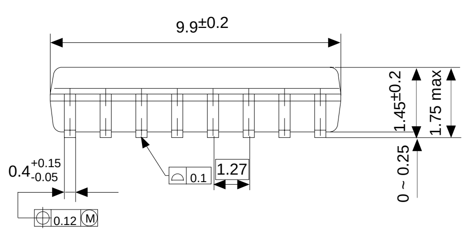
PACKAGE OUTLINE

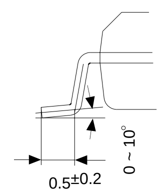
SOP-16

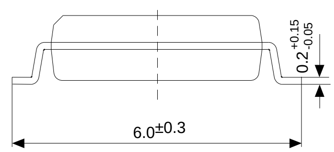




Recommended Mount Pad







Dimensions are shown in millimeters
Tolerance: x.x = ± 0.2 mm (unless otherwise specified)

Marking Information

	Marking
TK83361M	83361

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