IC DATABOOK

TOKO

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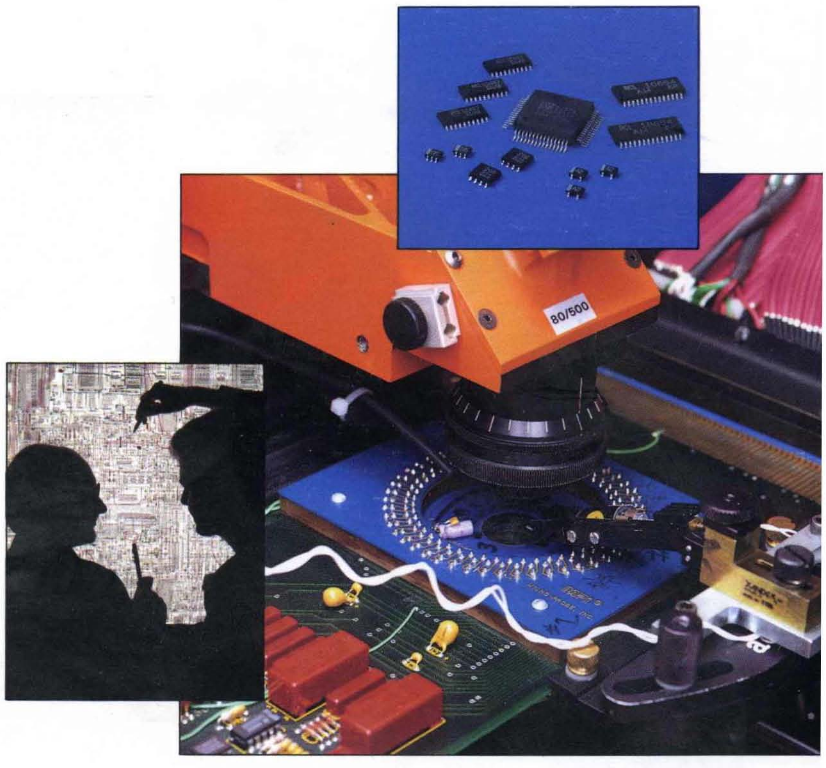
TOKO INTEGRATED CIRCUITS DATABOOK



TOKO

PREFACE

INTRODUCTION TO TOKO

Toko Inc., founded in 1955, is a worldwide manufacturer of electronic components, integrated circuits, assemblies and systems, and the world's largest manufacturer of coils and filters. Toko maintains 20 manufacturing operations in 9 countries, producing 2.5 billion individual components, assemblies and finished products annually. Our corporate mission, as demonstrated by our people, products and the partnerships we build, is to maintain flawless performance in our products through an unequalled commitment to quality.

TOKO'S INTEGRATED CIRCUITS

Toko has concentrated IC development in four distinct market segments: Consumer audio/video, RF communications, industrial/motion control and power control. Toko has chosen to focus on these segments as an extension of our expertise in developing components for numerous markets including communications, computers and peripherals, industrial and factory automation, broadcast and imaging. We believe that it is through this unique understanding of the other components that will populate your design, that we are able to deliver expertly designed linear integrated circuits that will address the needs of your application.

TOKO'S QUALITY COMMITMENT

Our commitment to quality products is illustrated by the numerous quality awards we have received from some of the world's largest and most discriminating corporations. This commitment is supported throughout every facet of our process, from design through all phases of production. At Toko, quality is designed in, built in, verified and delivered. In addition, our extensive research and development program carries forward our never-ending dedication to a higher level of integration, higher performance and overall added value for our customers.

ABOUT THIS DATA BOOK

We have compiled this data book to serve our customers as a single reference source of information on Toko's wide range of integrated circuits. Within these pages you will find complete technical information and specifications on our continually expanding product line.

We have tried to include all the information required to make an informed evaluation of our products. For additional clarification on any IC product, or to discuss unique product requirements which are not addressed within these pages, please contact the Toko Regional Sales Office nearest you. A complete listing of all Toko sales and applications centers is contained in the final chapter of this publication.

TOKO

TOKO, INC.

IC DATA BOOK

LIFE SUPPORT POLICY

TOKO'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF TOKO, INCORPORATED. As used herein:

a. Life support devices or systems are devices or systems which (1) are intended for surgical implant into the body, or (2) support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in a significant injury to the user.

b. A critical component is any component in a life support device or system whose failure can be reasonably expected to cause the failure of the life support device or system or to affect its safety or effectiveness.

Toko, Inc. • 1-17 Higashi-Yukigaya 2 chome, Ohta-ku, Tokyo, 145 Japan • Phone: (03) 727-1161 • Telex: J22696 • Fax: (03) 3728-4690

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CONSUMER AUDIO/VIDEO

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THREE-BAND GRAPHIC EQUALIZER

FEATURES

- ± 10 dB Boost/Cut Range
- Low Voltage Operation
- Low Current Drain for Battery Operation
- Two Independent Channels for Stereo
- Low Distortion
- Surface Mount Package

APPLICATIONS

- Head Phones
- Stereo Radios
- Tape Players
- Musical Instruments
- Effects Pedals
- Stereo Mixers

DESCRIPTION

The TK10581M is a low voltage three-band stereo graphic equalizer. The circuit is optimized for battery operation at 1.8 volts. Current consumption is typically 3 mA. The circuit can be used to implement a three-band audio equalizer in portable tape players, musical instruments, car stereos, mixers, effects pedals and other audio equipment. The TK10581 is configured for a ±10 dB boost/cut range. Features are low distortion (0.2%) and 40 dB ripple rejection.

The TK10581 is available in a MFP20 surface mount package.

ORDERING INFORMATION

TK10581 □ □ □□

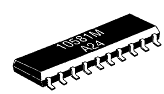
- Tape/Reel Code
- Temp. Range
- Package Code

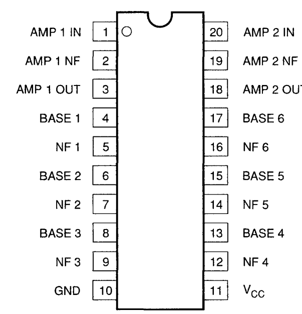
PACKAGE CODE
M: Surface Mount

TEMP. RANGE
C : -20 to +70 °C

TAPE/REEL CODE
BX: Bulk/Bag
TX: Paper Tape
TR: Tape Right
TL: Tape Left
MG: Magazine

TK10581M





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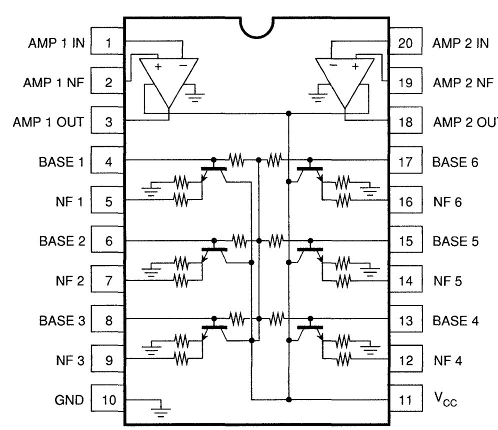

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 6 V
Power Dissipation (Note 1) .... 350 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +125 °C
Operating Temperature Range .... -20 to +70 °C
Lead Soldering Temp. (10 sec.) .... 240 °C
Operating Voltage Range .... 1.8 to 5.0 V

ELECTRICAL CHARACTERISTICS

Test Conditions: T_A = 25 °C, V_{CC} = 3 V

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Circuit Current			3.0	4.5	mA
V_{OMAX}	Max Output Voltage	THD = 1%, All Flat	500	600		mV
THD	Distortion	V_{IN} = 80 mV, All Flat		0.05	0.2	%
V_G	Voltage Gain	V_{IN} = 80 mV, All Flat	-3.2	-0.7	+2.0	dB
CR	Control Range	V_{IN} = 80 mV	±8.0	±10	±12.0	dB
RR	Ripple Rejection	F_{IN} = 100 Hz, V_{RIN} = 100 mVp-p Input Terminal Open	-35	-40		dB

Note 1: Power dissipation must be derated at the rate of 3.5 mW/°C for operation at T_A = 25 °C and above.

NOTES

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FIVE-BAND GRAPHIC EQUALIZER

FEATURES

- Low Voltage Operation (1.6 - 5 V)
- Low Current Drain for Battery Operation
- Two Independent Channels for Stereo
- Low Distortion (0.2%)
- ±10 dB Boost/Cut Range
- 40 dB Ripple Rejection
- Surface Mount Package

DESCRIPTION

The TK10585M is a low voltage five-band stereo graphic equalizer. The circuit is optimized for battery operation at 1.8 volts. Current consumption is typically 3.6 mA. The circuit can be used to implement a five-band audio equalizer in portable tape players, musical instruments, car stereos, mixers, effects pedals and other audio equipment. The TK10585 is configured for a ±10 dB boost/cut range. The main features are low distortion (0.2%) and 40 dB ripple rejection. The input amplifier is biased at 1/2 V_{CC}, thereby improving dynamic range.

The TK10585 is available in a MFP28 surface mount package.

ORDERING INFORMATION

TK10585 □ □ □□

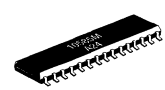
- Tape/Reel Code
- Temp. Range
- Package Code

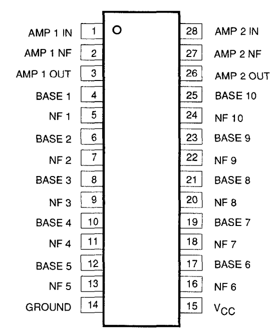
PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +70 °C	BX: Bulk/Bag
		TX: Paper Tape
		TR: Tape Right
		TL: Tape Left
		MG: Magazine

APPLICATIONS

- Head Phones
- Stereo Radios
- Tape Players
- Musical Instruments
- Effects Pedals
- Stereo Mixers

TK10585M





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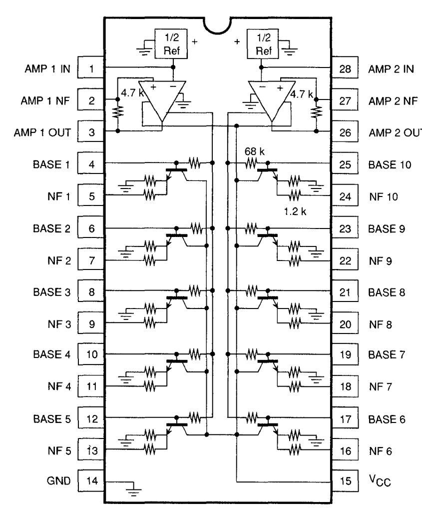


ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 6 V
Power Dissipation (Note 1) .... 350 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +125 °C
Operating Temperature Range .... -20 to +70 °C
Lead Soldering Temp. (10 sec.) .... 240 °C
Operating Voltage Range .... 1.6 to 5.0 V

ELECTRICAL CHARACTERISTICS

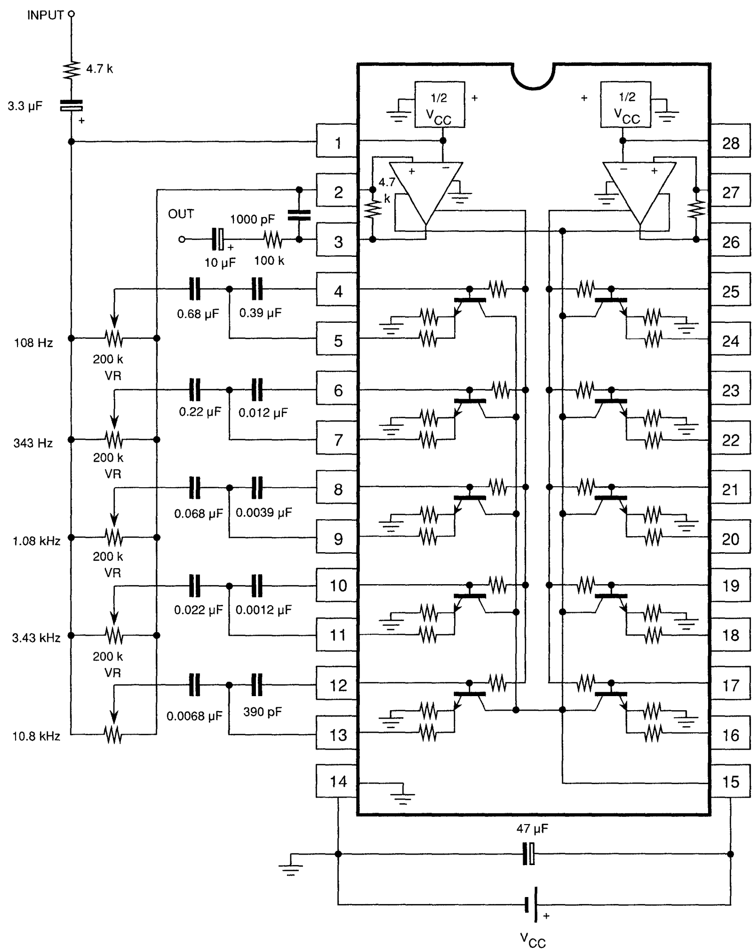
Test conditions: T_A = 25 °C, V_{CC} = 3 V, f = 1 kHz

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Circuit Current			3.6	4.7	mA
V_{OMAX}	Max Output Voltage	THD = 1%, All Flat	500	600		mV
THD	Distortion	V_{IN} = 80 mV, All Flat		0.05	0.2	%
V_G	Voltage Gain	V_{IN} = 80 mV, All Flat	-3.2	-0.7	+2.0	dB
CR	Control Range	V_{IN} = 80 mV	±8.0	±10	±12.0	dB
RR	Ripple Rejection	F_{IN} = 100 Hz, V_{RIN} = 70 mVp-p Input Terminal Open	-35	-40		dB

Note 1: Power dissipation must be derated at the rate of 3.5 mV/°C for operation at T_A = 25 °C and above.

NOTES

TEST CIRCUIT



NOTES

FIVE-BAND GRAPHIC EQUALIZER

FEATURES

- Low Voltage Operation (1.6 - 5 V)
- Low Current Drain for Battery Operation
- Two Independent Channels for Stereo
- Low Distortion (0.2%)
- ±10 dB Boost/Cut Range
- Surface Mount Package

APPLICATIONS

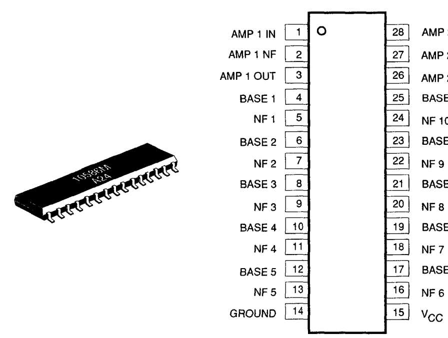
- Head Phones
- Stereo Radios
- Tape Players
- Musical Instruments
- Effects Pedals
- Stereo Mixers

DESCRIPTION

The TK10586M is a low voltage five-band stereo graphic equalizer. The circuit is optimized for battery operation at 1.8 volts. Current consumption is typically 3.6 mA. The circuit can be used to implement a five-band audio equalizer in portable tape players, musical instruments, car stereos, mixers, effects pedals and other audio equipment. The TK10586 is configured for a ±10 dB boost/cut range. The main feature is low distortion (0.2%).

The TK10586 is available in a MFP28 surface mount package.

TK10586M



ORDERING INFORMATION

TK10586 ☐ ☐ ☐☐

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +70 °C	BX: Bulk/Bag TX: Paper Tape TR: Tape Right TL: Tape Left MG: Magazine

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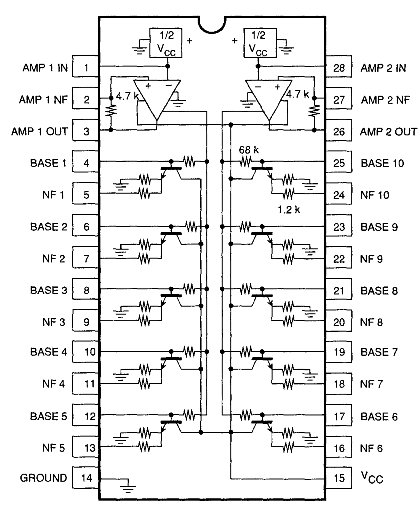


ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CCMAX} .... 6.0 V
Power Dissipation (Note 1) .... 350 mW
Operating Temperature Range .... -20 to +70 °C
Storage Temperature Range .... -55 to +125 °C
Operating Voltage Range .... 1.6 to 5.0 V
Junction Temperature .... 150 °C
Lead Soldering Temp. (10 sec.) .... 240 °C

ELECTRICAL CHARACTERISTICS

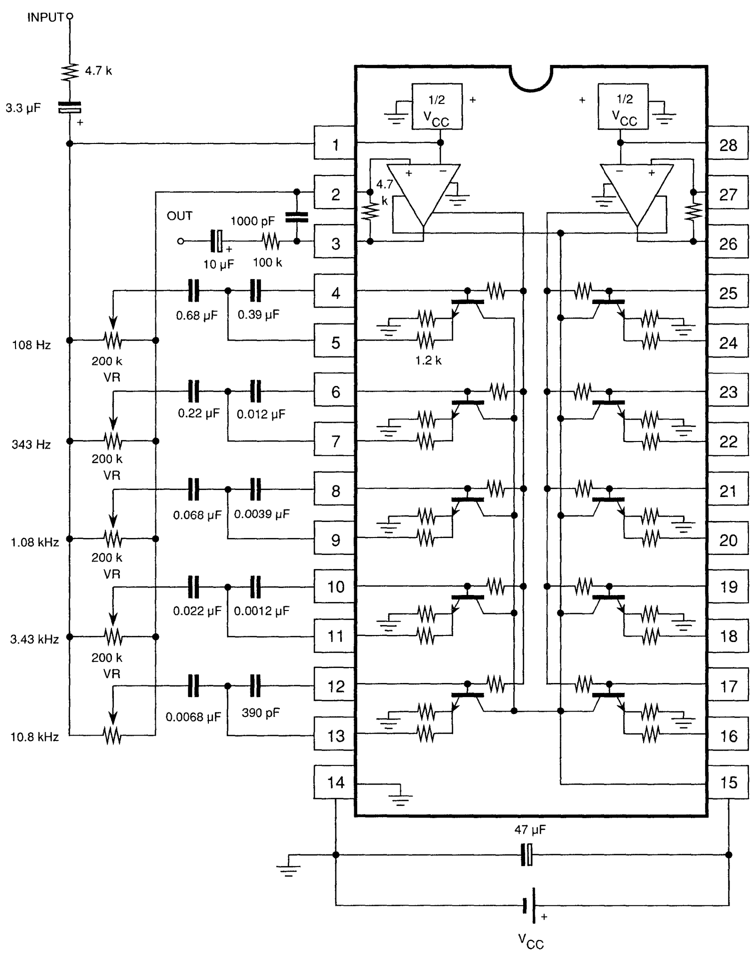
Test conditions: V_{CC} = 3 V, T_A = 25 °C, f = 1 kHz

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Circuit Current			3.6	4.7	mA
V_{OMAX}	Maximum Output Voltage	THD = 1%, All Flat	600	850		mA
THD	Total Harmonic Distortion	V_{IN} = 80 mV, All Flat		0.05	0.2	%
V_G	Voltage Gain	V_{IN} = 80 mV, All Flat	-3.2	-0.7	+2.0	dB
CR	Control Range	V_{IN} = 80 mV	±8.0	±10	±12.0	dB
RR	Ripple Rejection	f_{IN} = 100 Hz, V_{IN} = 70 mVp-p		-10		dB

Note 1: Power dissipation must be derated at the rate of 3.5 mV/°C for operation at T_A = 25 °C and above.

NOTES

TEST CIRCUIT



NOTES

FIVE-BAND GRAPHIC EQUALIZER

FEATURES

- Low Voltage Operation
- Low Current Drain for Battery Operation
- Two Independent Channels for Stereo
- Low Distortion
- ±10 dB Boost/Cut Range
- Surface Mount Package

APPLICATIONS

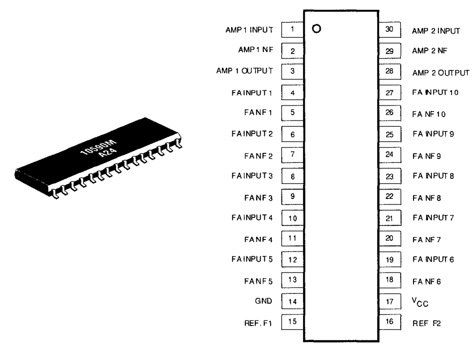
- Head Phones
- Stereo Radios
- Tape Players
- Musical Instruments
- Effects Pedals
- Stereo Mixers

DESCRIPTION

The TK10590M, is a low voltage five-band stereo graphic equalizer. The circuit is optimized for battery operation at 1.8 volts. Current consumption is typically 3 mA. The circuit can be used to implement a five-band audio equalizer in portable tape players, musical instruments, car stereos, mixers, effects pedals and other audio equipment. The TK10590 is configured for a ±10 dB boost/cut range. The main features are low distortion (0.2%) and 40 dB ripple rejection.

The TK10590 is available in a MFP30 surface mount package.

TK10590M



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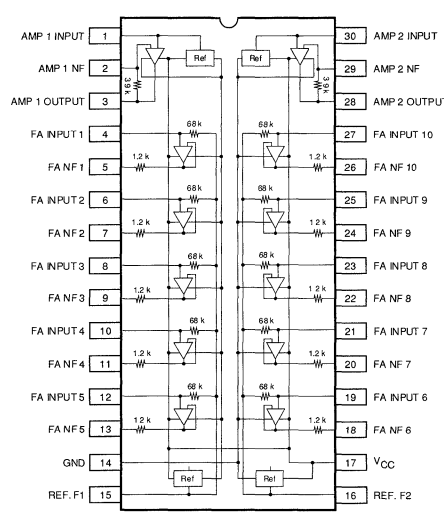


ORDERING INFORMATION

TK10590 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE
M: Surface Mount

TEMP. RANGE
C : -20 to +70 °C

TAPE/REEL CODE
BX: Bulk/Bag
TR: Tape Right
TL: Tape Left
MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 4 V
Power Dissipation (Note 1) .... 400 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +70 °C
Lead Soldering Temp. (3 to 5 sec.) .... 235 °C

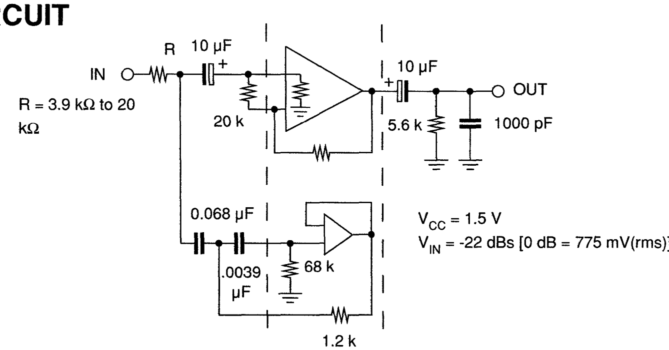
ELECTRICAL CHARACTERISTICS

Test conditions: T_A = 25 °C, V_{CC} = 1.5 V, F = 1.08 kHz

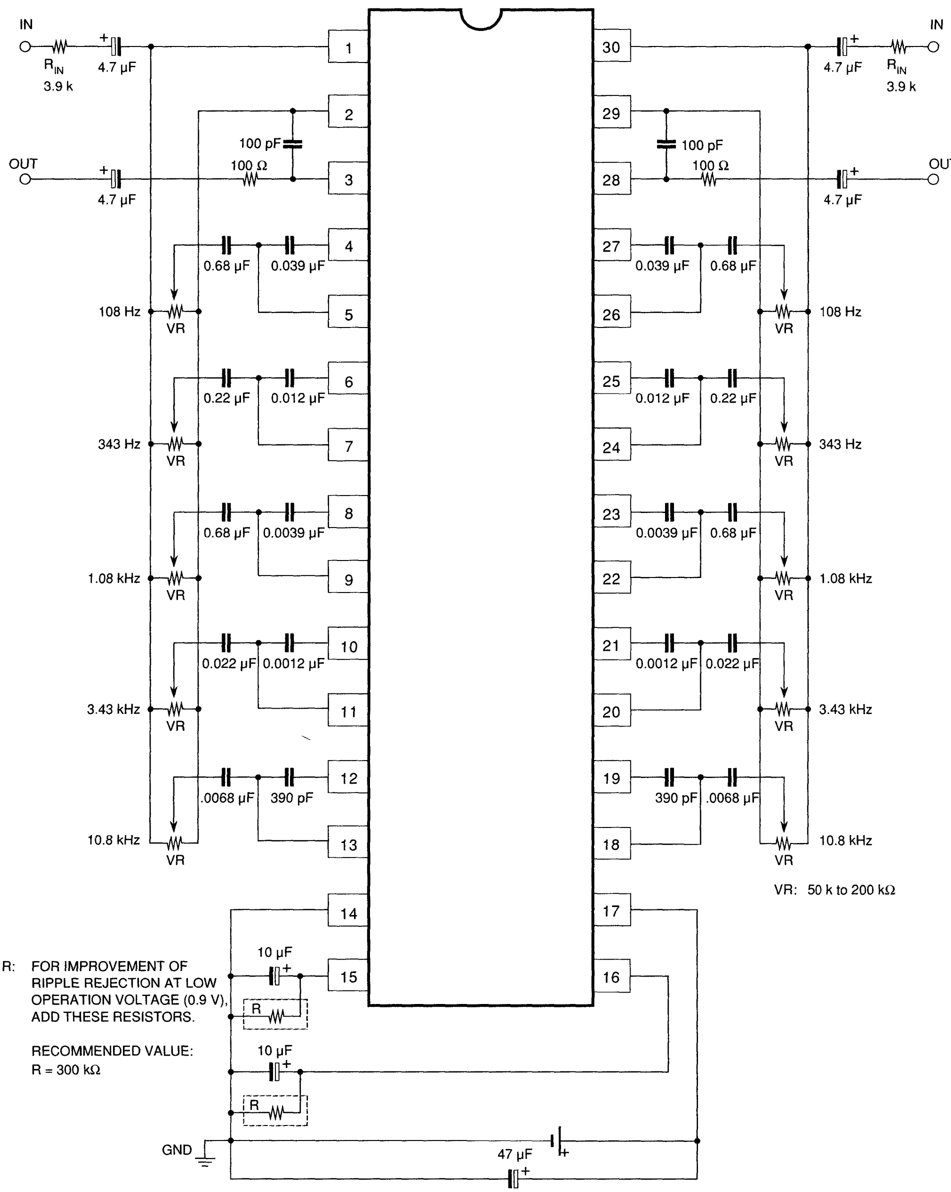
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Circuit Current			2.8	4.5	mA
V_{OMAX}	Max. Output Voltage	THD = 1%, All Flat	140	160		mVrms
V_G	Voltage Gain	V_{IN} = -28 dBs, All Flat	-2.2	-0.7	+1.5	dB
THD.F	Distortion (Flat)	V_{IN} = -28 dBs, All Flat		0.05	0.3	%
THD.B	Distortion (Boost)	V_{IN} = -28 dBs, 1.08 kHz, VR Boost		0.3	1.5	%
THD.C	Distortion (Cut)	V_{IN} = -28 dBs, 1.08 kHz, VR Cut		0.3	1.5	%
CR	Control Range	V_{IN} = -28 dBs, 1.08 kHz, Control	±8.0	±10	±12.0	dB
Ripple Rejection						
R.R F	(All Flat)	f R_{IN} = 100 Hz Input	-50			dB
R.R B	(All Boost)	Terminal 300 Ω	-50			dB
R.R C	(All Cut)	Short VR_{IN} = -30 dBs	-50			dB
NL	Noise Level	All Flat, Input Terminal, 300 Ω, Short D_{IN} Audio (Note 2)	-100	-105		dBs

Note 1: Power dissipation must be derated at the rate of 3.2 mV/°C for operation at T_A = 25 °C and above.
Note 2: 0 dBs = 775 mV(rms)

PARTIAL TEST CIRCUIT



TYPICAL APPLICATION

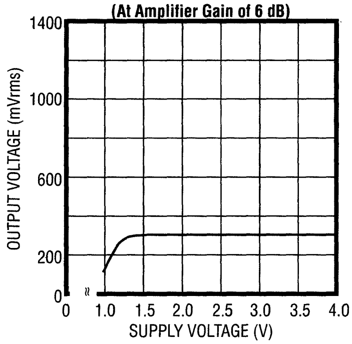


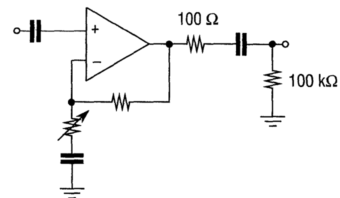
R: FOR IMPROVEMENT OF RIPPLE REJECTION AT LOW OPERATION VOLTAGE (0.9 V), ADD THESE RESISTORS.

RECOMMENDED VALUE:
R = 300 kΩ

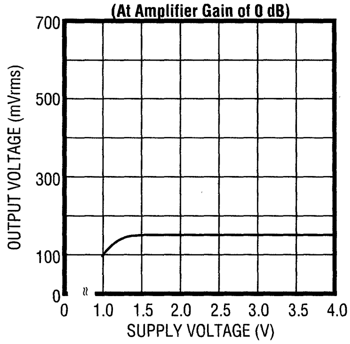
TYPICAL PERFORMANCE CHARACTERISTICS

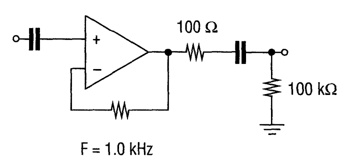
MAXIMUM OUTPUT VOLTAGE VS. SUPPLY VOLTAGE (At Amplifier Gain of 6 dB)



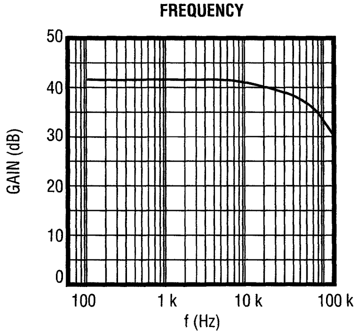


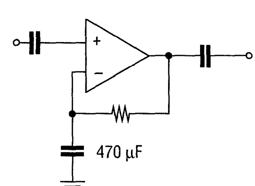
MAXIMUM OUTPUT VOLTAGE VS. SUPPLY VOLTAGE (At Amplifier Gain of 0 dB)





MAIN AMPLIFIER GAIN VS. FREQUENCY

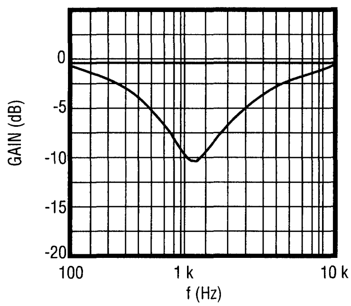




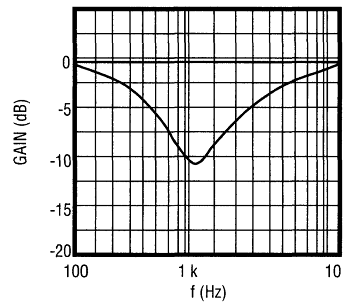
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

For the Value of R, please see the Test Circuit on page 1-12.

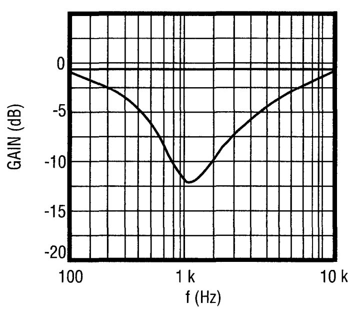
GAIN VS. FREQUENCY
R = 3.9 kΩ



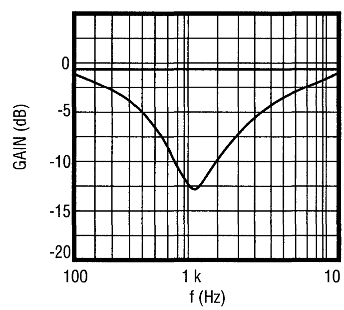
GAIN VS. FREQUENCY
R = 4.7 kΩ



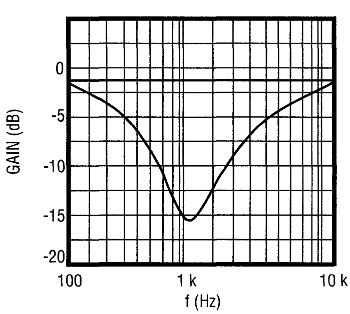
GAIN VS. FREQUENCY
R = 6.2 kΩ



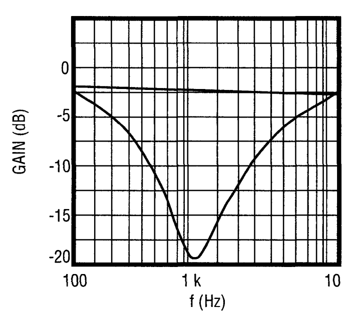
GAIN VS. FREQUENCY
R = 8.2 kΩ



GAIN VS. FREQUENCY
R = 10 kΩ



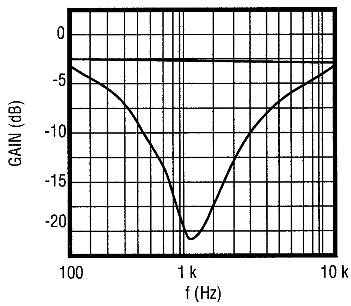
GAIN VS. FREQUENCY
R = 13 kΩ



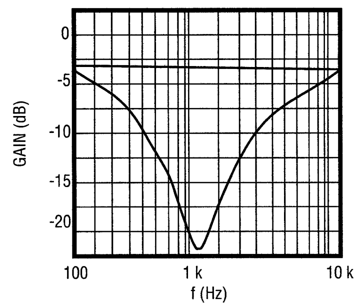
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

For the Value of R, please see the Test Circuit on page 1-12.

GAIN VS. FREQUENCY
R = 18 kΩ



GAIN VS. FREQUENCY
R = 20 kΩ



NOTES

TOKO

TK10650

LOW CURRENT COMPANDOR

FEATURES

- Low Supply Current
- Wide Operating Voltage
- Low Standby Current
- Microphone Amplifier
- Instantaneous Deviation Control Circuit

APPLICATIONS

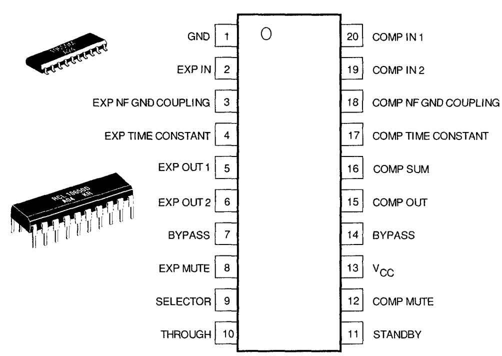
- Portable Instrumentation
- Cordless Telephones
- Handy Talkies
- Interphones

DESCRIPTION

TK10650 is a noise reduction IC developed mainly for cordless telephones. It has a built-in compressor circuit to increase the average modulation level and an expander circuit to reduce the noise level. The expander restores the original dynamics of the input signal and provides high quality signal transmission and low noise. Among many functions included, analog switching of the input and output signals are particularly useful in cordless telephones.

The TK10650 is available in both a dual in-line DIP20 and a MFP20 surface mount packages.

TK10650



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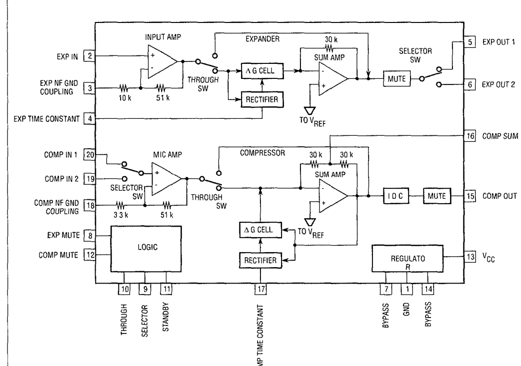


ORDERING INFORMATION

TK10650 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE
M: Surface Mount
D: Plastic DIP

TEMP. RANGE
C : -20 to +70 °C

TAPE/REEL CODE
BX: Bulk/Bag
TX: Paper Tape
TR: Tape Right
TL: Tape Left
MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 10 V
Operating Voltage Range .... 3.0 to 7.0 V
Power Dissipation, D Type (Note 1) .... 1000 mW
Power Dissipation, M Type (Note 2) .... 410 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 3.0 V, f = 1.0 kHz, R_L = 1.0 kΩ, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Current Consumption	No signal		3.5	5.5	mA
I_{STBY}	Standby Current Consumption	11 Pin Open		0.1	10	µA
V_{TH}	Through Voltage	8, 9, 10, 12 Pin	1.15	1.3	1.45	V
Compressor						
Z_{INC}	Input Impedance		90	120		kΩ
V_{INC}	Input Standard Level	V_{OC} = 300 mV(rms) (Note 3)	8	12	17	mV(rms)
V_{OC1}	Output Level 1	$V_{IN} = V_{INC}$ = 0 dB (Note 3)		0		dB
V_{OC2}	Output Level 2	V_{IN} = -20 dB (Note 3)	-10.5	-10	-9.5	dB
V_{OC3}	Output Level 3	V_{IN} = -40 dB (Note 3)	-21.0	-20	-19.0	dB
ΔG_{TC}	Through On/Off Difference	V_{OC} = 300 mV(rms) 10 Pin GND	0	1.5	3.0	dB
THD_C	Total Harmonic Distortion	V_{OC} = 300 mV(rms)		0.5	1.0	%
V_{NC}	Output Noise Voltage	Rg = 600 Ω (Note 3)		3.0	4.5	mV(rms)
Δ_{FC}	Frequency Characteristics	V_{OC} = 300 mV, F_{IN} = 200 ~5 kHz	-0.5	0	+0.5	dB
A_{TTC}	Mute Attenuation	V_{OC} = 300 mV(rms) 12 Pin GND	50	80		dB
V_{LIMC}	Limiting Voltage	IDC Circuit	1.10	1.25	1.40	Vp-p
ΔG_{CC}	Interchannel Gain Difference	V_{OC} = 300 mV(rms), 9 Pin GND	-1.0	0	+1.0	dB

Note 1: Power dissipation must be derated at the rate of 8 mW/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 3.3 mW/°C for operation at T_A = 25 °C and above.
Note 3: Measured using an estimated noise filter as recommended on CCITT page 53.

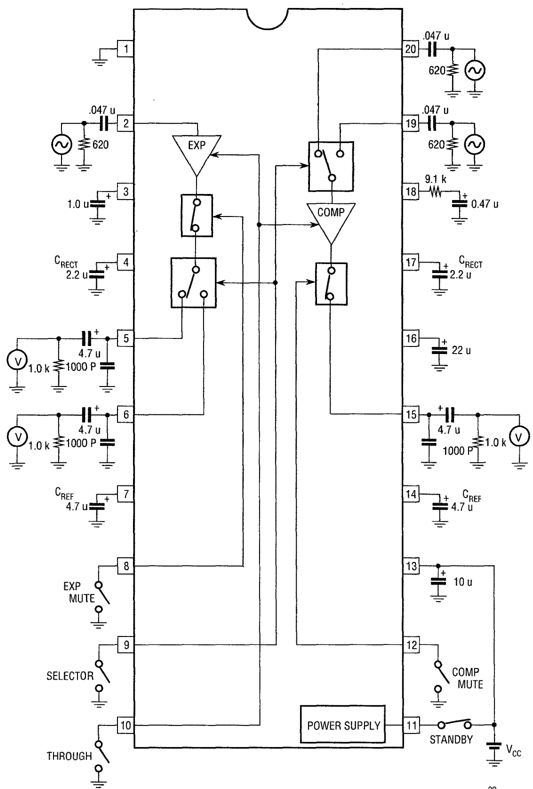
ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 3.0 V, f = 1.0 kHz, R_L = 1.0 kΩ, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Expander						
Z_{INE}	Input Impedance		90	120		kΩ
V_{OE}	Output Standard Level	V_{INE} = 30 mV(rms) (Note 3)	90	130	160	mV(rms)
V_{OE1}	Output Level 1	V_{INE} = 30 mV(rms) = 0 dB (Note 3)		0		dB
V_{OE2}	Output Level 2	V_{INE} = -10 dB (Note 3)	-20.5	-20	-19.5	dB
V_{OE3}	Output Level 3	V_{INE} = -20 dB (Note 3)	-41.0	-40	-39.0	dB
V_{OE4}	Output Level 4	V_{INE} = -30 dB (Note 3)	-61.0	-60	-58.0	dB
ΔG_{TE}	Through On/Off Difference	V_{INE} = 30 mV(rms),	-3.0	-1.5	0	dB
		10 Pin GND				
THD_E	Total Harmonic Distortion	V_{INE} = 30 mV(rms)		0.5	1.0	%
V_{NE}	Output Noise Voltage	Rg = 600 Ω		10	30	µV(rms)
Δ_{FE}	Frequency Characteristics	V_{INE} = 30 mV, F_{IN} = 200 ~5 kHz	-0.5	0	+0.5	dB
A_{TTE}	Mute Attenuation	V_{INE} = 30 mV(rms), 8 Pin GND	60	80		dB
V_{OMAX}	Maximum Output Voltage	THD = 10 %	500	600		mV(rms)
ΔG_{CE}	Interchannel Gain Difference	V_{INE} = 30 mV(rms), 9 Pin GND	-1.0	0	+1.0	dB
Compandor						
ΔG1	Gain Error 1	V_{INC} = +5 ~ -40 dB	-2.0	0	+1.5	dB
ΔG2	Gain Error 2	V_{INC} = -40 ~ -45 dB	-3.5	0	+2.0	dB
ΔG3	Gain Error 3	V_{INC} = -45 ~ -50 dB	-5.0	0	+2.0	dB
ΔG4	Gain Error 4	V_{INC} = -50 ~ -60 dB		0	+2.0	dB

Note 3: Measured using an estimated noise filter as recommended on CCITT page 53.

TEST CIRCUIT



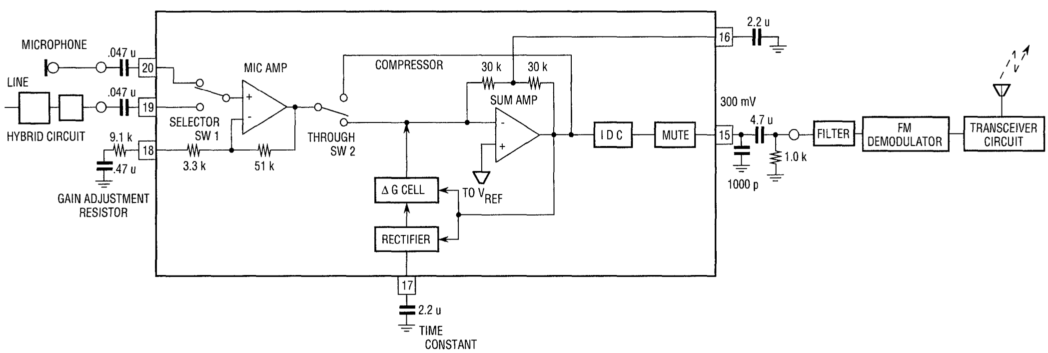
PIN NUMBER	PIN NAME	PIN VOLTAGE	PIN NUMBER	PIN NAME	PIN VOLTAGE
1	GND	0 V	11	Standby	V_{CC}
2	Exp IN	1.5 V	12	Mute C	1.4 V
3	G_C	1.5 V	13	V_{CC}	V_{CC}
4	T_C	0.7 V	14	V_{REF} C	1.5 V
5	Exp Out 1	1.5 V	15	Comp Out	1.5 V
6	Exp Out 2	1.5 V	16	DCF	1.5 V
7	V_{REF} E	1.5 V	17	T_C	0.7 V
8	Mute E	1.4 V	18	G_C	1.5 V
9	Selector	1.4 V	19	Comp IN 2	1.5 V
10	Through	1.4 V	20	Comp IN 1	1.5 V

APPLICATION INFORMATION

COMPRESSOR

The TK10650 is optimized for use in cordless telephones with speakers. It has two inputs: a "Line" input and a "Microphone" input. The latter receives its signal from the speaker which also functions as a microphone. This signal is amplified by the internal microphone amplifier and fed to the compressor circuit. The microphone amplifier gain can be changed by the adjustment of an external resistor. Microphones with different output voltages can be used.

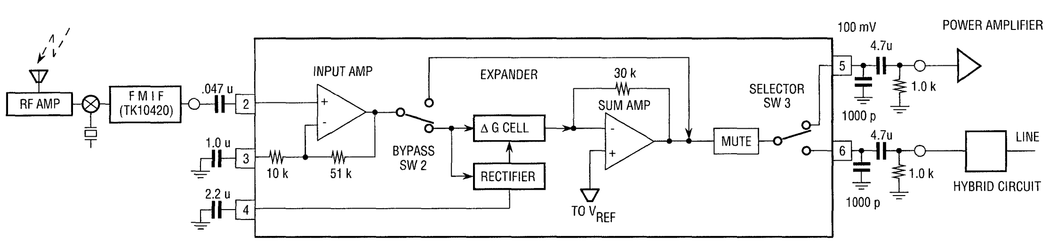
The compressor linearly compresses the input signal by a factor of 2:1 in dB, and then passes it through the Instantaneous Deviation Control (IDC) and the demodulator. In order to prevent overmodulation, the IDC can restrain the frequency deviation to ±4.5 kHz, which is1.5 times the average modulation (±3.0 kHz). In other words, it is not necessary to add an automatic deviation controller.



EXPANDER (FOR A CORDLESS TELEPHONE BASE UNIT)

After the signal is received, demodulated, and amplified, it is fed to the expander. (The input amplifier gain can be adjusted.)

The expander linearly expands the input signal by a 1:2 ratio in dB, and then forwards it either through the external hybrid circuit to the LINE output or through the power amplifier to the speaker, depending on the selector switch (SW3) position.



APPLICATION INFORMATION (CONT.)

MUTE

Independent muting circuits are built into the compressor and expander, allowing unnecessary transmission or reception to be prevented. The attenuation in muted mode is 60 dB or greater.

THROUGH

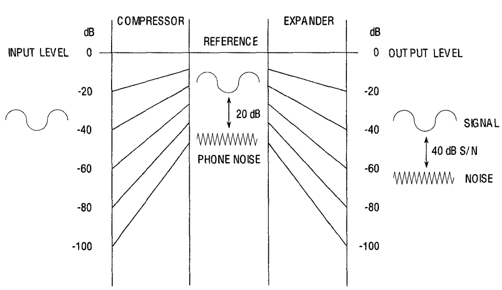
When the compandor's compression and expansion characteristics are unnecessary, the compressor and expander blocks can be bypassed.

STANDBY

When the TK10650's various functions are unnecessary (when waiting for reception, for example), current consumption can be reduced below 10 μA by using the standby function.

COMPANDOR

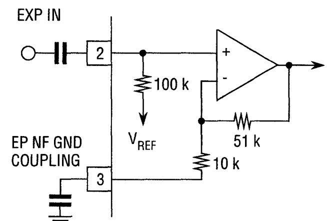
The signal to noise ratio can be improved with the compressor and the expander. The input signal to the compressor is compressed linearly by a 2:1 ratio in dB, and transmitted. In other words, the compression process elevates the signal above the noise level of the transmission medium. When this signal is fed to the expander, it is expanded by a ratio of 1:2 in dB. The accompanying transmission line noise is also expanded (reduced) by a ratio of 1:2.



IMPORTANT PIN FUNCTIONS

EXPANDER INPUT AMPLIFIER (PINS 2 AND 3)

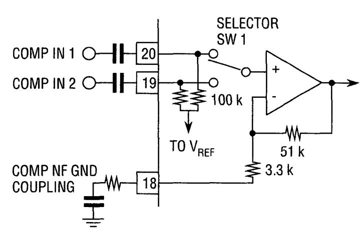
As can be seen in the following diagram, the input pin is connected to the reference voltage through a 100 kΩ resistor. The NF pin connects to the DC bypass, and its time constant with the 10 kΩ internal resistor determines the low-range cutoff frequency. The gain can be adjusted by adding resistance to the NF pin (pin 3). The user should set the gain and input level so that the output at pins 5 and 6 is normally 100 mV (standard level).



COMPRESSOR MICROPHONE AMPLIFIER (PINS 18 TO 20)

The input pins connect to the reference voltage through 100 kΩ bias resistors. Input pin switching is controlled by the selector switch, SW1 (pin 9) and the signal is fed from input 1 (pin 20) when pin 9 is High, and through input 2 (pin 19) when pin 9 is Low.

Pin 18 is the NF pin and the microphone amplifier's gain can be adjusted by adding a resistor externally. When the external resistance is 9.1 kΩ, the standard input level is 10 mV; when the external resistance is 68 kΩ, the standard input level is a 30 mV. The input can accommodate a variety of microphones by adjusting the gain to match the microphone's output voltage. The user should set the gain and input level so that the output at pin 15 is normally 300 mV (standard level).

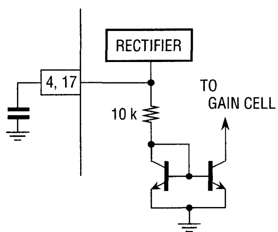


IMPORTANT PIN FUNCTIONS (CONT.)

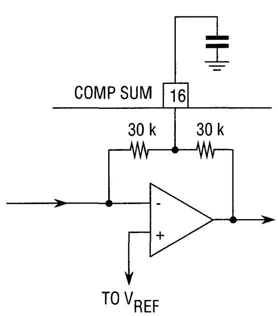
RECTIFIER (PINS 4 AND 17)

These pins determine smoothing and the dynamic characteristics for the compressor and expander. The time constant is determined by the external capacitor value and the internal 10 kΩ resistor.

COMPRESSOR SUMMING AMPLIFIER (PIN 16)



The compressor's summing amplifier (SUM AMP) has a DC gain of 1 and a high open loop AC gain. This characteristic eliminates AC feedback, and only DC feedback has to be dealt with. That is the reason for pin 16, and the AC bypass capacitor is attached here. The cutoff frequency is determined by the external capacitor value and the internal 30 kΩ resistor.



OUTPUT PINS (PINS 5, 6, AND 15)

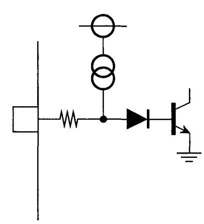
The compressor and expander output pins can drive a 1.0 kΩ load. The expander output has a built-in analog switch and the output pin is determined by the selector switch, SW 3 (pin 9). The signal appears at output 1 (pin 5) when pin 9 is High, and at output 2 (pin 6) when pin 9 is Low.

REFERENCE VOLTAGE SOURCE (PINS 7 AND 14)

Pin 7 is the reference voltage pin for the expander and pin 14 is the reference voltage pin for the compressor. They are derived from an internal band gap reference, and used as the bias source for each section.

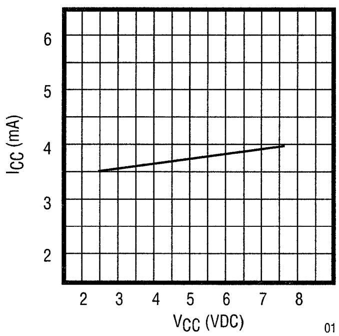
SWITCH LOGIC CIRCUIT (PINS 8 TO 12)

Pin 11 is the standby switch and is normally connected to V_{CC}. When this switch is open, all circuits are off and I_{CC} can be reduced to a few µA. The other pins (8,9,10,12) are pulled up by internal current sources, as shown below so they do not need to be pulled up externally. When these pins are connected to GND, the corresponding functions will operate.

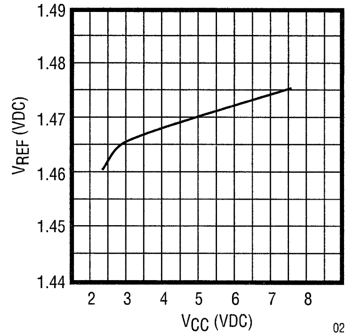


TYPICAL PERFORMANCE CHARACTERISTICS

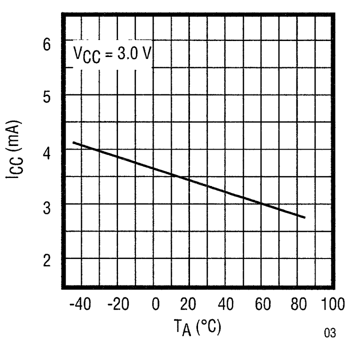
SUPPLY CURRENT vs. COMPANDOR SUPPLY VOLTAGE



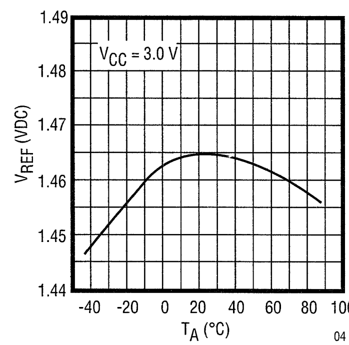
INTERNAL REFERENCE VOLTAGE vs. COMPANDOR SUPPLY VOLTAGE



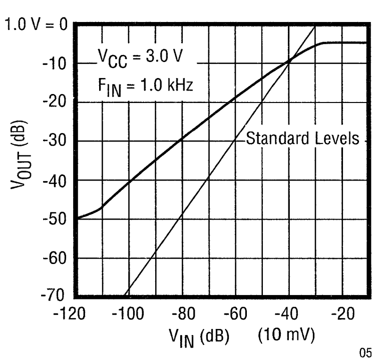
SUPPLY CURRENT vs. COMPANDOR AMBIENT TEMPERATURE



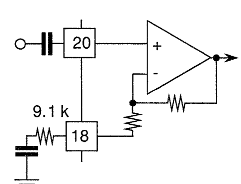
SUPPLY CURRENT vs. COMPANDOR AMBIENT TEMPERATURE



COMPRESSOR OUTPUT VOLTAGE vs. INPUT VOLTAGE

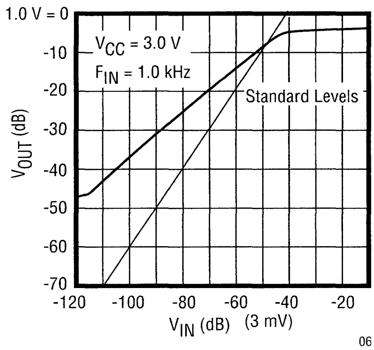


COMPRESSOR INPUT CIRCUIT

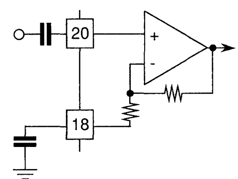


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

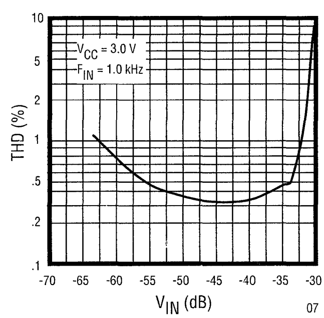
COMPRESSOR OUTPUT VOLTAGE vs. INPUT VOLTAGE



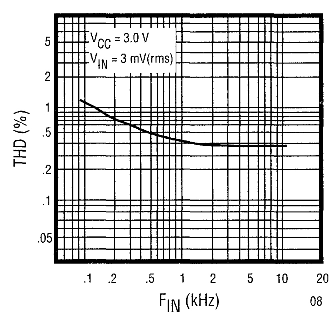
COMPRESSOR INPUT CIRCUIT



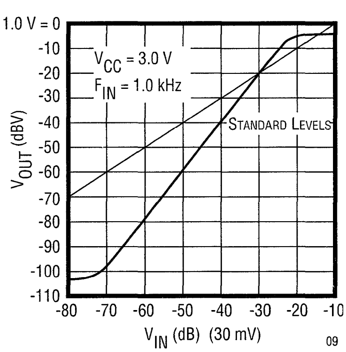
DISTORTION vs. COMPRESSOR INPUT VOLTAGE



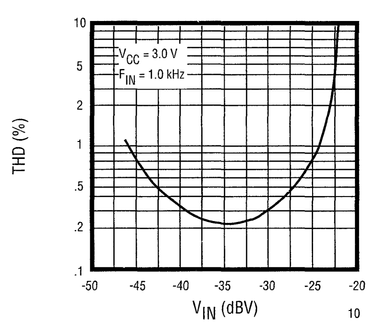
DISTORTION vs. COMPRESSOR INPUT FREQUENCY



EXPANDER OUTPUT VOLTAGE vs. INPUT VOLTAGE

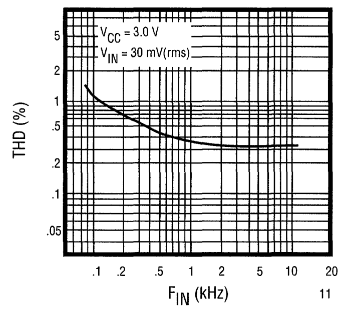


DISTORTION vs. INPUT VOLTAGE

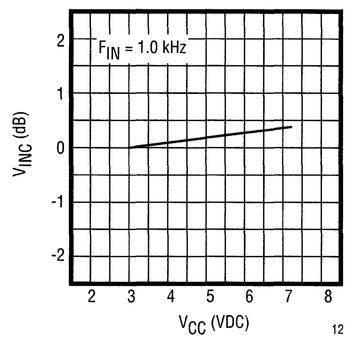


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

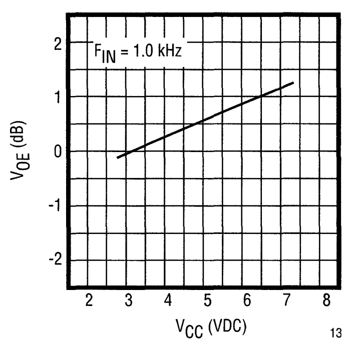
TOTAL HARMONIC DISTORTION vs. FREQUENCY



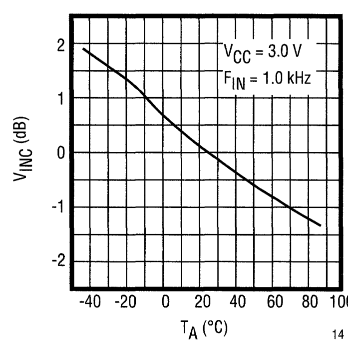
INPUT STANDARD VOLTAGE vs. COMPRESSOR SUPPLY VOLTAGE



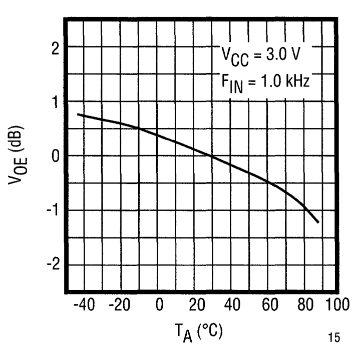
OUTPUT STANDARD VOLTAGE vs. EXPANDER SUPPLY VOLTAGE



INPUT STANDARD VOLTAGE vs. COMPRESSOR AMBIENT TEMPERATURE



OUTPUT STANDARD VOLTAGE vs. EXPANDER AMBIENT TEMPERATURE



LOW VOLTAGE COMPANDOR

FEATURES

- Data and Voice Inputs
- Data and Voice Outputs
- Low Supply Current
- Regulated Output
- Wide Operating Voltage
- Low Standby Current
- Microphone Amplifier
- IDC Circuit (Instantaneous Deviation Control)

APPLICATIONS

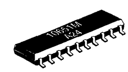
- Portable Instrumentation
- Cordless Telephone
- Handy Talkies
- Interphones

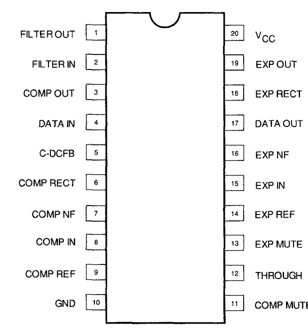
DESCRIPTION

TK10651 is a noise reduction IC developed mainly for cordless phones. It is also used for voice and data communications. It has a built-in compressor circuit to increase the average modulation level and an expander circuit to reduce the noise level. The expander restores the original dynamics of the input signal. The result is a high quality signal transmission with low noise. Among the many functions included, analog switching of the input and output signal is particularly useful in cordless telephones. Separate data input and output are provided. The audio signal path can be muted during data transmission. The signal path used for data transmission bypasses the compressor and expander circuits.

The TK10651 is available in a MFP20 surface mount package.

TK10651





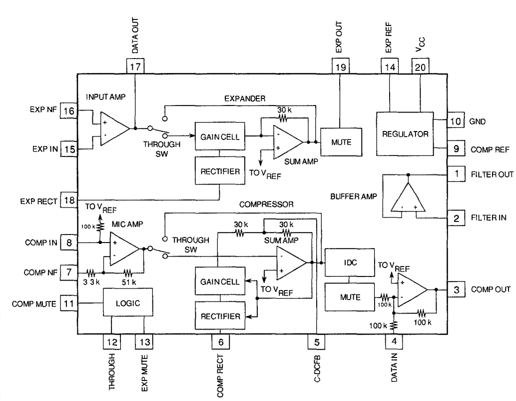
ORDERING INFORMATION

TK10651 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +70 °C	BX: Bulk/Bag
		TX: Paper Tape
		TR: Tape Right
		TL: Tape Left
		MG: Magazine

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 10 V
Power Dissipation (Note 1) .... 410 mW
Junction Temperature .... 150 °C
Operating Voltage .... 2.4 to 7.0 V
Input Frequency .... 100 kHz
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 3.0 V, f = 1.0 kHz, R_L = 10 kΩ, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	No signal		4.00	6.50	mA
V_{TH}	Threshold Voltage	11, 12, 13 Pin	1.15	1.30	1.45	V
Compressor						
Z_{INC}	Input Impedance		90	120		kΩ
V_{INC}	Input Standard Level	V_{OC} = 300 mV(rms), V_{IN} = 0 dB (Note 2)	8	12.5	17	mV(rms)
ΔG_{C1}	Gain Error 1	V_{IN} = -20 dB (Note 2)	-0.5	0	+0.5	dB
ΔG_{C2}	Gain Error 2	V_{IN} = -40 dB (Note 2)	-1.0	0	+1.0	dB
ΔG_{TC}	Through On/Off Difference	V_{IN} = 0 dB, 12 Pin GND, (Note 2)	-1.5	0	+1.5	dB
THD_C	Total Harmonic Distortion	V_{IN} = 0 dB		0.5	1.0	%
V_{NOC}	Output Noise Voltage	Rg = 620 Ω (Note 2)		3.0	5.5	mV(rms)
A_{TTC}	Mute Attenuation	V_{IN} = 0 dB, 11 Pin GND, (Note 2)	60	80		dB
V_{LIME}	Limiting Voltage		1.15	1.35	1.50	Vp-p
V_{GDATA}	Voltage Gain for DATA Terminal	V4 Pin = 300 mV(rms)	-0.5	0	+0.5	dB
VD_{MAX}	Maximum Output Voltage for DATA Terminal	THD = 10% Point	800	900		mV(rms)
$Crss_C$	Crosstalk	Exp V_{IN} = 30 mV(rms), Rg = 600 Ω (Note 2)		-35	-30	dB

Note 1: Power dissipation must be derated at the rate of 3.3 mW/°C for operation at 25 °C and above.
Note 2: Evaluated by CCITT standard P.53 noise filter.

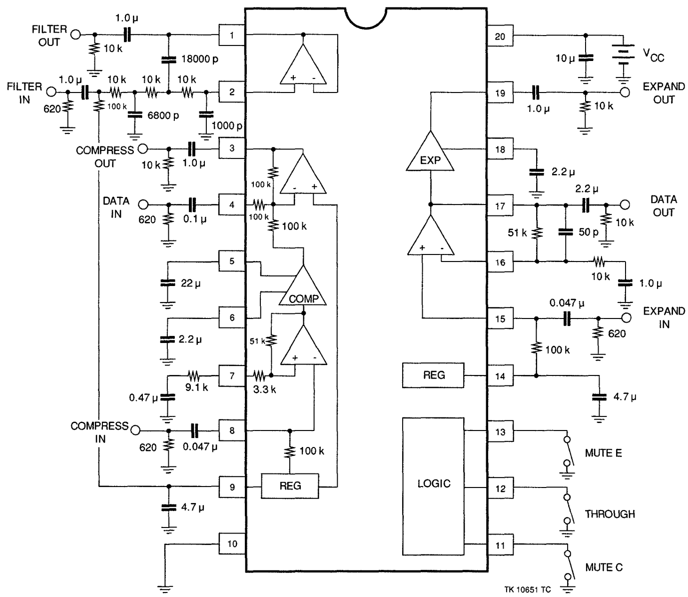
ELECTRICAL CHARACTERISTICS (CONT.)

Test conditions: V_{CC} = 3.0 V, f = 1.0 kHz, R_L = 10 kΩ, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Buffer Amplifier						
V_{GB}	Voltage Gain	V_{IN} = 300 mV(rms)	-0.5	0	+0.5	dB
ΔF1	Frequency Characteristics 1	V_{IN} = 300 mV(rms),	f = 3 kHz	-3		dB
ΔF2	Frequency Characteristics 2	V_{IN} = 300 mV(rms), f = 30 kHz		-60		dB
THD_B	Total Harmonic Distortion	V_{IN} = 300 mV(rms)		0.02	0.1	%
VB_{MAX}	Maximum Output Voltage	THD = 10% Point	550	700		mV(rms)
Expander						
V_{OE}	Output Standard Level	V_{IN} = 30 mV(rms), = 0 dB (Note 2)	110	130	160	mV(rms)
ΔG_{E1}	Gain Error 1	V_{IN} = -10 dB (Note 2)	-0.5	0	+0.5	dB
ΔG_{E2}	Gain Error 2	V_{IN} = -20 dB (Note 2)	-1.0	0	+1.0	dB
ΔG_{E3}	Gain Error 3	V_{IN} = -30 dB (Note 2)	-1.5	0	+2.0	dB
ΔG_{TE}	Through On/Off Difference	V_{IN} = 0 dB, 12 Pin GND, (Note 2)	-2.5	-1.0	+0.5	dB
THD_E	Total Harmonic Distortion	V_{IN} = 0 dB		0.5	1.5	%
V_{NOE}	Output Noise Voltage	Rg = 620 Ω, (Note 2)		10	30	µV(rms)
A_{TTE}	Mute Attenuation	V_{IN} = 0 dB, 13 Pin GND, (Note 2)	60	80		dB
VE_{MAX}	Maximum Output Voltage	THD = 10% Point	700	800		mV(rms)
V_{GI}	Voltage Gain for Input Amp.	V_{IN} = 0 dB	14.5	15.5	16.5	dB
V_{OMI}	Maximum Output Voltage	THD = 10%	450	500		mV(rms)
$Crss_E$	Crosstalk	Comp V_{IN} = V_{INC}		-70	-60	dB

Note 2: Evaluated by CCITT standard P.53 noise filter.

TEST CIRCUIT



SWITCH PIN	HIGH (OPEN OR V_{CC})	LOW (GND)
Pin 11	Comp Mute OFF	Comp Mute ON
Pin 12	Compandor	Through
Pin 13	Exp Mute OFF	Exp Mute ON

Switch pins priority order:
High > pins 11 and 13 > pin 12 > low.

APPLICATION INFORMATION

COMPRESSOR

By placing the data input pin following the compressor circuit, a data signal can be transmitted without being compressed. Audio from the microphone can be connected directly to the IC, because it passes through the built-in microphone amplifier (the gain is adjustable). Since there is a built-in limiter to prevent overmodulation, it is not necessary to add an external Instantaneous Deviation Control (IDC) circuit; furthermore, a Low Pass Filter (LPF) up to the third order can be constructed using the buffer amplifier.

When a data signal is being transmitted, the unneeded audio can be cut by engaging the mute switch.

EXPANDER

A wide range of applications is possible because all of the input amplifier pins are accessible. A LPF of up to the third order can be constructed at the input, and with an external resistor, it can be used as an amplifier. If the data out pin is used for the output, a data signal can be extracted without passing through the expander. During data transmission, the audio signal system can be inhibited by using the mute switch.

APPLICATION INFORMATION (CONT.)

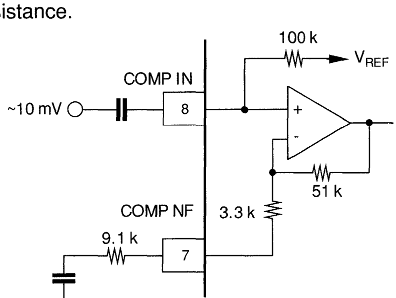
COMPRESSOR MICROPHONE AMPLIFIER

The input pin connects to the reference voltage through a 100 kΩ bias resistor, therefore external bias is not necessary. The microphone amplifier gain can be adjusted by connecting an external resistor to NF pin 7. The gain is highest when no resistor is added, and the standard input level is 3 mV. When an external resistor of 9.1 kΩ is added, the standard input level is about a 10 mV; when the external resistor value is 68 kΩ, the standard input level is 30 mV. The input can accommodate a variety of microphones by adjusting the gain to match the microphone's output voltage.

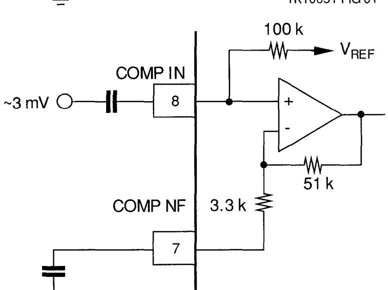
The user should set the gain and input level so that the output level at pin 3 is normally 300 mV (standard level).

RECTIFIER

The rectifier's smoothing capacitor pins (6 & 18), determine the smoothing characteristics and the time constants of the compressor and the expander. The time constant is determined by the external capacitor value and the internal 10 kΩ resistance.

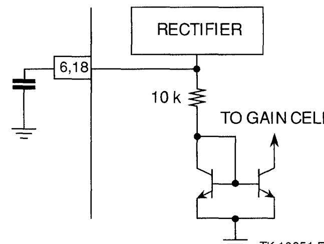


TK10651 FIG 01



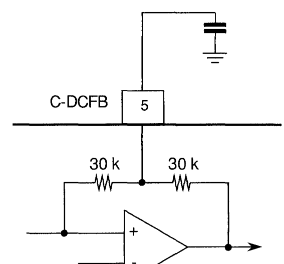
TK10651 FIG 02

COMPRESSOR SUMMING AMPLIFIER



TK 10651 FIG 03

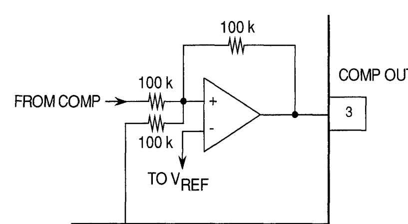
The compressor summing amplifier (SUM AMP) must have unity DC gain and the AC open loop gain is high. Since the feedback resistors are internal to the device, only one external capacitor is needed between pin 5 and GND. The cutoff frequency is determined by the external capacitor and the internal resistors.



TK 10651 FIG 04

COMPRESSOR DATA INPUT

An inverting amplifier is used at the DATA input. The internal input resistors are 100 kΩ, and the DC bias (V_{REF}) is about 1.5 V. The maximum load at the output pin is 10 kΩ.

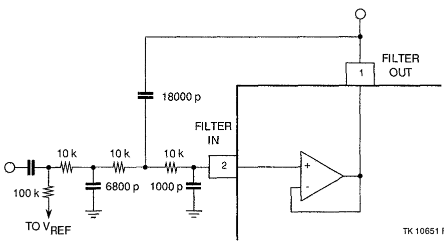


TK 10651 FIG 05

APPLICATION INFORMATION (CONT.)

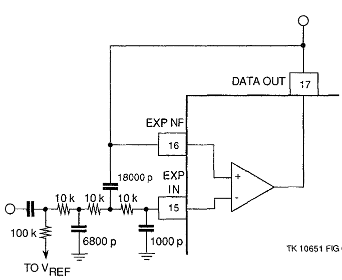
BUFFER AMPLIFIER

Up to a third order LPF (for example, a splatter filter) can be constructed using this amplifier. The maximum load at the output pin is 10 kΩ. The non-inverting input of the amplifier is not biased internally, therefore an external bias is needed whenever this pin is not direct-coupled from the output pin (pin 3).



TK 10651 FIG 06

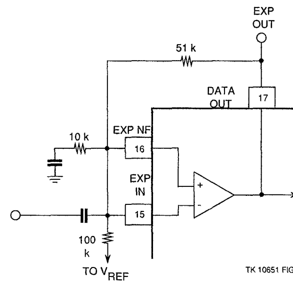
EXPANDER INPUT AMPLIFIER



TK 10651 FIG 07

The non-inverting and inverting input pins as well as the output pins are available, and can be used as a buffer amp or filter amp. A data signal can be obtained from the output pin, without passing through the expander. The input level and amplifier gain should be set to provide 180 mV(rms) standard level at the data output pin (pin 17). The expander input amplifier is not DC biased internally, therefore a bias voltage from the expander's V_{REF} pin (pin 14) should be used. The maximum allowable load at the output pin is 10 kΩ.

EXPANDER INPUT AMPLIFIER (CONT.)



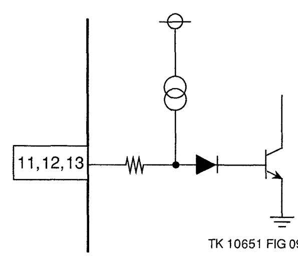
TK 10651 FIG 08

REFERENCE VOLTAGE SOURCE (PINS 9 AND 14)

Pin 9 is the reference voltage pin for the compressor and pin 14 is the reference voltage pin for the expander. The reference voltages are obtained from an internal band gap reference and used as the bias source for each section.

SWITCH CIRCUIT (PINS 11 TO 13)

The compressor's and expander's mute pins and the through pin (noise reduction is off) are pulled up by internal current sources, therefore they do not need an external pull up. Concerning the switching logic, refer to the table in the Test Circuit section.

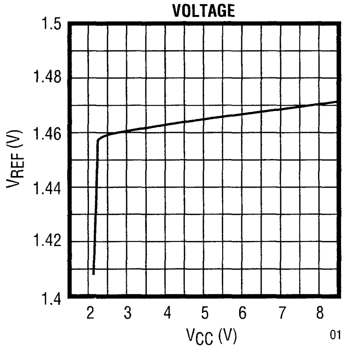


TK 10651 FIG 09

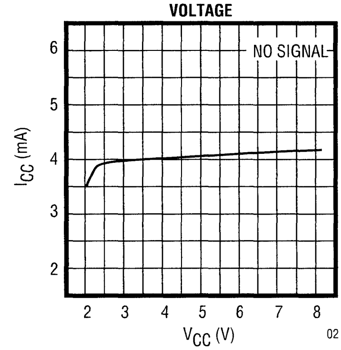
TYPICAL PERFORMANCE CHARACTERISTICS

DC CHARACTERISTICS

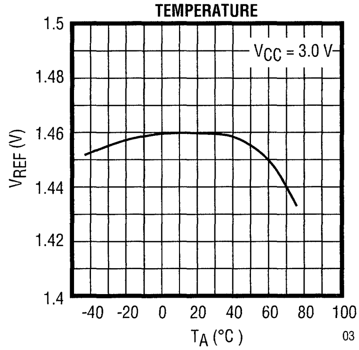
REFERENCE VOLTAGE vs. SUPPLY VOLTAGE



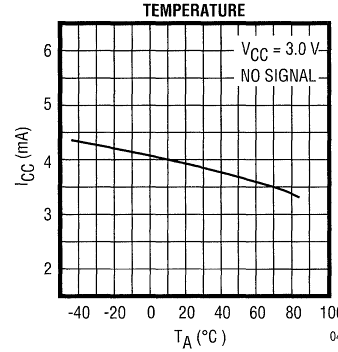
SUPPLY CURRENT vs. SUPPLY VOLTAGE



REFERENCE VOLTAGE vs. AMBIENT TEMPERATURE

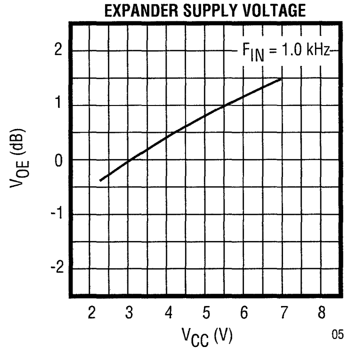


SUPPLY CURRENT vs. AMBIENT TEMPERATURE

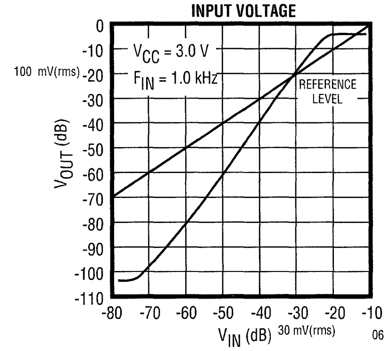


EXPANDER AC CHARACTERISTICS

OUTPUT REFERENCE VOLTAGE vs. EXPANDER SUPPLY VOLTAGE



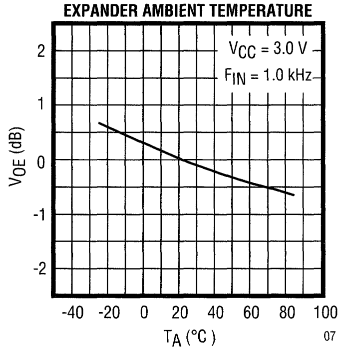
OUTPUT VOLTAGE vs. EXPANDER INPUT VOLTAGE



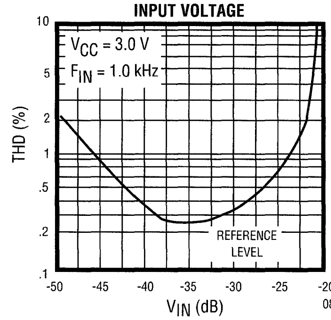
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

EXPANDER AC CHARACTERISTICS (CONT.)

OUTPUT REFERENCE VOLTAGE vs. EXPANDER AMBIENT TEMPERATURE

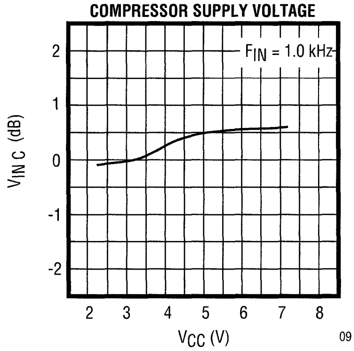


DISTORTION vs. EXPANDER INPUT VOLTAGE

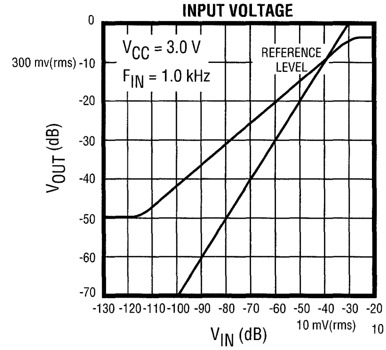


COMPRESSOR AC CHARACTERISTICS

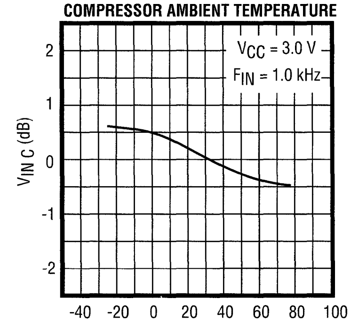
INPUT REFERENCE VOLTAGE vs. COMPRESSOR SUPPLY VOLTAGE



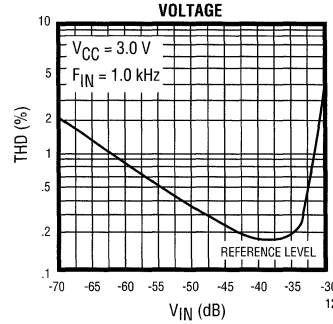
OUTPUT VOLTAGE vs. COMPRESSOR INPUT VOLTAGE



INPUT REFERENCE VOLTAGE vs. COMPRESSOR AMBIENT TEMPERATURE

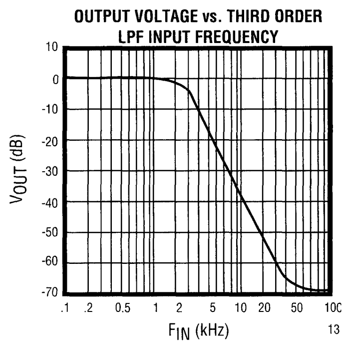


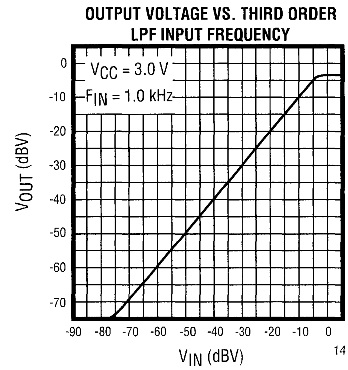
DISTORTION vs.COMPRESSOR INPUT VOLTAGE



TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

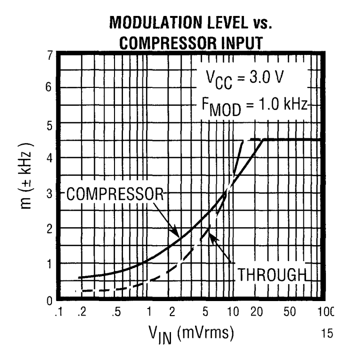
THIRD ORDER LPF CHARACTERISTICS



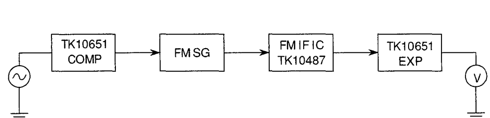


USING THE COMPANDOR TO IMPROVE S/N

This section provides an example of using the compandor to improve S/N in a narrow band FM communication system. In the test configuration below, the compressor modulation level was measured as a function of the input voltage to demonstrate the improvement resulting from the use of compressor. An audio signal is connected into the compressor and the output is measured with the modulation meter connected to the external modulation input of the FM signal generator. The compressor's reference input level was set to produce ±3.0 kHz frequency deviation. As shown in the graph on the right, the peak deviation remains the same when the compressor is used, but a wider input range is obtained. The built-in characteristics of the IDC limit the maximum frequency deviation to ±4.5 kHz.



TEST CONFIGURATION

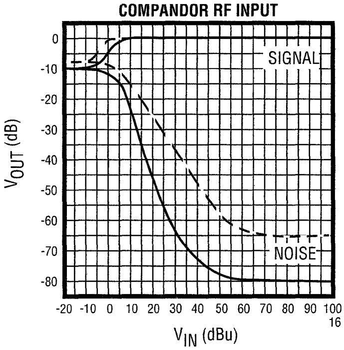


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

USING THE COMPANDOR TO IMPROVE S/N (CONT.)

The improvement resulting from the expander is expressed by measuring the overall characteristics of the FM IF System (TK10487M). The signal generator was switched to internal modulation and the output is defined as 0 dB when the RF input = 80 dBμ. As the graph below indicates, the noise is reduced when the expander is used, and good S/N ratio is maintained even when the RF signal input is weak.

OUTPUT VOLTAGE RATIO vs. COMPANDOR RF INPUT

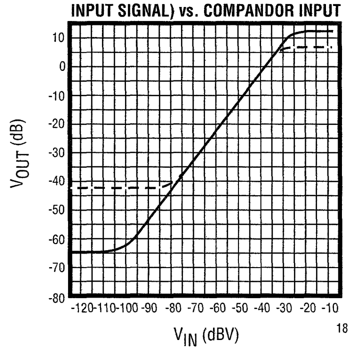


V_{CC} = 3.0 V
F_{OSC} = 10.245 MHz
DEV = ± 3.0 kHz
F_{MOD} = 1.0 kHz
FILTER : CCITT P.53
IF IC : TK10487M

SOLID LINE: COMPRESSOR
DASHED LINE: THROUGH

The following graph shows the characteristics when the RF input is weak (RF IN = 30 dBμ). There is a great difference when the compandor is used with a weak RF input. When the through function is used (noise reduction off), the output is lost in noise as the compressor input drops below –80 dBV; but when the compandor function is used, it remains level below –100 dBV. With a weak RF input, dynamic range is extended by 30 dB.

OUTPUT VOLTAGE RATIO (FOR WEAK INPUT SIGNAL) vs. COMPANDOR INPUT



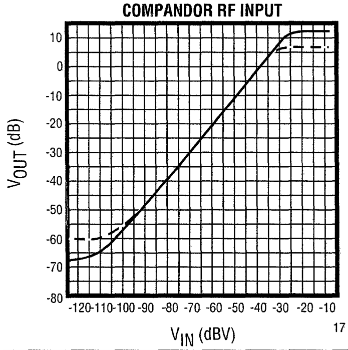
V_{CC} = 3.0 V
F_{OSC} = 10.245 MHz
F_{MOD} = 1.0 kHz
FILTER : CCITT P.53
IF IC :TK10487M
NO PREEMPHASIS
OR DE-EMPHASIS

SOLID LINE: COMPRESSOR
DASHED LINE: THROUGH

Finally, the overall characteristics are measured using both the compressor and the expander. The output is measured when the compressor's input is at –40 dBμV and the frequency deviation is ±3.0 kHz.

The graph below shows the characteristics when the RF input is strong (RF IN = 80 dBμ). The dynamic range is increased by more than 12 dB when the compandor is used.

OUTPUT VOLTAGE RATIO vs. COMPANDOR RF INPUT



V_{CC} = 3.0 V
F_{OSC} = 10.245 MHz
F_{MOD} = 1.0 kHz
FILTER : CCITT P.53
IF IC :TK10487M
NO PREEMPHASIS
OR DE-EMPHASIS

SOLID LINE: COMPRESSOR
DASHED LINE: THROUGH

The effects of the compandor within a narrow band FM communications system was demonstrated while a coaxial cable was used in place of transmission through free space. The signal source was an FM signal generator although there are some differences when actual transmision is through free space. However, the test configuration used in this experiment is useful in understanding the effects of the compandor.

TOKO

TK10652

COMPANDOR/DUAL OPAMP/VOLTAGE REGULATOR

FEATURES

- Low Supply Current
- Low Voltage Operation (2.7 V)
- Complete Compressor/Expander
- Built-In Mute and Analog Switch
- Through Function (Noise Reduction Off)
- Two Uncommitted Opamps
- Compress/Expand Slope Externally Adjustable

APPLICATIONS

- Portable Instrumentation
- Cordless Telephone
- Amateur Radio Transceivers
- Interphones
- Cellular Radio Phones
- Radio Communication (MCA, Mobile Telephone)

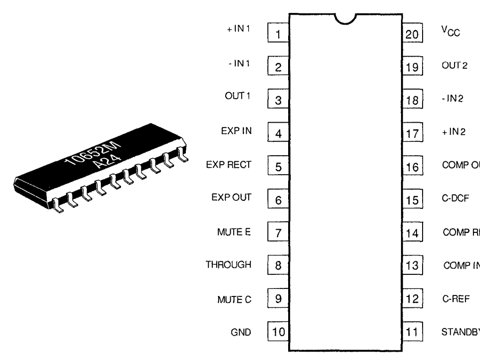
1

DESCRIPTION

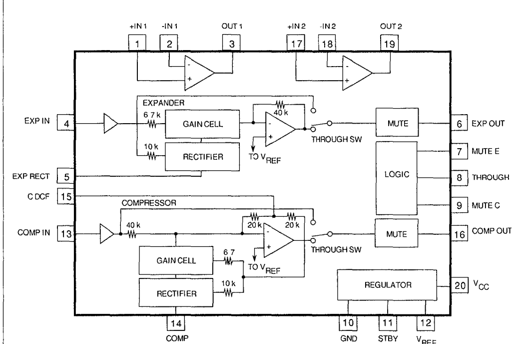
The TK10652 is a complete noise reduction system for communications systems. It includes a voltage regulator and two operational amplifiers for use as buffers or filters. An internal switch operates under TLL or CMOS logic control to enable or disable the compress/expand or through functions. The circuit is ideal for battery operated devices such as cordless and cellular telephones, handy talkies and other communications equipment where noise reduction is required.

The TK10652 is available in MFP20 surface mount packages.

TK10652M



BLOCK DIAGRAM



ORDERING INFORMATION

TK10652 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -35 to +85 °C	BX: Bulk/Bag
		TX: Paper Tape
		TR: Tape Right
		TL: Tape Left
		MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 12 V
Power Dissipation (Note 1) .... 410 mW
Operating Voltage .... 2.7 to 9.0 V
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -35 to +85 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 5.0 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	No signal		4.5	6.5	mA
I_{CCS}	Standby Supply Current	11 Pin GND		60	80	µA
Expander						
V_{OE}	Standard Output Voltage	V_{IN} = -23 dBV	-24.0	-22.5	-21.0	dBV
ΔG_{E1}	Gain Error 1	V_{IN} = -13 dBV	-0.5	0	+0.5	dB
ΔG_{E2}	Gain Error 2	V_{IN} = -33 dBV	-0.5	0	+0.5	dB
ΔG_{E3}	Gain Error 3	V_{IN} = -43 dBV	-0.5	0	+0.5	dB
ΔG_{E4}	Gain Error 4	V_{IN} = -53 dBV	-1.0	0	+1.0	dB
THD_E	Total Harmonic Distortion	V_{IN} = -23 dBV		0.2	0.5	%
V_{NOE}	Output Noise Voltage	Rg = 600 Ω, Non input, (Note 2)		-100	-95	dBV
A_{TTE}	Attenuation	V_{IN} = -23 dBV, 7 Pin GND	62	70		dB
$Crss_E$	Crosstalk	Comp V_{IN} = -23 dBV	70	75		dB
ΔGT_E	Through On/Off Difference	V_{IN} = -23 dBV, 8 Pin GND	-2.5	-1.0	+0.5	dB
Z_{INE}	Input Impedance		90	125		kΩ
Compressor						
V_{OC}	Standard Output Voltage	V_{IN} = -23 dBV	-25.5	-24	-22.5	dBV
ΔG_{C1}	Gain Error 1	V_{IN} = -3 dBV	-0.5	0	+0.5	dB
ΔG_{C2}	Gain Error 2	V_{IN} = -43 dBV	-0.5	0	+0.5	dB
ΔG_{C3}	Gain Error 3	V_{IN} = -63 dBV	-0.5	0	+0.5	dB
THD_C	Total Harmonic Distortion	V_{IN} = -23 dBV		0.2	0.5	%
V_{NOC}	Output Noise Voltage	Rg = 600 Ω, Non input, (Note 2)		-70	-60	dBV

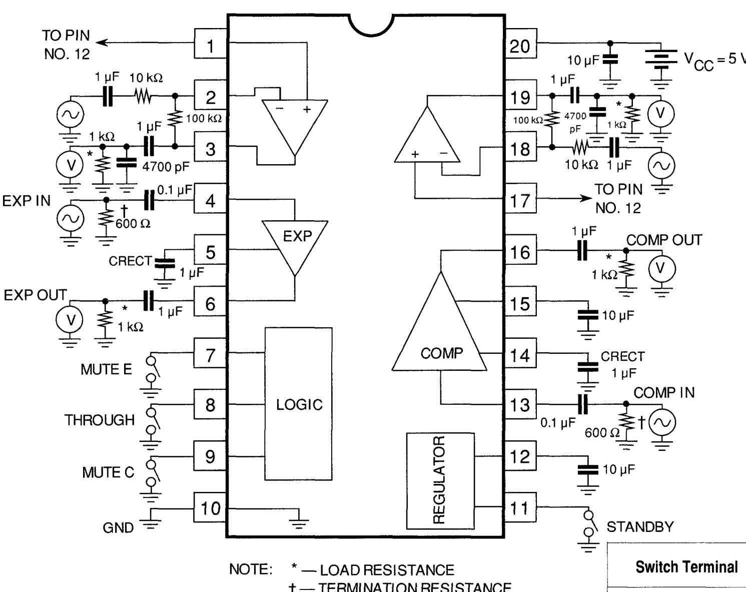
Note 1: Power dissipation must be derated at the rate of 3.3 mW/°C for operation at T_A = 25 °C and above.
Note 2: Evaluated by CCITT standard P.53 noise filter.

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 5.0 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
A_{TTC}	Attenuation	V_{IN} = -23 dBV, 9 Pin GND	55	70		dB
$Crss_C$	Crosstalk	|xp V_{IN} = -23 dBV	30	40		dB
ΔG_{TC}	Through ON/OFF Difference	V_{IN} = -23 dBV, 8 Pin GND	-2.0	-0.5	+1.0	dB
Z_{INC}	Input Impedance		-90	125		kΩ
VTH	Threshold Voltage	Pin 7, 8, 9, 11	1.10	1.35	1.55	V
Amplifier						
V_G	Gain	V_{IN} = -30 mV(rms)	19.5	20	20.5	dB
THD_A	Total Harmonic Distortion	V_{IN} = -30 mV(rms)		0.1	1.0	%
V_{OM}	Maximum Output Voltage	THD = 10% Point	1.5	1.8		V(rms)

TEST CIRCUIT



NOTE: * — LOAD RESISTANCE
† — TERMINATION RESISTANCE

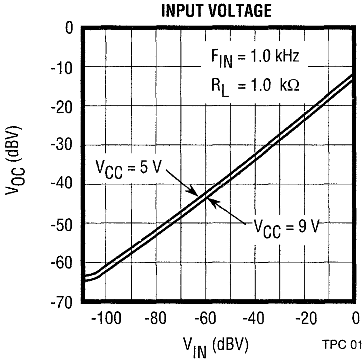
The order of priority of each switch terminal is: Pin 11, Pin 7, Pin 9, Pin 8.

Switch Terminal	High (OPEN or VCC)	Low (GND)
Pin 7	Exp Mute OFF	Exp Mute ON
Pin 8	Compandor	Through
Pin 9	Comp Mute OFF	Comp Mute ON
Pin 11	Normal	Standby

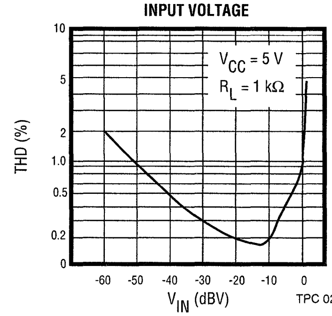
TYPICAL PERFORMANCE CHARACTERISTICS

COMPRESSOR AC CHARACTERISTICS

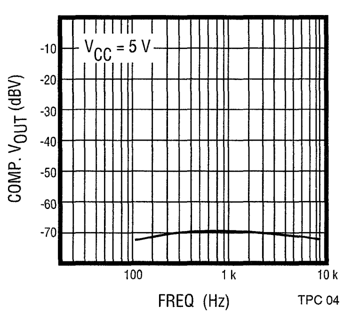
COMP. OUTPUT VOLTAGE vs. INPUT VOLTAGE

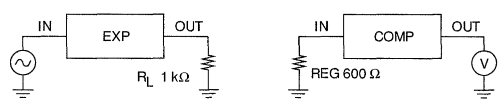


TOTAL HARMONIC DISTORTION vs. INPUT VOLTAGE

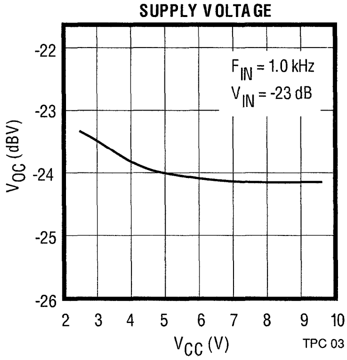


CROSSTALK vs. FREQUENCY





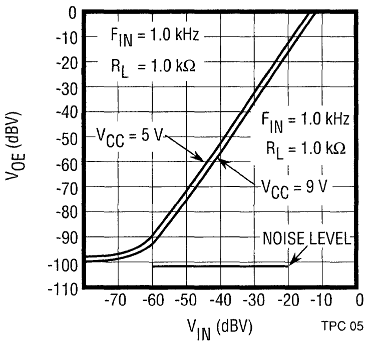
COMP. OUTPUT VOLTAGE vs. SUPPLY VOLTAGE



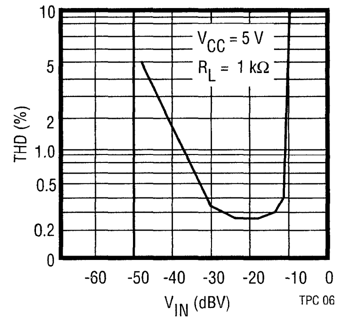
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

EXPANDER AC CHARACTERISTICS

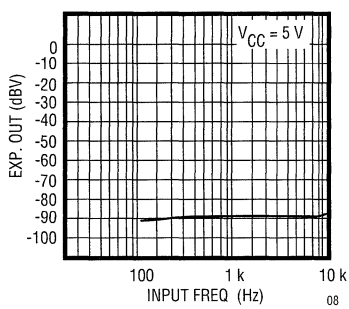
EXPANDER OUTPUT VOLTAGE vs. INPUT VOLTAGE

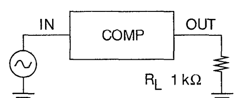


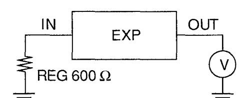
TOTAL HARMONIC DISTORTION vs. INPUT VOLTAGE



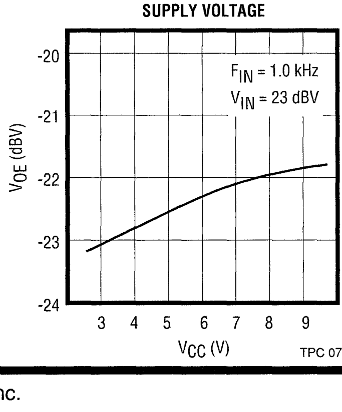
CROSSTALK vs. FREQUENCY







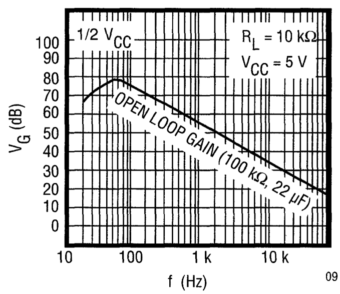
EXPANDER OUTPUT VOLTAGE vs. SUPPLY VOLTAGE

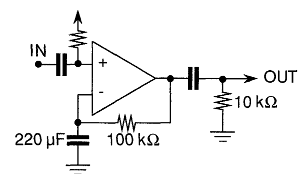


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

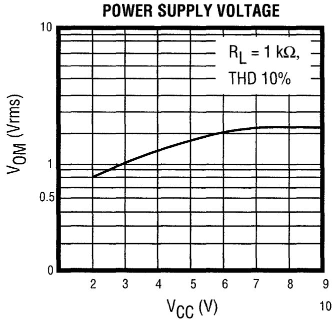
OPERATIONAL AMPLIFIER CHARACTERISTICS

OPEN LOOP GAIN vs. FREQUENCY

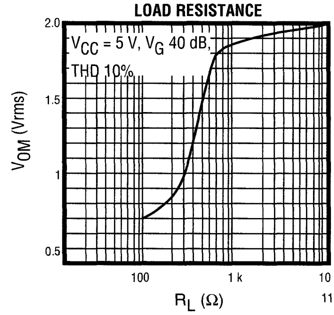




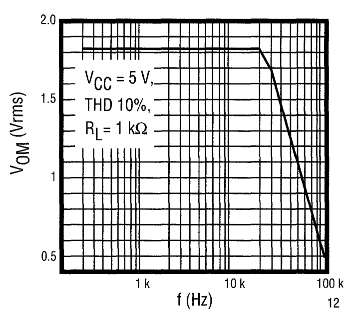
MAXIMUM OUTPUT VOLTAGE vs. POWER SUPPLY VOLTAGE



MAXIMUM OUTPUT VOLTAGE vs. LOAD RESISTANCE



MAXIMUM VOLTAGE vs. FREQUENCY



TOKO

TK10654

COMPANDOR/PRE-AMPLIFIER/BUFFER/VOLTAGE REGULATOR

FEATURES

- Built-In IDC Circuit
- Separate Voice and Data Inputs
- Through Function
- Low Voltage Operation (2.4 V)
- Uncommitted Opamp

APPLICATIONS

- Portable Instrumentation
- Cordless Telephone
- Amateur Radio Transceiver
- Interphones

DESCRIPTION

The TK10654 is a complete noise reduction system for portable communications systems. It is specially suited for cordless telephones and handy talkies. It has a built in analog switch for through function (noise reduction off) and an Instantaneous Deviation Control (IDC) circuit for modulation limiting. Separate voice and data inputs are provided. The data signal path bypasses the expander and compressor. The TK10654 is available in a MFP28 surface mount package.

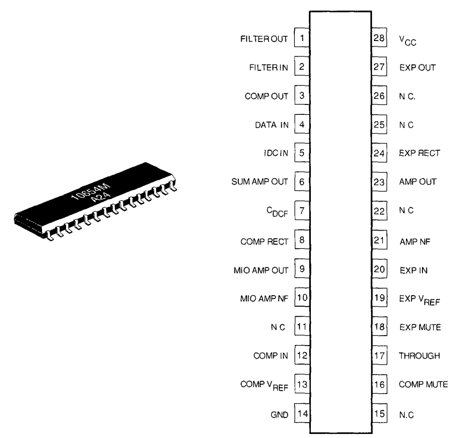
ORDERING INFORMATION

TK10654 □ □ □□

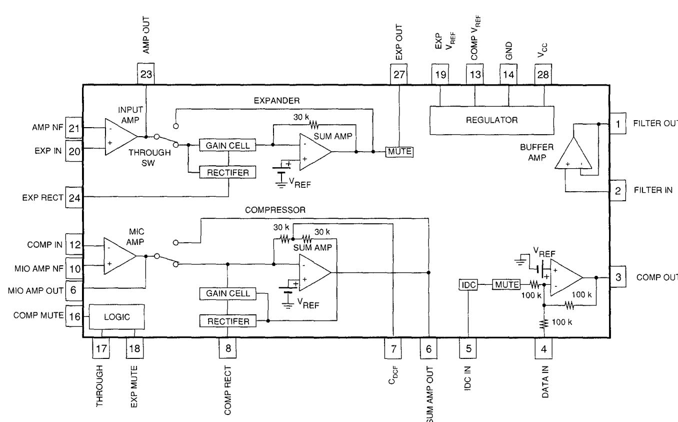
- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +70 °C	BX: Bulk/Bag
		TX: Paper Tape
		TR: Tape Right
		TL: Tape Left
		MG: Magazine

TK10654



BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 10 V
Power Dissipation (Note 1) .... 580 mW
Operating Voltage .... 2.4 to 7.0 V
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 3.0 V, T_A = 25 °C, f = 1.0 kHz, R_L = 10 kΩ, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	No signal		4.00	6.50	mA
V_{TH}	Threshold Voltage	16, 17, 18 Pin	1.15	1.30	1.45	V
Compressor						
V_{INC}	Standard Input Voltage	V_{OC} = 300 mV(rms), V_{IN} = 0 dB (Note 2)	8	12.5	17	mV(rms)
ΔG_{C1}	Gain Error 1	V_{IN} = -20 dB (Note 2)	-0.5	0	+0.5	dB
ΔG_{C2}	Gain Error 2	V_{IN} = -40 dB (Note 2)	-1.0	0	+1.0	dB
ΔG_{TC}	Through On/Off Difference	V_{IN} = 0 dB, 17 Pin GND, (Note 2)	-1.5	0	+1.5	dB
THD_C	Total Harmonic Distortion	V_{IN} = 0 dB, F_{IN} = 3.0 kHz		0.5	1.0	%
V_{NOC}	Output Noise Voltage	Rg = 600 Ω (Note 2)		3.0	5.5	mV(rms)
A_{TTC}	Attenuation	V_{IN} = 0 dB, 16 Pin GND (Note 2)	60	80		dB
V_{LC}	Limiting Voltage		1.15	1.35	1.50	Vp-p
V_{GD}	Voltage Gain for DATA Terminal	V4 Pin = 300 mV(rms)	-0.5	0	+0.5	dB
V_{OMD}	Maximum Output Voltage for DATA Terminal	THD = 10% Point	800	900		mV(rms)
$Crss_C$	Crosstalk	Exp V_{IN} = 30 mV(rms), Rg = 600 Ω (Note 2)		-35	-30	dB
Z_{OC}	Output Impedance	6 Pin		20		Ω
Z_{INIDC}	IDC Input Impedance	5 Pin		90		MΩ

Note 1: Power dissipation must be derated at the rate of 4.7 mW/°C for operation at T_A = 25 °C and above .
Note 2: Evaluated by CCITT standard P.53 noise filter.

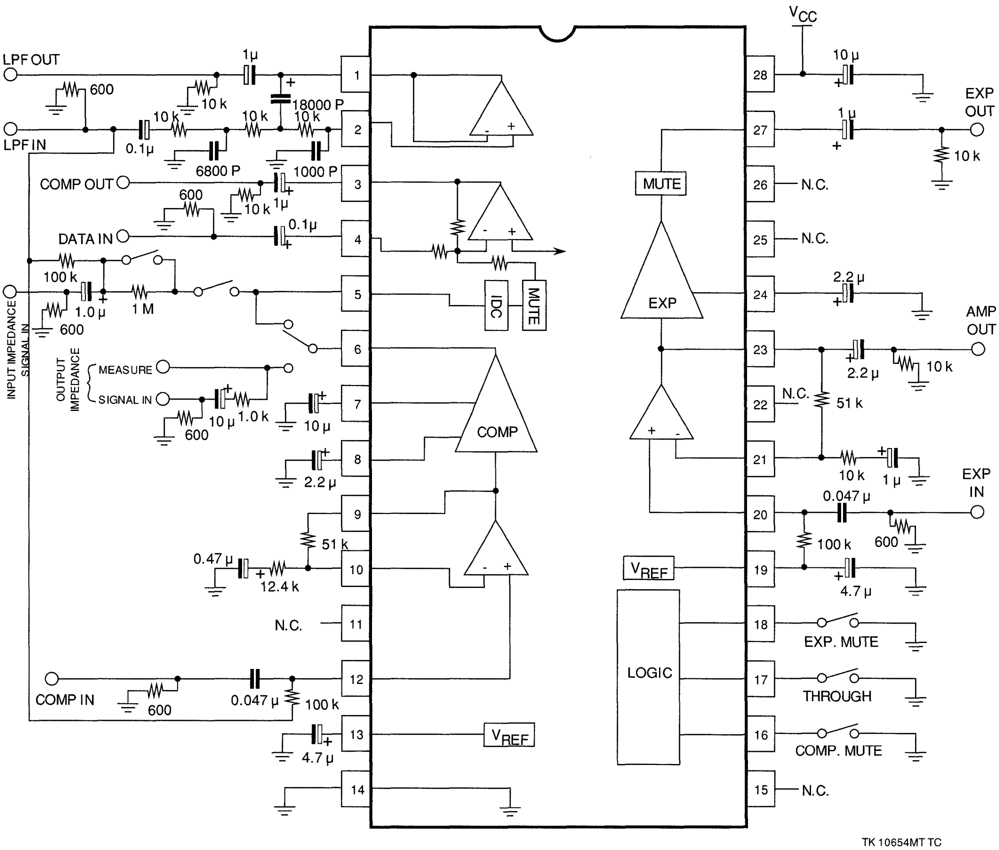
ELECTRICAL CHARACTERISTICS (CONT.)

Test conditions: V_{CC} = 3.0 V, T_A = 25 °C, f = 1.0 kHz, R_L = 10 kΩ, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Buffer Amp.						
V_{GB}	Voltage Gain	V_{IN} = 300 mV(rms)	-0.5	0	+0.5	dB
ΔF1	Frequency Characteristics 1	V_{IN} = 300 mV(rms),	f = 3 kHz	-3		dB
ΔF2	Frequency Characteristics 2	V_{IN} = 300 mV(rms), f = 30 kHz		-60		dB
THD_B	Total Harmonic Distortion	V_{IN} = 300 mV(rms)		0.02	0.1	%
V_{OMB}	Maximum Output Voltage	THD = 10% Point	550	700		mV(rms)
Expander						
V_{OE}	Standard Output Voltage	V_{IN} = 30 mV(rms), = 0 dB (Note 2)	110	130	160	mV(rms)
ΔG_{E1}	Gain Error 1	V_{IN} = -10 dB (Note 2)	-0.5	0	+0.5	dB
ΔG_{E2}	Gain Error 2	V_{IN} = -20 dB (Note 2)	-1.0	0	+1.0	dB
ΔG_{E3}	Gain Error 3	V_{IN} = -30 dB (Note 2)	-1.5	0	+2.0	dB
ΔG_{TE}	Through On/Off Difference	V_{IN} = 0 dB, 17 Pin GND (Note 2)	-2.5	-1.0	+0.5	dB
THD_E	Total Harmonic Distortion	V_{IN} = 0 dB, F_{IN} = 3.0 kHz		0.5	1.5	%
V_{NOE}	Output Noise Voltage	Rg = 600 Ω (Note 2)		10	30	µV(rms)
A_{TTE}	Attenuation	V_{IN} = 0 dB, 18 Pin GND (Note 2)	60	80		dB
V_{OME}	Maximum Output Voltage	THD = 10% Point	700	800		mV(rms)
V_{GI}	Voltage Gain for Input Amp.	V_{IN} = 0 dB	14.5	15.5	16.5	dB
V_{OMI}	Maximum Output Voltage	THD = 10%	450	500		mV(rms)
$Crss_E$	Crosstalk	Comp V_{IN} = V_{INC}, Rg = 600 Ω (Note 2)		-70	-60	dB

Note 2: Evaluated by CCITT standard P.53 noise filter.

TEST CIRCUIT



SWITCH TERMINAL	HIGH (OPEN OR V_{CC})	LOW (GND)
Pin 16	Comp Mute OFF	Comp Mute ON
Pin 17	Compandor	Through
Pin 18	Exp Mute OFF	Exp Mute ON

The order of priority of each switch terminal is: Pin 16, Pin 17, Pin 18.

TOKO

COMPANDOR/PRE-AMPLIFIER/BUFFER/VOLTAGE REGULATOR

FEATURES

- Low Supply Current
- Built-In IDC
- Internal Voltage Regulator
- Internal Analog Switch
- TTL or CMOS Mode Control Compatible
- Data and Voice Inputs and Outputs

APPLICATIONS

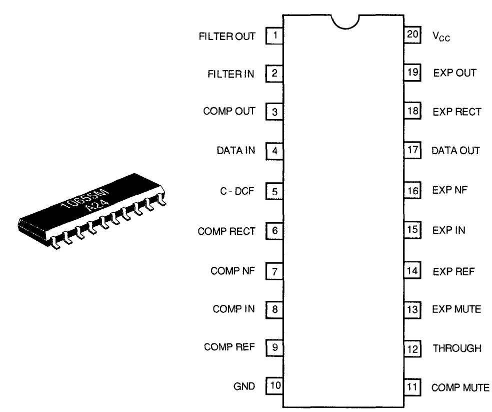
- Portable Instrumentation
- Cordless Telephone
- Amateur Radio Transceiver
- Interphones

DESCRIPTION

The TK10655 is a complete noise reduction system. A built in Instantaneous Deviation Control (IDC) circuit controls overmodulation and splatter in transmitters. The device is designed for low current consumption and is ideal for portable communications systems where noise reduction and modulation control is required. A voltage regulator and an uncommitted operational amplifier is provided for buffer or filter applications.

The TK10655 is available in a MFP20 surface mount package.

TK10655



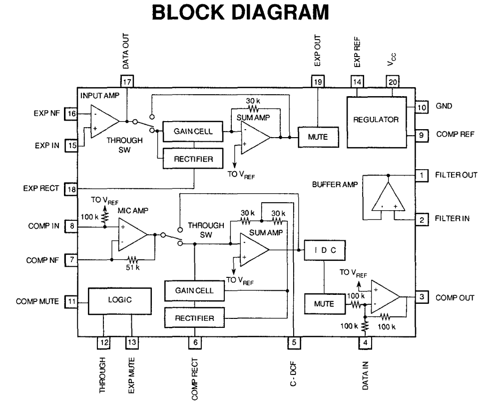
ORDERING INFORMATION

TK10655 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +70 °C	BX: Bulk/Bag
		TX: Paper Tape
		TR: Tape Right
		TL: Tape Left
		MG: Magazine

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 10 V
Power Dissipation (Note 1) .... 410 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +70 °C
Operating Voltage Range .... 2.4 to 7.0 V
Maximum Input Frequency .... 100 kHz
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 3.0 V, f = 1.0 kHz, R_L = 10 kΩ, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	No signal		4.00	6.50	mA
V_{TH}	Threshold Voltage	11, 12, 13 Pin	1.15	1.30	1.45	V
Compressor						
Z_{INC}	Input Impedance		90	120		kΩ
V_{INC}	Input Reference Voltage	V_{CC} = 300 mV(rms), V_{IN} = 0 dB (Note 2)	8	12.5	17	mV(rms)
ΔG_{C1}	Gain Error 1	V_{IN} = -20 dB (Note 2)	-0.5	0	+0.5	dB
ΔG_{C2}	Gain Error 2	V_{IN} = -40 dB (Note 2)	-1.0	0	+1.0	dB
ΔG_{TC}	Through On/Off Difference	V_{IN} = 0 dB, 12 Pin GND, (Note 2)	-1.5	0	+1.5	dB
THD_C	Total Harmonic Distortion	V_{IN} = 0 dB		0.5	1.0	%
V_{NOC}	Output Noise Voltage	Rg = 620 Ω, (Note 2)		3.0	5.5	mV(rms)
A_{TTC}	Mute Attenuation	V_{IN} = 0 dB, 11 Pin GND, (Note 2)	60	80		dB
V_L	Limiting Voltage		1.15	1.35	1.50	Vp-p
V_{GD}	Voltage Gain for DATA Terminal	V4 Pin = 300 mV(rms)	-0.5	0	+0.5	dB
V_{OMD}	Maximum Output Voltage for DATA Terminal	THD = 10% Point	800	900		mV(rms)
$Crss_C$	Crosstalk	Exp V_{IN} = 30 mV(rms), Rg = 620 Ω (Note 2)		-35	-30	dB

Note 1: Power dissipation must be derated at the rate of 3.3 mW/°C for operation at T_A = 25 °C and above.
Note 2: Measured by using the filter for noise evaluation based on CCITT Recommendation, P. 53.

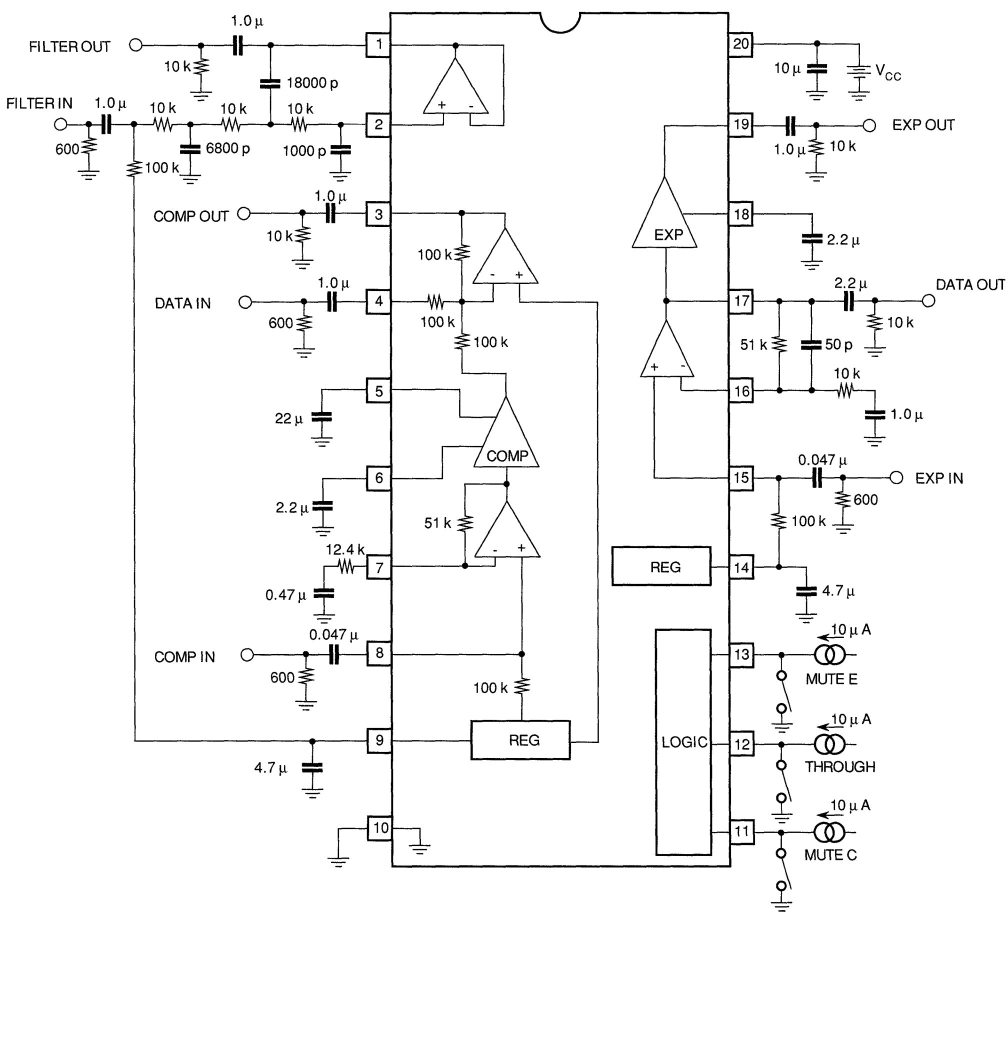
ELECTRICAL CHARACTERISTICS (CONT.)

Test conditions: V_{CC} = 3.0 V, f = 1.0 kHz, R_L = 10 kΩ, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Buffer Amplifier						
V_{GB}	Voltage Gain	V_{IN} = 300 mV(rms)	-0.5	0	+0.5	dB
ΔF1	Frequency Characteristics 1	V_{IN} = 300 mV(rms),	f = 3 kHz	-3		dB
ΔF2	Frequency Characteristics 2	V_{IN} = 300 mV(rms), f = 30 kHz		-60		dB
THD_B	Total Harmonic Distortion	V_{IN} = 300 mV(rms)		0.02	0.1	%
V_{OMB}	Maximum Output Voltage	THD = 10% Point	550	700		mV(rms)
Expander						
V_{OE}	Output Reference Voltage	V_{IN} = 30 mV(rms), = 0 dB (Note 2)	110	130	160	mV(rms)
ΔG_{E1}	Gain Error 1	V_{IN} = -10 dB (Note 2)	-0.5	0	+0.5	dB
ΔG_{E2}	Gain Error 2	V_{IN} = -20 dB (Note 2)	-1.0	0	+1.0	dB
ΔG_{E3}	Gain Error 3	V_{IN} = -30 dB (Note 2)	-1.5	0	+2.0	dB
ΔG_{TE}	Through On/Off Difference	V_{IN} = 0 dB, 12 Pin GND, (Note 2)	-2.5	-1.0	+0.5	dB
THD_E	Total Harmonic Distortion	V_{IN} = 0 dB		0.5	1.5	%
V_{NOE}	Output Noise Voltage	Rg = 620 Ω (Note 2)		10	30	µV(rms)
A_{TTE}	Mute Attenuation	V_{IN} = 0 dB, 13 Pin GND, (Note 2)	60	80		dB
V_{OME}	Maximum Output Voltage	THD = 10% Point	700	800		mV(rms)
V_{GI}	Voltage Gain for Input Amp.	V_{IN} = 0 dB	14.5	15.5	16.5	dB
V_{OMI}	Maximum Output Voltage	THD = 10%	450	500		mV(rms)
$Crss_E$	Crosstalk	Comp V_{IN} = V_{INC}, Rg = 620 Ω (Note 2)		-70	-60	dB

Note 2: Measured by using the filter for noise evaluation based on CCITT Recommendation, P. 53.

TEST CIRCUIT



TOKO

COMPANDOR/FILTER/VOLTAGE REGULATOR

FEATURES

- Low Voltage Operation
- Internal Amplifier for Splatter Filter
- Data In/Out Terminals Attached
- Internal IDC Circuit
- Standby Function

APPLICATIONS

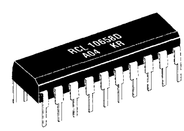
- Portable Instrumentation
- Cordless Telephone
- Amateur Radio Transceiver
- Interphones

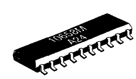
DESCRIPTION

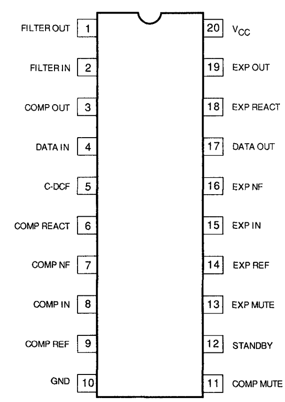
TK10658D/M is a compandor IC for cordless telephones. The device is designed for low current consumption and has a low power standby mode. The TK10658 is a complete noise reduction system with an Internal Deviation Control (IDC) circuit for limiting splatter and overmodulation. The device also includes a voltage regulator and uncommitted operational amplifier for buffer or filter applications.

The TK10658 is available in 20 pin dual in-line (DIP20) and MFP20 surface mount packages.

TK10658







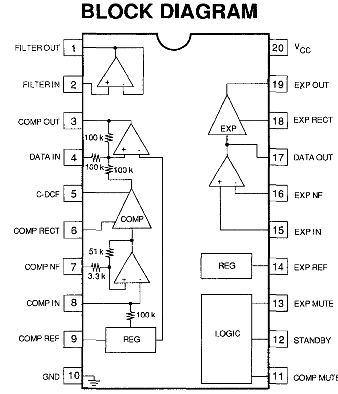
ORDERING INFORMATION

TK10658 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +70 °C	BX: Bulk/Bag
P: Plastic DIP		TX: Paper Tape
		TR: Tape Right
		TL: Tape Left
		MG: Magazine

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 10 V
Operating Voltage Range .... 2.4 to 7 V
Power Dissipation for D Package (Note 1) .... 720 mW
Power Dissipation for M Package (Note 2) .... 410 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 3.0 V, T_A = 25 °C, f = 1.0 kHz, R_L = 10 kΩ, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	No signal		4.00	6.50	mA
V_{TH}	Threshold Voltage	11, 12, 13 Pin	1.15	1.30	1.45	V
I_{CCS}	Standby Current	12 Pin = GND		20	50	µA
Compressor						
Z_{INS}	Input Impedance		90	120		kΩ
V_{INS}	Input Reference Voltage	V_{OC} = 300 mV(rms), V_{IN} = 0 dB (Note 3)	8	12.5	17	mV(rms)
ΔG_{C1}	Gain Error 1	V_{IN} = -20 dB (Note 3)	-0.5	0	+0.5	dB
ΔG_{C2}	Gain Error 2	V_{IN} = -40 dB (Note 3)	-1.0	0	+1.0	dB
THD_C	Total Harmonic Distortion	V_{IN} = 0 dB		0.5	1.0	%
V_{NOC}	Output Noise Voltage	Rg = 620 Ω (Note 3)		3.0	5.5	mV(rms)
A_{TTC}	Mute Attenuation	V_{IN} = 0 dB, 11 Pin GND (Note 3)	60	80		dB
V_1	Limiting Voltage		1.15	1.35	1.50	Vp-p
V_{GD}	Voltage Gain for DATA Terminal	V4 Pin = 300 mV(rms)	-0.5	0	+0.5	dB
V_{OMD}	Maximum Output Voltage for DATA Terminal	THD = 10% Point	800	900		mV(rms)
$Crss_C$	Crosstalk	Exp V_{IN} = 30 mV(rms), Rg = 620 Ω (Note 3)		-35	-30	dB

Note 1: Power dissipation must be derated at the rate of 5.76 mW/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 3.3 mW/°C for operation at T_A = 25 °C and above.
Note 3: Measured by using the filter for noise evaluation based on CCITT Recommendation, P. 53.

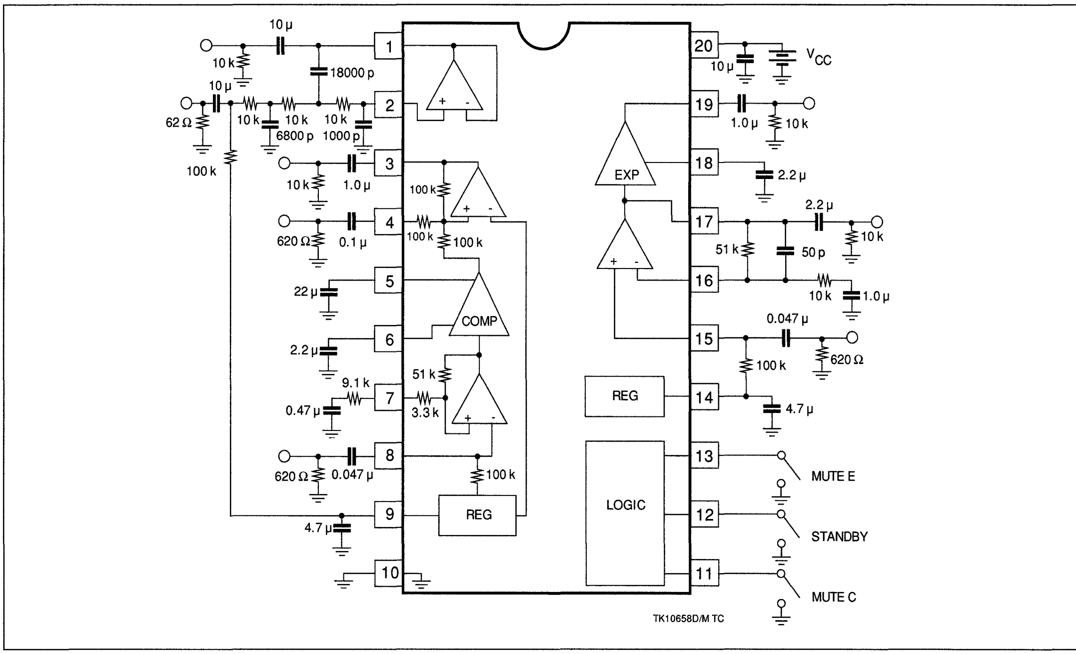
ELECTRICAL CHARACTERISTICS (CONT.)

Test conditions: V_{CC} = 3.0 V, T_A = 25 °C, f = 1.0 kHz, R_L = 10 kΩ, unless otherwise specified.

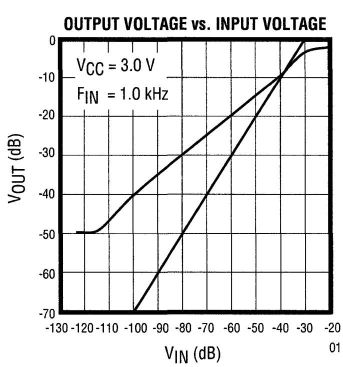
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Buffer Amp.						
V_{GB}	Voltage Gain	V_{IN} = 300 mV(rms)	-0.5	0	+0.5	dB
ΔF1	Frequency Characteristics 1	V_{IN} = 300 mV(rms),	f = 3 kHz	-3		dB
ΔF2	Frequency Characteristics 2	V_{IN} = 300 mV(rms), f = 30 kHz		-60		dB
THD_B	Total Harmonic Distortion	V_{IN} = 300 mV(rms)		0.02	0.1	%
V_{OMB}	Maximum Output Voltage	THD = 10% Point	550	700		mV(rms)
Expander						
V_{OE}	Output Reference Voltage	V_{IN} = 30 mV(rms), = 0 dB (Note 3)	110	130	160	mV(rms)
ΔG_{E1}	Gain Error 1	V_{IN} = -10 dB (Note 3)	-0.5	0	+0.5	dB
ΔG_{E2}	Gain Error 2	V_{IN} = -20 dB (Note 3)	-1.0	0	+1.0	dB
ΔG_{E3}	Gain Error 3	V_{IN} = -30 dB (Note 3)	-1.5	0	+2.0	dB
THD_E	Total Harmonic Distortion	V_{IN} = 0 dB		0.5	1.5	%
V_{NOE}	Output Noise Voltage	Rg = 620 Ω (Note 3)		10	30	µV(rms)
A_{TTE}	Mute Attenuation	V_{IN} = 0 dB, 13 Pin GND, (Note 3)	60	80		dB
V_{OME}	Maximum Output Voltage	THD = 10% Point	700	800		mV(rms)
V_{GI}	Voltage Gain for Input Amp.	V_{IN} = 0 dB	14.5	15.5	16.5	dB
V_{OMI}	Maximum Output Voltage	THD = 10%	450	500		mV(rms)
$Crss_E$	Crosstalk	Comp V_{IN} = V_{INC}, Rg = 620 Ω (Note 3)		-70	-60	dB

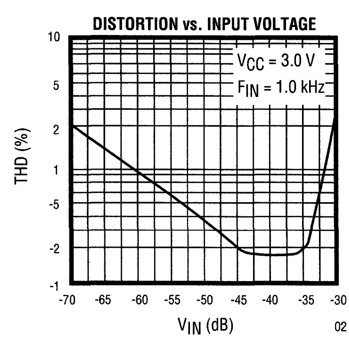
Note 3: Measured by using the filter for noise evaluation based on CCITT Recommendation, P. 53.

TEST CIRCUIT



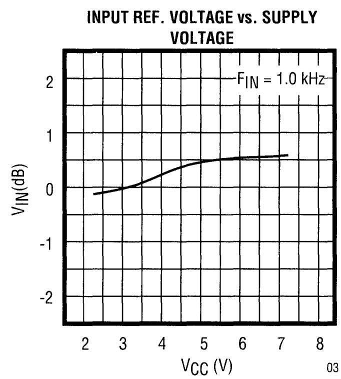
TYPICAL PERFORMANCE CHARACTERISTICS

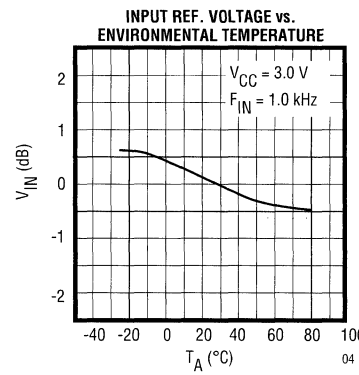




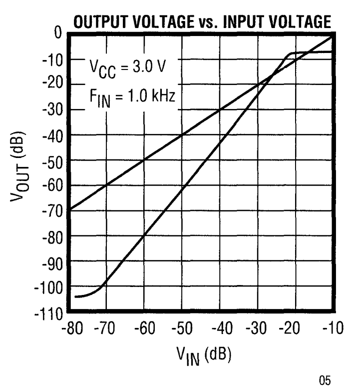
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

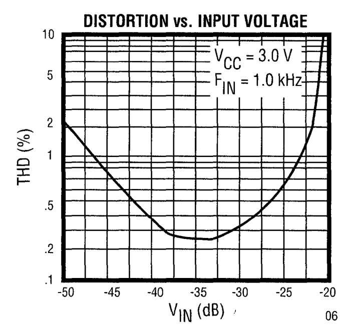
COMPRESSOR

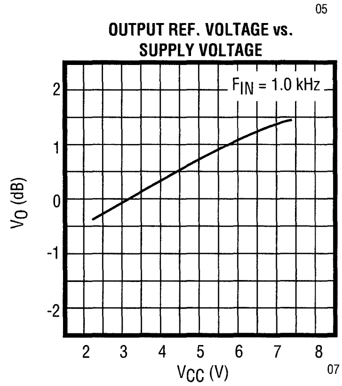


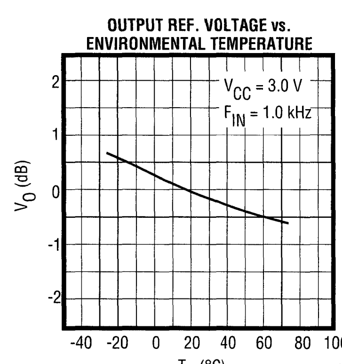


EXPANDER









NOTES

TOKO

COMPANDOR/OP AMP/VOLTAGE REGULATOR

FEATURES

- Low Supply Current (3.0 mA)
- Low Voltage Operation (1.8 V)
- Built-In Voltage Regulator
- Uncommitted Operational Amplifier

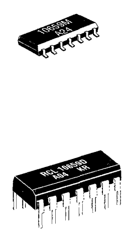
APPLICATIONS

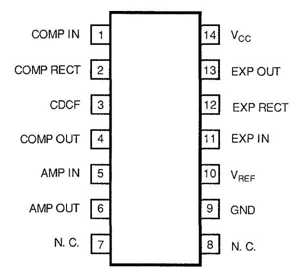
- Portable Communications
- Cordless Telephones
- Amateur Radio Transcievers
- VHF/UHF Handy Talkies

DESCRIPTION

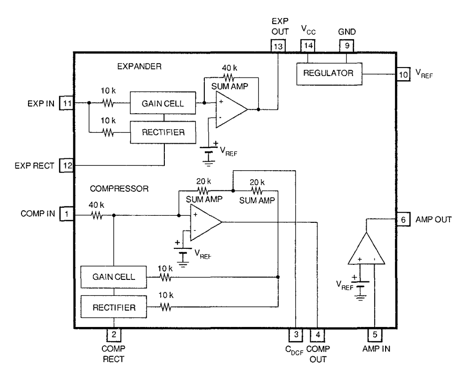
The TK10659 is a complete noise reduction system for communications systems. It is specially designed for battery operated equipment. The TK10659 contains an expander, compressor and a voltage regulator. Additionally an uncommitted operational amplifier is provided for use as a buffer or filter. The device requires a minimum number of external parts. The TK10659 is available in 14 pin dual in-line (DIP14) and surface mount (MFP14) packages.

TK10659M





BLOCK DIAGRAM



ORDERING INFORMATION

TK10659 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +70 °C	BX: Bulk/Bag
D: DIP		TX: Paper Tape
		TR: Tape Right
		TL: Tape Left
		MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 10 V
Power Dissipation (Note 1) .... 600 mW
Operating Voltage Range .... 1.8 to 7.0 V
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

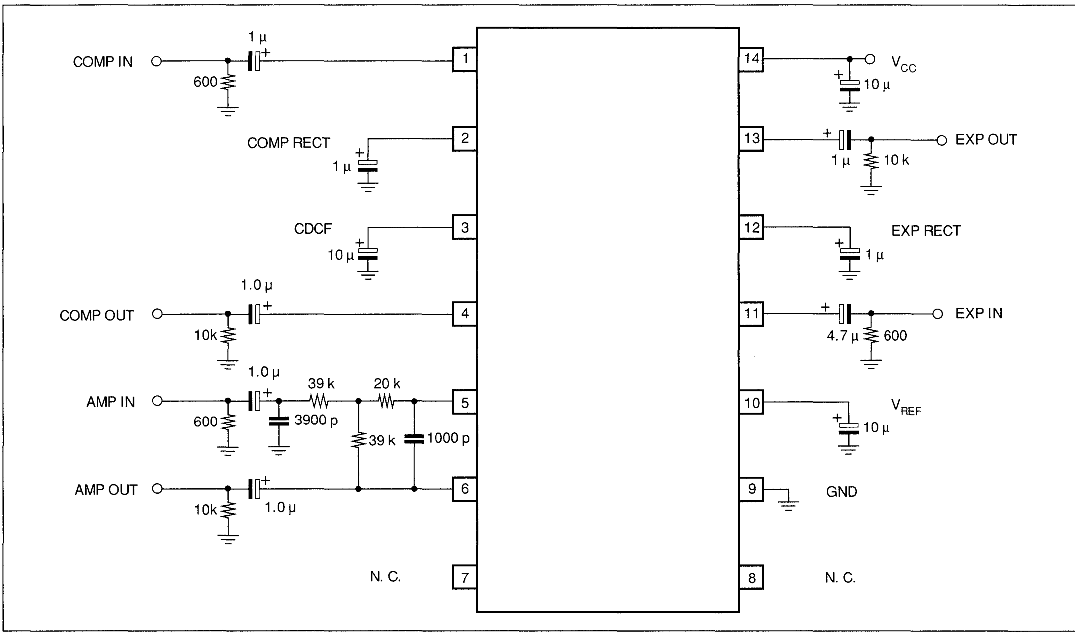
Test conditions: V_{CC} = 3.0 V, f = 1.0 kHz, R_L = 10 kΩ, T_A = 25 °C unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	No signal		3.0		mA
Compressor						
V_{OC}	Output Reference Voltage	V_{IN} = -20 dBV = 0 dB		-20		dBV
ΔG_{C0}	Gain Error 0	ΔV_{IN} = + 10 dB		0		dB
ΔG_{C1}	Gain Error 1	ΔV_{IN} = - 20 dB		- 0.1		dB
ΔG_{C2}	Gain Error 2	ΔV_{IN} = - 40 dB		0		dB
THD_C	Total Harmonic Distortion	V_{IN} = -20 dBV		0.3		%
V_{NOC}	Output Noise Voltage	Rg = 600 Ω		1.0		mV(rms)
V_{OMC}	Maximum Output Voltage	THD = 10 %		0.5		V(rms)
Expander						
V_{OE}	Output Reference Voltage	V_{IN} = -20 dBV = 0 dB		-19		dBV
ΔG_{E0}	Gain Error 0	ΔV_{IN} = + 5 dB		- 0.2		dB
ΔG_{E1}	Gain Error 1	ΔV_{IN} = - 10 dB		- 0.1		dB
ΔG_{E2}	Gain Error 2	ΔV_{IN} = - 20 dB		- 0.3		dB
THD_E	Total Harmonic Distortion	V_{IN} = -20 dBV		0.3		%
V_{NOE}	Output Noise Voltage	Rg = 600 Ω		15		µV(rms)
V_{OME}	Maximum Output Voltage	THD = 10 %		1.0		V(rms)
Buffer						
V_{GB}	Voltage Gain	V_{IN} = - 20 dBV		- 0.2		dB
ΔF1	Frequency Characteristic 1	F_{IN} = 3.0 kHz * (Note 2)		-3.6		dB
ΔF2	Frequency Characteristic 2	F_{IN} = 30 kHz * (Note 2)		- 40		dB
THD_B	Total Harmonic Distortion	V_{IN} = -20 dBV		0.02		%
V_{OMB}	Maximum Output Voltage	THD = 10 %		1.0		V(rms)

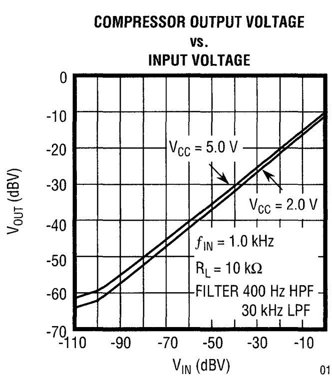
Note 1: Power dissipation must be derated at the rate of 4.8 mW/° C for operation at T_A = 25 °C and above.

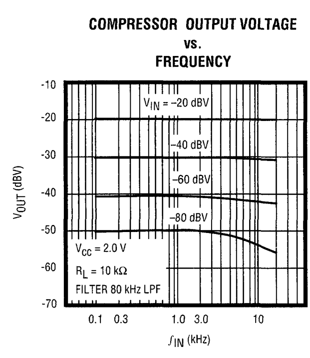
Note 2: AC characteristics are tested by using a band pass filter of 400 Hz - 30 kHz. Characteristics marked with an asterisk (*) are tested by using a 400 Hz high pass filter.

TEST CIRCUIT



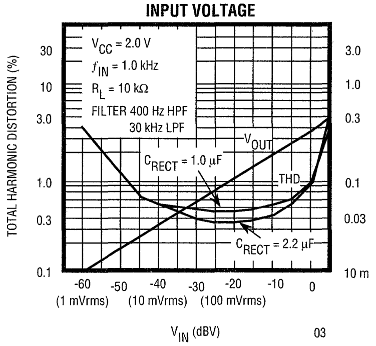
TYPICAL PERFORMANCE CHARACTERISTICS





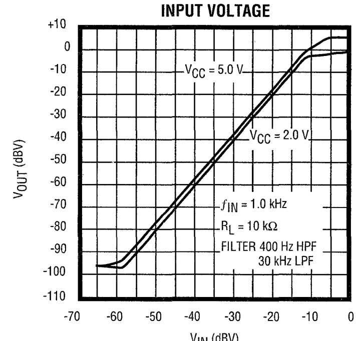
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

COMPRESSOR THD & OUTPUT VOLTAGE vs. INPUT VOLTAGE



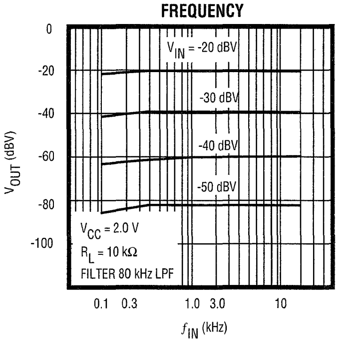
03

EXPANDER OUTPUT VOLTAGE vs. INPUT VOLTAGE



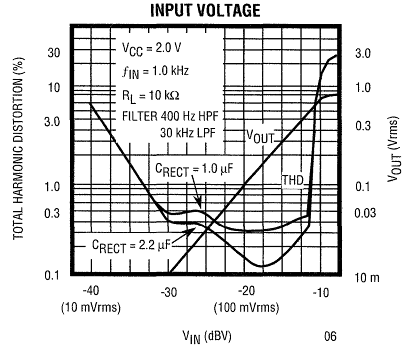
04

EXPANDER OUTPUT VOLTAGE vs. FREQUENCY



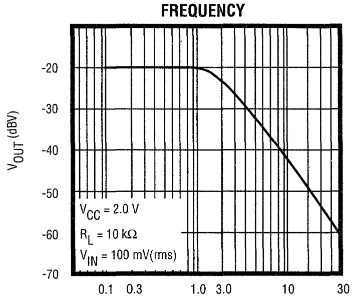
05

EXPANDER THD & OUTPUT VOLTAGE vs. INPUT VOLTAGE

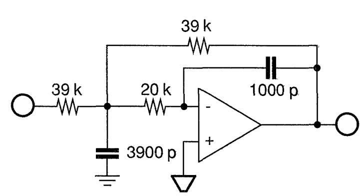


06

LOW PASS FILTER OUTPUT vs. FREQUENCY

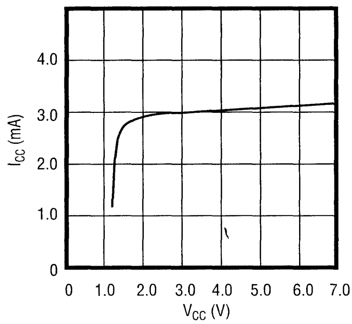


07



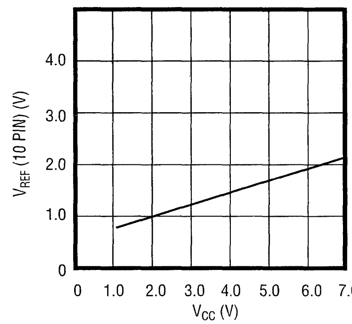
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

SUPPLY CURRENT
vs.
SUPPLY VOLTAGE



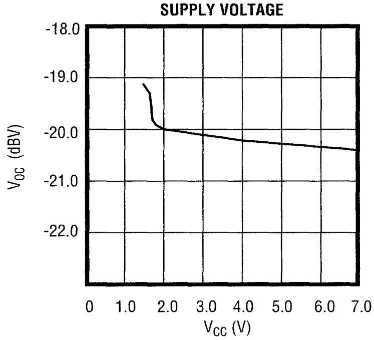
08

REFERENCE VOLTAGE
vs.
SUPPLY VOLTAGE



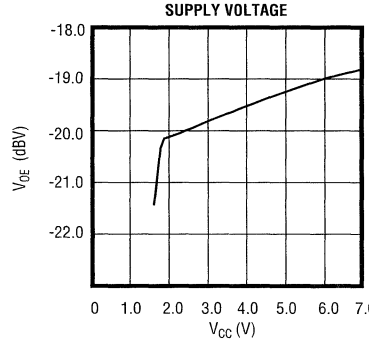
09

COMPRESSOR OUTPUT VOLTAGE
vs.
SUPPLY VOLTAGE



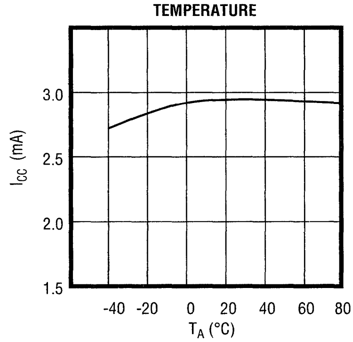
10

EXPANDER OUTPUT VOLTAGE
vs.
SUPPLY VOLTAGE



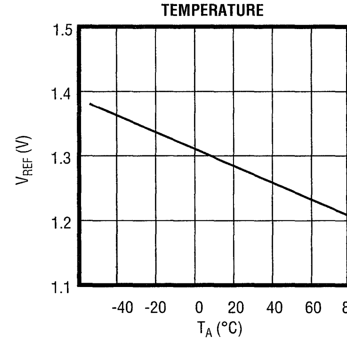
11

SUPPLY CURRENT
vs.
TEMPERATURE



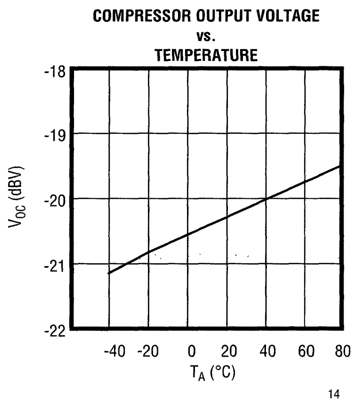
12

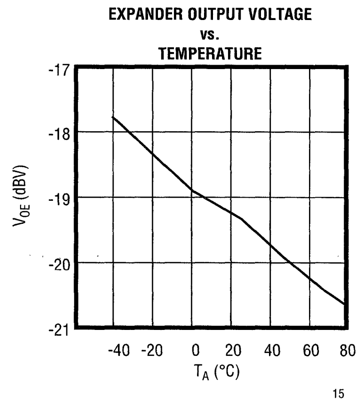
REFERENCE VOLTAGE
vs.
TEMPERATURE



13

TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)





NOTES

SCRAMBLER IC WITH COMPANDOR

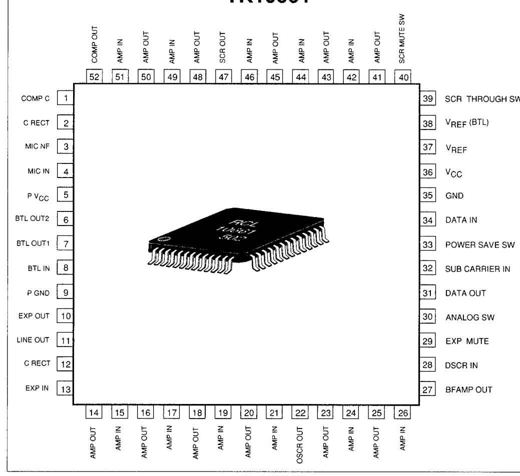
FEATURES

- **Compandor**
- **Speech Scrambler/Descrambler**
- **Low Voltage Operation (1.8 V)**
- **IDC for Modulation Control**
- **Mute Function**

APPLICATIONS

- **Cordless Telephone**
- **Secure Communications Devices**

TK10661

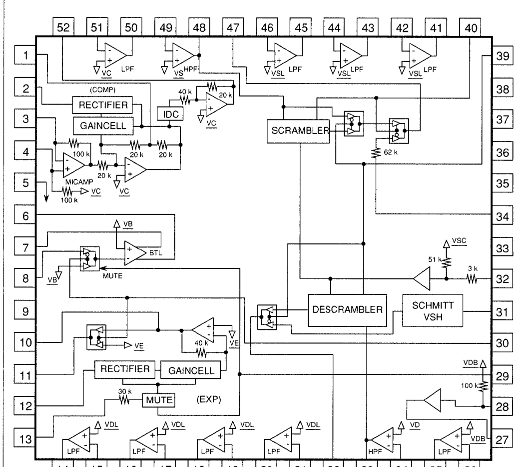


DESCRIPTION

The TK10661 is a complete noise reduction and voice scrambler/descrambler system. The device is designed for use in cordless telephones and can operate down to 1.8 V. Current consumption is typically 10.3 mA at V_{CC} = 2.0 V. Scrambling is accomplished by inverting the audio spectrum using an externally-generated carrier frequency. The IC has internal analog switches to disable or enable companding and scrambling functions under CMOS or TTL control. The device includes an Instantaneous Deviation Control (IDC) circuit for modulation control. A mute function is also provided. A power save control pin puts the chip in a low power standby mode, consuming only 60 μA.

The TK10661 is available in a QPACK-52 surface mounted package.

BLOCK DIAGRAM



ORDERING INFORMATION

TK10661 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
Q: Surface Mount	C : -10 to +70 °C	BX: Bulk/Bag
		TX: Paper Tape
		TR: Tape Right
		TL: Tape Left
		MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 8 V
Power Dissipation (Note 1) .... 650 mW
Operating Voltage Range .... 1.8 to 5.5 V
Maximum Input Frequency .... 80 kHz
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -10 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 2.0 V (36 Pin), V_{CCP} = 2.4 V (5 Pin), T_A = 25 °C, f = 1.0 kHz, Sub = 3.5 kHz, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current 1	36 Pin, 33 Pin = GND		10.3	16.0	mA
I_{CCP}	Supply Current 2	5 Pin, 33 Pin = GND		0.6	3.0	mA
I_{CCS}	Standby Supply Current 1	36 Pin, 33 Pin = Open		1.9	3.0	mA
I_{CCPS}	Standby Supply Current 2	5 Pin, 33 Pin = Open		60	150	µA
Compressor		4 Pin = 52 Pin				
V_{ORC}	Output Reference Voltage	V_{IN} = 50 mV, V_{IN} = 0dB	110	135	165	mV
ΔG_{C1}	Gain Error 1	V_{IN} = -20 dB	-1.0	0	+1.0	dB
ΔG_{C2}	Gain Error 2	V_{IN} = -40 dB	-1.5	0	+1.5	dB
THD_C	Total Harmonic Distortion	V_{IN} = 50 mV		0.2	1.0	%
V_{NOC}	Output Noise Voltage	Rg = 600 Ω (Note 2)		0.8	3.0	mV
V_L	Limiting Voltage	V_{IN} = 316 mV	0.45	0.55	0.65	Vp-p
BPF 1, 2		51 Pin - 48 Pin, 26 - 23 Pin				
V_{IN}	Maximum Input Voltage	THD = 3%	550	630		mV
V_{GBP}	Voltage Gain	V_{IN} = 100 mV	-2.5	0	+2.5	dB
THD_{BP}	Total Harmonic Distortion	V_{IN} = 100 mV		0.04	1.0	%
Scrambler		48 Pin - 47 Pin, 26 - 23 Pin				
V_{IMS}	Maximum Input Voltage	THD = 5 %, f = 2.5 kHz (Note 3)	250	350		mV
V_{GS}	Voltage Gain	V_{IN} = 100 mV, f = 2.5 kHz (Note 3)	-2.5	+0.5	-3.5	dB
ΔG_{ST}	Through On/Off Difference	V_{IN} = 100 mV, f = 2.5 kHz (Note 3)	-3.0	0	+3.0	dB

Note 1: Power dissipation must be derated at the rate of 4.7 mW/°C for operation at T_A = 25 °C and above.
Note 2: Measured by using the noise evaluation filter based on P. 53 of CCITT.
Note 3: Extended 3 kHz LPF is used.

ELECTRICAL CHARACTERISTICS (CONT.)

Test conditions: V_{CC} = 2.0 V (36 Pin), V_{CCP} = 2.4 V (5 Pin), T_A = 25 °C, f = 1.0 kHz, Sub = 3.5 kHz, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{GSD}	Data Voltage Gain	V_{IN} = 100 mV, 40 Pin = GND	-3.0	0	+3.0	dB
Leaks	Carrier Leak	After Offset Adjustment (47 k - 49 k)		0.3	1.3	mV
LPF (6th Order)		46 Pin - 41 Pin				
V_{IMLP6}	Maximum Input Voltage	THD = 3%	330	400		mV
V_{GLP6}	Voltage Gain	V_{IN} = 100 mV	1.1	3.8	6.5	dB
THD_{LP6}	Total Harmonic Distortion	V_{IN} = 100 mV		0.2	1.0	%
Buffer Amplifier		28 Pin - 27 Pin				
V_{IMBF}	Maximum Input Voltage	THD = 3%	250	300		mV
V_{GBF}	Voltage Gain	V_{IN} = 100 mV	-2.5	0	+2.5	dB
THD_{BF}	Total Harmonic Distortion			0.02	1.0	%
Descrambler						
V_{INDS}	Maximum Input Voltage	THD = 5%, f = 2.5 k (Note 3)	300	420		mV
V_{GDS}	Voltage Gain	V_{IN} = -100 mV, f = 2.5 kHz, (Note 3)	-4.8	-1.8	+2.2	dB
ΔG_{VDS}	Through On/Off Difference	V_{IN} = -100 mV, f = 2.5 kHz, (Note 3)	-3.0	0	+3.0	dB
Leak	Carrier Leak	After Offset Adjustment, (47 k - 49 k)		0.2	1.3	mV
Schmitt		28 Pin - 31 Pin				
V_{INST}	Input Sensitivity	Duty = 50 ± 5%	40	100		mV
V_{OSH}	Output Level (High)	V_{IN} = 100 mV	1.6	2.0		V
V_{OSL}	Output Level (Low)	V_{IN} = 100 mV		50	300	mV

Note 2: Measured by using the noise evaluation filter based on P. 53 of CCITT.
Note 3: Extended 3 kHz LPF is used.

ELECTRICAL CHARACTERISTICS (CONT.)

V_{CC} = 2.0 V (36 Pin), V_{CCP} = 2.4 V (5 Pin), T_A = 25 °C, f = 1.0 kHz, Sub = 3.5 kHz, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
LPF (8th Order)		21 Pin - 14 Pin				
V_{IMLP8}	Maximum Input Voltage	THD = 3%	600	700		mV
V_{GLP8}	Voltage Gain	V_{IN} = 316 mV	-14	-11	-8	dB
THD	Total Harmonic Distortion			0.4	1.0	%
Expander		13 Pin - 10 Pin, 11 Pin				
V_{ORE}	Output Reference Voltage	V_{IN} = 50 mV, V_{IN} = 0 dB	100	165	260	mV
ΔG_{E1}	Gain Error 1	V_{IN} = -10 dB	-1.0	0	+1.0	dB
ΔG_{E2}	Gain Error 2	V_{IN} = -20 dB	-1.5	0	+1.5	dB
THD_E	Total Harmonic Distortion	V_{IN} = 50 mV		0.3	1.0	%
V_{NOE}	Output Noise Voltage	Rg = 600 Ω (Note 3)		5	50	µV
A_{TT}	Mute Attenuation	V_{IN} = 50 mV (Note 3)	75	87		dB
ΔG_{EL}	Expander Line Gain Error	V_{IN} = 50 mV	-2	0	+2	dB
BTL Amplifier						
V_{OMB}	Maximum Output Voltage	THD = 10%, R1 = 2k	1.2	1.6		V
V_{NOB}	Output Noise Voltage	Rg = 600 Ω		4.0	100	µV
THD	Total Harmonic Distortion	V_{IN} = -100 mV		0.6	2.0	%
A_{TT}	Mute Attenuation	V_{IN} = -100 mV	65	80		dB
SW Threshold Voltage						
V_{P29}	Exp. BTL/Mute	20 Pin		1.35		V
V_{P29HI}	Exp. BTL Out		V_{P29}		V_{CC}	V
V_{P29LO}	Mute		0		0.6	V
V_{P30}	Line/BTL Out	30 Pin		1.35		V
V_{P30HI}	Line Out		V_{P30}		V_{CC}	V
V_{P30LO}	BTL Out		0		0.6	V
V_{P33}	Power Save	33 Pin		1.35		V
V_{P33HI}	Save		V_{P33}		V_{CC}	V
V_{P33LO}	Power		0		0.6	V

Note 2: Measured by using the noise evaluation filter based on P. 53 of CCITT.
Note 3: External 3 kHz LPF is used.

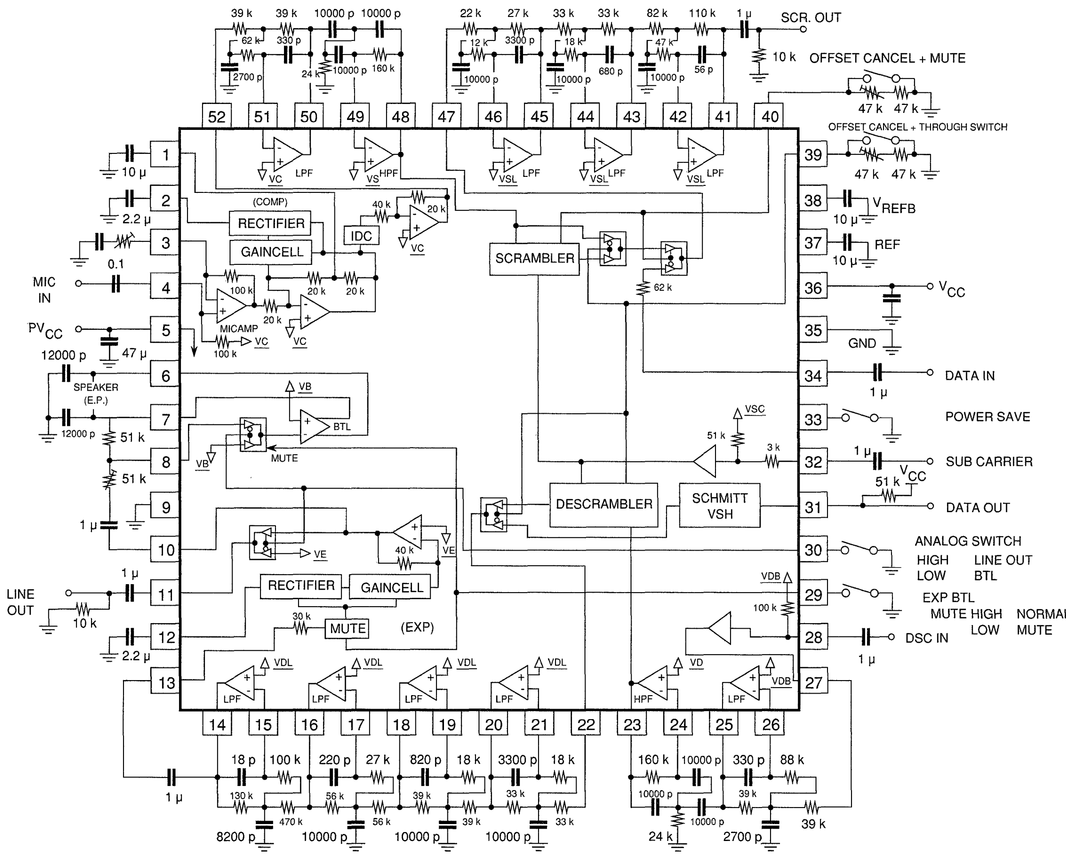
ELECTRICAL CHARACTERISTICS (CONT.)

Test conditions: V_{CC} = 2.0 V (36 Pin), V_{CCP} = 2.4 V (5 Pin), T_A = 25 °C, f = 1.0 kHz, Sub = 3.5 kHz, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{P39}	Offset/Through	39 Pin		1.15		V
V_{P39HI}	Offset		0.9		V_{P39}	V
V_{P39LO}	Through		0		0.6	V
V_{P40}	Offset/Mute.Data	40 Pin		1.15		V
V_{P40HI}	Offset		0.9		V_{P40}	V
V_{P40LO}	SCR Mute.Data		0		0.6	V
V_{SUB}	Subcarrier Input Level	Square Wave, 32 Pin	0.2	0.4	1.0	Vp-p

Note 2: Measured by using the noise evaluation filter based on P. 53 of CCITT.
Note 3: External 3 kHz LPF is used.

TEST CIRCUIT



FUNCTION OF EACH SWITCH

PIN 29: EXP, BTL MUTE SWITCH

PIN 29	10 (EXPOUT)	11 (LINEOUT)	6/7 (BTLOUT 1/2)
OPEN	EXPOUT	LINEOUT/MUTE*	BTLOUT/MUTE**
GND	MUTE	MUTE	MUTE

* When Pin 30 is connected to GND.
** When Pin 30 is open.

PIN 30: LINE/BTL SWITCH

PIN 30	11 (LINEOUT)	6/7 (BTLOUT 1/2)
OPEN	LINEOUT	MUTE*
GND	MUTE	BTLOUT*

* Pins 11 and 6/7 will be MUTED when Pin 29 is connected to GND, regardless of conditions at Pin 30.

FUNCTION OF EACH SWITCH (CONT.)

PIN 33: POWER SAVE SWITCH

PIN 33	CIRCUIT OPERATION
OPEN	PARTIAL*
GND	ALL

* Operates only the following circuits:
DSCR IN Buffer Amp
DSCR LPF Amp
DSCR HPF Amp
Data Schmitt Trigger

PIN 40: SCR OFFSET ADJUSTMENT/MUTE (DATA.OUT) SWITCH

PIN 40	47 (SCR.OUT)*
OPEN	SCR.OUT
GND	DATA.OUT

* When Pin 40 is open, Pin 34 is MUTED. When Pin 40 is connected to GND, Pin 34 INPUT is connected to Pin 47 OUT through an analog switch.

PIN 39: DSCR OFFSET ADJUSTMENT/ SCR, DSCR THROUGH SWITCH

PIN 39	22 (DSCR.OUT)	47 (SCR.OUT)*
OPEN	DSCR.OUT	SCR.OUT
GND	THROUGH.OUT	THROUGH.OUT

* When Pin 40 is connected to GND, Pin 47 OUT is connected to Pin 34 IN through an analog switch, regardless of conditions at Pin 39.

NOTES

NOTES

SCRAMBLER IC WITH COMPANDOR

FEATURES

- **Low Supply Current**
- **Low Operating Voltage (1.9 V)**
- **Complete Noise Reduction System**
- **Complete Scrambler/Descrambler**
- **IDC Circuit for Modulation Control**

DESCRIPTION

The TK10665 is a compandor and voice scrambler system for cordless telephones and other communications equipment. It is designed for battery operated systems and can operate from 1.8 to 5.5 V. In addition, it contains an Instantaneous Deviation Control (IDC) circuit for modulation control, separate data inputs and outputs. A microphone preamplifier is also provided. The TK10665Q is available in QFP48 surface mount package.

ORDERING INFORMATION

TK10665 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

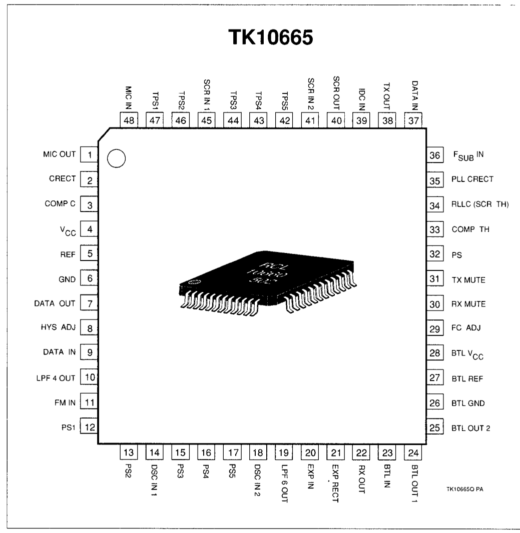
PACKAGE CODE
Q: Surface Mount

TEMP. RANGE
C : -10 to +75 °C

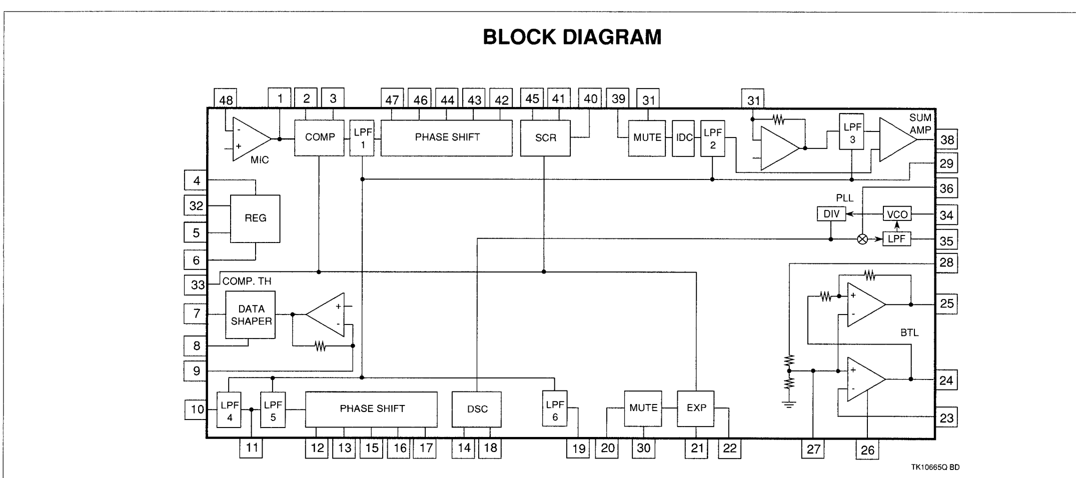
TAPE/REEL CODE
BX: Bulk/Bag
TX: Paper Tape
TR: Tape Right
TL: Tape Left
MG: Magazine

APPLICATIONS

- **Amateur Radio**
- **Transceiver**
- **Cordless Telephone**



BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} ....6.0 V
Operating Voltage Range ....1.9 to 5.5 V
Maximum Input Frequency ....80 kHz
Power Dissipation (Note 1) ....300 mW
Junction Temperature ....150 °C
Storage Temperature Range ....-55 to +150 °C
Operating Temperature Range ....-10 to +75 °C
Lead Soldering Temp. (10 sec.) ....300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 2.3 V, P_{VCC} = 2.6 V, T_A = 25 °C, f = 1 kHz, Sub = 3.25 kHz, 0.4 Vp-p

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current 1			11.0		mA
I_{CCP}	Supply Current 2			0.7		mA
I_{CCS}	Standby Supply Current 1	Data System Operation		2.0		mA
I_{CCPS}	Standby Supply Current 2			48		µA
Compressor		48→43 Pin, MICAMP = 0 dB				
V_{ORC}	Output Reference Voltage	V_{IN} = 100 mV (0 dB)		63		mV
THD_C	Total Harmonic Distortion	V_{IN} = 100 mV		0.45		%
ΔG_{C1}	Gain Error 1	V_{IN} = -20 dB		0		dB
ΔG_{C2}	Gain Error 2	V_{IN} = -40 dB		0		dB
ΔG_{TC}	Through On/Off Difference	V_{IN} = 100 mV		-1		dB
IDC		39→38 Pin				
V_{OIDC}	Output Voltage	V_{IN} = 50 mV		195		mV
THD_{IDC}	Total Harmonic Distortion	V_{IN} = 50 mV		0.6		%
V_{LIM}	Limiting Voltage			1.4		Vp-p
DATA AMP		37→38 Pin				
V_{ODATA}	Output Voltage	V_{IN} = 50 mV		350		mV
THD_{DATA}	Total Harmonic Distortion	V_{IN} = 50 mV		0.5		%
Transmitting System Characteristics		48→38 Pin				
V_{OTX}	Output Voltage	V_{IN} = 50 mV		200		mV
THDTX	Total Harmonic Distortion	V_{IN} = 50 mV, (F_{IN} = 2.25 kHz)		1.0		%

Note 1: Power dissipation must be derated at the rate of 2.4 mW/°C for operation at T_A = 25 °C and above.

ELECTRICAL CHARACTERISTICS (CONT.)

Test conditions: V_{CC} = 2.3 V, P_{VCC} = 2.6 V, T_A = 25 °C, f = 1 kHz, Sub = 3.25 kHz, 0.4 Vp-p

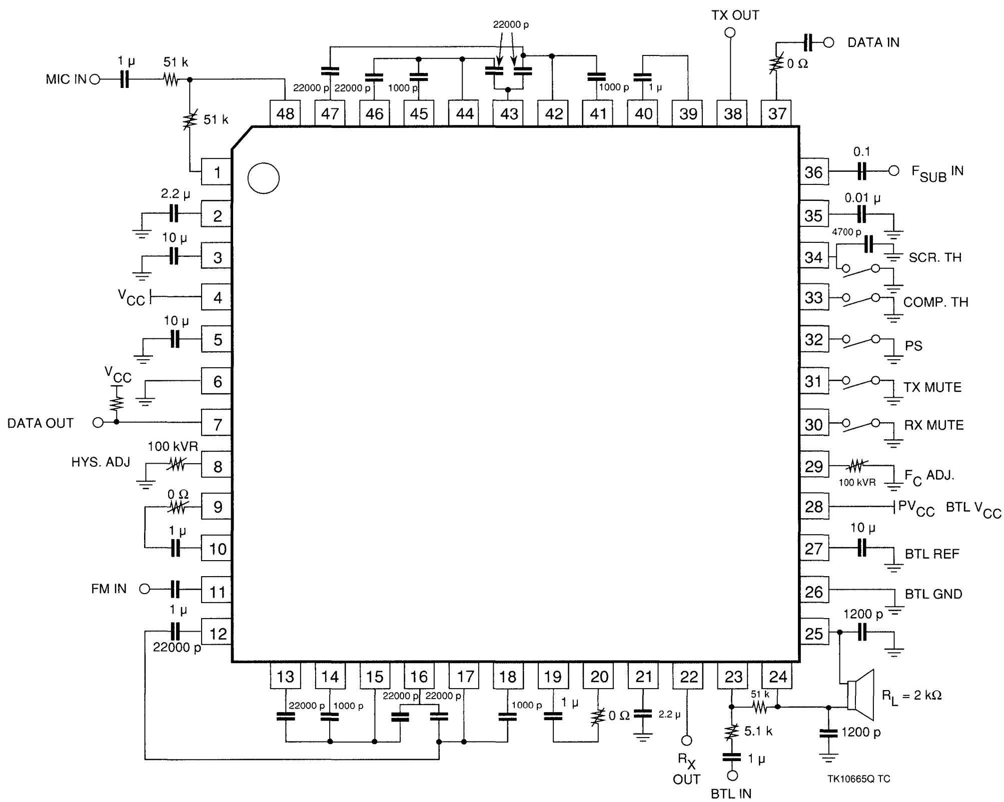
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
ATT_{TX}	Mute S/N Ratio			-45		dB
$Crss_{TX}$	Crosstalk	$R_X \rightarrow T_X$		-37		dB
V_{NTX}	Output Noise Voltage			2.5		mV
Desk Ramble		11→19 Pin				
V_{ODSC}	Output Voltage	V_{IN} = 100 mV		41		mV
THD_{DSC}	Total Harmonic Distortion	V_{IN} = 100 mV, (F_{IN} = 2.25 kHz)		0.65		%
LPF4		11→10 Pin				
V_{OLP4}	Output Voltage	V_{IN} = 100 mV		70		mV
THD_{LP4}	Total Harmonic Distortion	V_{IN} = 100 mV		0.6		%
Schmitt		9→7 Pin				
V_{INST}	Input Sensitivity	Duty = 50 ± 5%, R_{HYS} = 51 kΩ	2.5			mV
Expander		20→22 Pin				
V_{ORE}	Output Reference Voltage	V_{IN} = 50 mV, (0 dB)		290		mV
THD_E	Total Harmonic Distortion	V_{IN} = 50 mV		0.22		%
ΔG_{E1}	Gain Error 1	V_{IN} = -10 mV		0		dB
ΔG_{E2}	Gain Error 2	V_{IN} = -20 mV		0		dB
ΔG_{TE}	Through On/Off Difference	V_{IN} = 50 mV		-8		dB
ATT_E	Mute S/N Ratio	V_{IN} = 50 mV		-84		dB
Receiving System Characteristics		11→22 Pin				
V_{ORX}	Output Voltage	V_{IN} = 100 mV		240		mV
THD_{RX}	Total Harmonic Distortion	V_{IN} = 100 mV, (F_{IN} = 2.25 kHz)		0.66		%
$Crss_{RX}$	Crosstalk	$T_X \rightarrow R_X$		-83		dB
V_{NRX}	Output Noise Voltage			16		µV

ELECTRICAL CHARACTERISTICS (CONT.)

Test conditions: V_{CC} = 2.3 V, P_{VCC} = 2.6 V, T_A = 25 °C, f = 1 kHz, Sub = 3.25 kHz, 0.4 Vp-p

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
BTL AMP		23→24/25 Pin				
V_{CBTL}	Voltage Gain	R_L = 2 k		5.0		dB
THD_B	Total Harmonic Distortion	V_{IN} = 200 mV		0.15		%
V_{OMB}	Maximum Output Voltage	THD = 5%	1.4			V
Filter Characteristics						
F_{CHE4}	LPF1	Chebyshev Type 4 fc = 3 kHz		-3		dB
F_{CHE6}	LPF2	Chebyshev Type 6 fc = 3 kHz		-3		dB
F_{BES3A}	LPF3	Bessel Type 3 fc = 5 kHz		-3		dB
F_{BES3B}	LPF4	Bessel Type 3 fc = 5 kHz		-3		dB
F_{CHE3}	LPF5	Chebyshev Type 3 fc = 3 kHz		-3		dB
F_{CHE5}	LPF6	Chebyshev Type 5 fc = 3 kHz		-3		dB
DC Characteristics						
SW Low	Individual SW Low Level			0	0.4	V
SW High	Individual SW High Level			1.4	V_{CC}	V

TEST CIRCUIT



NOTES

TOKO

MULTIPLEX AUDIO SIGNAL RESTORER

FEATURES

- Low Voltage Operation
- PLL Demodulation
- Two-Level Conversion Circuit
- Multiplex Detection Level Variation Circuit
- Active Filter Operational Amplifier

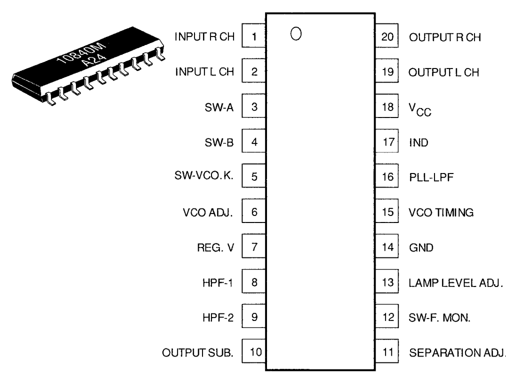
APPLICATIONS

- Stereo-Headphone LCD TVs
- Television
- VCR
- Bilingual Broadcast Decoder

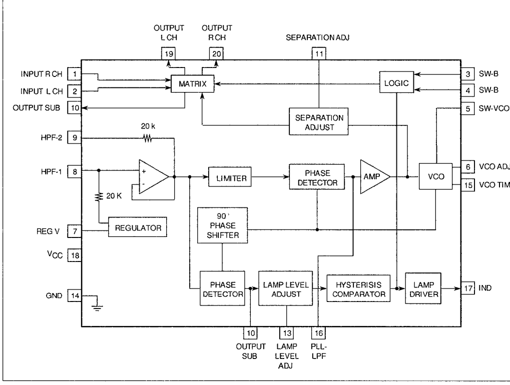
DESCRIPTION

TK10840M is a demodulator developed for the Japanese broadcast standard. It was developed for use in products such as stereo-headphone receivers and liquid crystal display TVs. The chip's 20-pin mini-flat construction simplifies product miniaturization. The device includes a lamp driver to indicate stereo operation. The TK10840 is ideal for battery operated receivers as the operating voltage range extends from 0.9 to 5.0 V and the operating current is only 5.0 mA. The device requires a minimum number of external components. The TK10840 is available in MFP20 surface mount package.

TK10840



BLOCK DIAGRAM



ORDERING INFORMATION

TK10840 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +70 °C	BX: Bulk/Bag
		TX: Paper Tape
		TR: Tape Right
		TL: Tape Left
		MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 7 V
Power Dissipation (Note 1) .... 350 mW
Operating Power Supply Voltage .... 0.9 to 5.0 V
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +125 °C
Operating Temperature Range .... -20 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 1.2 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	No signal		5.00		mA
Z_{IN}	Input Impedance			21		kΩ
Z_{OUT}	Output Impedance			3.2		kΩ
V_G	I/O Gain	Each mode, without de-emphasis		-0.5		dB
CB	Channel Balance	Each mode, CR=GvL-GvR		0		dB
D_{MAI}	Distortion, Main	Main mode		0.1		%
D_{STE}	Distortion, Stereo	Stereo mode		0.3		%
D_{SUB}	Distortion, Sub	Sub mode		0.6		%
SN_{MAI}	Signal to Noise Ratio, Main	Main mode		62		dB
SN_{STE}	Signal to Noise Ratio, Stereo	Stereo mode		52		dB
SN_{SUB}	Signal to Noise Ratio, Sub	Sub mode		52		dB
$Crss_{SM}$	Crosstalk, Sub →Main	Sub mode		50		dB
$Crss_{MS}$	Crosstalk, Main → Sub	Main mode		50		dB
SEP	Separation	Stereo mode		44		dB
C_{LEAK}	Carrier Leak	Sub mode		24		dB
CR1	Capture Range (lamp)	Input signal voltage 15.0 mV(rms) (Measured when lamp is lit)		±6.5		kHz
LR_P	Lock Range (PLL)	Input signal voltage 15.0 mV(rms) (Measured when PLL locked)		±20.0		kHz
$V_{IN\ MAX}$	Maximum Input Level	Input signal frequency 1 kHz, distortion 3%		150		mV(rms)
H_{LAMP}	Lamp Hysteresis	Input signal frequency 31.468 kHz		1.0		dB

Note 1: Power dissipation must be derated at the rate of 3.3 mW/°C for operation at T_A = 25 °C and above.

ELECTRICAL CHARACTERISTICS (CONT.)

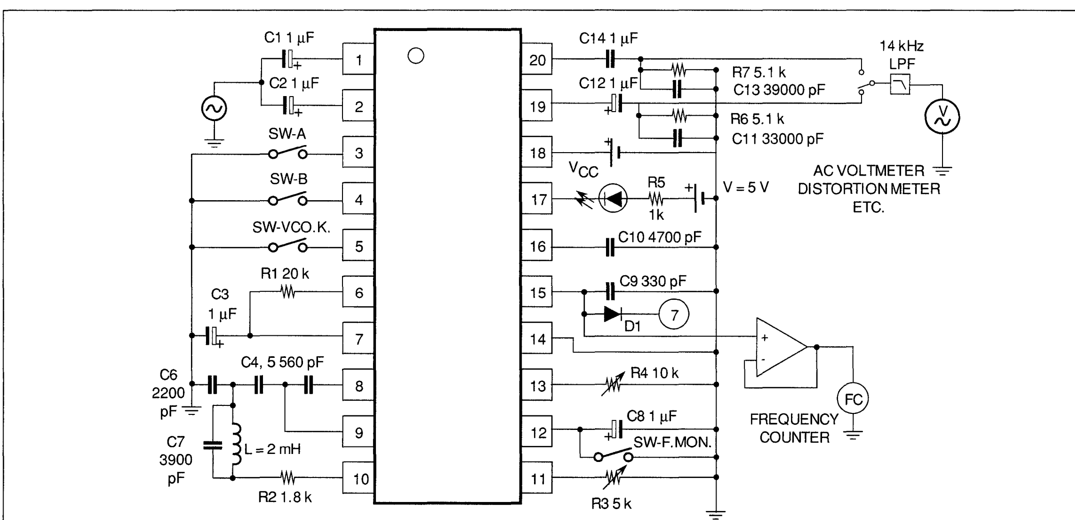
Test conditions: V_{CC} = 1.2 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{SAT}	Lamp Driver Saturation Voltage	When lamp is drawing 7 mA current		30		mV
I_{LEAK}	Lamp Driver Leakage Current	When 5 V is applied to the lamp pin		0		µA
RRR	Ripple Removal Ratio	V_{CC} = 1.2 F + 23.7 mV(rms), f = 100 Hz		46		dB
V_{SW}	Mode Switch Voltage			—		V

The following conditions may be of interest: VCO auto-set frequency = 31.468 kHz, Multiplex detection level = 10 mV(rms), after separation adjustment.

MODE	INPUT SIGNAL					MODE SWITCH	
	MAIN		SUB				
	Voltage (mVrms)	Frequency (kHz)	Voltage (mVrms)	Frequency Variation (kHz)	Modulation Frequency (kHz)	A	B
Main	25	1	15	31.468±0	—	Open	Open
Stereo	12.5	1	20	31.468±5	1	Gnd	Open
Sub	0	—	15	31.468 ±10	1	Open	Gnd

TEST CIRCUIT



TYPICAL APPLICATIONS

IC OPERATION

MONO/MULTIPLEX DETECTION

The TK10840M can automatically determine whether a received signal is monophonic or multiplex (stereo or bilingual) broadcast.

The mono/multiplex discrimination is accomplished using the input level of the sub-channel signal (PLL lock status). Thus a stereo broadcast is not automatically distinguished from a bilingual broadcast. These broadcasts are distinguished manually using a mode switch.

When it is determined that a monophonic broadcast is being received, the matrix circuit changes to mode set on the mode switch and the indicator is turned on. However, during VCO killer or forced monophonic operation, the IC will operate as if a monophonic signal were received even if the received signal is a multiplex broadcast.

There were errors in mono-multiplex detection in earlier models that used the sub-channel signal level to discriminate between monophonic and multiplex signals. The TK10840M has been equipped with two types of malfunction prevention circuits that eliminate these errors: (1) automatic lock/capture range selector circuit, and (2) multiplex detection level selector circuit.

Automatic Lock-Capture Range Selection Circuit

This circuit is used to prevent errors in mono/multiplex discrimination due to the 19 kHz FM stereo pilot signal. The spectrums of the FM stereo composite signal and the Japanese television audio multiplex signal are shown in Figures 1 and 2.

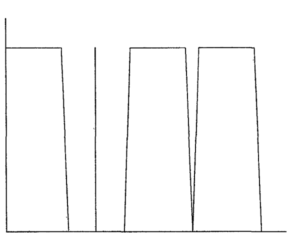


Figure 1: The spectrum of the FM stereo composite signal.

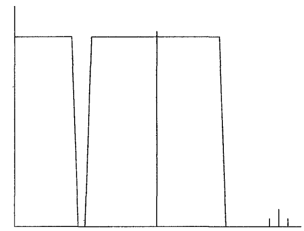


Figure 2: The spectrum of the television audio multiplex signal.

As shown in Figure 3, a PLL having a wide lock range is required in order to recover the sub-channel signal of television audio multiplex by the PLL method. When the FM stereo pilot signal enters the PLL, there is a possibility that the PLL will lock onto this signal and an error in detection will occur. One method to avoid errors caused by the FM pilot signal is to narrow the capture range by narrowing the bandwidth of the PLL Low Pass Filter, decreasing sensitivity in the over 10 kHz region. However, if this method is used, the sub-channel demodulation output rises dramatically at higher frequencies as shown in Figure 6. A variety of negative side effects result, so it is impossible to narrow the PLL Low Pass Filter to the point that the PLL would not lock on to 19 kHz.

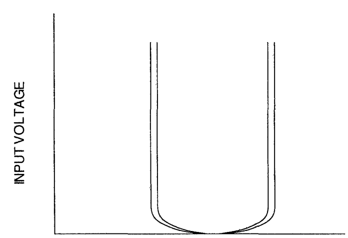


Figure 3: Earlier model's PLL lock and capture range used for the recovery of television audio multiplex signals.

The TK10840M has a PLL with selectable capture range that prevents errors in signal discrimination due to the FM pilot signal. This circuit automatically switches between the two capture ranges as shown in Figure 4, depending on the input level of the sub-channel signal. In other words, if the input level of the sub-channel signal is lower than the

TYPICAL APPLICATIONS (CONT.)

multiplex detection level*, the narrow lock-capture range is used. If it is higher, the wider lock-capture range is used. (The selection of the capture range is synchronized with the on/off switching of the indicator.)

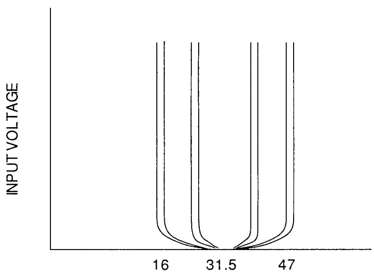


Figure 4: The lock and capture range of the TK10840M, which has a PLL with selectable capture range.

Multiplex Detection Level Selector Circuit

This circuit is used to prevent errors in mono/multiplex discrimination due to noise. The type and level of noise can vary a great deal depending on the setting, particularly when the input is weak. Thus noise can be a cause for errors, too.

The TK10840M has a multiplex detection level selector circuit that can be set with an external resistor to prevent errors due to noise and provide the best multiplex detection level for the setting. Since the TK10840M has a PLL with selectable capture range and a variable multiplex detector circuit, the lock-capture range observed with the PLL locked/unlocked is different from the lock-capture ranges observed with the indicator on/off.

When observed with the PLL locked/unlocked, Figure 4 shows the wide lock and capture ranges when the indicator is on, and the narrow lock and capture ranges when the indicator is off.

Figure 7 shows the lock-capture ranges when observed with the indicator on/off. The capture range becomes ±0 kHz at the set point of the multiplex detection level. When the multiplex detection level is changed, the lock-capture range is shifted up or down.

* The multiplex detection level can vary. See Multiplex Detection Level Variation Circuit section.

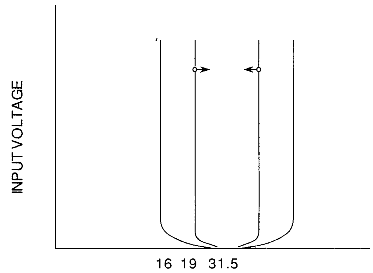


Figure 5: The lock and capture range of the PLL (used in earlier versions) when the Loop bandwidth was narrowed. (The lock and capture range narrowed.)

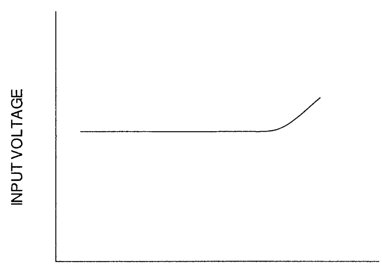
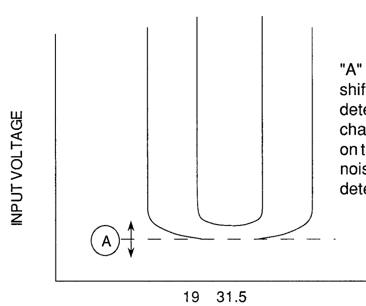


Figure 6: The frequency characteristics of the PLL detector output when the Loop-LPF was narrowed. (There is a sudden rise in the higher frequencies.)



"A" shows the up or down shift when the multiplex detection level setting is changed. It does not lock on the 19 kHz signal or the noise below the multiplex detection level.

Figure 7: The lock-capture range of the TK10840M when observed with the indicator on and off.

TYPICAL APPLICATIONS (CONT.)

MATRIX CIRCUIT

The block diagram of the matrix circuit is shown in Figure 1. The truth table of the corresponding switches is shown in Table 1. The TK10840M can distinguish between a monophonic and multiplex (bilingual or stereo) broadcast, but a bilingual broadcast is not automatically distinguished from a stereo broadcast. These signals are selected manually using an external switch. The external switch must be set appropriately depending upon whether a stereo broadcast or a bilingual broadcast is being received. Table 2 shows the outputs for various modes for stereo and bilingual broadcasts.

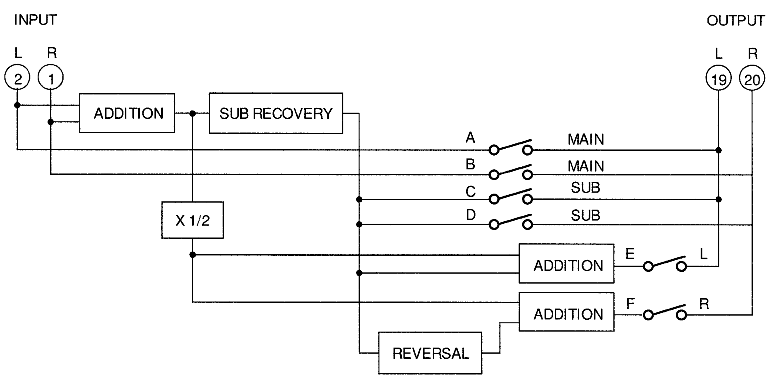


Figure 1: Matrix circuit

MODE	OUTPUT		MODE SWITCH		INTERNAL MATRIX SWITCH					
	L CH	R CH	A	B	a	c	e	b	d	f
Main	Main	Main	H	H	o	x	x	o	x	x
Sub	Sub	Sub	H	L	x	o	x	x	o	x
Stereo	L	R	L	H	x	x	o	x	x	o
Main/Sub	Main	Sub	L	L	o	x	x	x	o	x

"H" is open or 0.8 to V_{CC} V. "L" is 0.4 V. "o" is ON, and "x" is OFF

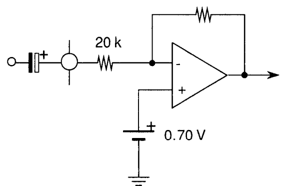
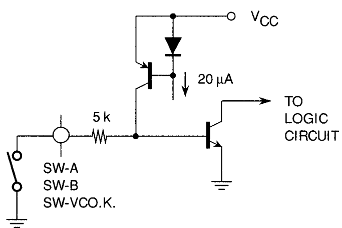
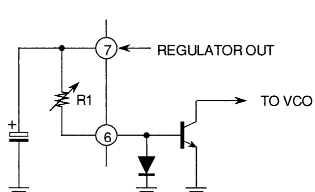
Table 1: Modes and Switch Settings

MODE	BILINGUAL BROADCAST		STEREO BROADCAST	
	L CH	R CH	L CH	R CH
Main	Main	Main	(L + R) /2	(L + R) /2
Sub	Sub	Sub	(L – R) /2	(L – R) /2
Stereo	(Main + Sub) /2	(Main + Sub) /2	L	R
Main/Sub	Main	Sub	(L + R) /2	(L – R) /2

Table 2: Outputs

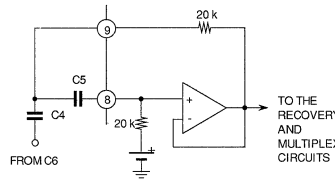
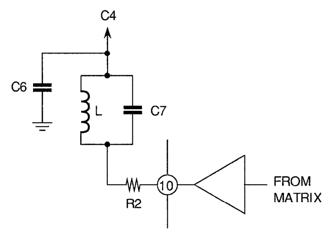
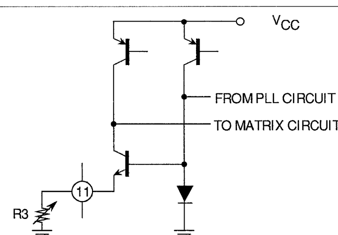
TYPICAL APPLICATIONS (CONT.)

TERMINAL CONNECTIONS

PIN NUMBER	PIN NAME	EQUIVALENT CIRCUIT	FUNCTION	PIN VOLTAGE (VDC)
1	Right Channel Signal Input (Input - R CH)		These are signal input pins. The output signal(s) from either the FM restorer or FM stereo restorer is connected to these pins. C1 and C2 are coupling capacitors.	0.70
2	Left Channel Signal Input (Input - L CH)			
3	Mode Switch A		These are the mode switching pins. The matrix circuit can be switched to any mode manually with the SW-A and SW-B mode switches. However, if any of the following conditions exist, the matrix circuit will be in monophonic mode regardless of the SW-A and SW-B mode switch settings. 1. A monophonic signal is being received. 2. The VCO killer is operating. 3. Monophonic operation is being selected. These pins are pulled up internally, therefore external pull up is not necessary. When an external 5 kΩ current limiting resistor is used, the pull up threshhold voltage is 0.8 V.	0.65
4	Mode Switch B			
5	VCO Killer Switch (SW - VCO.K.)		This is the VCO killer pin. Pulling down pin 5 (0 to 0.4 V) has the following effects: 1. VCO oscillation is stopped. 2. The matrix circuit goes into monophonic mode. 3. The multiplex indicator is turned off.	
6	VCO Frequency Adjustment (VCO - Adjust)		This is the VCO frequency adjustment pin. The VCO frequency can be adjusted to 31.5 kHz with the trim resistor (R1) connected across pins 6 and 7.	0.65
7	Regulator Output (Regulated - Voltage)		This is the regulator output pin. C3 is a bypass capacitor.	0.80

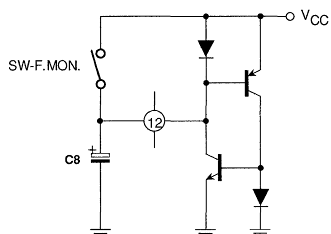
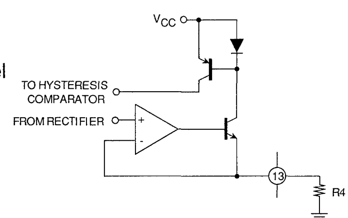
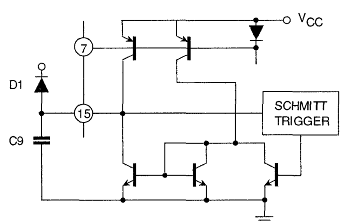
TYPICAL APPLICATIONS (CONT.)

TERMINAL CONNECTIONS

PIN NUMBER	PIN NAME	EQUIVALENT CIRCUIT	FUNCTION	PIN VOLTAGE (VDC)
8 9	Filter 1 (HPF-1) Filter 2 (HPF-2)		These are the active filter pins for sub-channel signal extraction. A high-pass filter is constructed by connecting the C4 and C5 capacitors. The main channel signal is reduced by this high-pass filter and the sub-channel signal is sent on to the recovery circuit and multiplex detector circuit. When C4=C5, the cutoff frequency f_C of the high-pass filter is $f_C=1/(2\ CR)$ Hz. The rolloff is 12 dB/Oct.	0.80
10	Sub-Channel Signal Output (Output-Sub)		This is the signal output pin for the sub-channel signal extraction filter. The Right Channel input (pin 1) and the Left Channel (pin 2) signals are added, and the sum is multiplied by 2 and made available at the output. We recommend connecting a filter to this terminal that will remove the control channel. If this filter is not included, an audible beat in the audio signal will develop from interaction between the sub-channel signal and control signal channel. The parallel resonance of coil L and capacitor C7 create a filter that removes the control channel. Capacitor C6 acts as a low pass filter as well as a phase shift corrector for the sub-channel signal.	0.45
11	Separation Adjustment (Separation-Adjust)		This is the separation adjustment pin. R3 is the separation adjustment resistor. The sub-channel signal detector output is highest when R3=0 .	0.03

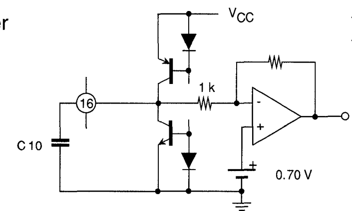
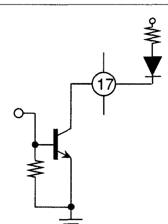
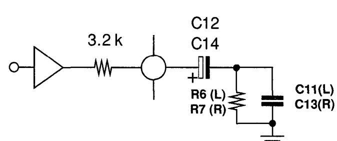
TYPICAL APPLICATIONS (CONT.)

TERMINAL CONNECTIONS

PIN NUMBER	PIN NAME	EQUIVALENT CIRCUIT	FUNCTION	PIN VOLTAGE (VDC)
12	Forced Monophonic Switch (SW-F. Mon.)		This pin is used to force monophonic operation and level detection rectification. Pulling up this pin to V_{CC} has the following effects: 1. The matrix circuit goes into the mode selected by the mode switch. 2. The multiplex indicator is turned off. (forced multiplex operation). C8 is the smoothing capacitor for sub-channel signal level detection. Increasing C8 lengthens the response time of the multiplex indicator light. Omitting this capacitor is possible and the following conditions will occur when drawing several µA of current from this pin: 1. The matrix circuit goes into the mode selected by the mode switch. 2. The multiplex indicator is turned off (forced multiplex operation).	—
13	Mono/Multiplex Detection Level Setting (Lamp Level Adjust)		This is the mono/multiplex detection level setting pin. The resistor R4 sets the mono/multiplex detection level. The detection level rises as R4 is increased (sensitivity decreases). This pin is susceptible to capacitive loads.	0
14	GND		GND Pin	0
15	VCO Timing Capacitance		This is the pin for connecting the VCO timing capacitor. The user can monitor the VCO oscillation frequency from this pin. Since this pin has high impedance, either an external buffer or test equipment should be used for measuring the VCO frequency. When using a power supply voltage greater than 2 V, insert diode D1 between this pin and point 7 Regulated-Voltage in order to start VCO oscillation. The following effects occur when C9 is increased: 1. The lock range becomes narrow. 2. The sub-channel signal's detection output becomes large.	—

TYPICAL APPLICATIONS (CONT.)

TERMINAL CONNECTIONS

PIN NUMBER	PIN NAME	EQUIVALENT CIRCUIT	FUNCTION	PIN VOLTAGE (VDC)
16	PLL Low Pass Filter (PLL-LPF)		This is the PLL loop low pass filter pin. The following effects occur when C10 is increased: 1. The capture range becomes narrow. 2. Carrier rejection becomes higher. 3. The sub-channel signal detector out put rises a thigh frequencies.	0.70
17	Multiplex Indicator (IND)		This is the multiplex indicator pin. It is an open collector connecter internally.	
18	V_{CC}		V_{CC} pin.	1.20
19 20	Left Channel Signal Output (Output-L CH) Right Channel Signal Output (Output-R CH)		These are the audio signal output pins. The pin bias is 0.45 VDC. The output impedance is 3.2 kΩ. Capacitors C11 and C13 are used for de-emphasis. C12 and C14 are coupling capacitors. R6 and R7 represent load resistances.	0.45

TYPICAL APPLICATIONS

1. PIN #10 OUTPUT SUB-CHANNEL SIGNAL VS. INPUT SIGNAL (L + R)

The relationship between pin #10 output sub-channel voltage, distortion and the input signal (L + R) voltage shown in Figures 1 and 2, respectively.

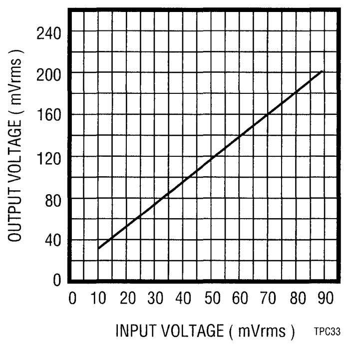


Figure 1: Pin #10 output sub-channel signal vs. Input signal (L + R).

Test conditions:

Input signal L + R
Main channel signal = x mV(rms)
Frequency = 1 kHz
Sub-channel signal = 20x/25 mV(rms)
Frequency = ±0 kHz

Pin #10's output signal is passed through a a 31.5 kHz BPF. The sub-channel signal and distortion are measured. Pin 10 is not loaded.

The sub-channel signal distortion is about 3% at an input signal of 50 mV(rms). The sub-channel is FM, so there is no effect on the detection output if the distortion is at the 3% level.

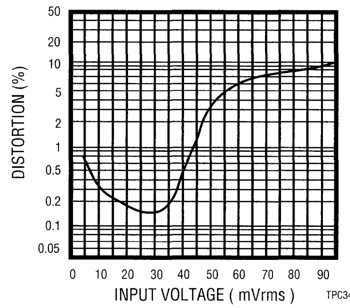


Figure 2: Pin 10 output sub-channel distortion vs. Input signal (L + R).

2. PIN #10 PIN #10 OUTPUT SUB-CHANNEL SIGNAL AND DISTORTION vs. LOAD RESISTANCE

The relationships between pin10 output sub-channel signal distortion and pin10 load resistance is shown in Figures 3 and 4, respectively.

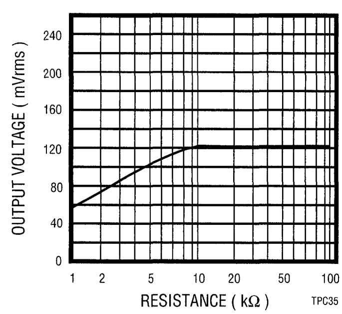


Figure 3: Pin 10 output sub-channel signal vs. load resistance.

Measurement conditions:

Input signal L + R
Main channel signal = 50 mV(rms)
Frequency = 1 kHz
Sub-channel signal = 40 mV(rms)
Frequency = ±0 kHz

TYPICAL APPLICATIONS (CONT.)

Pin 10 output signal is passed through on a 31.5 kHz BPF. The subchannel signal and distortion are measured. An AC load is connected to pin10 and measurements made with various load conditions.

The distortion increases suddenly as the load is reduced below 15 kΩ. Consequently, it is recommended to keep the load greater than 15 kΩ at pin 10 when the input signal voltage is 50 mV(rms).

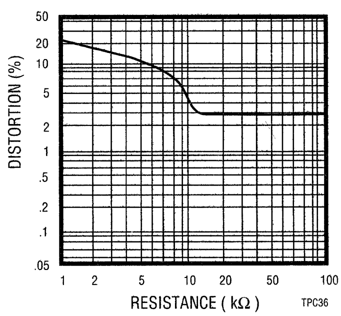


Figure 4: Pin 10 output sub-channel distortion vs. load resistance.

3. PLL-LPF AND THE PIN 19 AND 20 OUTPUT AUDIO SIGNALS (A METHOD IMPROVING CARRIER REJECTION)

According to the specifications, the maximum input level is 150 mV(rms) (generating a distortion of 3%) when a monophonic signal is being received, but the maximum input level is lower when a signal with a sub-carrier is received. When a 50 mV(rms) signal is received, it is necessary to increase carrier rejection, especially for stereo recovery. Carrier rejection can be increased by increasing the PLL filter capacitor, C10 at pin 16.

4. AN APPLICATION IN WHICH THE INPUT SIGNAL LEVEL WAS SET AT 50 mV(rms)

Figure 5 shows an application in which the input signal level was set at 50 mV(rms). The section within the dashed box was modified.

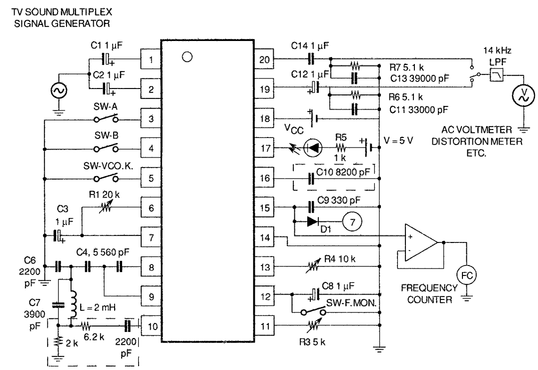
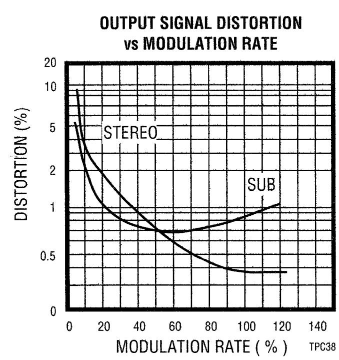


Figure 5: An application in which the input signal level was set to 50 mV(rms).

5. CHARACTERISTICS

Figures 6 to 12 show the characteristics of the application shown in Figure 5. The test conditions are the same as those listed in the specifications, except the signal level, which was doubled.

Figure 6



TYPICAL APPLICATIONS (CONT.)

Figure 7

SEPARATION vs MODULATION RATE

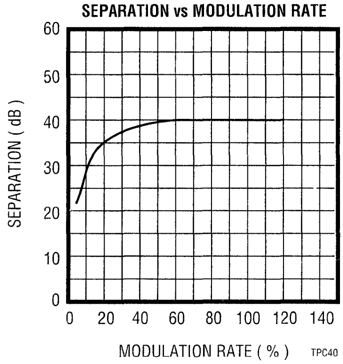


Figure 10

OUTPUT SIGNAL DISTORTION vs FREQUENCY

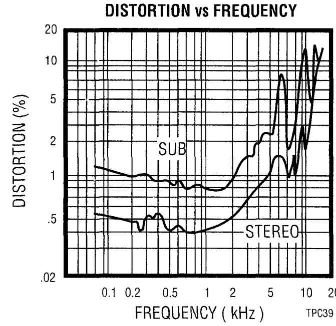


Figure 8

LOCK RANGE vs INPUT SIGNAL VOLTAGE

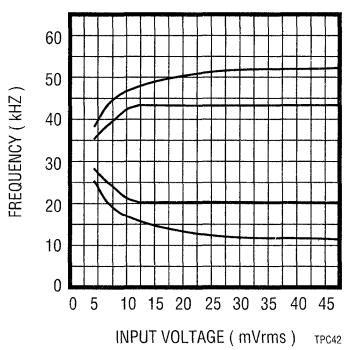


Figure 11

SEPARATION vs FREQUENCY

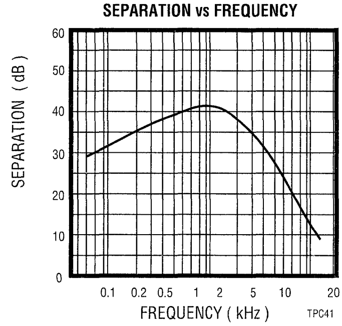


Figure 9

OUTPUT SIGNAL LEVEL vs FREQUENCY

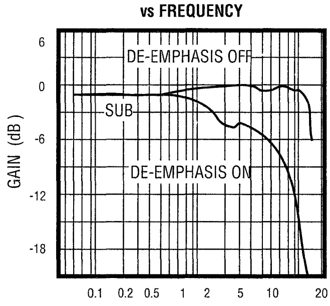
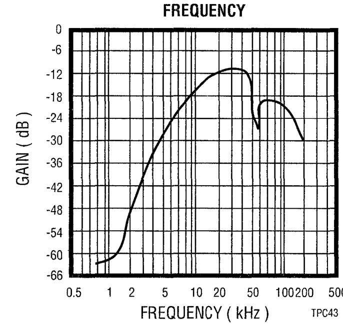


Figure 12

PIN 10 OUTPUT LEVEL vs FREQUENCY



TYPICAL APPLICATIONS (CONT.)

THE S-CURVE OF THE FM IF, THE I/O PHASE SHIFT OF THE FM MPX, AND THE TK10840'S OUTPUT

Pins 13 and 14 might correspond to either the left and right or right and left audio signals depending upon whether the S-curve of the FM IF is regular or reversed, and whether the phase shift between the FM MPX's input and output is regular or reversed. Wire as shown in Figure 1 when both the S-curve of the FM IF and the phase shift between the FM MPX's input and output are regular, or both are reversed. The outputs for this case are shown in Table 1. Wire as shown in Figure 14 when one is regular and the other is reversed. The outputs for this case are shown in Table 2.

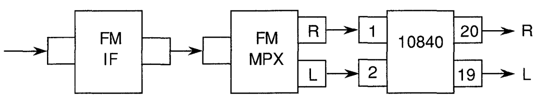


Figure 13: Both regular or both reversed.

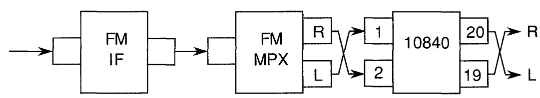


Figure 14: One regular and the other reversed.

		INPUT		OUTPUT		INPUT		OUTPUT	
		Pin 2	Pin 1	Pin 19	Pin 20	Pin 2	Pin 1	Pin 19	Pin 20
FM stereo		Left audio	Right audio	Left audio	Right audio	V /	V /	V /	V /
TV audio	Stereo	TV audio multiplex signal Stereo		Left audio	Right audio			V /	V /
	Main	TV audio multiplex signal		Main audio	Main audio	V /	+f /	V /	V /
	Sub	Bilingual		Sub-audio	Sub-audio			V /	V /
	Stereo/Sub			Main audio	Sub-audio			V /	V /

Table 1: Input and output allocation corresponding to Figure 1.

		INPUT		OUTPUT		INPUT		OUTPUT	
		Pin 2	Pin 1	Pin 19	Pin 20	Pin 2	Pin 1	Pin 19	Pin 20
FM stereo		Left audio	Right audio	Left audio	Right audio	V \	V \	V \	V \
TV audio	Stereo	TV audio multiplex signal Stereo		Left audio	Right audio			V \	V \
	Main	TV audio multiplex signal		Main audio	Main audio	V \	+f /	V \	V \
	Sub	Bilingual		Sub-audio	Sub-audio			V /	V /
	Stereo/Sub			Main audio	Sub-audio			V \	V /

Table 2: Input and output allocation corresponding to Figure 2.

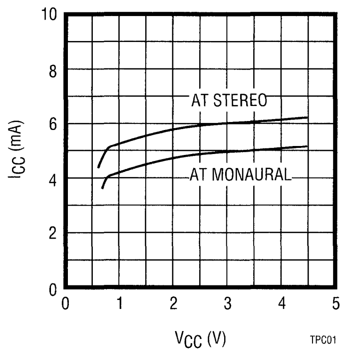
Note: For the diagrams in Tables 1 and 2:

V Horizontal axis = time, vertical axis = DC signal voltage

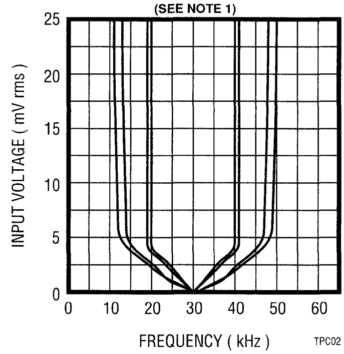
f Horizontal axis = time, vertical axis = frequencies

TYPICAL PERFORMANCE CHARACTERISTICS

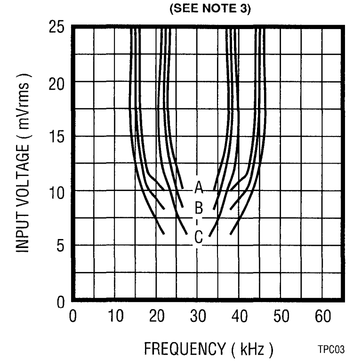
SUPPLY CURRENT vs SUPPLY VOLTAGE



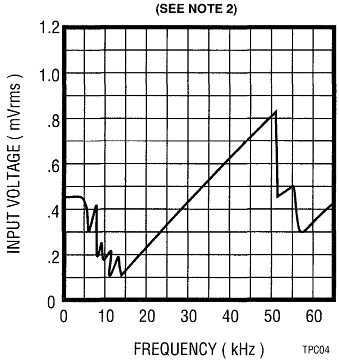
LOCK RANGE, CAPTURE RANGE, AND MULTIPLEX DETECTION LEVEL
(SEE NOTE 1)



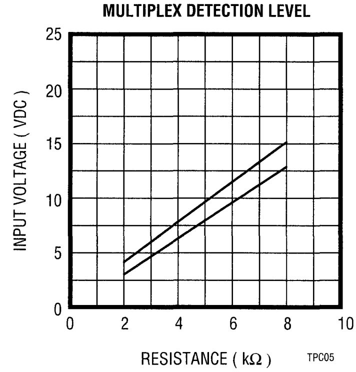
INPUT SIGNAL vs LOCK, CAPTURE RANGE
(SEE NOTE 3)



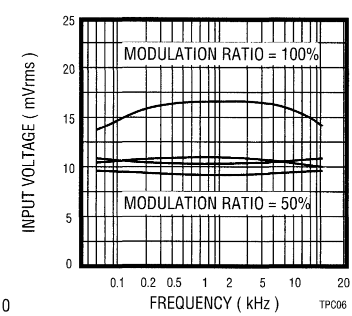
INPUT SIGNAL vs DC OUTPUT VOLTAGE
(SEE NOTE 2)



MULTIPLEX DETECTION LEVEL RESISTANCE SETTING vs MULTIPLEX DETECTION LEVEL



MULTIPLEX DETECTION LEVEL vs SUB-CHANNEL SIGNAL MODULATION FREQUENCY



Note 1: Determines whether or not the VCO oscillator is locked to the input frequency. Monophonic mode is forced and the value during standby mode is measured. Multiplex mode is forced and the value during operation is measured.

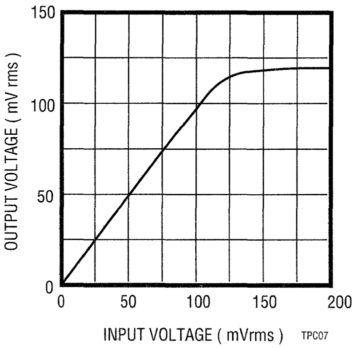
Note 2: The separation adjustment resistor value is zero (R3=0 Ω). Input signal = 20 mV(rms) pure tone. The mode switch is set to sub mode. Multiplex operation is selected.

Note 3: Determines whether or not the multiplex indicator is turned on.
A: Multiplex detection level = 10 mV(rms)
B. Multiplex detection level = 8 mV(rms)
C. Multiplex detection level = 6 mV(rms)

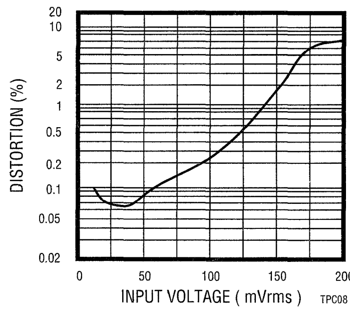
(SEE NOTE 1)

TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

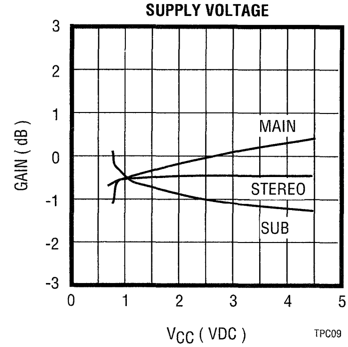
OUTPUT SIGNAL VOLTAGE vs INPUT SIGNAL VOLTAGE



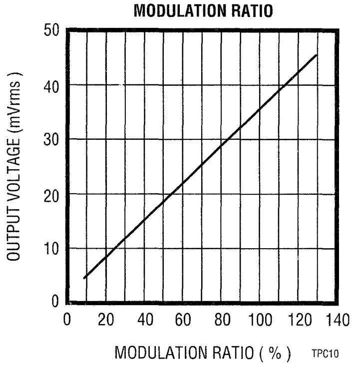
OUTPUT SIGNAL DISTORTION vs INPUT SIGNAL VOLTAGE



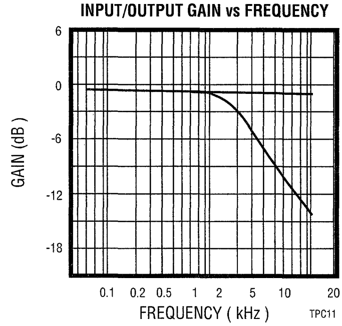
INPUT/OUTPUT GAIN vs SUPPLY VOLTAGE



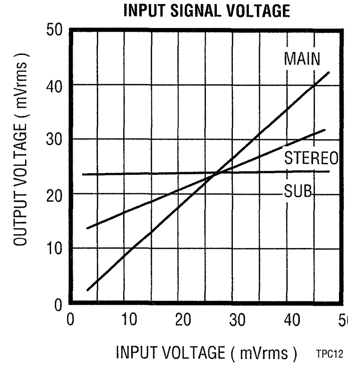
OUTPUT SIGNAL VOLTAGE vs MODULATION RATIO



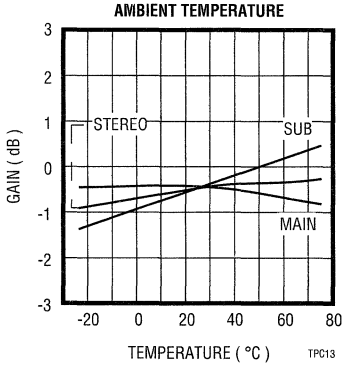
INPUT/OUTPUT GAIN vs FREQUENCY



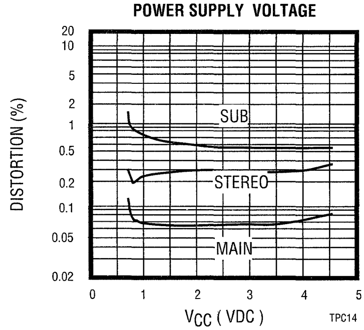
OUTPUT SIGNAL VOLTAGE vs INPUT SIGNAL VOLTAGE



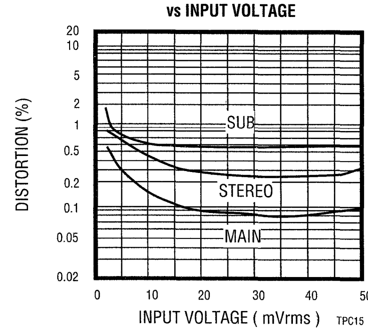
INPUT/OUTPUT GAIN vs AMBIENT TEMPERATURE



OUTPUT SIGNAL DISTORTION vs POWER SUPPLY VOLTAGE

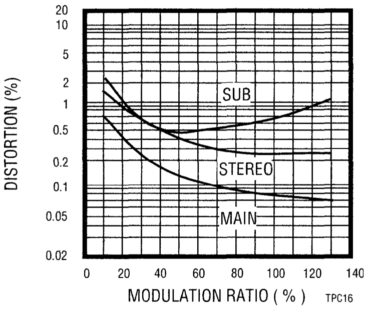


OUTPUT SIGNAL DISTORTION vs INPUT VOLTAGE

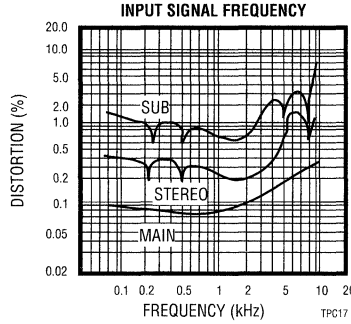


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

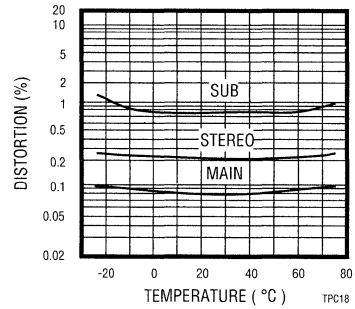
OUTPUT SIGNAL DISTORTION vs MODULATION RATIO



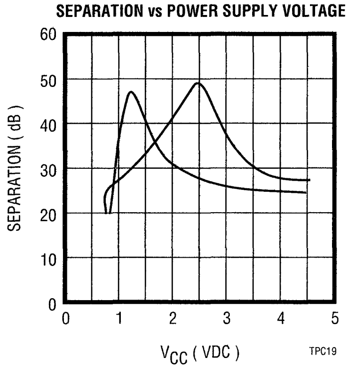
OUTPUT SIGNAL DISTORTION vs INPUT SIGNAL FREQUENCY



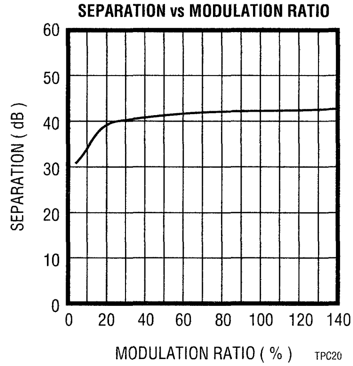
OUTPUT SIGNAL DISTORTION vs AMBIENT TEMPERATURE



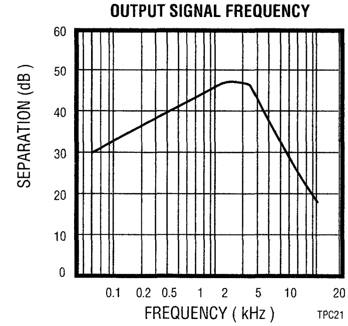
SEPARATION vs POWER SUPPLY VOLTAGE



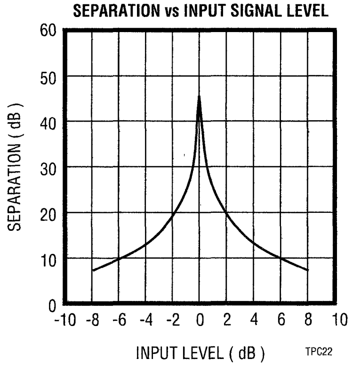
SEPARATION vs MODULATION RATIO



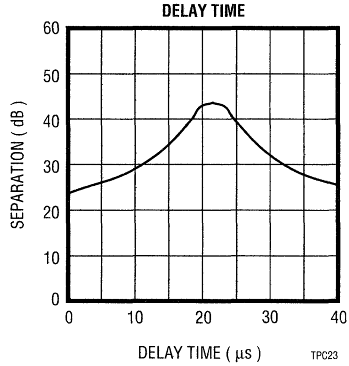
SEPARATION vs OUTPUT SIGNAL FREQUENCY



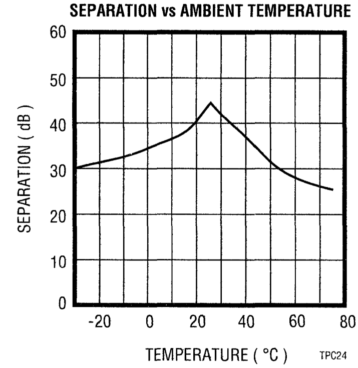
SEPARATION vs INPUT SIGNAL LEVEL



SEPARATION vs SUB-CHANNEL SIGNAL DELAY TIME

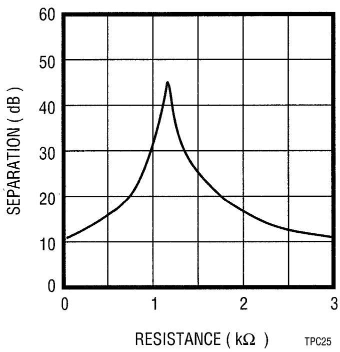


SEPARATION vs AMBIENT TEMPERATURE

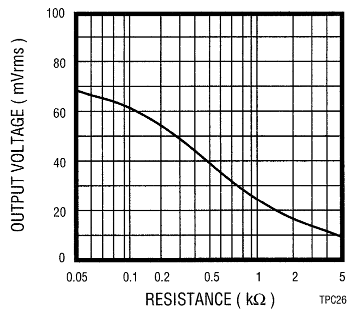


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

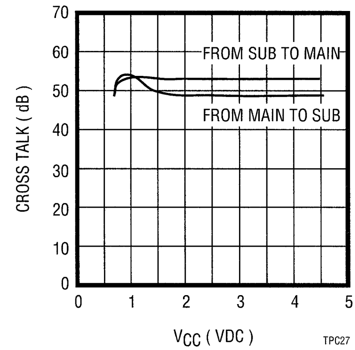
SEPARATION vs SEPARATION ADJUSTMENT RESISTANCE



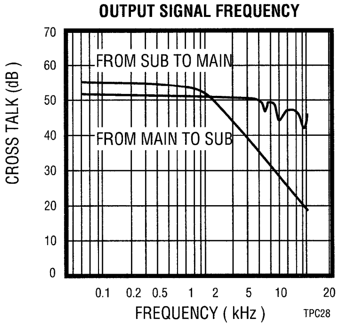
SUB-AUDIO SIGNAL VOLTAGE vs SEPARATION ADJUSTMENT RESISTANCE



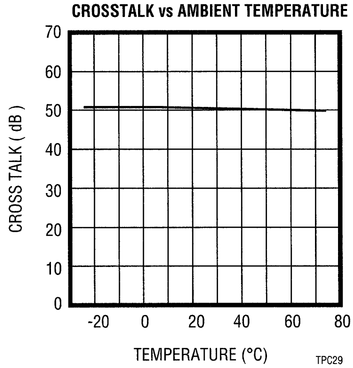
CROSSTALK vs POWER SUPPLY VOLTAGE



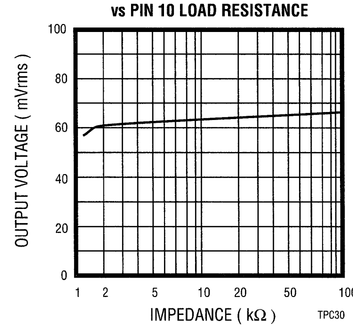
CROSS TALK vs OUTPUT SIGNAL FREQUENCY



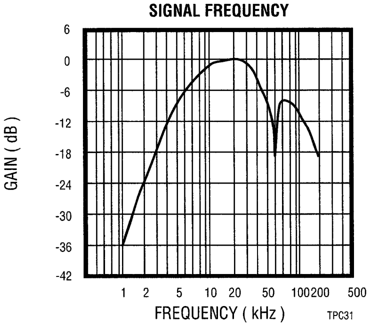
CROSSTALK vs AMBIENT TEMPERATURE



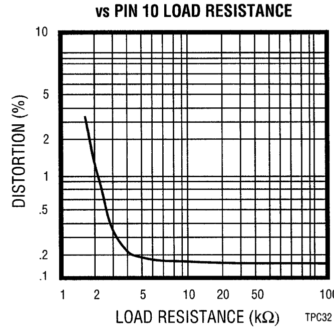
PIN 10 OUTPUT SIGNAL VOLTAGE vs PIN 10 LOAD RESISTANCE



PIN 8 VOLTAGE vs INPUT SIGNAL FREQUENCY



PIN 10 OUTPUT SIGNAL DISTORTION vs PIN 10 LOAD RESISTANCE



MULTIPLEX AUDIO SIGNAL RESTORER

FEATURES

- Low Voltage Operation
- PLL Demodulation
- VCO Killer Pin
- Multiplex Detection Level Variation Circuit

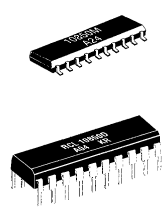
APPLICATIONS

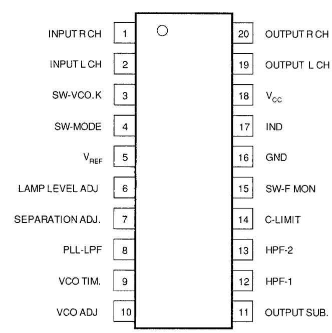
- Portable TVs
- Radio/Cassette Players With TV Sound
- VCR

DESCRIPTION

TK10850M and TK10850D are Japanese television multiplex audio signal restorers suited for use in products such as portable TVs and radio/cassette players. They provide a complete decoder system for stereo sound and subchannel decoders based on a PLL detection circuit. The IC has a built in Lamp Driver for a LED multiplex indicator. The TK10850 is designed for low voltage operation (2.7 V) and low operating current (1.5 mA) and is ideal for battery operated equipment. The IC uses a minimum of external components and includes a built in voltage regulator. The TK10850 is available in DIP20 and MFP20 surface mount packages.

TK10850





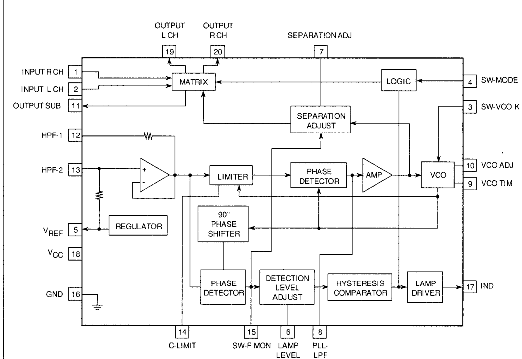
ORDERING INFORMATION

TK10850 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +70 °C	BX: Bulk/Bag
D: Plastic Dip		TX: Paper Tape
		TR: Tape Right
		TL: Tape Left
		MG: Magazine

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} ....10 V
Power Dissipation (Note 1) ....410 mW
Operating Power Supply Voltage ....2.7 to 9.0 V
Junction Temperature..150 °C
Storage Temperature Range....................-55 to +150 °C
Operating Temperature Range ....-20 to +70 °C
Lead Soldering Temp. (10 sec.) ....300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 4.5 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CCQ}	Supply Current	No signal, stereo mode		3.5		mA
I_{CCK}	Supply Current (VCO Killer Operation)	When VCO Killer is operating, stereo mode		1.5		mA
V_{GMAI}	I/O Gain, Main	Main mode		-0.5		dB
V_{GSTE}	I/O Gain, Stereo	Stereo mode		-0.5		dB
V_{GSUB}	I/O Gain, Sub	Sub mode		-1.5		dB
CB	Channel Balance	Each mode		0		dB
D_{MAI}	Distortion, Main	Main mode		0.07		%
D_{STE}	Distortion, Stereo	Stereo mode		0.15		%
D_{SUB}	Distortion, Sub	Sub mode		0.60		%
SN_{MAI}	Signal to Noise Ratio, Main	Main mode		68		dB
SN_{STE}	Signal to Noise Ratio, Stereo	Stereo mode		63		dB
SN_{SUB}	Signal to Noise Ratio, Sub	Sub mode		63		dB
CS	Channel Separation	Stereo mode		47		dB
$Crss_{SM}$	Crosstalk, Sub →Main	Sub mode		62		dB
$Crss_{MS}$	Crosstalk, Main → Sub	Main mode		64		dB
Crss	Crosstalk	Monophonic mode		68		dB
C_{LSTE}	Carrier Leakage	Stereo mode		28		dB
V_{IN}	Maximum Input Level	Monophonic mode, distortion 3%		-5		dB
H_{LAMP}	Lamp Hysteresis	Stereo mode, modulation ratio 0%		4		dB
Z_{IN}	Input Impedance			50		k
V_{SAT}	Lamp driver saturation voltage	When lamp is drawing 5 mA		60		mV
L_{LEAK}	Lamp driver leakage current	When 4.5 V is applied to the lamp pin		0		μA

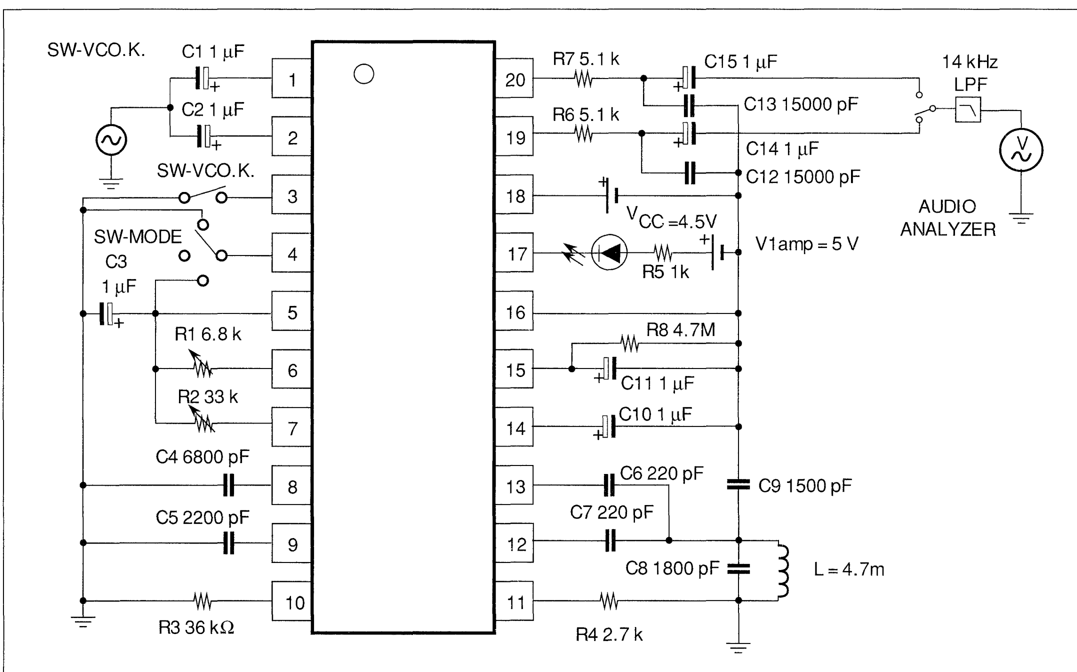
ELECTRICAL CHARACTERISTICS (CONT.)

Test conditions: V_{CC} = 4.5 V, T_A = 25 °C, unless otherwise specified.

The following conditions apply unless otherwise noted: Multiplex detection level (lamp on) = -30 dB (stereo mode, modulation ratio 0%); measured after channel separation adjustment (stereo mode).

MODE	INPUT SIGNAL					MODE SWITCH
	MAIN CHANNEL SIGNAL		SUB-CHANNEL SIGNAL			
	Level (dBV)	Frequency (kHz)	Level (dBV)	Frequency Variation (kHz)	Modulation Frequency (kHz)	
Monophonic	-24.0	1	-∞	—	—	Open
Main	-24.0	1	-28.4	31.468±0	—	V_{REF}
Stereo	-30.0	1	-25.9	31.468 ±5	1	Open
Sub	-∞	—	-28.4	31.468±10	1	Gnd

TEST CIRCUIT



TYPICAL APPLICATIONS

IC OPERATION

CHANNEL SEPARATION CORRECTION

A channel separation correction circuit has been built into the TK10850 to prevent deterioration of channel separation due to variation of the input signal level. Japanese television audio multiplex uses the FM-FM method, so theoretically the level of the signal input to the audio multiplex signal restorer doesn't vary. In reality, however, the signal level does vary due to factors such as the power supply and temperature dependence of components connected to the audio multiplex signal restorer (such as the FM-IF).

The formula below shows the channel separation in dB of typical audio multiplex signal restorers (i.e., those without channel separation correction circuits). The E term is the input signal level variation in dB.

$$CS = -20 \log \frac{1 - 10^{-\left|\frac{\Delta E}{20}\right|}}{1 + 10^{-\left|\frac{\Delta E}{20}\right|}}$$

Formula 1

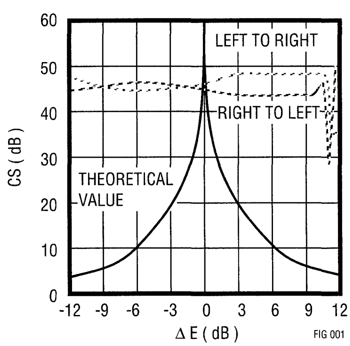


Figure 1: Audio multiplex signal restorer input signal level vs. channel separation

This function is shown in Figure 1 (the solid line). It is clear from Formula 1 and Figure 1 that channel separation deteriorates quickly with a variation in the input signal level. The channel separation correction circuit protects against this deterioration. This circuit controls the level of the signal (the L-R signal and sub-audio signal) that recovered the sub-channel (FM) signal being input. With this circuit, the deterioration of channel separation due to input signal level variation is sharply reduced. The dashed line in Figure 1 shows the improvement.

Furthermore, with typical audio multiplex signal restorers, a discrepancy develops between the main audio and sub-audio levels when the input signal level changes. Figure 2 shows the relationship between the input signal level and output signal level. Figure 3 clearly shows that this problem is solved in the TK10850 with the addition of the correction circuit.

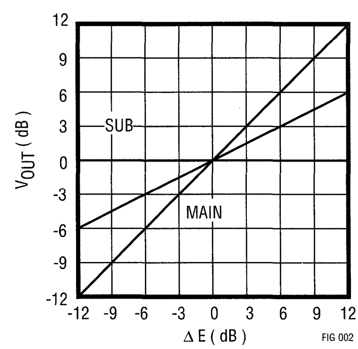


Figure 2: Input signal level vs. output signal level in a typical audio multiplex signal restorer.

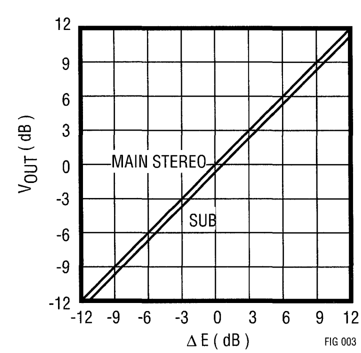


Figure 3: Input signal level vs. output signal level in the TK10850.

TYPICAL APPLICATIONS (CONT.)

IC OPERATION (CONT.)

MONO/MULTIPLEX DETECTION

The TK10850 can automatically determine whether a received signal is a monophonic or multiplex (stereo or bilingual) broadcast. This determination is made based on the input level of the sub-channel signal (with PLL locked). Thus a stereo broadcast is not automatically distinguished from a bilingual broadcast. These broadcasts are distinguished manually using a mode switch. When it is determined that a monophonic broadcast is being received, the matrix circuit converts to monophonic mode and the indicator is turned off. When a multiplex broadcast is being received, the matrix circuit converts to mode set on the mode switch and the indicator is turned on. However, during VCO killer or forced monophonic operation, the IC will operate as if a monophonic signal were received even if the received signal is a multiplex broadcast.

There were errors in mono/multiplex detection in earlier models which used the sub-channel signal level to discriminate between monophonic and multiplex signals. The TK10850 has been equipped with two types of malfunction prevention circuits described below, eliminating these errors.

1. **The Lock-Capture Range Two-Level Conversion Circuit**

   This circuit is used to prevent errors in mono/multiplex discrimination due to the 19 kHz FM stereo pilot signal. The spectrums of the FM stereo composite signal and the Japanese television audio multiplex signal are shown in Figures 1 and 2, respectively.

   As shown in Figure 3, a PLL with a wide lock range is required in order to recover the sub-channel signal of television audio multiplex by the PLL method. When the FM stereo pilot signal enters the PLL, there is the possibility that the PLL will lock onto this signal and an error will occur in detection. One method to avoid errors due to the FM pilot signal is to narrow the capture range by narrowing the bandwidth of the PLL's Loop-low pass filter, thus decreasing sensitivity in the 19 kHz region. However, if this method is used, the sub-channel detection output rises dramatically at higher frequencies, as shown in Figure 6. A variety of negative side effects result, so it is impossible to narrow the PLL's Loop-low

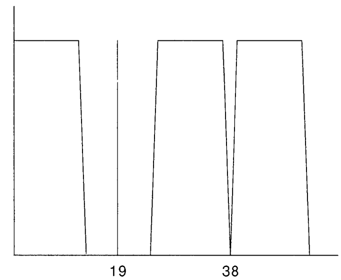


Figure 1: The spectrum of the FM stereo composite signal.

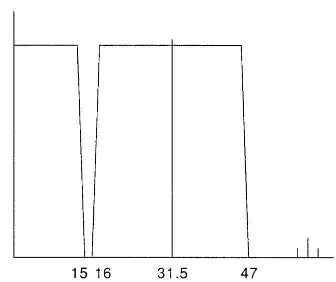


Figure 2: The spectrum of the television audio multiplex signal.

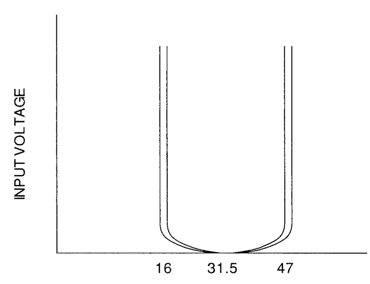


Figure 3: Earlier models' PLL lock and capture range used for the recovery of television audio multiplex signals. (These models locked onto the FM stereo pilot signal.)

TYPICAL APPLICATIONS (CONT.)

IC OPERATION (CONT.)

pass fi lter to the point that the PLL would not lock onto 19 kHz.

The TK10850 has a PLL with selectable capture range that prevents errors in signal discrimination due to the FM pilot signal. This circuit automatically switches between the two capture ranges as shown in Figure 4, depending on the input level of the sub-channel signal. In other words, if the input level of the sub-channel signal is lower than the multiplex detection level, the narrow lock-capture range is used. (The multiplex detection level can vary. See "2. Multiplex Detection Level Variation Circuit.") If it is higher, the wider lock-capture range is used. (The selection of the capture range is synchronized with the on/off switching of the indicator.)

2. Multiplex Detection Level Variation Circuit

This circuit is used to prevent errors in mono/multiplex discrimination due to noise. The type and level of noise can vary a great deal depending on the radio or TV, particularly when the input is weak. Thus, noise can be a cause for errors, too. The TK10850 has been equipped with a multiplex detection level variation circuit that can be set with external resistance to prevent errors due to noise and provide the best multiplex detection level for the particular radio or TV.

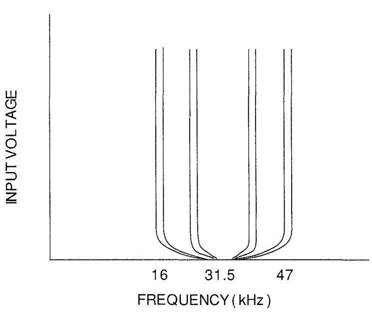


Figure 4: The lock-capture range of the TK10850M, has a PLL with selectable capture range.

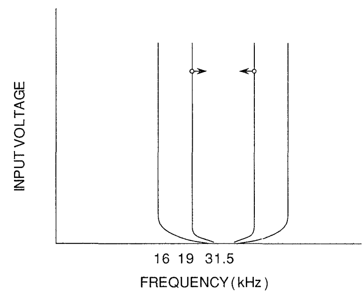


Figure 5: The lock and capture range of the PLL (used in earlier versions for TV audio multiplex sub-channel recovery) when the Loop-bandwidth was narrowed. (The lock and capture range narrowed.)

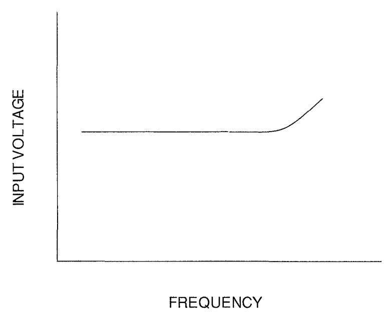


Figure 6: The frequency characteristics of the PLL detector output (used for TV audio multiplex sub-channel recovery) when the Loop-LPF is narrowed. (There is a sudden rise in the higher frequencies.)

Since the TK10850 has a two-level lock-capture range switching circuit as well as a multiplex detection level variation circuit, the lock-capture range observed with the PLL locked/unlocked is different than the lock-capture range observed with the indicator on/off. When observed with the PLL locked/unlocked, Figure 4 shows the wide lock-capture range when the indicator is on, and the narrow lock-capture range when the indicator is off. Figure 7 shows the lock-capture ranges when observed

TYPICAL APPLICATIONS (CONT.)

IC OPERATION (CONT.)

2. Multiplex Detection Level Variation Circuit (Cont.)

with the indicator on/off. That is, the capture range becomes ±0 kHz at the set point of the multiplex detection level. When the multiplex detection level is changed, the lock-capture range is shifted up or down.

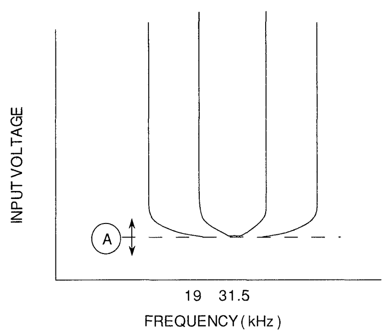


Figure 7: The lock and captures range of the TK10850M when observed with the indicator on and off. "A" shows the up or down shift when the multiplex detection level setting is changed. It does not lock on the 19 kHz signal or noise below the multiplex detection level.

TYPICAL APPLICATIONS (CONT.)

MATRIX CIRCUIT

The block diagram matrix circuit is shown in Figure 1. The truth table of corresponding switches is shown in Table 1.

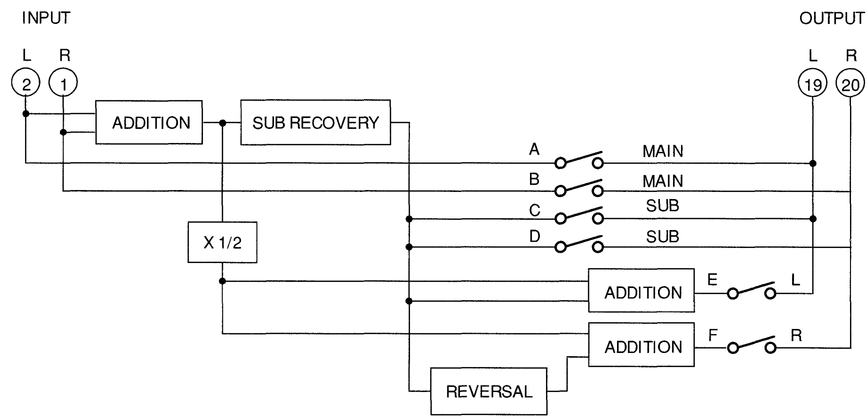


Figure 1: Matrix equivalent circuit

MODE	OUTPUT		MODE SWITCH	INTERNAL MATRIX SWITCH					
	L CH	R CH		a	c	e	b	d	f
Main	Main	Main	V_{REF}	o	x	x	o	x	x
Sub	Sub	Sub	GND	x	o	x	x	o	x
Stereo	L	R	Open	x	x	o	x	x	o

"o" is ON, and "x" is OFF

Table 1: Modes and Switch Settings

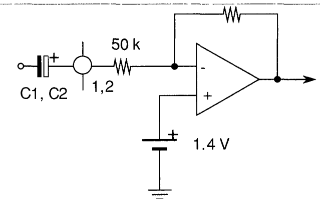
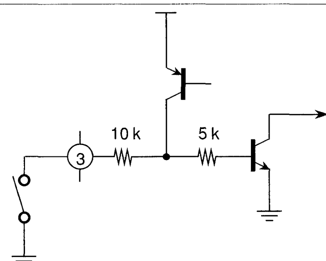
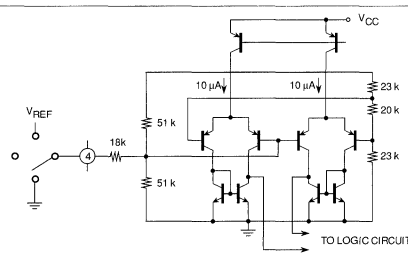
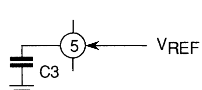
MODE	BILINGUAL BROADCAST		STEREO BROADCAST	
	L CH	R CH	L CH	R CH
Main	Main	Main	(L + R) /2	(L + R) /2
Sub	Sub	Sub	(L – R) /2	(L – R) /2
Stereo	(Main + Sub) /2	(Main – Sub) /2	L	R

Table 2: Outputs

1

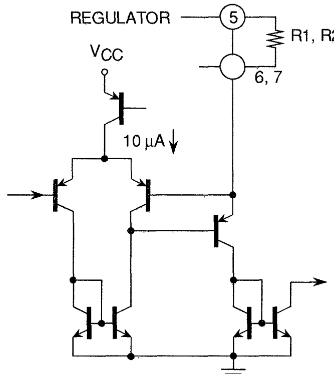
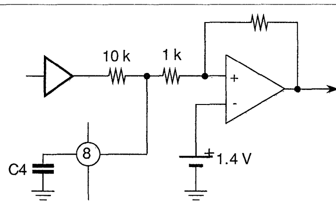
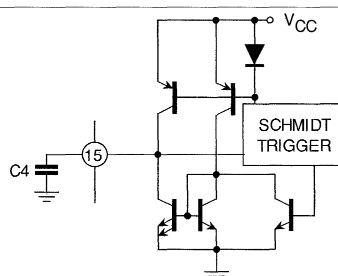
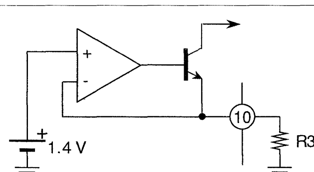
TYPICAL APPLICATIONS (CONT.)

TERMINAL CONNECTIONS

PIN NUMBER	PIN NAME	EQUIVALENT CIRCUIT	FUNCTION	PIN VOLTAGE (VDC)
1 2	Right channel signal input (Input - R CH) Left channel signal input (Input - L CH)		These are signal input pins. The output signal(s) from either the FM restorer or FM stereo restorer is connected to these pins. C1 and C2 are coupling capacitors. The input impedance is 50 kΩ.	1.4
3	VCO killer switch (SW - VCO.K.)		This is the VCO killer pin. Pulling down this pin (0 to 0.4 V) has the following effects: 1. VCO oscillation is stopped. 2. The matrix circuit goes into monophonic mode. 3. The multiplex indicator is turned off. 4. The current consumption becomes 1.5 mA. This pin is used when an AM signal is being received, for example.	0.7
4	Mode switch (SW-Mode)		This is the mode switching pin. The matrix circuit can be switched to any mode manually with the mode switch. However, if any of the following conditions exist, the matrix circuit will be in monophonic mode regardless of the mode switch setting. 1. A monophonic signal is being received. 2. The VCO killer is operating. 3. Monophonic operation is being selected.	0.7
5	Standard voltage output (Reference Voltage)		This is the standard voltage output pin. C3 is a smoothing capacitor.	1.4

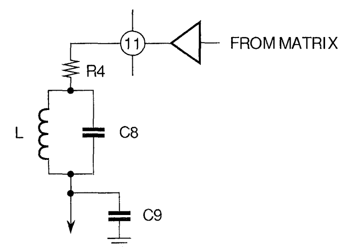
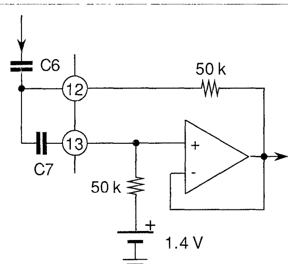
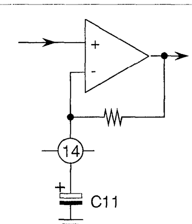
TYPICAL APPLICATIONS (CONT.)

TERMINAL CONNECTIONS

PIN NUMBER	PIN NAME	EQUIVALENT CIRCUIT	FUNCTION	PIN VOLTAGE (VDC)
6	Mono/multiplex detection level setting (Lamp Level Adjust)		This is the mono/multiplex detection level setting pin. The resistor R1 sets the mono/ multiplex detection level. The detection level rises as R1 is increased. (Sensitivity decreases.)	1.4
7	Channel Separation Adjustment		This is the channel separation adjustment pin. The R2 resistance is used to adjust channel separation. The signal that recovered the sub-channel signal increases as R2 is decreased.	0.45
8	PLL low pass filter (PLL-LPF)		This is the PLL loop low pass filter pin. The following effects occur when C4 is increased: 1. The capture range narrows. 2. Carrier rejection becomes higher. 3. The f-characteristic of the signal that recovered the sub-channel signal rises at high frequencies.	1.4
9	VCO timing capacitance		This is the pin for connecting the VCO timing capacitor. The user can monitor the VCO oscillation frequency from this pin. Since this pin has high impedance, either an external buffer or test equipment with high input impedance should be used for measuring the VCO frequency. The following effects occur when C5 is increased: 1. The lock capture range narrows. 2. The level of the signal that recovered the sub-channel signal increases.	–
10	VCO free running frequency setting		This is the VCO free running frequency setting pin. The VCO free-running frequency is set to 31.468 kHz with R3.	1.4

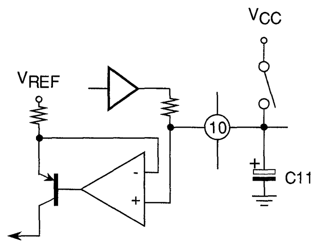
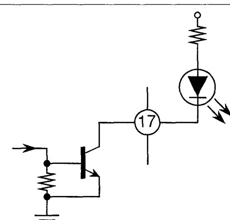
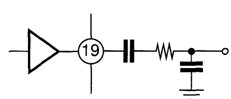
TYPICAL APPLICATIONS (CONT.)

TERMINAL CONNECTIONS

PIN NUMBER	PIN NAME	EQUIVALENT CIRCUIT	FUNCTION	PIN VOLTAGE (VDC)
11	Sub signal output (Output Sub)		This pin is used for sub-channel signal output. The Right Channel input (pin 1) and the Left Channel input (pin 2) are added, and the sum is divided by 2 and made available at the output. It is recommended to insert a filter to remove the control channel signal from this pin's output. If this filter is not included, not functional problems will arise, but with the television audio multiplex method, an audible beat in the audio signal will develop from interaction between the sub-channel signal and control signal channel. The parallel resonance in coil L and capacitor C8 create a filter removing the control channel. Capacitor C9 acts as a low pass filter as well as a phase shift corrector for the sub-channel signal.	1.4
12 13	Filter 1 (HPF-1) Filter 2 (HPF-2)		These pins connect to the active filter for sub-channel signal extraction. A high pass filter is constructed by connecting the C6 and C7 capacitors. The mail channel signal is reduced by the high pass filter and the sub-channel signal is sent on to the recovery circuit and multiplex detection circuit. When C4 = C5 = C, the cutoff frequency f_C of the high pass filter is: $f_C = 1/(2\ CR)$ Hz. The rolloff is 12 dB/Oct.	–
14	Decoupling capacitor (C-limit)		This terminal connects to the decoupling capacitor used as a limiter. C10 is the decoupling capacitor.	1.4

TYPICAL APPLICATIONS (CONT.)

TERMINAL CONNECTIONS

PIN NUMBER	PIN NAME	EQUIVALENT CIRCUIT	FUNCTION	PIN VOLTAGE (VDC)
15	Forced monophonic switch (SW-F. Mon.)		This is the PLL loop low pass filter pin. The following effects occur when C10 is large: 1. The capture range becomes narrow. 2. Carrier rejection becomes higher. 3. The f-characteristic of the sub-channel signal's detection output rises at high frequencies.	1.4
16	GND		GND pin.	0
17	Multiplex indicator (Lamp Driver)		This is the multiplex indicator pin. It is an open collector.	–
18	V_{CC}		V_{CC} pin.	4.5
19	Left channel signal output (Output-L CH)		These are the audio signal output pins. The pin bias is 1.4 VDC.	1.4
20	Right channel signal output (Output-R CH)			

TYPICAL APPLICATIONS (CONT.)

THE S-CURVE OF THE FM IF, THE I/O PHASE SHIFT OF THE FM MPX, AND THE TK10850'S OUTPUT

Pin 19 and 20 might correspond to either the left and right or right and left audio signals depending upon whether the S-curve of the FM IF is regular or reversed, and whether the phase shift between the FM MPX's input and output is regular or reversed. Wire as shown in Figure 1 when both the S-curve of the FM IF and the phase shift between the FM MPX's input and output are regular, or both are reversed. The outputs for this case are shown in Table 1. Wire as shown in Figure 2 when one is regular and the other is reversed. The outputs for this case are shown in Table 2.

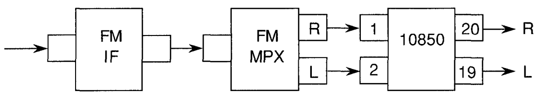


Figure 1: Both regular or both reversed.

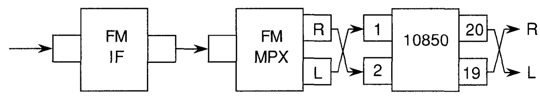


Figure 2: One regular and the other reversed.

		INPUT		OUTPUT		INPUT		OUTPUT	
		Pin 2	Pin 1	Pin 19	Pin 20	Pin 2	Pin 1	Pin 19	Pin 20
FM stereo		Left audio	Right audio	Left audio	Right audio	V /	V /	V \	V \
TV audio	Stereo	TV audio multiplex signal Stereo		Left audio	Right audio			V \	V \
	Main	TV audio multiplex signal		Main audio	Main audio	V /	+ f /	V \	V \
	Sub	Bilingual		Sub-audio	Sub-audio			V \	V \

Table 1: Input and output allocation corresponding to Figure 1.

		INPUT		OUTPUT		INPUT		OUTPUT	
		Pin 2	Pin 1	Pin 19	Pin 20	Pin 2	Pin 1	Pin 19	Pin 20
FM stereo		Left audio	Right audio	Left audio	Right audio	V \	V \	V /	V /
TV audio	Stereo	TV audio multiplex signal Stereo		Left audio	Right audio			V /	V /
	Main	TV audio multiplex signal		Main audio	Main audio	V \	+ f /	V /	V /
	Sub	Bilingual		Sub-audio	Sub-audio			V \	V \

Table 2: Input and output allocation corresponding to Figure 2.

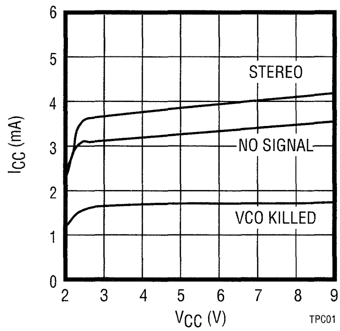
Note: For the diagrams in Tables 1 and 2:

V Horizontal axis = time, vertical axis = DC signal voltage

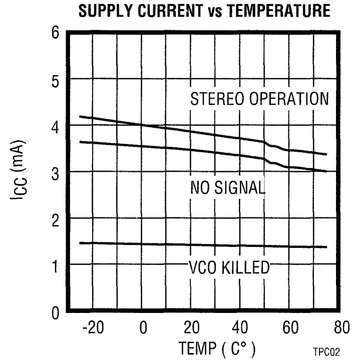
f Horizontal axis = time, vertical axis = frequency

TYPICAL PERFORMANCE CHARACTERISTICS

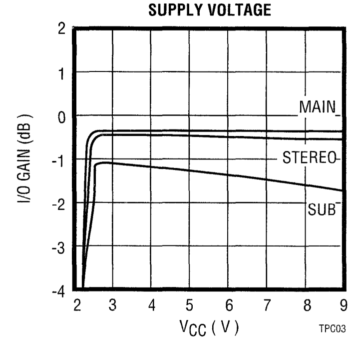
SUPPLY CURRENT vs SUPPLY VOLTAGE



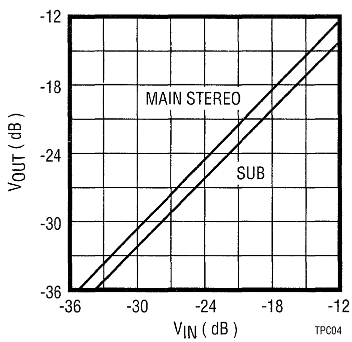
SUPPLY CURRENT vs TEMPERATURE



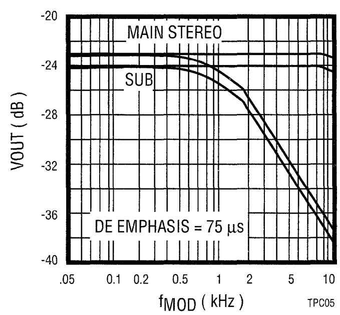
INPUT/OUTPUT GAIN vs SUPPLY VOLTAGE



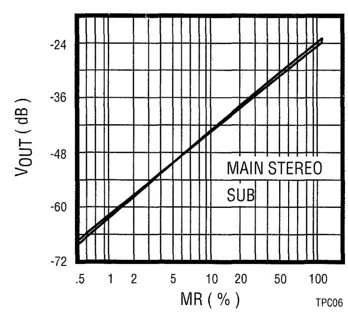
OUTPUT SIGNAL LEVEL vs INPUT SIGNAL LEVEL



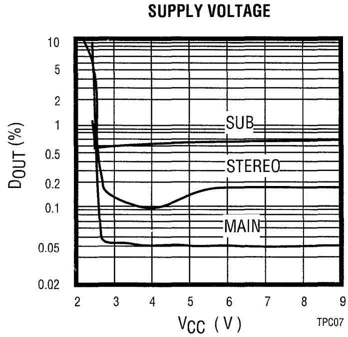
OUTPUT SIGNAL LEVEL vs MODULATION FREQUENCY



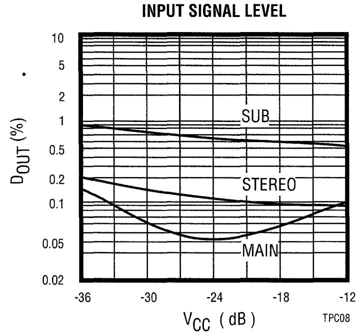
OUTPUT SIGNAL LEVEL vs MODULATION FREQUENCY



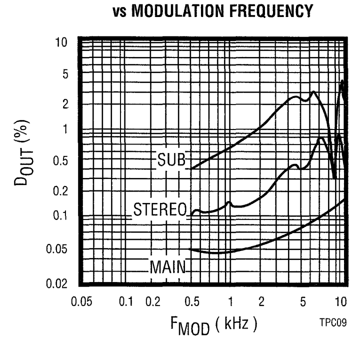
OUTPUT SIGNAL DISTORTION vs SUPPLY VOLTAGE



OUTPUT SIGNAL DISTORTION vs INPUT SIGNAL LEVEL

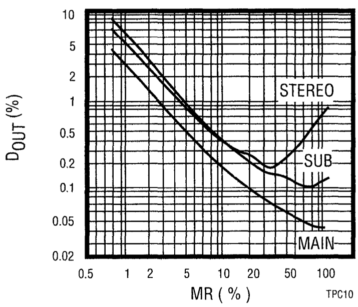


OUTPUT SIGNAL DISTORTION vs MODULATION FREQUENCY

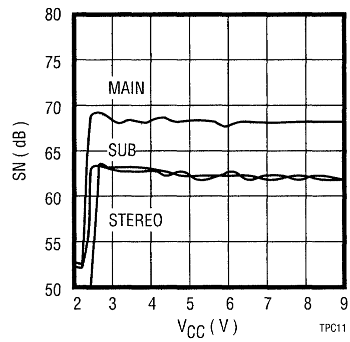


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

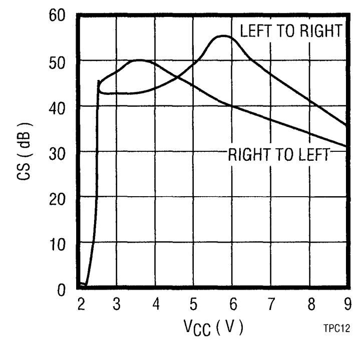
OUTPUT SIGNAL DISTORTION vs MODULATION RATIO



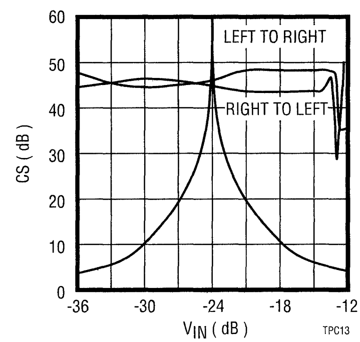
SIGNAL TO NOISE RATIO vs POWER SUPPLY VOLTAGE



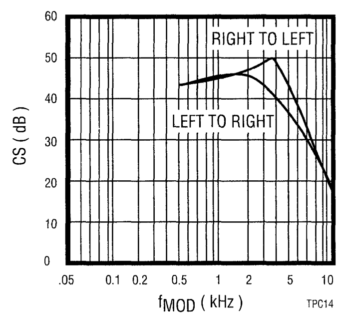
SEPARATION vs POWER SUPPLY VOLTAGE



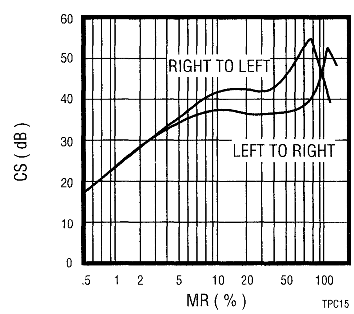
SEPARATION vs INPUT SIGNAL LEVEL



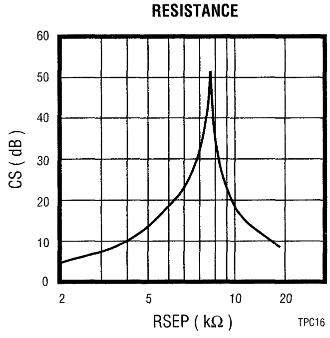
SEPARATION vs MODULATION FREQUENCY



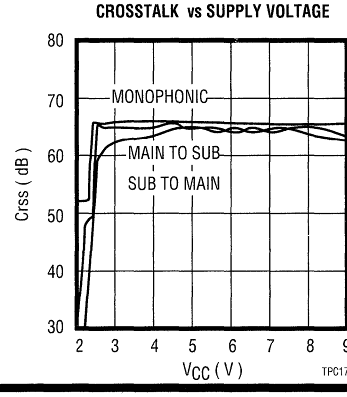
SEPARATION vs MODULATION RATIO



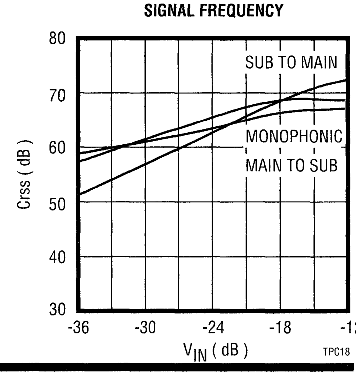
SEPARATION vs SEPARATION ADJUSTMENT RESISTANCE



CROSSTALK vs SUPPLY VOLTAGE

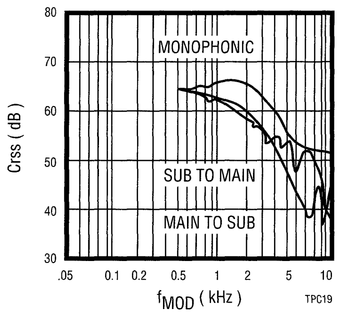


CROSSTALK vs INPUT SIGNAL FREQUENCY

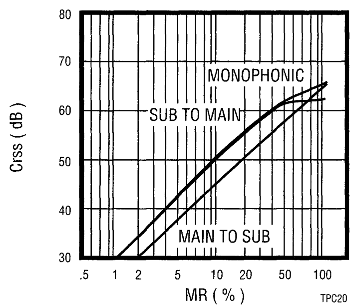


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

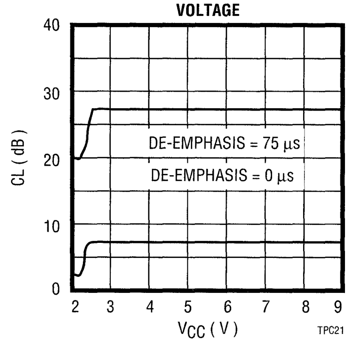
CROSSTALK vs MODULATION FREQUENCY



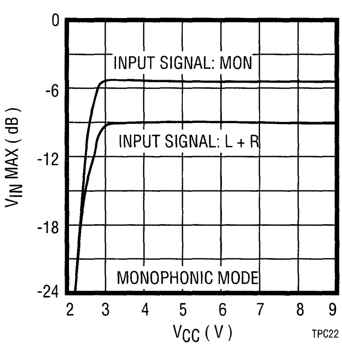
CROSSTALK vs MODULATION RATIO



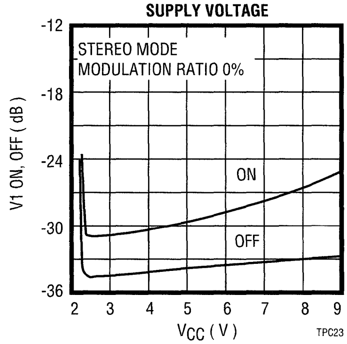
CARRIER LEAKAGE vs SUPPLY VOLTAGE



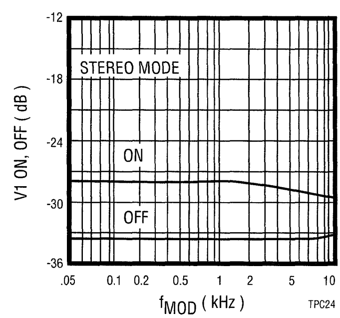
MAXIMUM INPUT SIGNAL LEVEL vs SUPPLY VOLTAGE



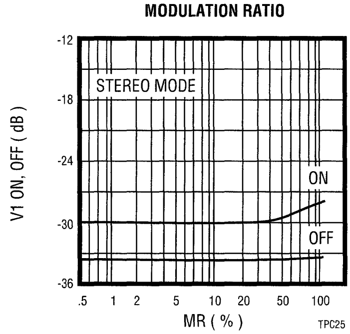
DETECTION LEVEL vs SUPPLY VOLTAGE



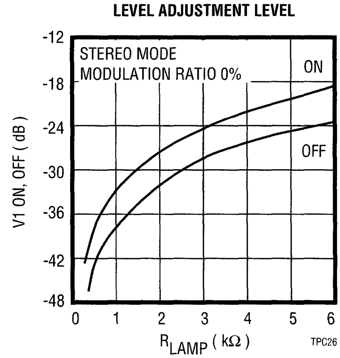
DETECTION LEVEL vs MODULATION FREQUENCY



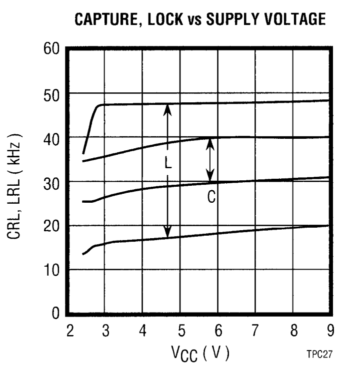
DETECTION LEVEL vs MODULATION RATIO

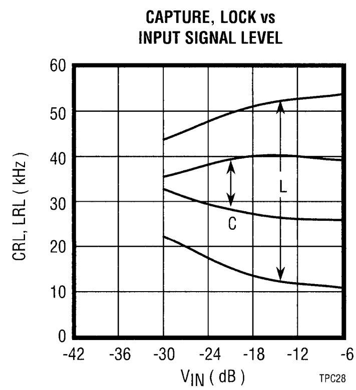


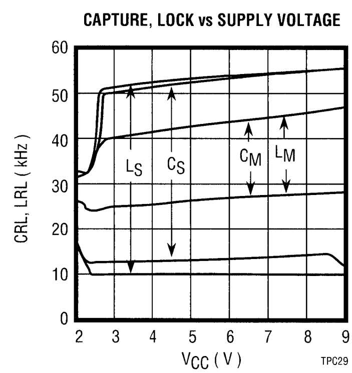
DETECTION LEVEL vs DETECTION LEVEL ADJUSTMENT LEVEL

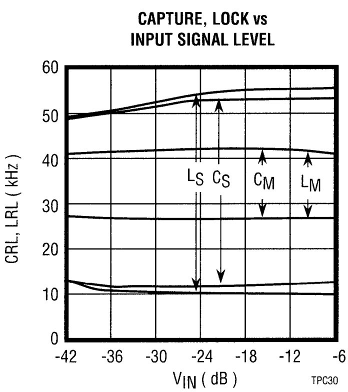


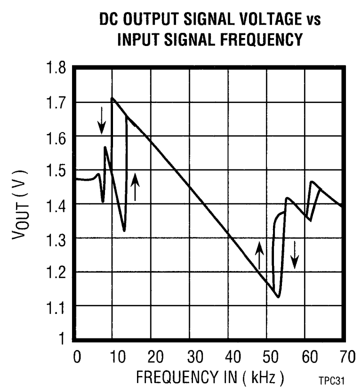
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

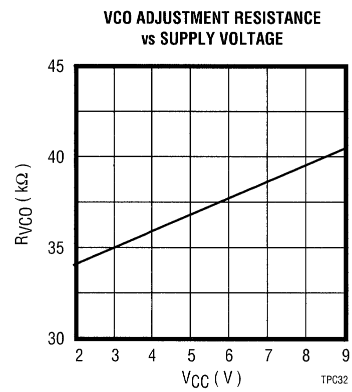


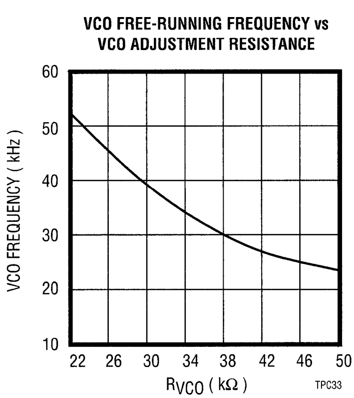












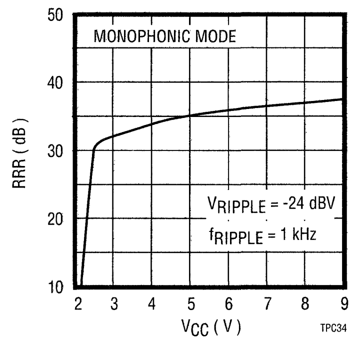
Notes: Measurements in graphs 1 to 4 of this section were taken in stereo mode. Measurements in graphs 1 and 2 were observed according to whether the lamp (multiplex indicator) was on or off. "L" indicates the lock range and "C" the capture range. Measurements in graphs 3 and 4 of this section were observed according to whether the VCO frequency was locked onto the input signal or not.

"L_S" and "C_S" are the lock range and capture range during forced monophonic operation.

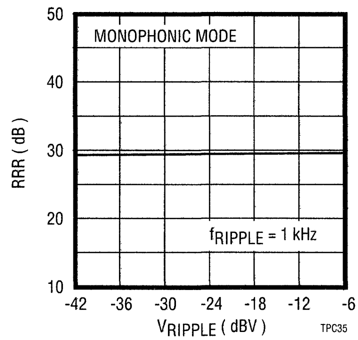
In graph 6, the VCO adjustment resistance is set so that the VCO free-running frequency is 31.5 kHz.

TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

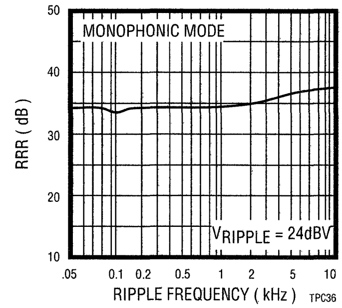
RIPPLE REMOVAL RATIO vs POWER SUPPLY VOLTAGE



RIPPLE REMOVAL RATIO vs RIPPLE LEVEL



RIPPLE REMOVAL RATIO vs RIPPLE FREQUENCY



DUAL TWO-INPUT/SINGLE OUTPUT AUDIO ANALOG SWITCH

FEATURES

- 0.005% Distortion
- Low Voltage Operation (3 V)
- High Input-Output Isolation
- Less Sensitive to ESD than CMOS Switches
- 2 SPDT Channels Independently Controlled
- Unity Gain
- High Input Impedance, Low Output Impedance
- 100 kHz Bandwidth

APPLICATIONS

- Audio Mixers/Effects
- Car Stereo
- Telecom
- Telecommunication Equipment
- Audio Systems
- Portable Consumer Equipment

DESCRIPTION

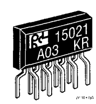
The TK15021 is an active analog switch using transconductance amplifiers to provide wide audio bandwidth, low distortion dual SPDT switch for AC signals.

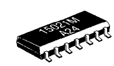
The circuit has two separate sections to switch each of two outputs. The IC features high input impedance (75 kΩ) and low output impedance (25 Ω).

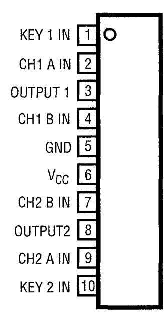
The switch control inputs have internal pull-up resistors and can be driven by open collector type circuits. The TK15021 has a wide dynamic range and can accept AC signals up to 4.5 V(rms), and has a maximum noise level of 10 µV. Typical crosstalk is -80 dB. The IC will operate from 3 to 20 volts and typical current consumption is 3.5 mA.

The TTK15021 is available in ZIP10 plastic zig zag package and MFP14 Mini Flat Plastic package.

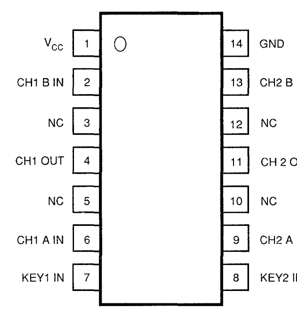
TK15021Z **TK15021M**



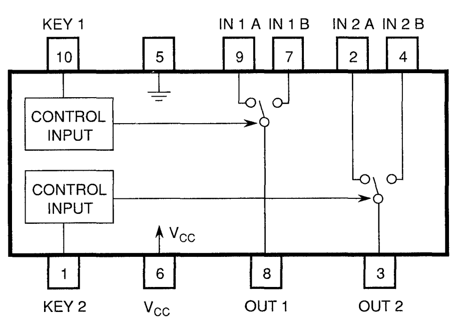




TK15021Z • PO



BLOCK DIAGRAM



ORDERING INFORMATION

TK15021 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M : Surface Mount Z : ZIP	C : -20 to +75 °C	BX : Bulk/Bag TX : Paper Tape TR : Tape Right TL : Tape Left MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} ....24 V
Power Dissipation (Z Package) Note 1 ....490 mW
Power Dissipation (M Package) Note 2 ....600 mW
Junction Temperature ....150 °C
Storage Temperature Range ....-55 to +125 °C
Operating Temperature Range ....-20 to +75 °C
Lead Soldering Temp. (10 sec.) ....300 °C

Control Section
Input Voltage ....-0.3 V to V_{CC} +0.3 V
Analog Switch Section
Input Voltage ....-0.3 V to V_{CC} +0.3 V
Output Current ....3 mA
Operating Voltage Range ....3 to 20 V
Maximum Input Frequency ....100 kHz

ELECTRICAL CHARACTERISTICS

Device specification for ZIP10 Package: V_{CC} = 20 V, T_A = 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current			3.5	7.0	mA
Control Section						
V_{IL}	Low Input Level		-0.3		0.8	V
V_{IH}	High Input Level	Control terminal open (Note 3)	2.3		V_{CC} +0.3	V
Analog Switch Section						
THD	Distortion	V_{IN} = 1 V(rms), f = 1 kHz, R_L = 10 kΩ		0.005	0.01	%
NL	Residual Noise	Input terminal, R_L = 10 kΩ grounded with 10 µF, (Note 4)			10.0	µV(rms)
Crss	Crosstalk	V_{IN} = 1V(rms), f =10 kHz, R_L = 10 kΩ, (Note 5)			-64	dB
DYN	Dynamic Range	THD = 0.1%, R_L = 10 kΩ, f = 1 kHz	4.5			V(rms)
V_{CENT}	In/Output Terminal Voltage	At no input		$V_{CC}/2$		V
V_G	Voltage Gain			0.0		dB
ΔV_{CENT}	DC Center Point Difference between channels	V_{CC} = 9 V			50.0	mV

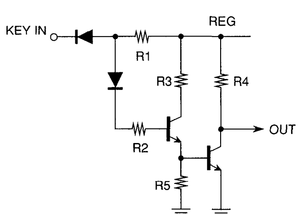
Note 1: Power dissipation must be derated at the rate of 4 mW/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 4.8 mW/°C for operation at T_A = 25 °C and above.
Note 3: When control terminals are High, the switch is ON.
Note 4: Residual Noise is measured with input terminal grounded using 10 µF capacitor. (See Test Circuit)
Note 5: Crosstalk is measured with unused input terminals grounded using 10 µF capacitor and 10 kΩ resistor in series. (See Test Circuit)

ELECTRICAL CHARACTERISTICS

Device Specification for MFP14 package: V_{CC} = 20 V, T_A = 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current			3.5	7.0	mA
Control Section						
V_{IL}	Low Input Level		0		0.8	V
V_{IH}	High Input Level	1.8 V, control terminal open (Note 3)	2.3		V_{CC} +0.3	V
Analog Switch Section						
THD	Distortion	V_{IN} = 1 V(rms), f = 1 kHz, R_L = 10 kΩ		0.005	0.01	%
NL	Residual Noise	Input terminal, R_L = 10 kΩ grounded with 10 µF, (Note 4)			10.0	µV(rms)
Crss	Crosstalk	(Note 5)		-80	-75	dB
DYN	Dynamic Range	THD = 0.1%, R_L = 10 kΩ, f = 1 kHz	4.5			V(rms)
DC_{CENT}	In/Out DC Bias Mismatch	At no signal		$V_{CC}/2$		V
ΔDC_{CENT}	Output DC Bias Mismatch	V_{CC} = 9 V			50	mV
V_G	Voltage Gain	f = ~20 kHz		0		dB
R_{IN}	Input Resistance			75		kΩ
R_{OUT}	Output Resistance			25		Ω

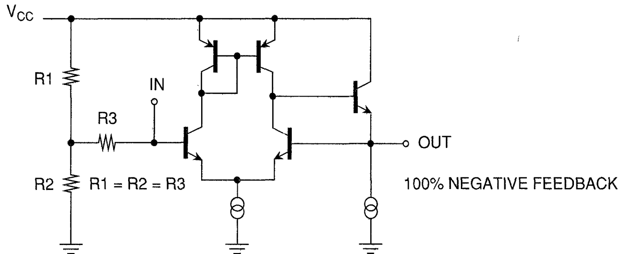
Note 3: The switch control terminal is at 1.8 V (high) when left open. The input circuit is shown below.



Note 4: Residual Noise is measured with input terminal grounded using 10 µF capacitor. (See Test Circuit)

Note 5: Crosstalk is measured with unused input terminals grounded using 10 µF capacitor and 10 kΩ resistor in series. (See Test Circuit)

BASIC CIRCUIT



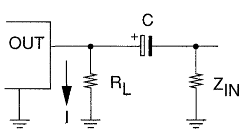
ADDITIONAL INFORMATION

1. Switching Speed

Switch control (KEY) response time is typically 200 µsec.

2. AC Loading

Recommended load resistance (R_L) is 10 kΩ. When using capacitive coupling, set $R_L \le Z_{IN}$. Where I≤ 3 mA.



3. Crosstalk (Isolation, Separation)

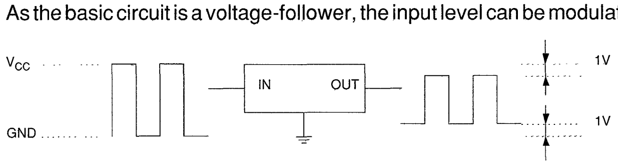
Since the impedance is high (75 kΩ), the input coupling capacitor works as an antenna, causing increased crosstalk, particularly when inputs are located close together. Locate the capacitors as far as possible from each other on the printed circuit board.

4. Short Circuit of Input/Output Terminals

Since the input terminals have high impedance (75 kΩ), a short circuit to V_{CC} or ground doesn't cause any damage. Also, a short circuit at the output terminals to V_{CC} doesn't cause any damage. However, a long term short circuit of the output terminals to ground may cause damage, as the current is determined by the base current of the transistor (refer to the basic circuit).

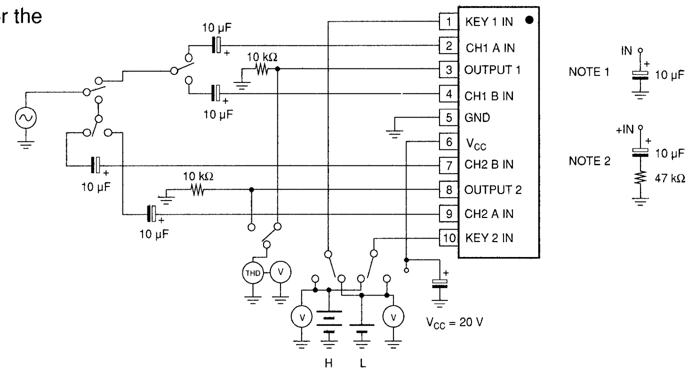
5. DC Signal Input

As the basic circuit is a voltage-follower, the input level can be modulated to within 1 V lower of either V_{CC} or ground.



TEST CIRCUIT

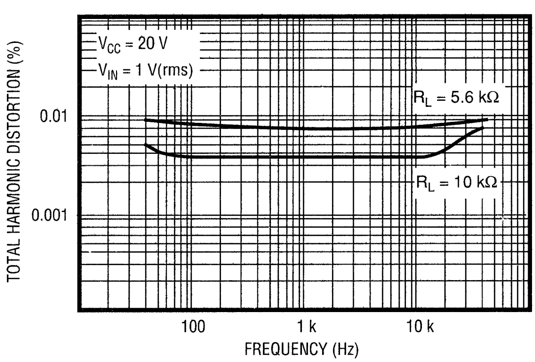
Test Circuit is for the ZIP10 Package



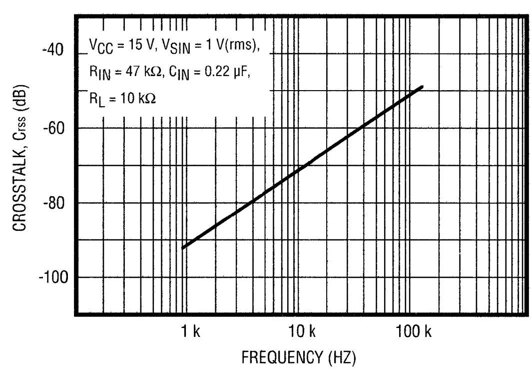
Note 1: For residual noise measurement, ground the input terminal with a 10 µF capacitor.
Note 2: For crosstalk measurement, ground the input terminal with a 10 µF capacitor and 47 kΩ resistor connected in series.
Note 3: Following power on, a minimum of 2 msec waiting time is necessary before testing.

TYPICAL PERFORMANCE CHARACTERISTICS

DISTORTION vs FREQUENCY

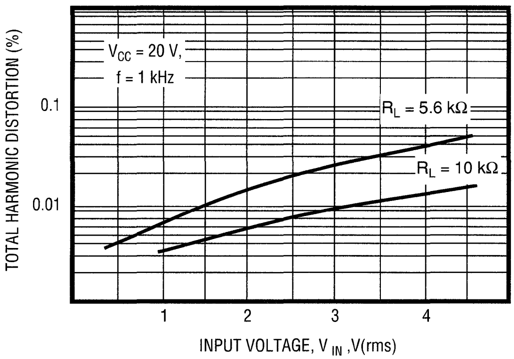


CROSSTALK vs FREQUENCY

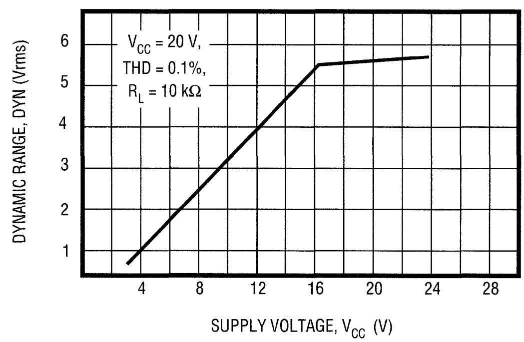


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

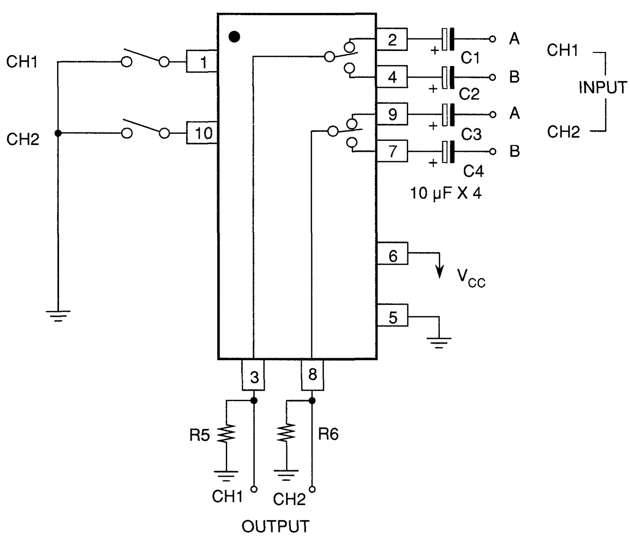
DISTORTION vs DYNAMIC RANGE



DYNAMIC RANGE vs SUPPLY VOLTAGE



TYPICAL APPLICATION



Note: At normal condition (Low Level) of the selector switch, the A input side is ON.

DUAL TWO-INPUT/SINGLE OUTPUT AUDIO ANALOG SWITCH

FEATURES

- **0.005% Distortion**
- **Low Voltage Operation (1.8 V)**
- **High Input-Output Isolation**
- **Less Sensitive to ESD than CMOS Switches**
- **2 SPDT Channels Independently Controlled**
- **Unity Gain**
- **High Input Impedance, Low Output Impedance**
- **100 kHz Bandwidth**

APPLICATIONS

- **Audio Mixers/Effects**
- **Car Stereo**
- **Telecommunication Equipment**
- **Audio Systems**
- **Portable Consumer Equipment**

DESCRIPTION

The TK15022 is an active analog switch using transconductance amplifiers to provide a wide audio bandwidth, low distortion dual SPDT switch for AC signals.

The circuit has two separate sections to switch each of two outputs. The IC features high input impedance (75 kΩ) and low output impedance (25 Ω).

The switch control inputs have internal pull-up resistors and can be driven by open collector type circuits. The TK15022 has a wide dynamic range and can accept AC signals up to 4.5 V(rms), and has a maximum noise level of 10 μV. Typical crosstalk is -80 dB. The IC will operate from 1.8 to 15 volts and typical current consumption is 3.5 mA.

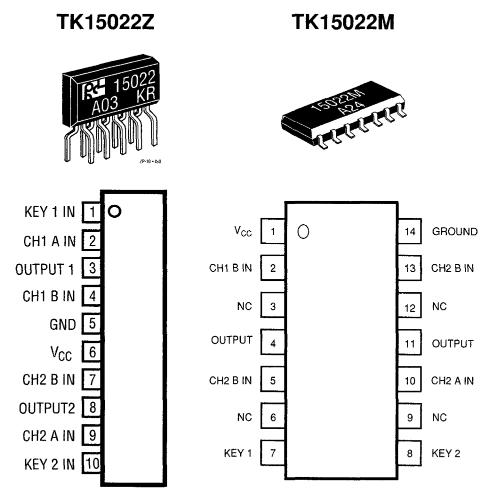
The TK15022 is available in ZIP10 plastic zig zag package and MFP14 surface mount package.

ORDERING INFORMATION

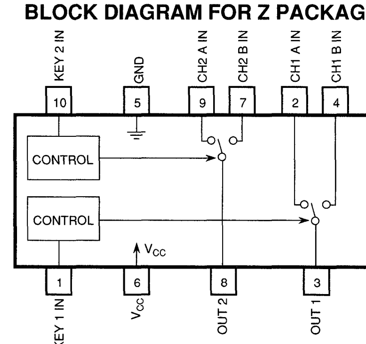
TK15022 ☐ ☐ ☐☐

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M : Surface Mount	C : -20 to +75 °C	BX : Bulk/Bag
Z : ZIP		TX : Paper Tape
		TR : Tape Right
		TL : Tape Left
		MG: Magazine



BLOCK DIAGRAM FOR Z PACKAGE



ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 18 V
Power Dissipation (Note 1) Z Package .... 540 mW
Power Dissipation (Note 2) M Package .... 600 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +125 °C
Operating Temperature Range .... -20 to +75 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

Control Section
Input Voltage .... -0.3V to V_{CC} +0.3 V
Analog Switch Section
Input Voltage .... -0.3V to V_{CC} +0.3 V
Output Current .... 3 mA
Operating Voltage Range .... 1.8 to 15 V
Maximum Input Frequency .... 100 kHz

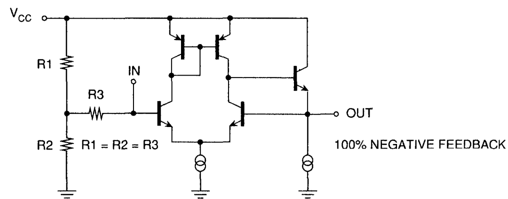
ELECTRICAL CHARACTERISTICS

Specifications for the TK15022Z: V_{CC} = 8 V, T_A = 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC1}	Supply Current			1.2	2.0	mA
Control Section						
V_{IL}	Low Input Level		-0.3		0.4	V
V_{IH}	High Input Level	Control terminal open (Note 3)	1.8		V_{CC} + 0.3	V
Analog Switch Section						
THD	Distortion	V_{SIN} = 1 V(rms), f = 1 kHz, R_L = 10 kΩ		0.005	0.01	%
NL	Residual Noise	R_L = 10 kΩ; input terminal grounded with 10 µF, (Note 4)			10	µV(rms)
Crss	Crosstalk	V_{SIN} = 1 V(rms), f =10 kHz, R_L = 10 kΩ, (Note 5)			-64	dB
DYN	Dynamic Range	THD = 0.1%, R_L = 10 kΩ, f = 1 kHz	3.0	3.5		V(rms)
V_{CENT}	Input/Output Term. Voltage	With no input signal		$V_{CC}/2$		V
V_G	Voltage Gain			0		dB
ΔV_{CENT}	Output Mismatch Voltage				50.0	mV

Note 1: Power dissipation must be derated at the rate of 3.12 mW/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 4.8 mW/°C for operation at T_A = 25 °C and above.
Note 3: When control terminals are open (HIGH), the switch is ON.
Note 4: R_L = 10 kΩ. Unused inputs grounded through 10 µF.
Note 5: See page 1-123.

BASIC CIRCUIT

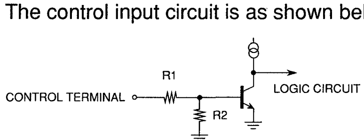


ELECTRICAL CHARACTERISTICS

Specifications for the TK15022M: V_{CC} = 8 V, T_A = 25 °C

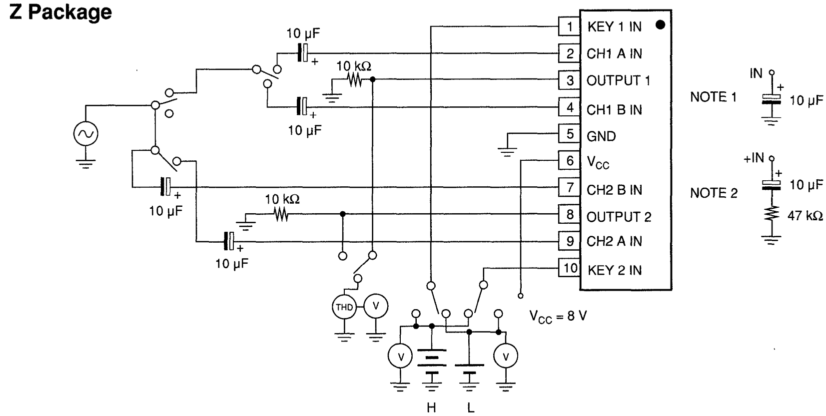
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	Output Open		1.5	2.5	mA
Control Section						
V_{IL}	Low Input Level	(Note 6)	0		0.8	V
V_{IH}	High Input Level	1.8 V at control terminal	1.8		V_{CC}	V
Analog Switch Section						
THD	Distortion	V_{IN} = 1 V(rms), f = 1 kHz, (Note 7)		0.005	0.01	%
NL	Residual Noise	(Note 4)			10	µV(rms)
Crss	Crosstalk	V_{IN} = 1V(rms), f =10 kHz, R_L = 10 kΩ, (Note 5)		-80	-75	dB
DYN	Dynamic Range	THD = 0.1%, R_L = 10 kΩ, f = 1 kHz	2.0			V(rms)
V_{CENT}	Input/Output Term. Voltage	At no input		4		V
V_G	Voltage Gain			0		dB
ΔV_{CENT}	Output Mismatch Voltage	f = ~20 kHz			50	mV
Z_{IN}	Input Impedance	DC		75		kΩ
Z_{OUT}	Output Impedance	DC		20		Ω

Note 6: The control input circuit is as shown below, Low level at Open:



Note 7: The distortion and dynamic range of CH1A is measured with control terminal open.

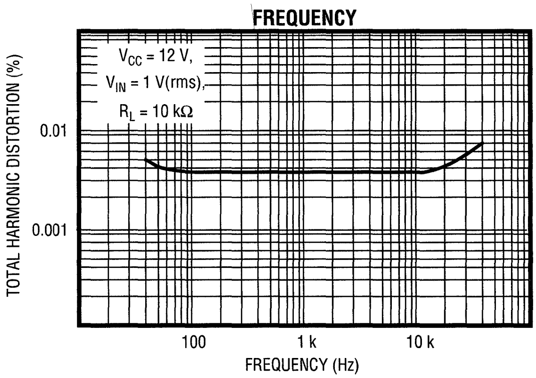
TEST CIRCUIT



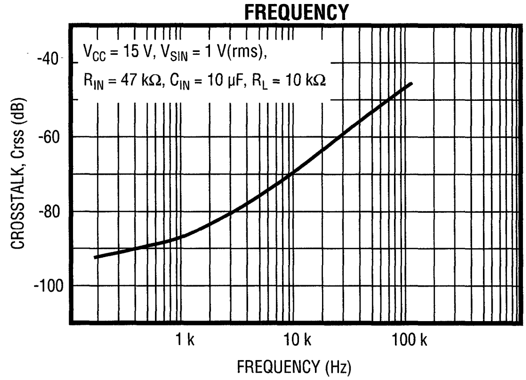
Note 1: For residual noise measurement, ground the input terminal with a 10 µF capacitor.
Note 2: For crosstalk measurement, ground the input terminal with a 10 µF capacitor and 47 kΩ resistor connected in series.

TYPICAL PERFORMANCE CHARACTERISTICS

DISTORTION vs FREQUENCY

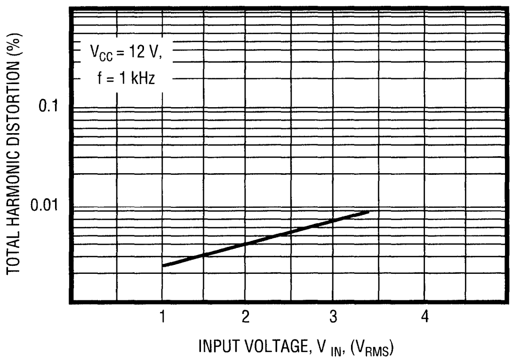


CROSSTALK vs FREQUENCY

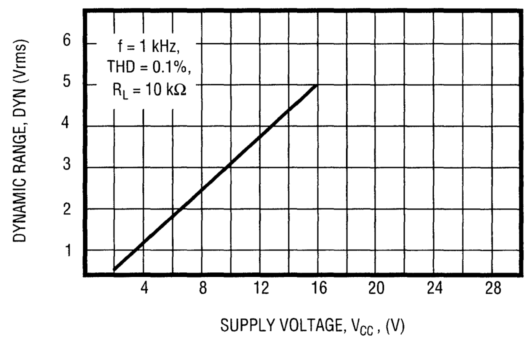


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

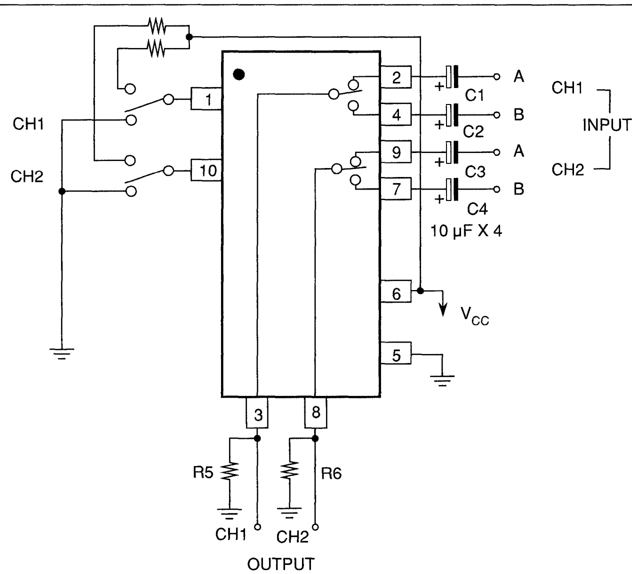
DISTORTION vs DYNAMIC RANGE



DYNAMIC RANGE vs SUPPLY VOLTAGE



TYPICAL APPLICATION



Note: At normal condition ("L" level) of the selector switch, the A input side is ON.

APPLICATION INFORMATION

1. Switching Speed

Switch control response time is typically 200 μsec.

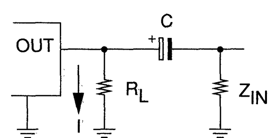
2. Short Circuit of Input-Output Terminals

Since the input impedance is high (75 kΩ), short circuit of input terminals to V_{CC} or GND doesn't cause any damage. Also a short circuit of output terminals to V_{CC} doesn't cause any damage. However, long term short circuit of output terminals to GND may cause damage, as the current is determined by base current of the transistor (refer to the basic circuit).

3. Crosstalk (Isolation, Separation)

Since the input impedance is high (75 kΩ), the input coupling capacitor works as an antenna, causing increased crosstalk, particularly when the inputs are located close together. Locate the capacitors as far as possible from each other on the printed circuit board.

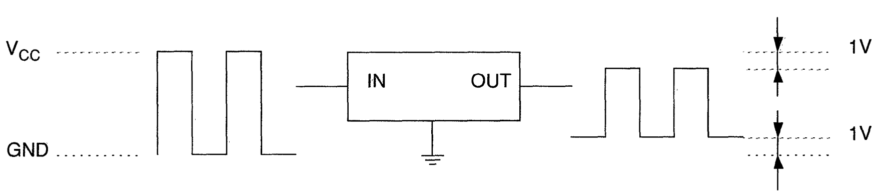
4. AC Loading



The recommended load resistance (R_L) is 10 kΩ.
When using capacitive coupling, set $R_L \leq Z_{IN}$. Where $I \leq 3$ mA.

5. DC Signal Input

As basic circuit is a voltage-follower, the inputs can be modulated to within 1 V of either V_{CC} or GND.



TOKO TK15023

DUAL TWO-INPUT/SINGLE OUTPUT AUDIO ANALOG SWITCH WITH MUTING

FEATURES

- 0.005% Distortion
- Low Voltage Operation (3 V)
- High Input-Output Isolation
- Less Sensitive to ESD than CMOS Switches
- 2 SPDT Channels Independently Controlled
- Independent Mute Control For Each Channel
- Unity Gain
- High Impedance Input/Low Impedance Output
- 100 kHz Bandwidth

DESCRIPTION

The TK15023 is an active analog switch using transconductance amplifiers to provide wide audio bandwidth and low distortion. It has a dual SPDT switch and circuitry for muting the audio signals.

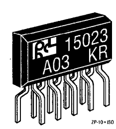
The circuit has two separate sections to switch each of two outputs. The IC features high input impedance (75 kΩ) and low output impedance (25 Ω). The switch control inputs have internal pull-up resistors and can be driven by open collector type circuits. The TK15023 has a wide dynamic range and can accept AC signals up to 4.5 V(rms). It has a maximum noise level of 10 µV. Typical crosstalk is -80 db. The device will operate from 3 to 20 Volts and typical current consumption is 3.5 mA.

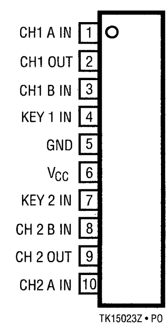
The TK15023 is available in ZIP10 plastic zig zag package.

APPLICATIONS

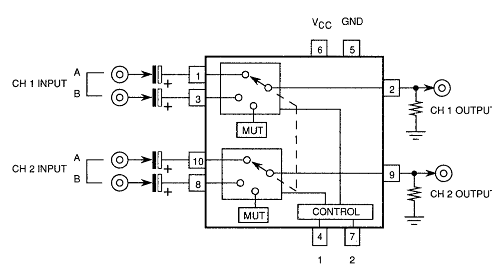
- Audio Systems
- Radio Cassettes
- Effects Pedals
- Musical Instruments

TK15023Z





BLOCK DIAGRAM



TRUTH TABLE

KEY 1 IN	KEY 2 IN	CH 1	CH 2
HIGH	LOW	CH 1, A ON	CH 2, A ON
LOW	HIGH	CH 1, BON	CH 2, B ON
OTHER		MUTE CH	MUTE CH

ORDERING INFORMATION

TK15023 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
Z: Zig Zag Plastic	C : -30 to +85 °C	BX: Bulk/Bag
		MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 24 V
Power Dissipation (Note 1) .... 450 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -30 to +85 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

Control Section
Input Voltage .... -0.3 V to V_{CC} +0.3 V
Analog Switch Section
Input Voltage .... -0.3 V to V_{CC} +0.3 V
Output Current .... 3 mA

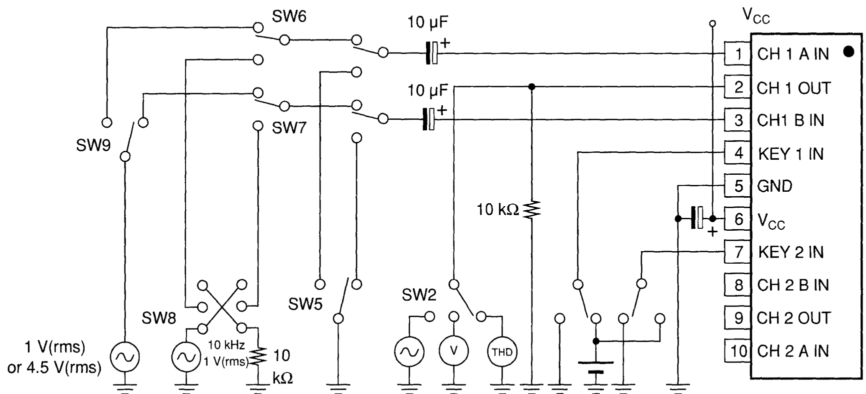
ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 12 V, R_L = 10 kΩ, T_A = 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{CC}	Operating Voltage Range		3.0		20.0	V
I_{CC}	Supply Current	at R_L=Open		2.5	5.0	mA
Control Section						
V_{IL}	Input Low Level		0		0.4	V
V_{IH}	Input High Level	Note 2	2.6		V_{CC}	V
Analog Switch Section						
THD	Distortion	V_{IN} =1 V(rms), f=1 kHz, Note 3		0.005	0.010	%
THD2	Distortion	V_{IN} =1 V(rms), f=20 kHz		0.005	0.020	%
N_L	Residual Noise	Note 4			10.0	μV(rms)
N_{LM}	Residual Noise Mute CH				20.0	μV(rms)
Crss	Crosstalk	Note 5		-80	-75	dB
DYN	Max. Input Signal Level	THD= 0.1%, f =1 kHz	3.0	3.5		V(rms)
DCcent	IN/OUT DC Bias	at no signal		V_{CC}		V
ΔDCcent	Output DC Bias Mismatch				75	mV
V_G	Voltage Gain	f = ~20 kHz	-.02	0	+0.2	dB
Z_{IN}	Input Resistance			75		kΩ
Z_{OUT}	Output Resistance			25		Ω

Note 1: Power dissipation must be derated at a rate of 3.6 mW/°C for operation at T_A = 25 °C and above.
Note 2: An Open Control Input corresponds to logic 'Low' level.
Note 3: See Test Circuit
Note 4: Residual Noise is measured with input terminal grounded using 10 μF capacitor. (See Test Circuit)
Note 5: Crosstalk is measured with unused input terminals grounded using 10 μF capacitor and 10 kΩ resister in series. (See Test Circuit)

TEST CIRCUIT



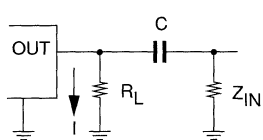
1. Only 1 ch is shown.
2. Use this circuit for THD and dynamic range tests.
3. NL, DCcent and ΔDCcent is measured using SW5.
4. Crss is measured using SW8.
5. Following power on, a minimum of 2 msec waiting time is necessary before testing.

APPLICATION INFORMATION

1. Switching Speed

Switching control response time is typically 200 µsec.

2. AC Loading



Recommended load resistance (R_L) is 10 kΩ. When using capacitive coupling, set $R_L \leq Z_{IN}$. Where $I \leq 3$ mA.

3. Crosstalk (Isolation, Separation)

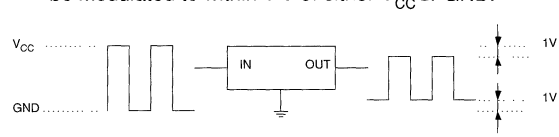
Since the input impedance is high (75 kΩ), the input coupling capacitor works as an antenna, causing increased crosstalk, particularly when inputs are located in close proximity. Locate the capacitors as far as possible from each other on the printed circuit board.

4. Short Circuit of Input-Output Terminals

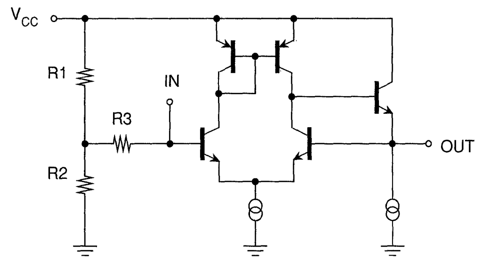
Since the input terminals have high impedance (75 kΩ), short circuit at the input terminals to V_{CC} or GND doesn't cause any damage. Also short circuit of output terminals to V_{CC} doesn't cause any damage. However, a long term short circuit of the output terminals to GND may cause damage, as the current is only limited by the base current of the output transistor, as shown in the basic circuit.

5. DC Signal Input

As the basic circuit is a voltage-follower, the inputs can be modulated to within 1 V of either V_{CC} or GND.

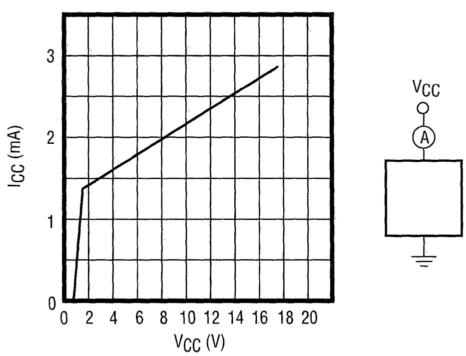


BASIC CIRCUIT

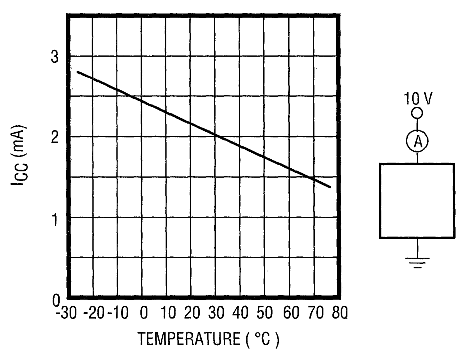


TYPICAL PERFORMANCE CHARACTERISTICS

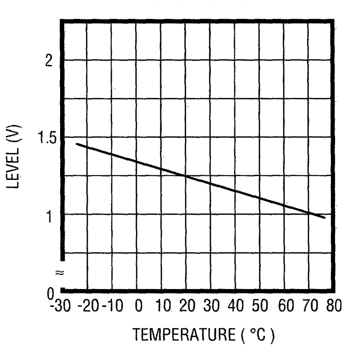
SUPPLY CURRENT vs SUPPLY VOLTAGE

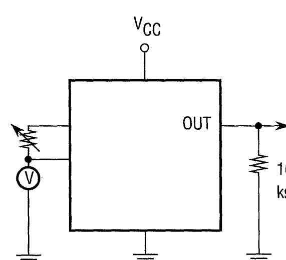


SUPPLY CURRENT vs TEMPERATURE

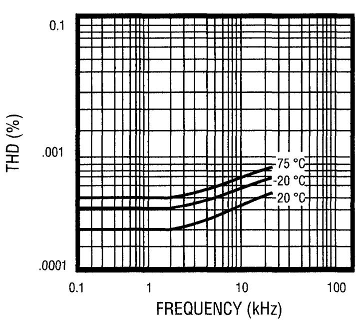


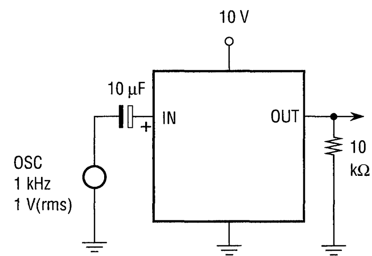
CONTROL KEY THRESHOLD LEVEL vs TEMPERATURE

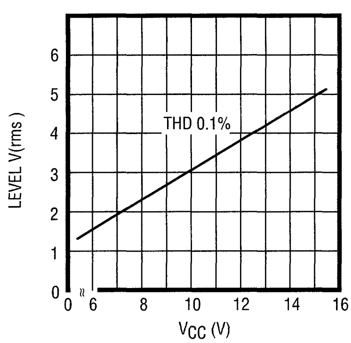


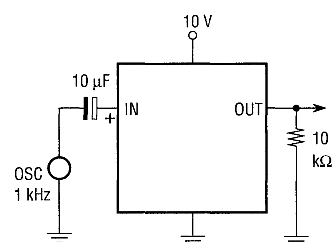


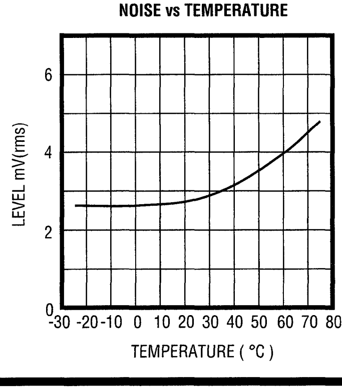
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

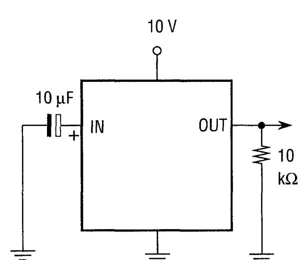




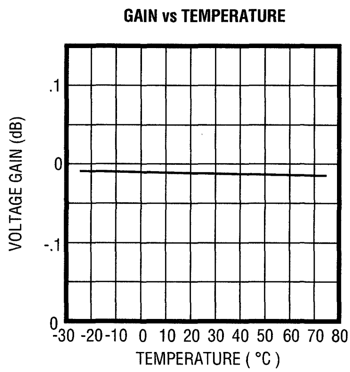


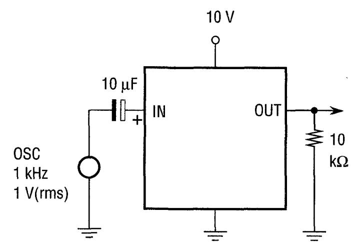


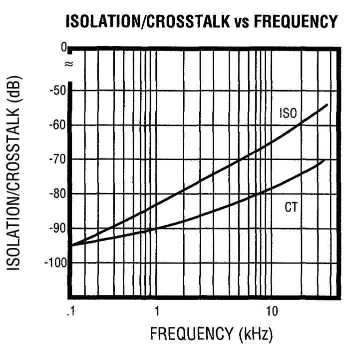


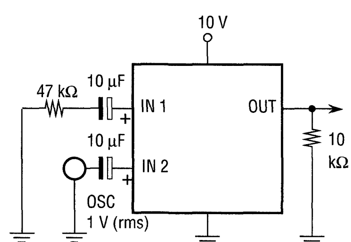


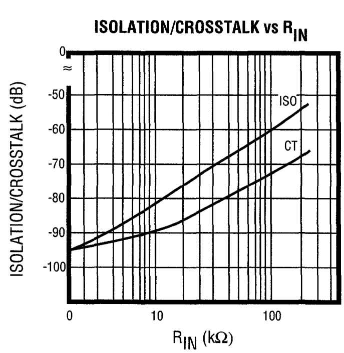
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

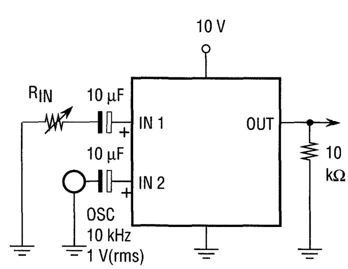




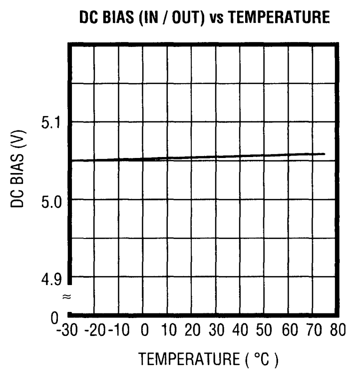


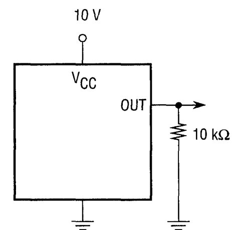


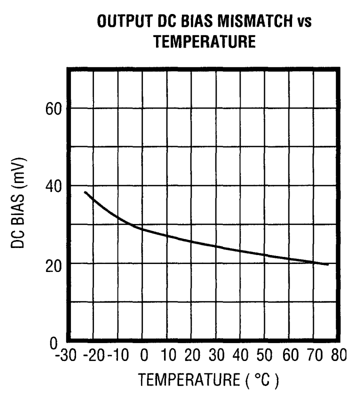


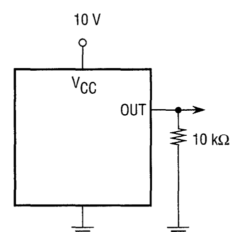


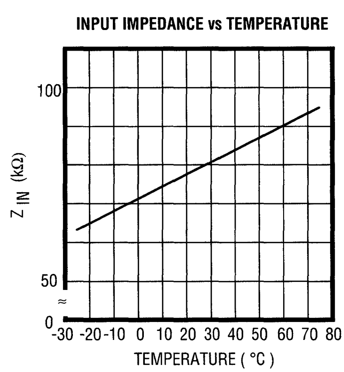
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

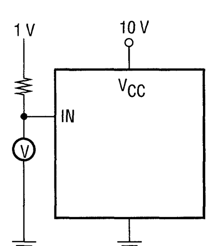




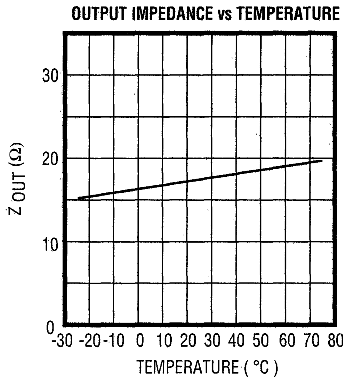


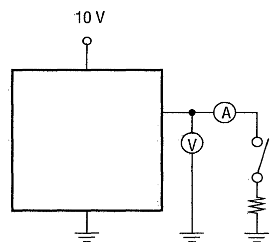




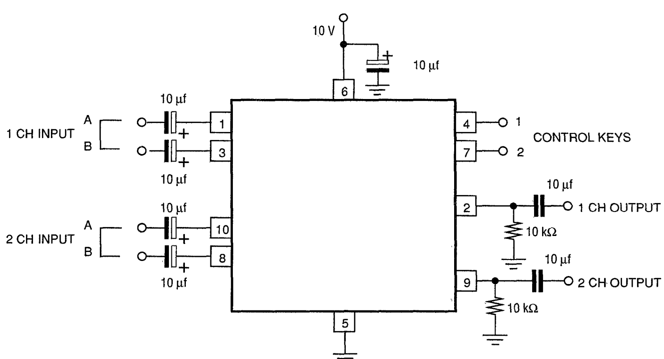


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)





TYPICAL APPLICATIONS



DUAL TWO-INPUT/SINGLE OUTPUT AUDIO ANALOG SWITCH

FEATURES

- 0.005% Distortion
- Low Voltage Operation (3 V)
- High Input and Output Isolation
- Less Sensitive to ESD than CMOS Switches
- 2 SPDT Channels Independently Controlled
- Unity Gain
- High Input Impedance, Low Output Impedance
- 100 kHz Bandwidth

APPLICATIONS

- Audio Equipment
- Musical Instruments
- Effects Pedals
- Mixers/Effects

DESCRIPTION

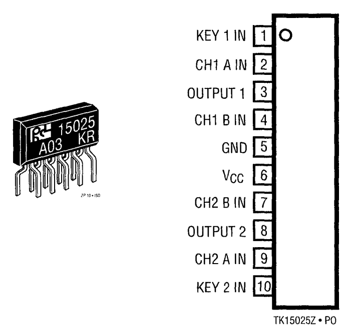
The TK15025 is an active analog switch using transconductance amplifiers to provide a wide audio bandwidth and low distortion. A dual SPDT switch is used for signal selection.

The circuit has two separate sections to switch each of the two outputs. The IC features high input impedance (75 kΩ) and low output impedance (25 Ω).

Channel 1 "A" input is selected when select key 1 is "H" or "open". "B" output is selected when select key 1 is low. The TK15025 has a wide dynamic range and can accept AC signals up to 4.5 V(rms), and has a maximum noise level of 10 μV. Typical crosstalk is -80 dB. The IC will operate from 3 to 20 Volts and typical current consumption is 3.5 mA.

The TK15025 is available in ZIP10 plastic zig-zag package.

TK15025



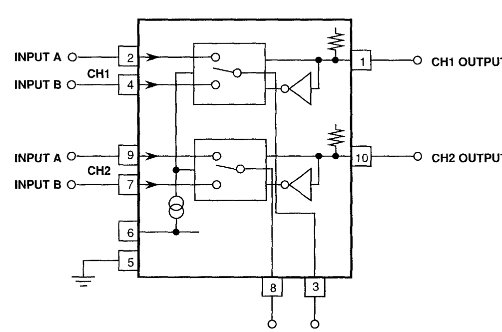
ORDERING INFORMATION

TK15025 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
Z : ZIP	C : -20 to +75 °C	BX : Bulk/Bag MG: Magazine

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CCMAX} .... 14 V
Power Dissipation (Note 1) .... 490 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +125 °C
Operating Temperature Range .... -20 to +75 °C
Maximum Input Frequency .... 100 kHz
Operating Voltage Range .... 3 to 12 V
Lead Soldering Temp. (10 sec.) .... 300 °C
Control Section
  Input Voltage .... 0 to V_{CC} V
Analog Switch Section
  Input Voltage .... 0 to V_{CC} V
  Output Current .... 3 mA

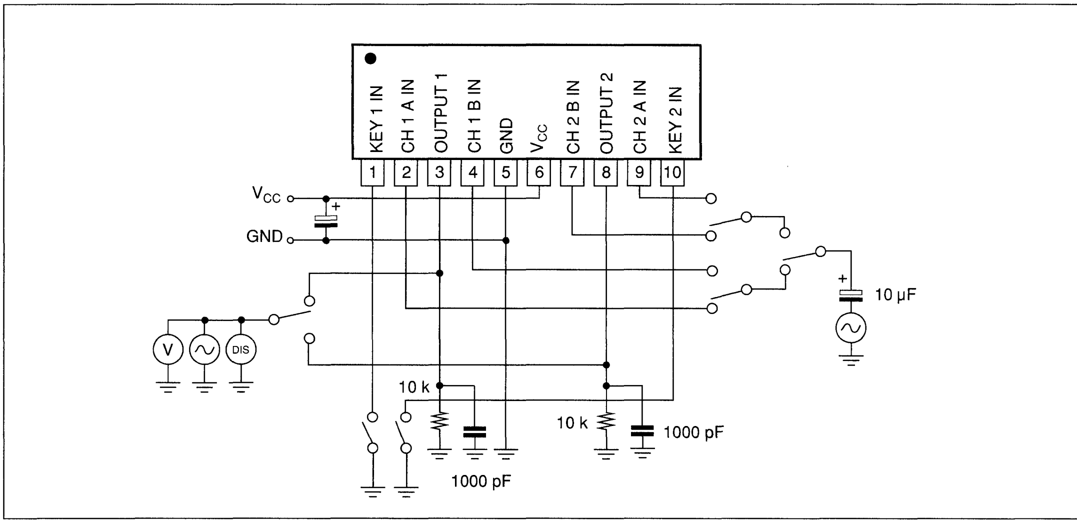
ELECTRICAL CHARACTERISTICS

Test Conditions: V_{CC} = 8 V, T_A = 25 °C

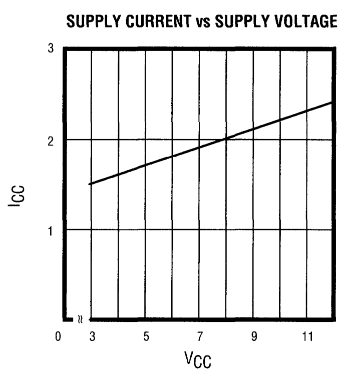
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	R_L = 10 kΩ x 2		3.2	6.5	mA
Key Control						
V_{IL}	"L" Input Level		0		0.8	V
V_{IH}	"H" Input Level	Note 2	2.3		V_{CC}	V
Analog Switch						
THD	Distortion	V_{SIN} = 1 V(rms), R_L = 5 kΩ 1000 pF, f = 1 kHz, Note 3		0.005	0.10	%
NL	Residual Noise	R_L = 10 kΩ, 1000 pF, Note 4			10	µV(rms)
Iso	Isolation	Note 5			-70	dB
Sep	Separation	Note 5			-80	dB
Dyn	Dynamic Range	THD = 0.1%, R_L = 10 kΩ, 1000 pF, f = 1 kHz		0		dB
V_G	Voltage Gain	V_{SIN} = 1 V(rms), R_L = 10 kΩ 1000 pF, f = 10 to 20 kHz		0		dB
Z_{IN}	Input Resistance			75		kΩ
Z_{OUT}	Output Resistance			20		Ω
V_{CENT}	In/Out Terminal Voltage	No Input	-0.5	$V_{CC}/2$	+0.5	V
ΔV_{CENT}	DC Center Point Difference between channels				50	mV

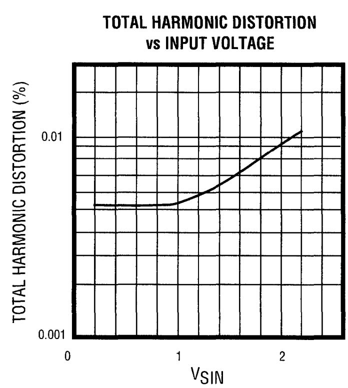
Note 1: Power dissipation must be derated at the rate of 4 mW/°C for operation at T_A = 25 °C and above.
Note 2: "Open" terminal voltage is 2.0 V, (High Level CH A is "on")
Note 3: A 10 kΩ resistor and a 1000 pF capacitor required for output termination.
Note 4: Measure at V_{IL} = 0.8 V, V_{IH} = 2.3 V with input terminal of the test channel grounded using a 10 µF capacitor.
Note 5: Isolation = Crosstalk between Channels A-B, measured at the output.
Separation = Crosstalk between Channels 1-2, measured at the output.
Grounded with a 10 pF capacitor and a 5 kΩ resistor.

TEST CIRCUIT

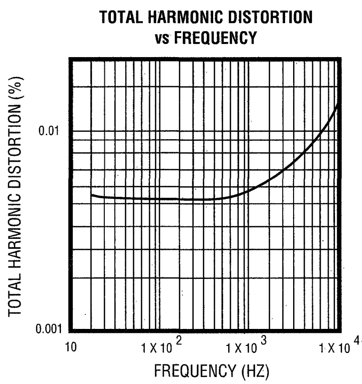


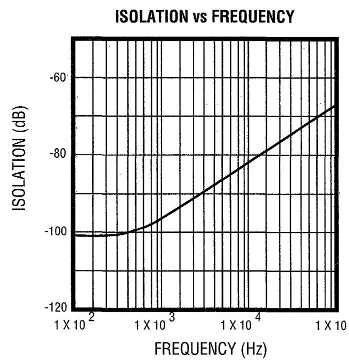
TYPICAL PERFORMANCE CHARACTERISTICS

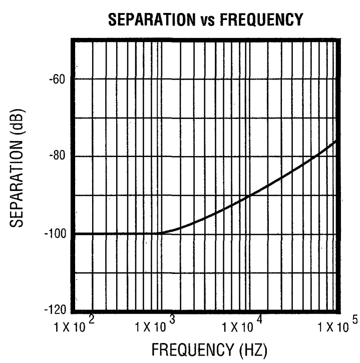


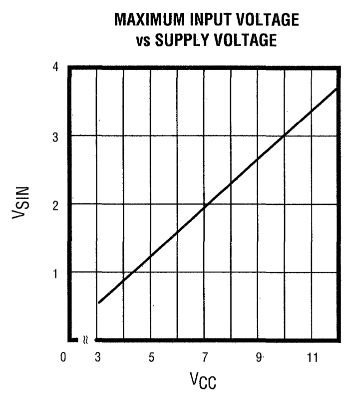


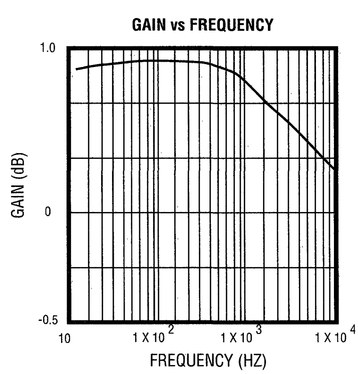
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)











DUAL TWO-INPUT/SINGLE OUTPUT AUDIO ANALOG SWITCH

FEATURES

- **0.005% Distortion**
- **Low Voltage Operation**
- **High Input-Output Isolation**
- **Less Sensitive to ESD than CMOS Switches**
- **2 SPDT Channels Independently Controlled**
- **Unity Gain**
- **High Input Impedance, Low Output Impedance**
- **100 kHz Bandwidth**

APPLICATIONS

- **Audio Equipment**
- **Radios**
- **Musical Instruments**
- **Effects Pedals**
- **Mixers/Effects**

DESCRIPTION

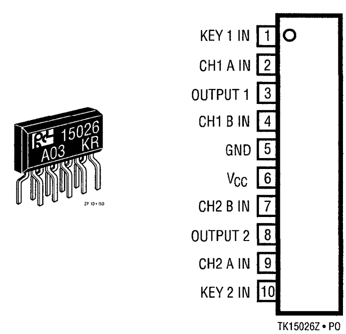
The TK15026 is an active analog switch using transconductance amplifiers to provide wide audio bandwidth and low distortion. A dual SPDT switch is used for selecting the desired channel.

The circuit has two separate sections to switch each of two outputs. The IC features high input impedance (75 kΩ) and low output impedance (25 Ω).

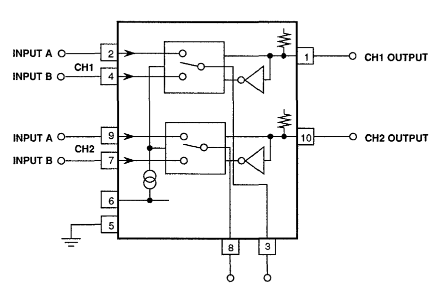
Channel 1 "A" input is active when the select input is "Low" or "open". The TK15026 has a wide dynamic range and can accept AC signals up to 4.5 V(rms). It has a maximum noise level of 10 µV. Typical crosstalk is -80 dB. The IC will operate from 3 to 20 V and typical current consumption is 3.5 mA.

The TK15026 is available in ZIP10 plastic zig-zag package.

TK15026



BLOCK DIAGRAM



ORDERING INFORMATION

TK15026 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
Z : ZIP	C : -20 to +75 °C	BX : Bulk/Bag
		TX : Paper Tape
		TR : Tape Right
		TL : Tape Left
		MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CCMAX} .... 15 V
Power Dissipation (Note 1) .... 450 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +125 °C
Operating Temperature Range .... -20 to +75 °C
Operating Voltage Range .... 3 to 14 V

Lead Soldering Temp. (10 sec.) .... 300 °C
Control Section
Input Voltage .... -0.3 V to V_{CC} + 0.3 V
Analog Switch Section
Input Voltage .... -0.3 V to V_{CC} + 0.3 V
Output Current .... 3 mA

ELECTRICAL CHARACTERISTICS

V_{CC} = 8 V, T_A = 25 °C

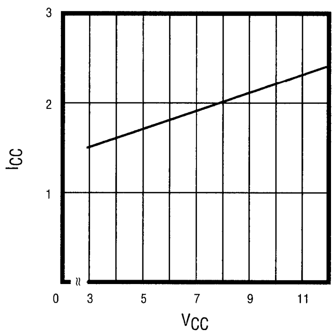
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	Figure 1, $R_L = \infty$		2.0	6.5	mA
Key Control						
V_{IL}	Input Low Level	Note 2	0		0.4	V
I_{IL}	Input Low Current	V_{IL} 0.4 V		10	30	µA
V_{IH}	Input High Level		1.8		V_{CC}	V
I_{IH}	Input High Current	V_{IH}		350	500	µA
Analog Switch						
THD	Distortion	V_{SIN} = 1 V(rms), R_L = 5 kΩ f = 1 kHz		0.005	0.10	%
NL	Residual Noise	R_L = 3 kΩ, Note 3			10	µV(rms)
Iso	Isolation	Note 4			-70	dB
Sep	Separation	Note 4			-80	dB
Dyn	Dynamic Range	THD = 0.1%, R_L = 5 kΩ, f = 1 kHz	2.0	2.2		dB
V_G	Voltage Gain	V_{SIN} = 1 V(rms), R_L = 5 kΩ f = 10 to 20 kHz	-0.2	0	+0.2	dB
Z_{IN}	Input Resistance			75		kΩ
Z_{OUT}	Output Resistance			20		Ω
V_{CENT}	In/Out Terminal Voltage	No Input		$V_{CC}/2$		V
ΔV_{CENT}	DC Center Point Difference between channels				50	mV

Note 1: Power dissipation must be derated at a rate of 4 mW/°C for operation at T_A = 25 °C and above.
Note 2: Terminal open voltage is 2.0 V, High Level (A CH circuit is "on")
Note 3: Measure at V_{IL} = 0.8 V, V_{IH} = 2.3 V with input terminal of the test channel grounded using a 10 µF capacitor.
Note 4: Isolation = Crosstalk between Channels A-B, measured at the output.
Separation = Crosstalk between Channels 1-2, measured at the output.
Grounded with a 10 pF capacitor and a 5 kΩ resistor.

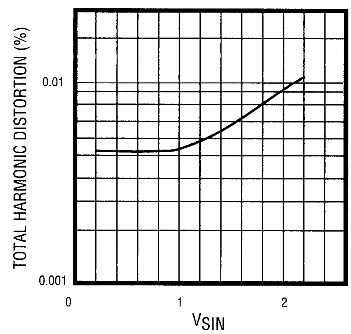
TYPICAL PERFORMANCE CHARACTERISTICS

1

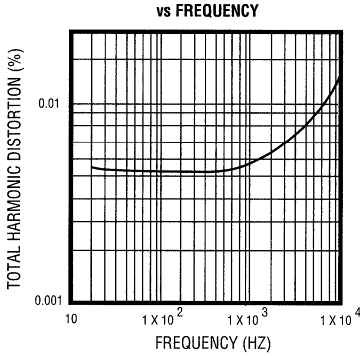
SUPPLY CURRENT vs SUPPLY VOLTAGE



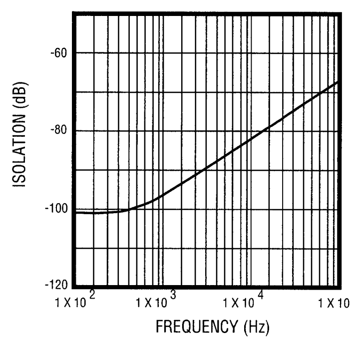
TOTAL HARMONIC DISTORTION vs INPUT VOLTAGE



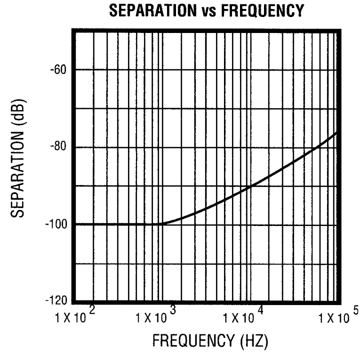
TOTAL HARMONIC DISTORTION vs FREQUENCY



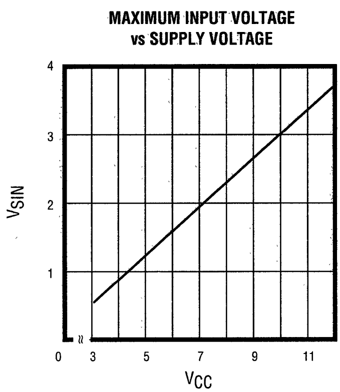
ISOLATION vs FREQUENCY

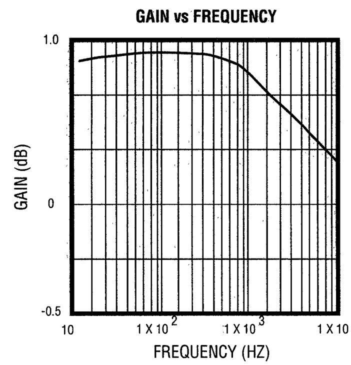


SEPARATION vs FREQUENCY



TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)





NOTES

DUAL TWO-INPUT/SINGLE OUTPUT AUDIO ANALOG SWITCH

FEATURES

- **0.005% Distortion**
- **Low Voltage Operation (3 V)**
- **High Input-Output Isolation**
- **Less Sensitive to ESD than CMOS Switches**
- **2 SPDT Channels Independently Controlled**
- **Floating Output Mode for Parallel Device Connection**
- **Unity Gain**
- **High Input Impedance, Low Output Impedance**
- **100 kHz Bandwidth**

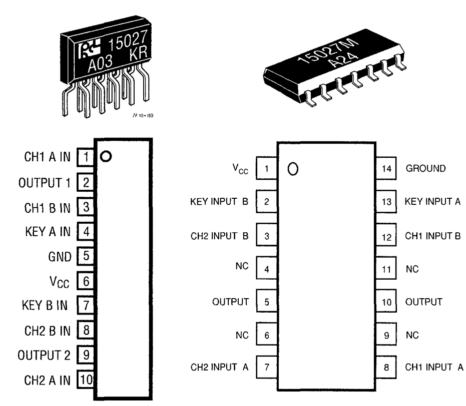
APPLICATIONS

- **Audio Systems**
- **Radio Cassettes**
- **Musical Instruments**
- **Effects Pedals**

DESCRIPTION

The TK15027 is an active analog switch using transconductance amplifiers to provide wide audio bandwidth and low distortion dual SPDT switch. A floating output mode is available when the control inputs are switched to either High-High or Low-Low to provide a method for connecting devices in parallel (see page 1-144).

The TK15027 is available in MFP14 plastic surface mount package and ZIP10 plastic zig-zag package.



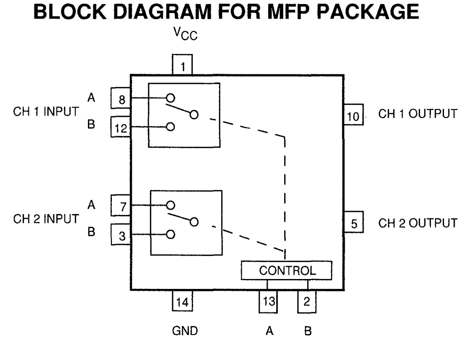
ORDERING INFORMATION

TK15027 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -30 to +70 °C	BX: Bulk/Bag
Z: Zig Zag		TX: Paper Tape
		TR: Tape Right
		TL: Tape Left
		MG: Magazine

BLOCK DIAGRAM FOR MFP PACKAGE



ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 16 V
Power Dissipation (Note 1) M Package .... 600 mW
Power Dissipation (Note 2) Z Package .... 490 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +75 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

Control Section
Input Voltage .... 0 V to V_{CC} V
Analog Switch Section
Input Voltage .... 0.3 V to V_{CC} V
Output Current .... 3 mA
Operating Voltage Range .... 1.8 to 15 V
Maximum Input Frequency .... 100 kHz

ELECTRICAL CHARACTERISTICS

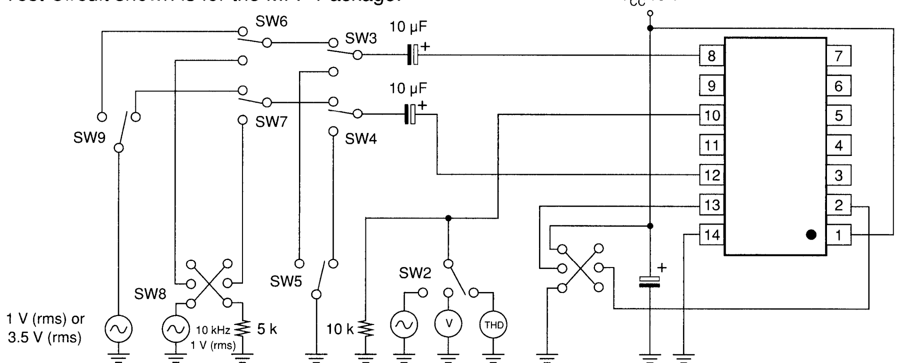
Test conditions: V_{CC} = 12 V, R_L = 10 kΩ, T_A = 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	at R_L = Open		5	8	mA
Control Section						
V_{IL}	Input Low Level		0		0.4	V
V_{IH}	Input High Level		1.8		V_{CC}	V
Key Z_{IN}	Key Input Resistance			40		kΩ
Analog Switch Section						
THD	Distortion	V_{SIN} = 1 V(rms), f = 1 kHz		0.005	0.01	%
N_L	Residual Noise	Input Connected to 10 µF to GND			10.0	µV(rms)
Crss	Crosstalk	Note 3		-70.0	-60.0	dB
DYN	Dynamic Range	THD = 0.1%, f = 1 kHz	3.0	3.5		V(rms)
Vcent	IN/OUT Pin Voltage	Note 4	4.8		5.2	V
V_{OFC}	Output Offset Voltage	Note 5			60.0	mV
V_G	Voltage Gain			0		dB
Z_{IN}	Input Resistance			75		kΩ
Z_{OUT}	Output Resistance	A, B CH		20		Ω
Z_{OUT}	Output Resistance	Open CH		∞		Ω

Note 1: Power dissipation must be derated at the rate of 4.8 mW/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 3.12 mW/°C for operation at T_A = 25 °C and above.
Note 3: Measured at f = 10 kHz, V_{SIN} = 1 V (rms) input at test channel grounded using 10 µF capacitor and 5 kΩ resistor.
Note 4: Output at V_{CC} /2
Note 5: Measured with mute function enabled.

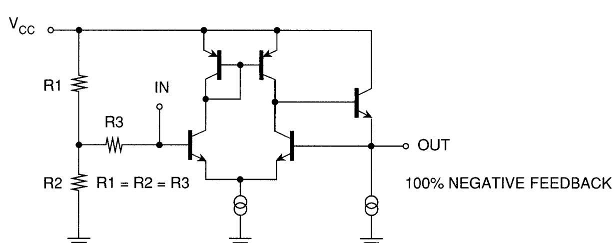
TEST CIRCUIT

Test Circuit shown is for the MFP Package.



1. CH 1 test circuit is shown.
2. CH 1 A, B distortion and dynamic range test is shown.
3. NL and Vcent is measured using SW5.
4. Crss is measured using SW8.
5. Following power on, a minimum of 2 msec waiting time is necessary before testing.

BASIC CIRCUIT



TRUTH TABLE

CONTROL KEY A	CONTROL KEY B	OUTPUT CH 1	OUTPUT CH 2
Hi	Hi	Floating	Floating
Hi	Low	Ch 1, A In	Ch 2, A In
Low	Hi	Ch1, B In	Ch 2, B In
Low	Low	Floating	Floating

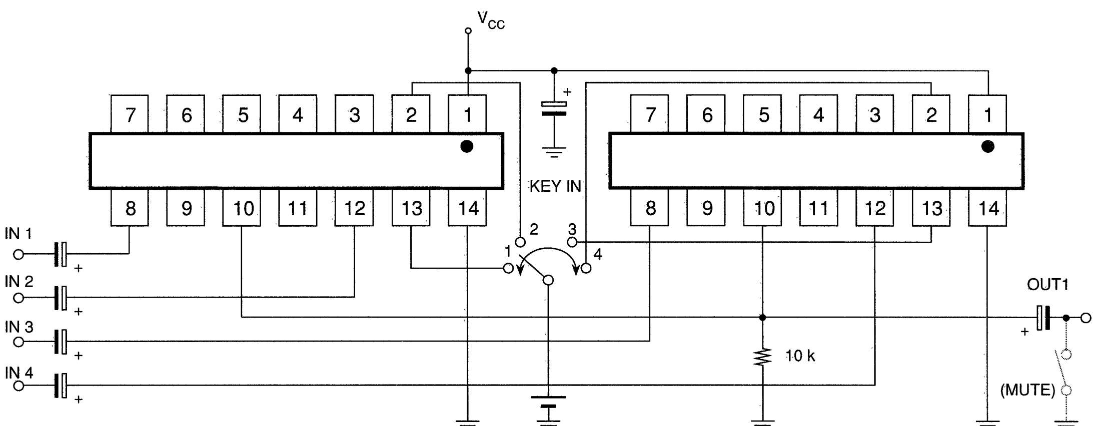
APPLICATION INFORMATION

1. Switching Speed

Switch control response time is typically 200 µsec.

2. Parallel Connection of Outputs

Basically, when High-High or Low-Low type switch control is used, the outputs can be connected parallel. Additional muting circuit is recommended to prevent clicks caused by differences in DC level.
Example:



3. Short Circuit of Input-Output Terminals

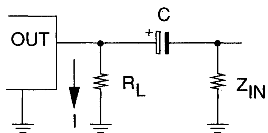
Since the input terminals have high input impedance (75 kΩ), short circuit of the input terminals to V_{CC} or GND doesn't cause any damage. Also, short circuit of the output terminals to V_{CC} doesn't cause any damage either. However, a long term short circuit of the output terminals to GND may cause damage, as current is only limited by the base current of the output transistor.

4. Crosstalk (Isolation, Separation)

Since the input impedance is high (75 kΩ), the input coupling capacitor works as an antenna, increased crosstalk may result, particularly when the inputs are located in close proximity. Locate the input capacitors as far as possible from each other on the printed circuit board.

APPLICATION INFORMATION (CONT.)

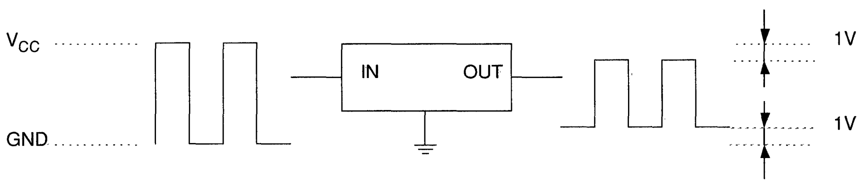
5. AC Loading



The recommended load resistance (R_L) is 10 kΩ. When using capacitive coupling, set $R_L \leq Z_{IN}$. Where $I \leq 3$ mA.

6. DC Signal Input

Since the basic circuit is a voltage-follower, the inputs can be modulated to within1 V of either V_{CC} or GND.



NOTES

DUAL TWO-INPUT/SINGLE OUTPUT AUDIO ANALOG SWITCH

FEATURES

- 0.005% Distortion
- Low Voltage Operation (3 V)
- High Input-Output Isolation
- Less Sensitive to ESD than CMOS Switches
- 2 SPDT Channels Independently Controlled
- Unity Gain
- High Input Impedance/Low Output Impedance
- 100 kHz Bandwidth

APPLICATIONS

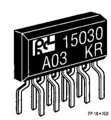
- Audio Systems
- Radio Cassettes
- Effects Pedals
- Audio Mixers/Effects

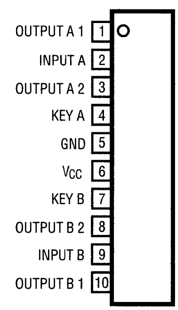
DESCRIPTION

The TK15030 is an active analog switch using transconductance amplifiers to provide wide audio bandwidth and low distortion. A dual SPDT switch is used for input channel selection.

The TK15030 is available in a ZIP10 plastic zig-zag package.

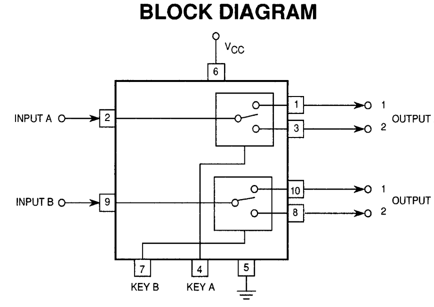
TK15030Z





TK15030Z • P0

BLOCK DIAGRAM



Key A

Hi Open	A1 Out
Low	A2 Out

Key B

Hi Open	B1 Out
Low	B2 Out

ORDERING INFORMATION

TK15030 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
Z : ZIP	C : -20 to +75 °C	BX : Bulk/Bag
		MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 16 V
Power Dissipation (Note 1) .... 450 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +75 °C
Lead Soldering Temp. (10 sec.) .... 300 °C
Operating Voltage Range .... 3 to 14 V

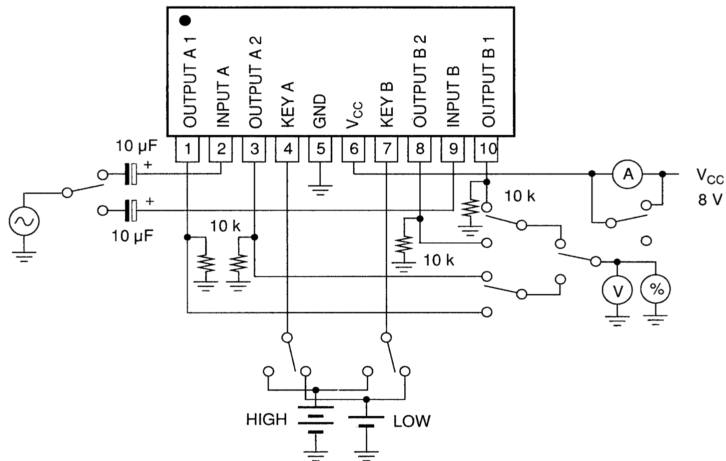
ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 8 V, f = 1 kHz, T_A = 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Voltage Range	at $R_L = \infty$		3.2	6.4	mA
Control Section						
V_{IL}	Input Low Level		0		0.9	V
V_{IH}	Input High Level		2.3		V_{CC}	V
Analog Switch Section						
THD	Distortion	R_L = 10 Ω, 1 V(rms)		0.005	0.05	%
V_N	Output Noise Voltage	Rg = 0 Ω, R_L = 10 kΩ			10.0	µV(rms)
Crss	Crosstalk	10 kHz			-50	dB
DYN	Dynamic Range	THD = 0.1%, R_L = 10 kΩ	2.0	2.3		V(rms)
V_{DC}	IN/OUT Terminal Voltage			$V_{CC}/2$		V
V_G	Voltage Gain			0		dB

Note 1: Power dissipation must be derated at the rate of 4.5 mW/°C for operation at T_A = 25 °C and above.

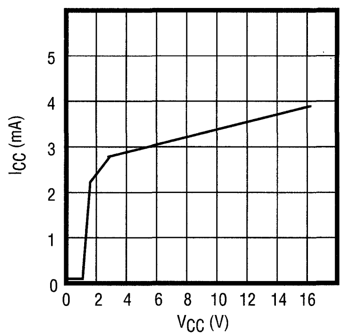
TEST CIRCUIT



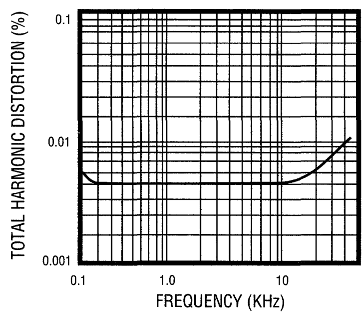
NOTES

TYPICAL PERFORMANCE CHARACTERISTICS

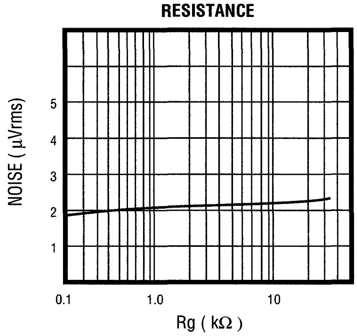
SUPPLY CURRENT vs SUPPLY VOLTAGE



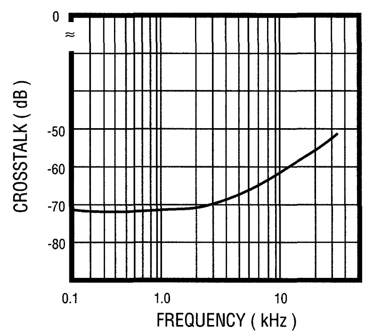
TOTAL HARMONIC DISTORTION vs FREQUENCY



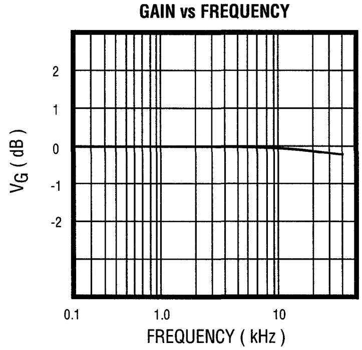
OUTPUT NOISE vs SOURCE RESISTANCE



CROSSTALK vs FREQUENCY



GAIN vs FREQUENCY



TOKO

TK15052

DUAL TWO-INPUT/TWO-OUTPUT AUDIO ANALOG SWITCH

FEATURES

- High Input Impedance/Low Output Impedance
- Low Distortion
- Input Channel Reverse
- Separate Input/Output Select Key Inputs

APPLICATIONS

- Audio Systems
- Radios with Cassette Tape Recorders
- Musical Instruments
- Effects
- TV/VCR Audio Switches

DESCRIPTION

The TK15052 is a two-channel analog switch with four inputs and two outputs. Any input can be connected to any output. When both control pins are pulled "Low," both outputs are floating. The control pins are TTL and CMOS compatible. Additionally, the TK15052 has two dual-input, single output transfer switches, controlled by a single toggle key.

The TK15052 is available in a DIP16 plastic package.

ORDERING INFORMATION

TK15052 □ □ □□

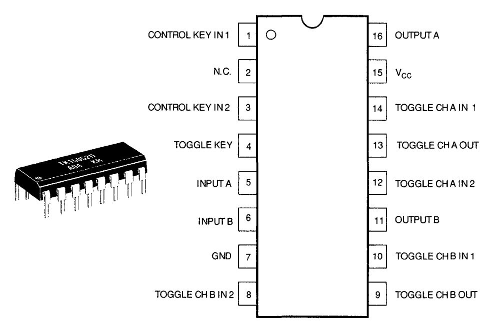
- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE
D: Plastic DIP

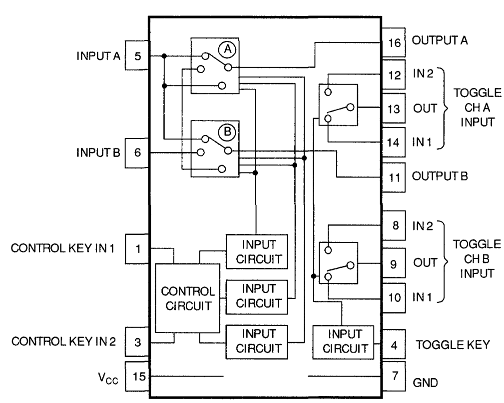
TEMP. RANGE
C : -20 to +75 °C

TAPE/REEL CODE
BX: Bulk/Bag
MG: Magazine

TK15052



BLOCK DIAGRAM



TRUTH TABLE

CONTROL KEY		OUTPUT		OUT DC BIAS	
Key 1 In	Key 2 In	Out-A	Out-B	Out-A	Out-B
Hi	Low	In A	In A	$V_{CC}/2$	$V_{CC}/2$
Low	Hi	In B	In B	$V_{CC}/2$	$V_{CC}/2$
Hi	Hi	In A	In B	$V_{CC}/2$	$V_{CC}/2$
Low	Low	Off	Off	Floating	

ABSOLUTE MAXIMUM RATINGS

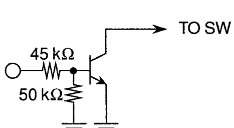
Input Voltage V_{CCMAX} .... 16 V
Power Dissipation (Note 1) .... 540 mW
Operating Voltage Range .... 1.8 to 15 V
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +125 °C
Operating Temperature Range .... -20 to +75 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 9.0 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current		1.7	2.5	5.0	mA
V_{ILC}	Control Level	Input Level "L" (Note 2)	– 0.3		0.9	V
V_{IHC}	Control Level	Input Level "H"	1.8		V_{CC} + 0.3	V
Key Z_{IN}	Key Input Resistance	(Note 3)	30	45		kΩ
Analog Switch Section						
THD	Distortion	V_{SIN} = 1 V (rms), R_L = 10 kΩ, f = 1 kHz		0.005	0.01	%
N_L	Residual Noise	R_L = 10 kΩ Input Terminal Grounded at 10 µF			10	µV (rms)
Crss	Crosstalk	V_{SIN} = 1 V (rms), R_L = 10 kΩ, f = 10 kHz, R_G = 47 kΩ (Note 4)	– 45	– 50		dB
DYN	Dynamic Range In/Out Terminal Voltage	THD = 0.1%, R_L = 10 kΩ, f = 1 kHz	2.0	2.5		V (rms)
V_{CENT1}	DC Center Point 1	No Input		V_{CC}/2		V
V_{CENT2}	DC Center Point 2	DC Center point different between channels			50	mV
V_G	Voltage Gain			0		dB

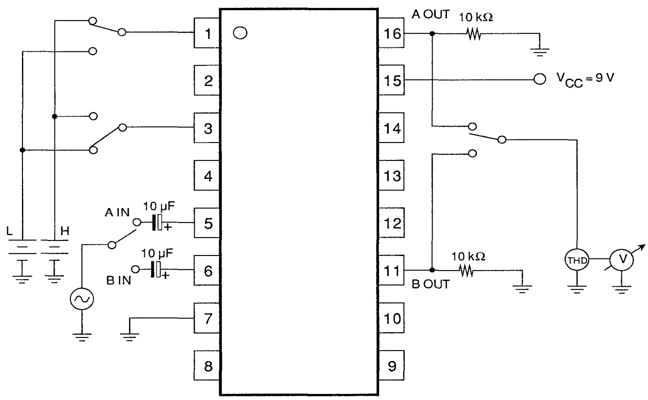
Note 1: Power dissipation must be derated at the rate of 5.4 mW/°C for operation at T_A = 25 °C and above.
Note 2: "L" condition when control terminal is "open."
Note 3:



Note 4: The input terminals (except for signal input terminal) are grounded using a 10 µF capacitor.

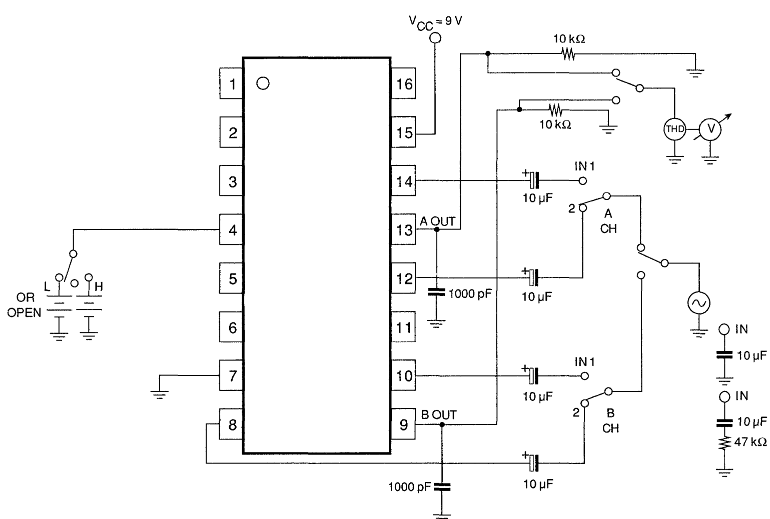
TEST CIRCUITS

TWO-INPUT/TWO-OUTPUT TEST CONFIGURATION



TK15052D TC

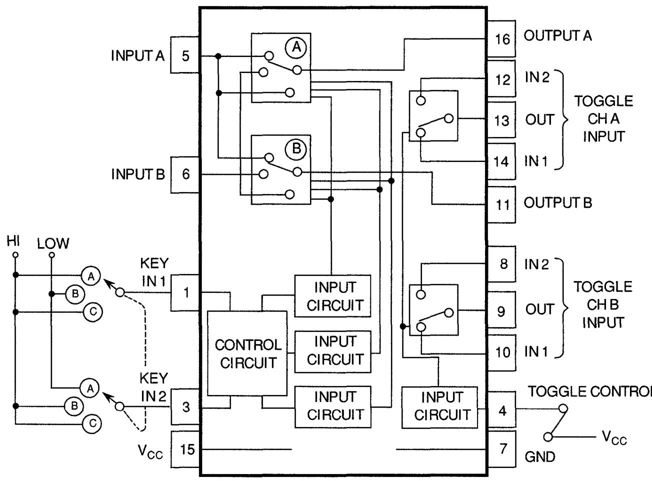
TRANSFER SWITCH TEST CONFIGURATION



Residual noise is measured with the input terminal grounded using a 10 µF capacitor.

Crosstalk is measured with the unused input terminal grounded using a 10 µF capacitor and a 47 k resistor in series.

TYPICAL APPLICATION



TK15052D TA

NOTES

DUAL TWO-INPUT/SINGLE OUTPUT VIDEO ANALOG SWITCH

FEATURES

- **Wide Bandwidth**
- **Wide Operating Voltage Range**
- **Minimum External Parts Count**
- **CMOS or TTL Control**
- **Two Independent Channels**

APPLICATIONS

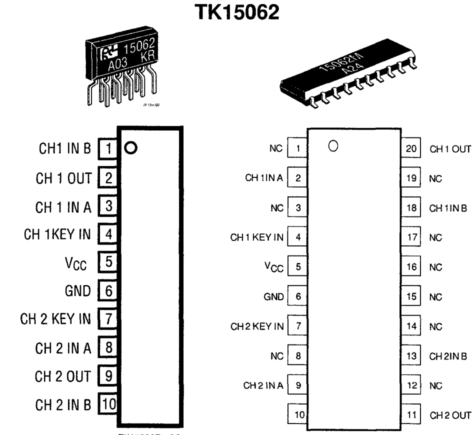
- **Wide/Narrow IF Switch**
- **Effects Generators**
- **VTR/VCR**
- **Television**

DESCRIPTION

The TK15062 is a two-input/single output video analog switch developed for use in video equipment. Its features include low distortion, wide bandwidth and wide dynamic range. The device has two pairs of inputs and one of either pair of inputs can be independently switched to the corresponding output. (See Block Diagram)

The TK15062 is available in MFP20 plastic or ZIP10 plastic zig zag packages.

TK15062



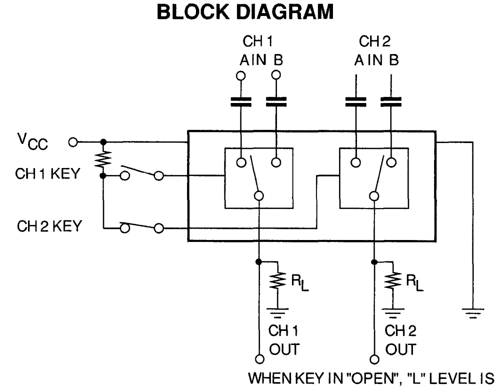
ORDERING INFORMATION

TK15062 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +75 °C	BX: Bulk/Bag
Z: ZIP		TX: Paper Tape
		TR: Tape Right
		TL: Tape Left
		MG: Magazine

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 18 V
Power Dissipation, M Pack (Note 1) .... 350 mW
Power Dissipation, Z Pack (Note 2) .... 450 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +125 °C
Operating Temperature Range .... -20 to +75 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 8.0 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{CC}	Operating Voltage Range		4.0		16.0	V
I_{CC}	Supply Current			11.2	16.8	mA
Key L	Input "L" Level		-0.3		0.4	V
Key H	Input "H" Level		1.8		V_{CC} + 0.8	V
f (3 dB)	Frequency Range				10	MHz
DYN	Dynamic Range	f = 5 MHz, R_L = 10 kΩ	0.9	1.0		Vp-p
V_G	Voltage Gain	f = 5 MHz, R_L = 10 kΩ	-0.5		+0.5	dB
Crss	Crosstalk	f = 10 MHz, V_{IN} = 110 dBμ, R_{IN} = 50 Ω	-40	-45		dB
I_{SOUT}	Load Current				2	mA

Note 1: Power dissipation must be derated at the rate of 3.5 mW/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 4.5 mW/°C for operation at T_A = 25 °C and above.

NOTES

TOKO

TK15064

DUAL TWO-INPUT/SINGLE OUTPUT VIDEO ANALOG SWITCH

1

FEATURES

- Low Voltage Operation
- Low Power Dissipation
- Broad Dynamic Range
- High Control Terminal Input Impedance
- Broad Input Frequency Range

APPLICATIONS

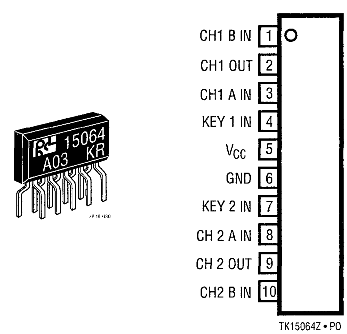
- VTR
- High Frequency Analog Switch
- Effects
- Television

DESCRIPTION

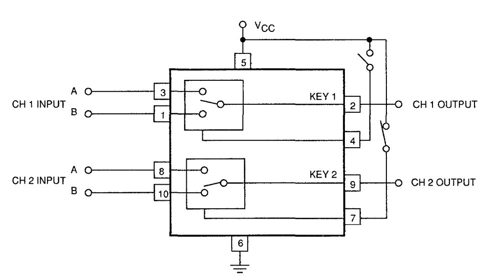
The TK15064 is a dual two-input, dual output video analog switch developed for consumer equipment. Either one of the input pairs can be switched independently to the corresponding output. The device features low distortion, wide bandwidth and wide dynamic range. The input resistance is 10 kΩ and the output resistance is <100 Ω.

The TK15064 is available in a ZIP10 plastic zig zag package.

TK15064Z



BLOCK DIAGRAM



ORDERING INFORMATION

TK15064 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
Z : ZIP	C : -20 to +75 °C	BX : Bulk/Bag
		MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 9 V
Power Dissipation (Note 1) .... 490 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +75 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

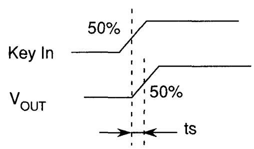
ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 5.0 V, unless otherwise specified. T_A = 25 °C

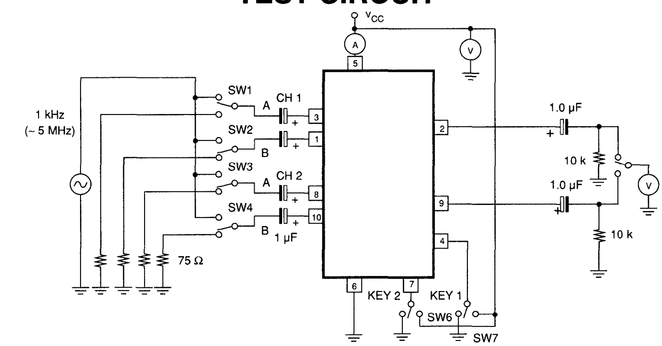
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{CC}	Operating Voltage Range		4	5	9	V
I_{CC}	Power Supply Current	R_L open		14	18.5	mA
Key-L	Key Low Input Level		0		0.4	V
Key-H	Key High input Level		1.8		V_{CC}	
Key Z_{IN}	Key Input Resistance			40		kΩ
f	Frequency Range	Note 2	10 Hz		10 MHz	
V_{G1}	Voltage Gain	R_L = 10 kΩ, 10 Hz to 5 MHz	- 0.5	0	+ 0.5	dB
V_{G2}	Voltage Gain	R_L = 10 kΩ, 5 to 10 MHz	-1.0	0	+ 1.0	dB
ΔV_{G1}	Voltage Gain Variation with Temperature	Note 3	- 0.5	0.0	+ 0.5	dB
ΔV_{G2}	Voltage Gain Variation with Temperature	Note 4	- 1.0	0.0	+ 1.0	dB
THD1	Distortion	f = 1 kHz, V_{IN} = 2Vp-p R_L = 10 kΩ		0.1	0.5	%
THD2	Distortion	f = 5 MHz, V_{IN} = 2Vp-p R_L = 10 kΩ		2.0		%
Crss	Crosstalk	f = 10 Hz to 5 MHz V_{IN} = 2Vp-p, R_L = 50 kΩ R_{IN} = 10 kΩ		-50	-40	dB
I_{SOUT}	DC Load Current				2	mA
VDC_{OUT}	Output DC Voltage	when no input, R_L = 10 kΩ	1.5	1.8	2.2	V
R_{IN}	Signal Input Resistance	DC Test	10			kΩ
Z_{OUT}	Signal Output Resistance	DC Test			100	Ω
ts	Switching Speed	Note 5		500.0		n sec

Note 1: Power dissipation must be derated at the rate of 3.6 mV/°C for operation at T_A= 25 °C and above.
Note 2: V_{IN}= 2Vp-p, R_L= 10 kΩ, referenced at 100 kHz, 10 Hz to 5 MHz, ±0.5 dB, 5 to 10 MHz, ±1.0 dB
Note 3: V_{IN}= 2Vp-p, R_L= 10 kΩ, Initial Value is the value at 20 °C. f = 10 Hz to 5 MHz

Note 4: V_{IN}= 2Vp-p, R_L= 10 kΩ, Initial Value is the value at 20 °C. f = 5 to 10 MHz
Note 5:



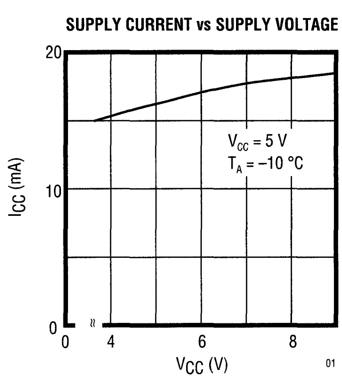
TEST CIRCUIT

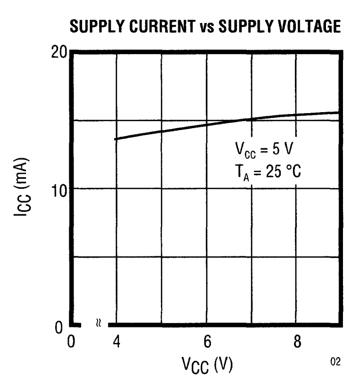


SW6, SW7, Level		
Key	GND(Open)	A Side
Key	V_{CC}	B Side

TYPICAL PERFORMANCE CHARACTERISTICS

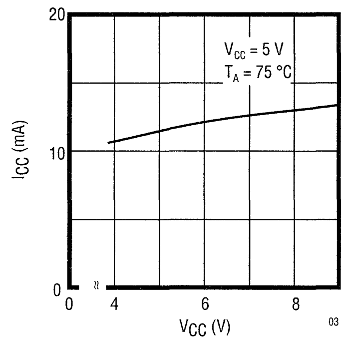
The TK15064 is designed for a typical supply voltage of 5 V.

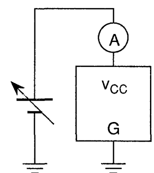




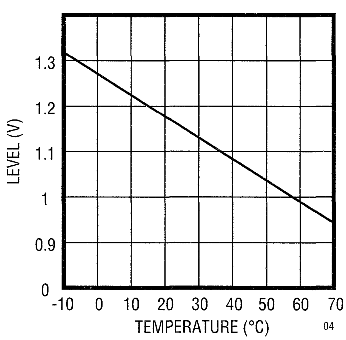
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

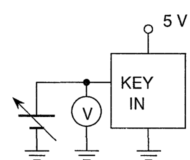
SUPPLY CURRENT vs SUPPLY VOLTAGE





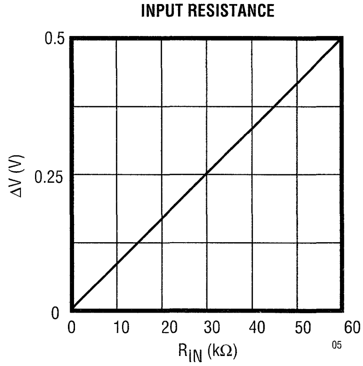
THRESHOLD LEVEL vs TEMPERATURE

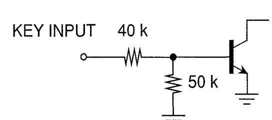


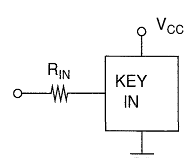


The control circuitry is designed to operate as shown below. The threshold can be raised by adding an external resistor.

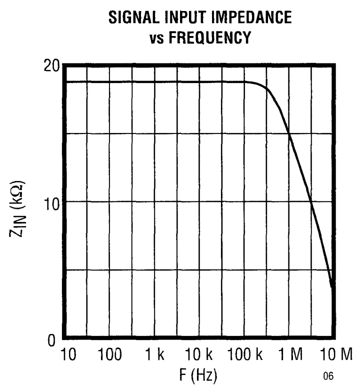
KEY INPUT THRESHOLD vs INPUT RESISTANCE

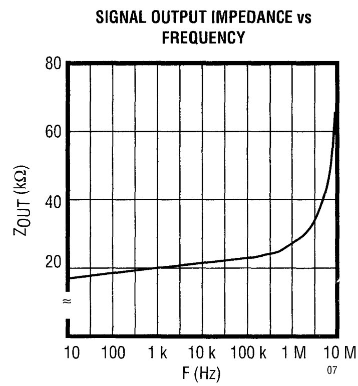




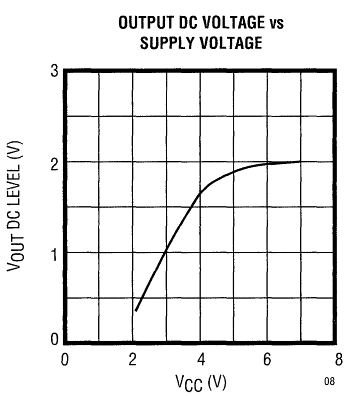


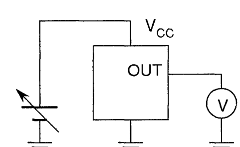
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)





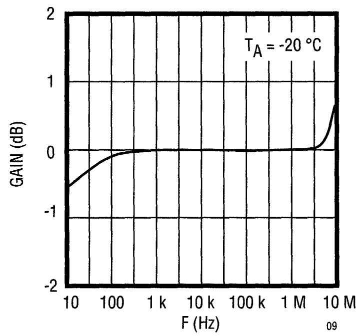
Note: Special attention must be paid to input capacitances, as they may affect frequency response.

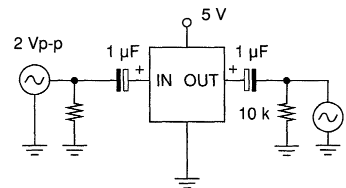




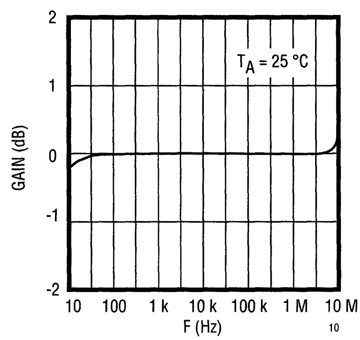
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

GAIN vs FREQUENCY

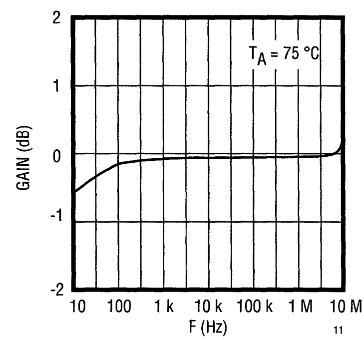




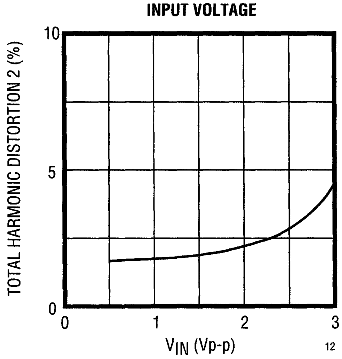
GAIN vs FREQUENCY

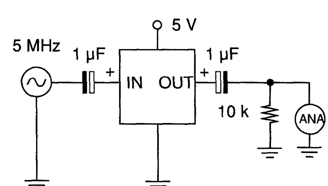


GAIN vs FREQUENCY



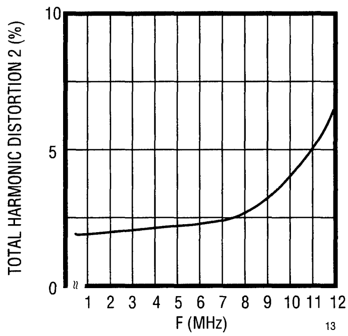
TOTAL HARMONIC DISTORTION vs INPUT VOLTAGE

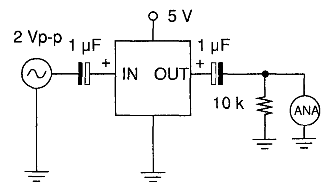




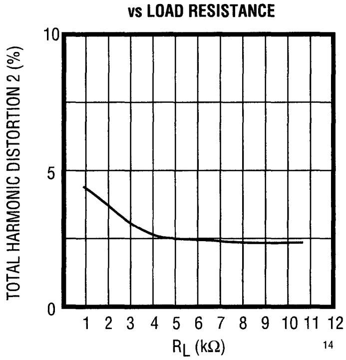
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

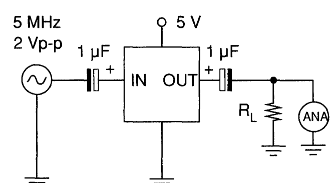
TOTAL HARMONIC DISTORTION vs FREQUENCY





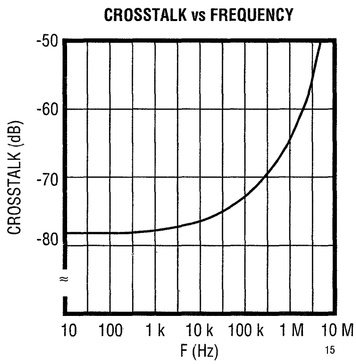
TOTAL HARMONIC DISTORTION vs LOAD RESISTANCE

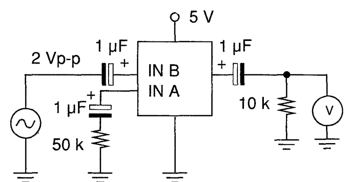




TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

Crosstalk is measured with the IC mounted on a standard printed circuit board. However, the input terminal wiring and the position of the input coupling capacitor have an effect on crosstalk, so special care must be taken to optimize the PCB layout.





CAUTION

Do not reverse V_{CC} and Ground or damage will occur. Do not exceed V_{CC} = 9 V or IC will be damaged. Pay attention to the DC level on all inputs and outputs.

TOKO

TK15065/66

TWO INPUT/SINGLE OUTPUT VIDEO ANALOG SWITCH

1

FEATURES

- **Low Output Impedance (100)**
- **Less Sensitive to ESD than CMOS Devices**
- **Wide Bandwidth**
- **Can Be Used as IF Bandwidth Switch**

APPLICATIONS

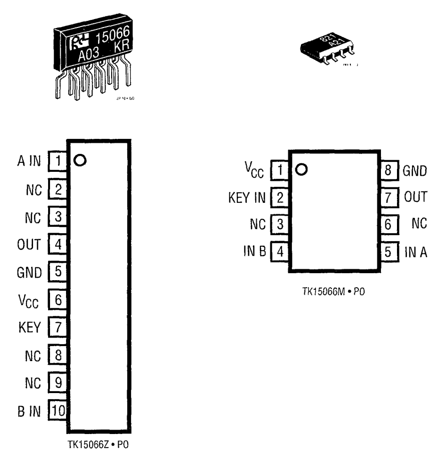
- **Television**
- **VTR**
- **Switchers**
- **Effects**
- **Radio**

DESCRIPTION

The TK15065/66 are video analog switches designed for consumer video equipment. These devices can be used as video selectors in TV's, VCR's and video switchers and effects units. The TK15065/66 devices feature wide bandwidth, high input and output impedance, and high isolation of the output from the input. The TK15065 has an active HIGH/LOW control pin, while the TK15066 has an active LOW/HIGH control pin.

The TK15065/66 are available in ZIP10 plastic zig zag and MFP8 surface mount packages.

TK15066Z **15066M**



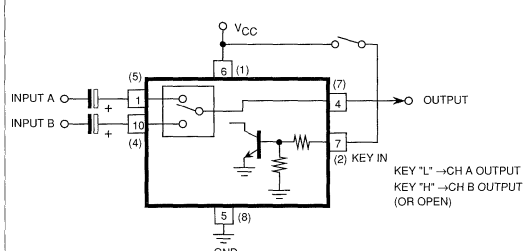
ORDERING INFORMATION

TK15065/66 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
Z : ZIP	C : -20 to +75 °C	BX : Bulk/Bag
M: Surface Mount		TX : Paper Tape
		TR : Tape Right
		TL : Tape Left
		MG: Magazine

BLOCK DIAGRAM



NUMBERS IN PARENTHESES ARE FOR THE MFP8

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 9 V
Maximum Input Frequency .... 10 MHz
Power Dissipation (Note 1) Z Pkg .... 490 mW
Power Dissipation (Note 2) M Pkg .... 390 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +75 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

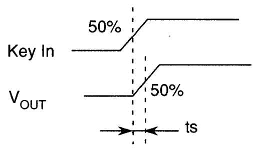
ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 5.0 V, unless otherwise specified. T_A = 20 ± 5 °C

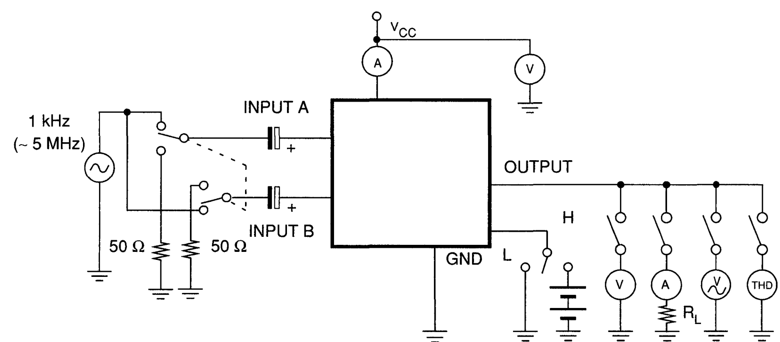
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{CC}	Operating Supply Range		4	5	7	V
I_{CC}	Supply Current	R_L open		8	12	mA
Key-L	Key Input Low Level		0		0.4	V
Key-H	Key Input High Level		1.8		V_{CC}	V
Key Z_{IN}	Key Input Resistance			40.0		kΩ
f	Frequency Range	Note 3	10.0		10×10^6	Hz
V_{G1}	Voltage Gain 10 ~5×10^6 Hz	R_L = 10 kΩ	- 0.5	0	+ 0.5	dB
V_{G2}	Voltage Gain	R_L=10 kΩ f = 5×10^6 ~10×10^6 Hz	-1.0	0	+ 1.0	dB
ΔV_{G1}	Voltage Gain Variation with Temperature	Note 4	- 0.5	0	+ 0.5	dB
ΔV_{G2}	Voltage Gain Variation with Temperature	Note 5	- 1.0	0	+ 1.0	dB
THD1	Distortion	f = 1 kHz, V_{IN} = 2Vp-p R_L=10 kΩ		0.1	0.5	%
THD2	Distortion	f = 5 MHz, V_{IN} = 2Vp-p R_L=10 kΩ		2.0		%
Crss	Crosstalk	f = 10 ~ 5×10^6 Hz V_{IN} = 2Vp-p, R_L=10 kΩ, R_{IN} = 50 Ω		-55	-50	dB
I_{SOUT}	DC Loaded Current				2.0	mA
VDC_{OUT}	Output DC Voltage	at no input, R_L=10 kΩ	1.5	1.8	2.2	V
Z_{IN}	Signal Input Resistance	DC Tested	10			kΩ
Z_{OUT}	Signal Output Resistance	DC Tested			100	Ω
ts	Switching Speed	Note 4		500		nSec

Note 1: Power dissipation must be derated at the rate of 4.0 mV/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 3.2 mW/°C for operation at T_A = 25 °C and above.

Note 3: V_{IN} = 2Vp-p, R_L= 10 kΩ, 0 dB at 100 kHz, then 10 ~5 x 10^6 Hz, ± 0.5 dB, 5 x 10^6 ~10 x 10^6 Hz, ±1.0 dB
Note 4: V_{IN} = 2Vp-p, R_L= 10 kΩ, value at 20 °C is initial value, F = 10 5 x 10^6 Hz
Note 5: V_{IN} = 2Vp-p, R_L= 10 kΩ, value at 20 °C is initial value, F = 5 x 10^6 ~10 x 10^6 Hz
Note 6:



TEST CIRCUIT



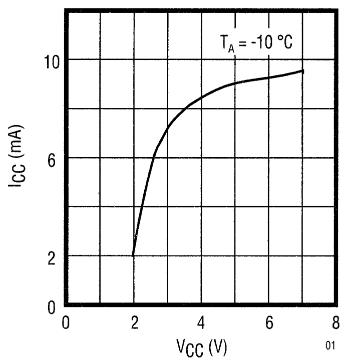
TRUTH TABLE

	Output	Key	Output	Key
15065M/Z	Ch A	L	Ch B	H
15066M/Z	Ch A	H	Ch B	L

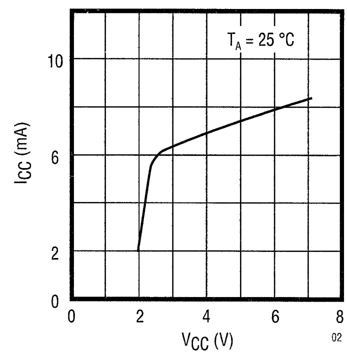
TYPICAL PERFORMANCE CHARACTERISTICS

The TK15064 circuit is designed at typical supply voltage of 5 V. Please refer to the following graphs for Supply Voltage vs. Supply Current Temperature Characteristics.

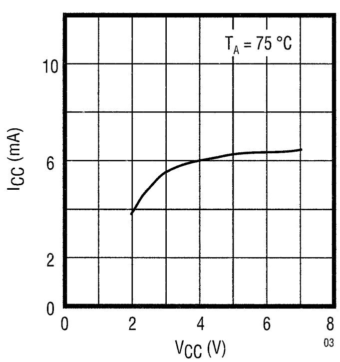
SUPPLY CURRENT vs SUPPLY VOLTAGE

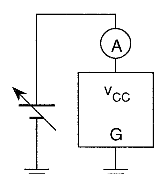


SUPPLY CURRENT vs SUPPLY VOLTAGE

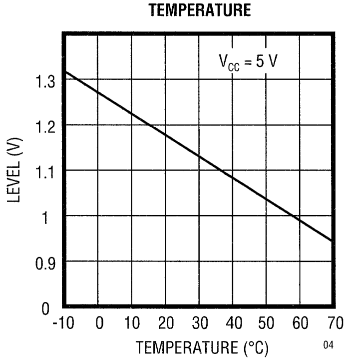


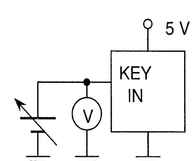
SUPPLY CURRENT vs SUPPLY VOLTAGE





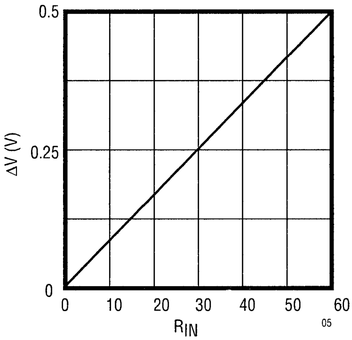
THRESHOLD LEVEL vs TEMPERATURE



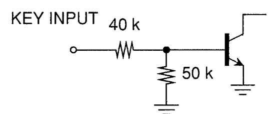


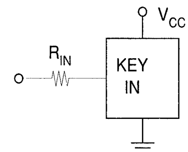
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

KEY INPUT THRESHOLD VOLTAGE vs INPUT RESISTANCE

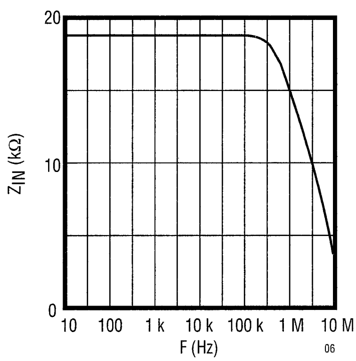


Key-In Circuit is designed based on the constants as the figures below. The threshold can be raised by adding an external resistor.

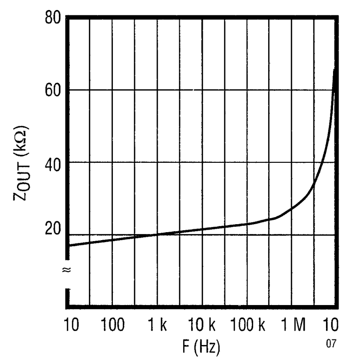




INPUT IMPEDANCE vs FREQUENCY

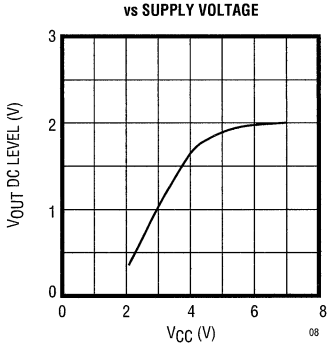


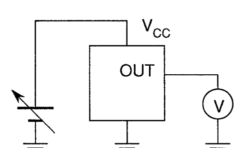
OUTPUT IMPEDANCE vs FREQUENCY



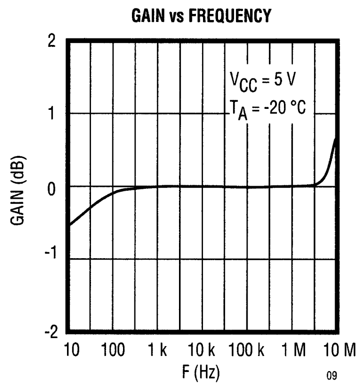
Note: Special attention must be paid to input capacitances, as they may affect frequency response.

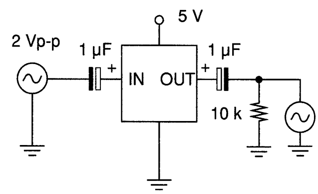
OUTPUT DC VOLTAGE vs SUPPLY VOLTAGE

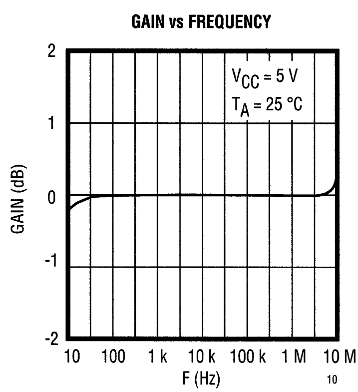


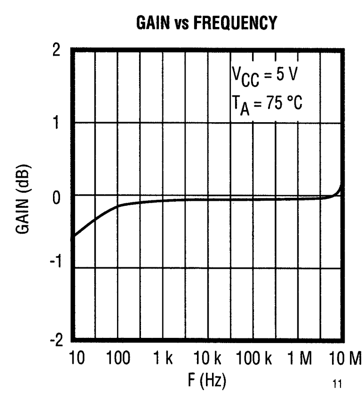


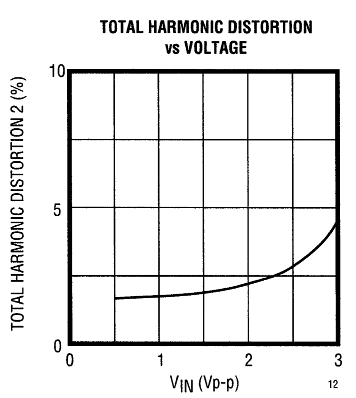
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

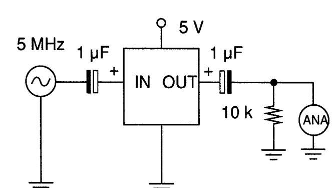




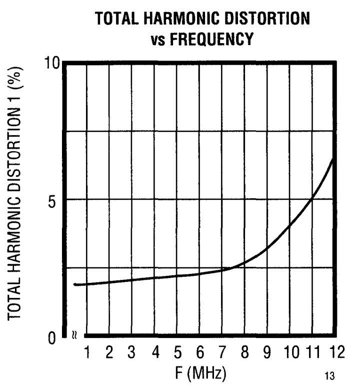


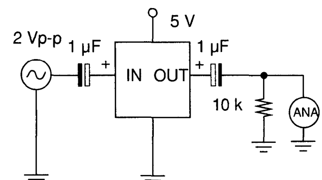


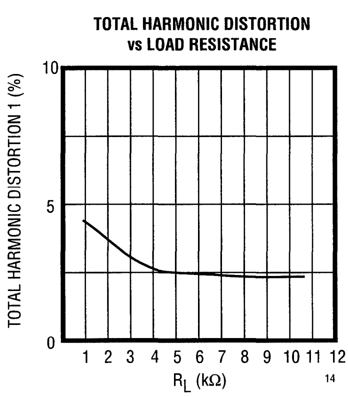


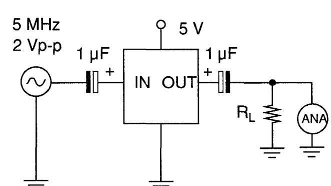


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)



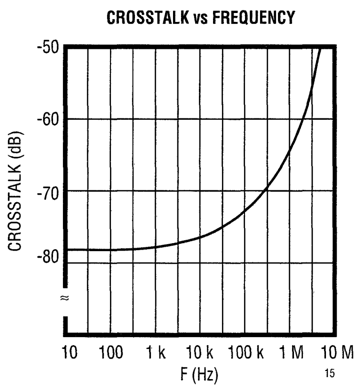


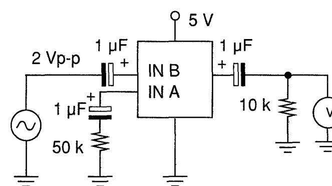




TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

Crosstalk is measured with the IC mounted on a standard printed circuit board. However, the input terminal wiring and the position of the input coupling capacitor have an effect on crosstalk, so special care must be taken to optimize the PCB layout.





CAUTION

Do not reverse V_{CC} and Ground or the IC may be damaged. Do not exceed V_{CC} = 7 V or damage may occur.

TWO INPUT/SINGLE OUTPUT VIDEO ANALOG SWITCH

FEATURES

- Low Operating Voltage
- Low Input Current
- Wide Dynamic Range
- Wide Bandwidth
- 55 dB Isolation

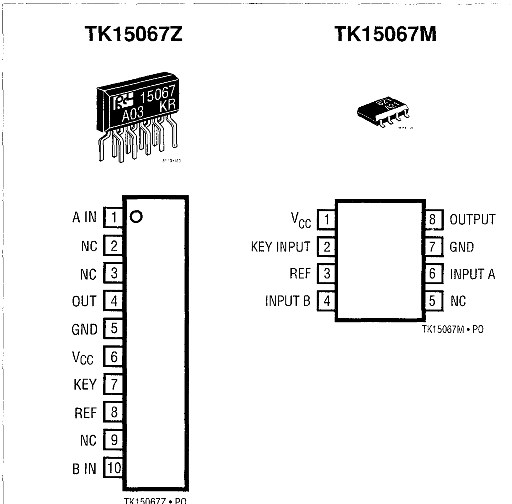
APPLICATIONS

- Television
- VCR Input Selector
- Special Effects Generators
- Wide/Narrow RF Bandwidth Switch

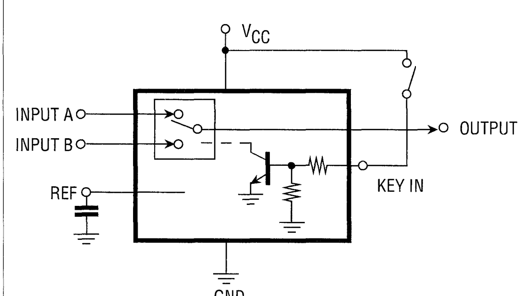
DESCRIPTION

The TK15067 is an analog switch designed for consumer video equipment. Either one of two inputs can be selected and connected to one output. The device features high input impedance and low output impedance. The circuit is built around a wide bandwidth transconductance amplifier and maintains high isolation between the output and input. The device has TTL logic level control.

The TK15067 is available in plastic MFP8 surface mount and ZIP10 plastic zig zag packages.



BLOCK DIAGRAM



ORDERING INFORMATION

TK15067 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE
M : Surface Mount
Z : ZIP

TEMP. RANGE
C : -20 to + 70 °C

TAPE/REEL CODE
BX : Bulk/Bag
TX : Paper Tape
TR : Tape Right
TL : Tape Left
MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 9 V
Power Dissipation TK15067M (Note 1) .... 390 mW
Power Dissipation TK15067Z (Note 2) .... 490 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +75 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

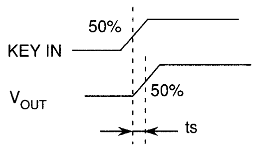
ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 5.0 V, T_A = 25 °C, unless otherwise specified.

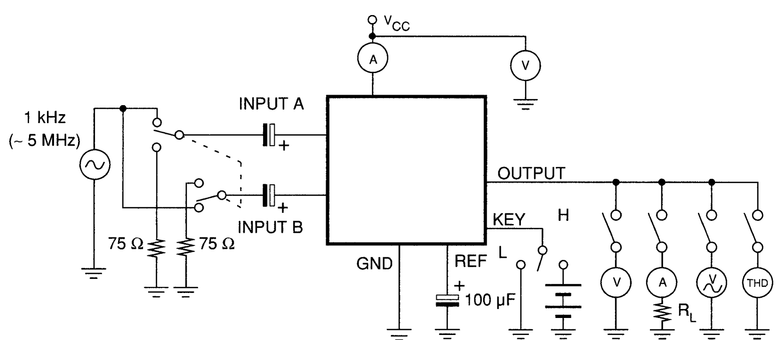
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{CC}	Operating Voltage Range		4	5	6.5	V
I_{CC}	Power Supply Current	R_L open		4	7	mA
Key-L	Key Low Input Level		0		0.4	V
Key-H	Key High input Level		1.8		V_{CC}	
Key Z_{IN}	Key Input Resistance			40		kΩ
f	Frequency Range	Note 3	10 Hz		10 MHz	
V_{G1}	Voltage Gain	R_L = 3.3 kΩ, 10 Hz to 5 MHz	- 0.5	0	+ 0.5	dB
V_{G2}	Voltage Gain	R_L = 3.3 kΩ, 5 to 10 MHz	-1.0	0	+ 1.0	dB
ΔV_{G1}	Voltage Gain Variation with Temperature	Note 4	- 0.5	0.0	+ 0.5	dB
ΔV_{G2}	Voltage Gain Variation with Temperature	Note 5	- 1.0	0.0	+ 1.0	dB
THD1	Distortion	f = 1 kHz, V_{IN} = 2Vp-p R_L = 3.3 kΩ		0.1	0.5	%
THD2	Distortion	f = 5 MHz, V_I = 2Vp-p R_L = 3.3 kΩ		2.0		%
Crss	Crosstalk	f = 10 Hz to 5 MHz V_{IN} = 2Vp-p, C_{REF} = 100 µF R_L = 3.3 kΩ, R_{IN} = 75 Ω		-55	-50	dB
I_{SOUT}	DC Load Current				2	mA
VDC_{OUT}	Output DC Voltage	when no input, R_L = 3.3 kΩ	1.5	1.8	2.2	V
Z_{IN}	Signal Input Impedance	DC Tested	10			kΩ
Z_{OUT}	Signal Output Impedance	DC Tested			100	Ω
ts	Switching Speed	Note 6		300		nsec

Note 1: Power dissipation must be derated at the rate of 3.2 mW/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 4.0 mW/°C for operation at T_A = 25 °C and above.

Note 3: V_{IN} = 2Vp-p, R_L = 3.3 kΩ, referenced at 100 kHz, 10 Hz to 5 MHz, ±0.5 dB, 5 to 10 MHz, ±1.0 dB
Note 4: V_{IN} = 2Vp-p, R_L = 3.3 kΩ, Initial Value is the value at 25 °C. f = 10 Hz to 5 MHz
Note 5: V_{IN} = 2Vp-p, R_L = 3.3 kΩ, Initial Value is the value at 25 °C. f = 5 to 10 MHz
Note 6:



TEST CIRCUIT

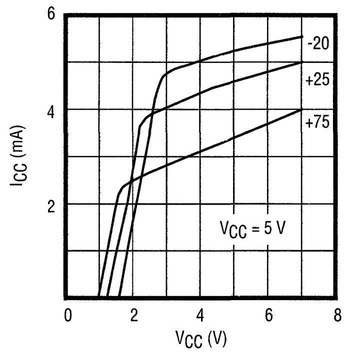


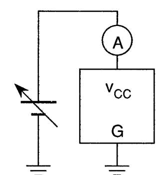
TRUTH TABLE

15067M/Z	Channel to Output
Key In "HIgh"	In A
Key In "Low"	In B

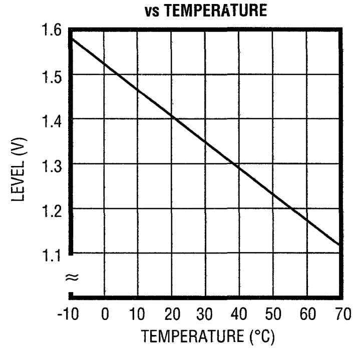
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

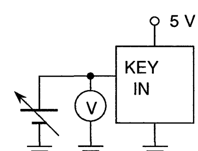
SUPPLY CURRENT vs SUPPLY VOLTAGE



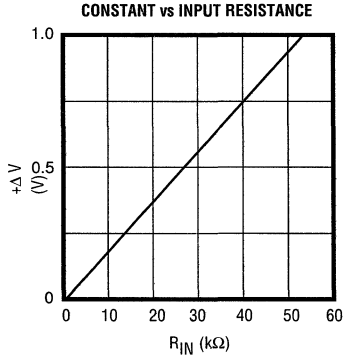


KEY IN THRESHOLD LEVEL vs TEMPERATURE

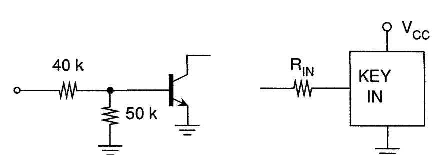




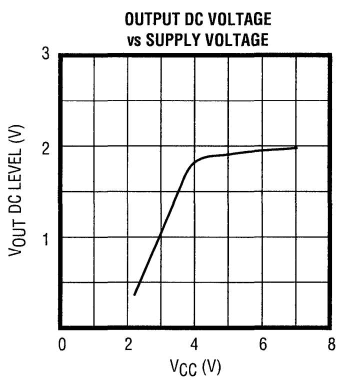
KEY IN THRESHOLD LEVEL: CONSTANT vs INPUT RESISTANCE

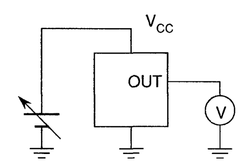


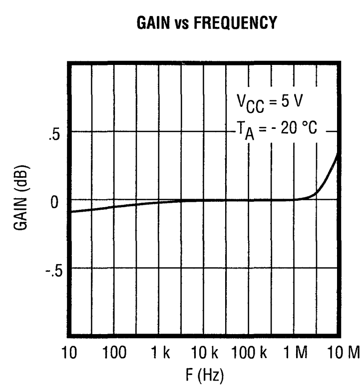
The control circuitry is designed to operate as shown below. The threshold can be raised by adding an external resistor.

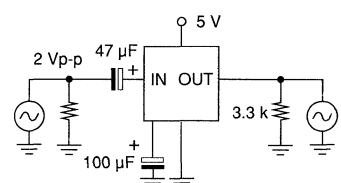


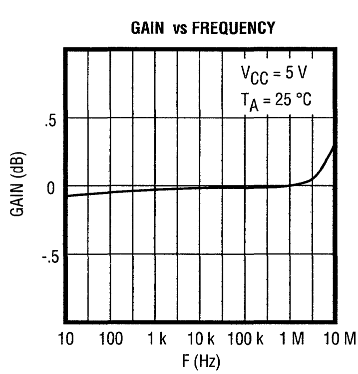
TYPICAL PERFORMANCE CHARACTERISTICS

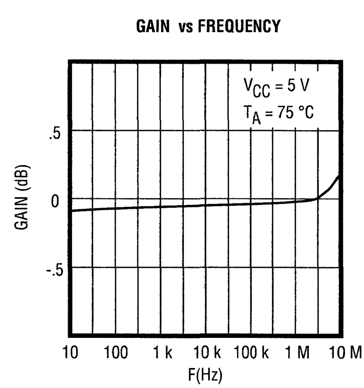




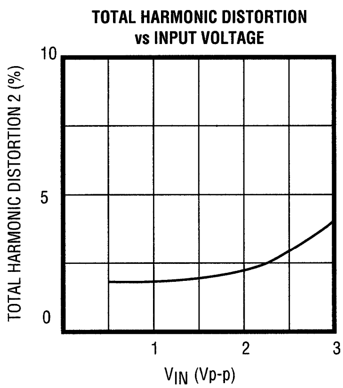


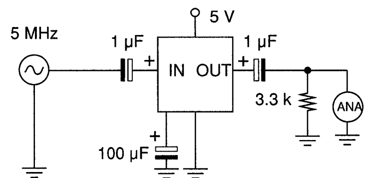


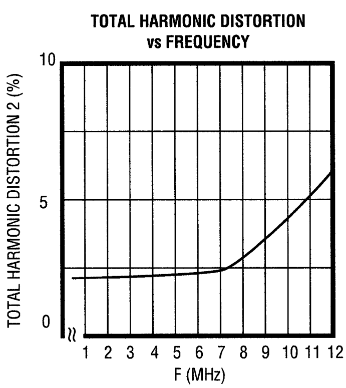


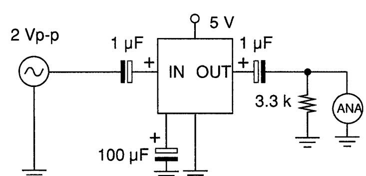


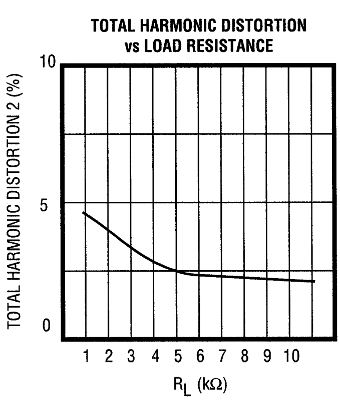
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

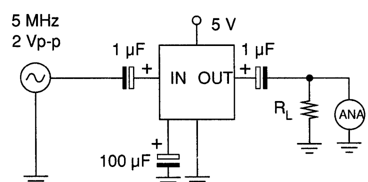




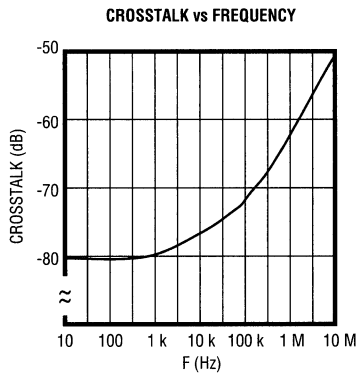


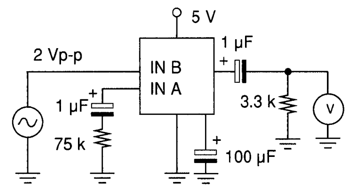




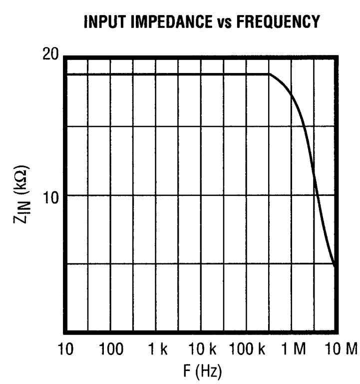


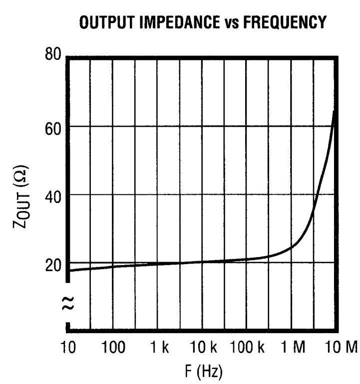
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)





Crosstalk is measured with the IC mounted on a standard printed circuit board. However, the input terminal wiring and the position of the input coupling capacitor have an effect on crosstalk, so special care must be taken to optimize the PCB layout.





Note: Special attention must be paid to input capacitances, as they may affect frequency response.

NOTES

DUAL QUAD-INPUT/SINGLE OUTPUT VIDEO ANALOG SWITCH

FEATURES

- High Input, Low Output Impedance
- Transconductance Amplifier
- Low Distortion
- Low Current Consumption
- Low Voltage Operation
- 53 dB Isolation Between Inputs
- 90 dB Isolation Between Channels

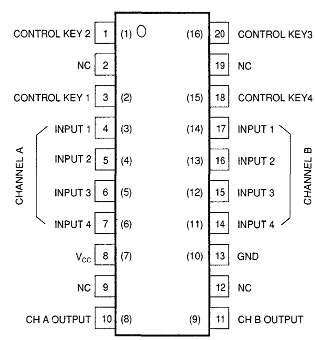
APPLICATIONS

- Audio Systems
- Tape Decks
- Special Effects Processing
- Musical Instruments
- Automotive Audio Systems
- Audio Mixers/Switchers

DESCRIPTION

The TK15080 is a dual, 4-pole analog switch bipolar linear integrated circuit. The device has 4 inputs and one output per channel and has 2 channels. The circuit is controlled by TTL Logic Level Inputs. The TK15080 is built around a transconductance amplifier with high imput impedance and low output impedance, and isolates the output from the input.

TK15080M **TK15080D**



NUMBERS IN ( ) ARE FOR THE 16 PIN DIP PACKAGE.

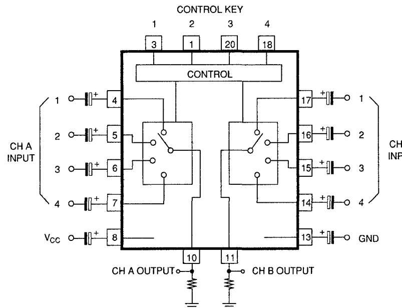
ORDERING INFORMATION

TK15080 □ □ □□

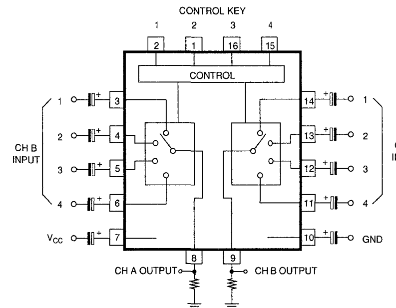
- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +75 °C	BX : Bulk/Bag
D: Plastic DIP		TX : Paper Tape
		TR : Tape Right
		TL : Tape Left
		MG: Magazine

BLOCK DIAGRAM TK15080M



BLOCK DIAGRAM TK15080D



ABSOLUTE MAXIMUM RATINGS

Control
Input Voltage .... -0.3 V to V_{CC} +0.3 V
Analog Switch
Input Voltage .... -0.3 V to V_{CC} +0.3 V
Output Current .... 3 mA
Operating Voltage Range .... 1.8 to 15 V
Input Voltage V_{CCMAX} .... 15 V
Power Dissipation (Note 1) D Package .... 540 mW
Power Dissipation (Note 2) M Package .... 410 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +75 °C
Lead Soldering Temp. (10 sec.) .... 240 °C

ELECTRICAL CHARACTERISTICS

For the TK15080D, T_A = 25 °C, V_{CC} = 12 V

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current			3.5	7.0	mA
Control Section						
V_{IL}	Input Low Level		-0.3		0.4	V
V_{IH}	Input High Level		1.8		V_{CC} +0.3	V
Analog Switch Section						
THD	Distortion	V_{IN} = 1 V(rms), f = 1 kHz, R_L = 10 kΩ		0.005	0.01	%
NL	Noise	R_L = 10 kΩ, input terminal 10 μF, connect to Ground			10	μV (rms)
Crss	Crosstalk	V_{SIN} = 1 V(rms), f = 10 kHz R_L = 10 kΩ (Note 3)				
DYN	Dynamic Range	THD = 0.1%, f = 1 kHz, R_L = 10 kΩ	3.0	3.5		V
ISO	Isolation	Note 4		-53	-40	dB
SEP	Separation	Note 5		-90	-80	dB
ΔV_{CENT}	DC Center Point	At no input		$V_{CC}/2$		V
V_{CENT}	In/Output Terminal Voltage	At no input		50		mV
V_G	Voltage Gain			0		dB

Note 1: Power dissipation must be derated at the rate of 4.32 mV/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 3.3 mW/°C for operation at T_A = 25 °C and above.
Note 3: V_{IL} = 0.4 V, V_{IH} = 1.8 V, Input terminal that does not input signal is to be connected to Ground with 10 μF and 47 kΩ directly.
Note 4: Crosstalk between channel 1, 2, 3, 4.
Note 5: Crosstalk between channel A, B.

1

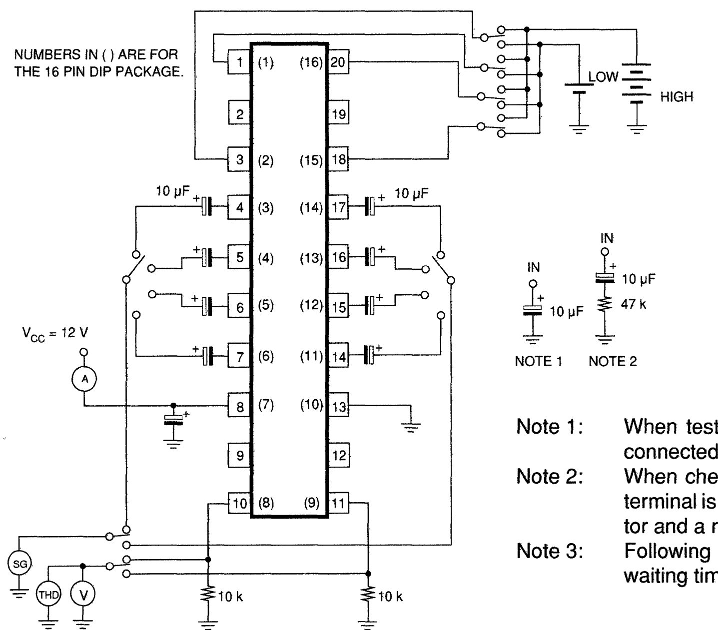
ELECTRICAL CHARACTERISTICS

For the TK15080M, T_A = 25 °C, V_{CC} = 12 V

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current			3.5	7.0	mA
Control Section						
V_{IL}	Low Input Level		-0.3		0.4	V
V_{IH}	High Input Level		1.8		V_{CC} +0.3	V
Z_{KEY}	Key Input Resistance			40		kΩ
Analog Switch Section						
THD	Distortion	V_{SIN} = 1 V(rms), f = 1 kHz, R_L = 10 kΩ		0.005	0.01	%
NL	Noise	R_L = 10 kΩ, input terminal 10 µF, connect to Ground			10	µV(rms)
Crss	Crosstalk	R_L = 10 kΩ (Note 1)				
ISO	Isolation	Note 2		-70	-65	dB
SEP	Separation	Note 3		-85	-80	dB
DYN	Dynamic Range	THD = 0.1%, f = 1 kHz, R_L = 10 kΩ	3.0	3.5		V(rms)
ΔV_{CENT}	DC Center Point	Note 5, No Input			50	mV
V_{CENT}	In/Output Terminal Voltage	Note 4, No Input	5.8		6.2	V
V_G	Voltage Gain			0		dB
Z_{IN}	Input Impedance	DC tested		75		kΩ
Z_{OUT}	Output Impedance	DC tested		20		kΩ
Z_{OUT}	Output Impedance	Floating Channel		∞		Ω

Note 1: Measured at f = 10 kHz, V_{SIN} = 1 V(rms) with test channel grounded, through a 5 kΩ resistor, in series with a 10 µF capacitor.
Note 2: Crosstalk between channel 1, 2, 3, 4.
Note 3: Crosstalk between channel A, B.
Note 4: Typical value for output at $V_{CC}/2$
Note 5: Output mute function recommended because of inconsistency of V_{CENT} when the devices are parallel connected.

TEST CIRCUIT



Note 1: When testing noise, input terminal is to be connected to ground through a capacitor.

Note 2: When checking crosstalk, the unused input terminal is to be connected to ground capacitor and a resistor as shown.

Note 3: Following power on, a minimum of 2 msec waiting time is necessary before testing.

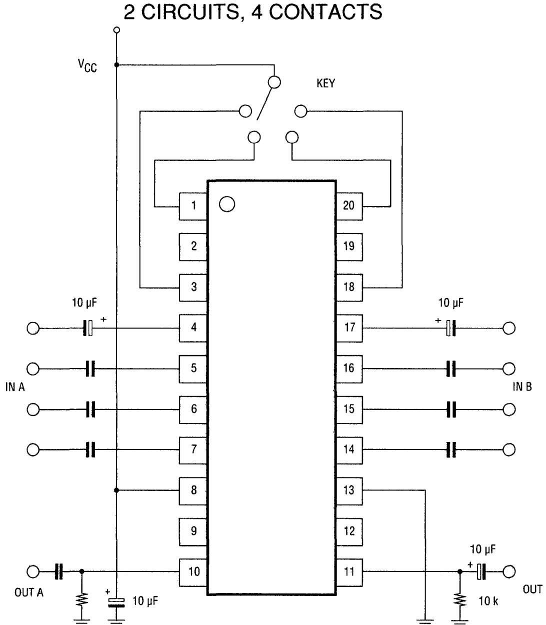
TRUTH TABLE

KEY				OUTPUT	
1	2	3	4	A CH	B CH
L	L	L	L	FLOATING	FLOATING
H	L	L	L	1 CH	1 CH
L	H	L	L	2 CH	2 CH
L	L	H	H	3 CH	3 CH
L	L	L	H	4 CH	4 CH

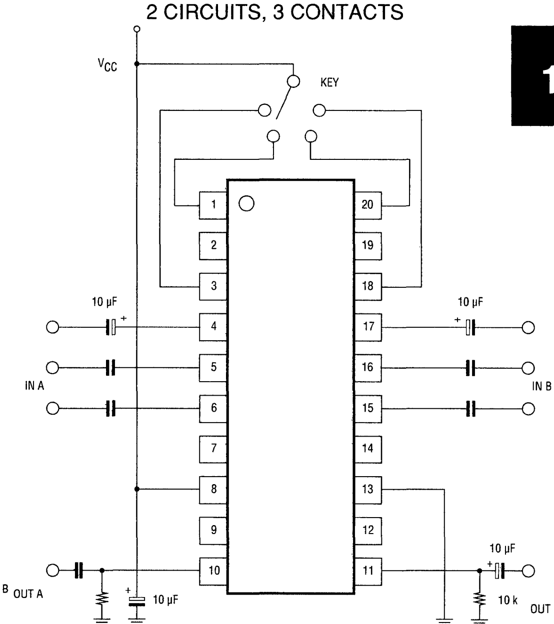
Notes: Low level kept at control key normal condition (Open).
Input selected at "H" level. Do not input more than 2 "H" levels.
All control keys at "L", in case of "open", output will be floating.

TYPICAL APPLICATIONS

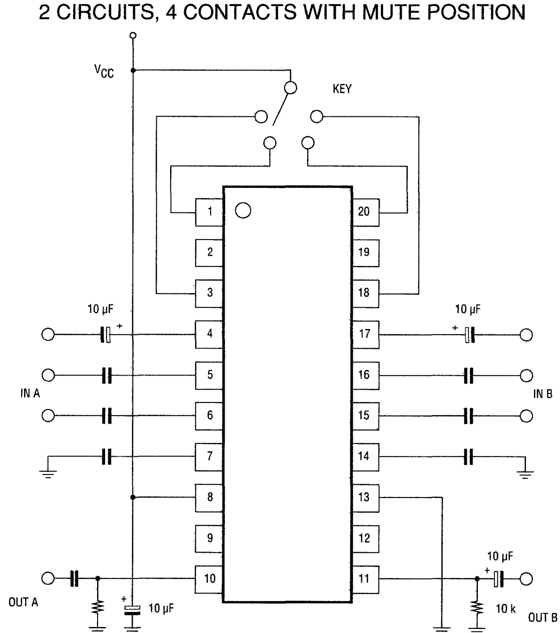
2 CIRCUITS, 4 CONTACTS



2 CIRCUITS, 3 CONTACTS

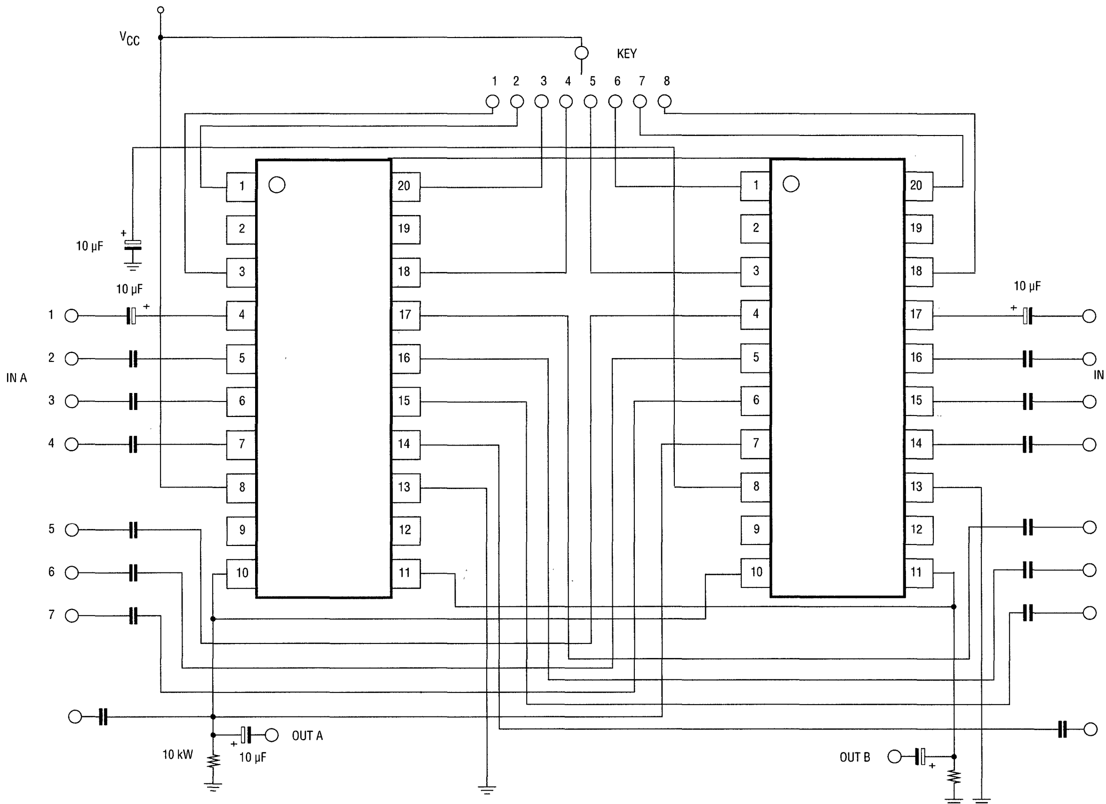


2 CIRCUITS, 4 CONTACTS WITH MUTE POSITION



TYPICAL APPLICATIONS

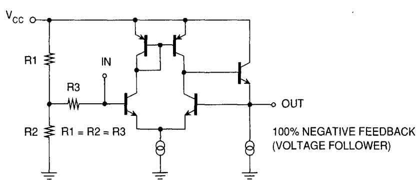
2 CIRCUITS, 8 CONTACTS



Recommended circuit to prevent switching noise due to output DC Bias difference when connecting devices in parallel.

ADDITIONAL INFORMATION

1. Basic Circuit

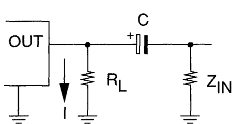


2. Switching Speed

Switching response of signal corresponding to the KEY input: typically 200 µsec.

3. AC Loading

Recommended load resistance (R_L) is 10 kΩ.When using capacitive coupling, set $R_L \leq Z_{IN}$. Where I≤ 3 mA.



4. Crosstalk (Isolation, Separation)

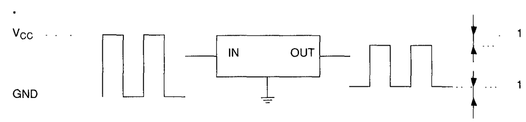
Since the input impedance is high (75 kΩ), short circuit of input terminals to V_{CC} or GND doesn't cause any damage. Also a short circuit of output terminals to V_{CC} doesn't cause any damage. However, long term short circuit of output terminals to GND may cause damage, as the current is determined by base current of the transistor (refer to the basic circuit).

5. In/Out Current

The signal input terminal will not be damaged even if connected to V_{CC} or GND because of the high input impedance (75 kΩ). Do not connect the output to V_{CC} or GND for extended periods as the IC may be damaged.

6. DC Signal Input

As basic circuit is a voltage-follower, the inputs can be modulated to within 1 V of either VCC or GND.



NOTES

TWO INPUT/SINGLE OUTPUT VIDEO ANALOG SWITCH

FEATURES

- Low Operating Voltage
- Low Input Current
- Wide Dynamic Range
- Video Frequency Range
- 55 dB Isolation

APPLICATIONS

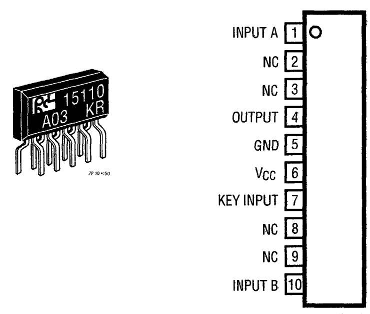
- Television
- VCR Input Selector
- Special Effects Generators
- Wide/Narrow RF Bandwidth Switch

DESCRIPTION

The TK15110Z is an analog switch for video use. Two inputs are provided and switched to one output. The device features high input impedance and low output impedance. The circuit is built around a wide bandwidth transconductance amplifier and maintains isolation between the output and input of the switch. The device is TTL logic level controllable.

The TK15110 is available in a ZIP10 plastic zig zag package.

TK15110Z



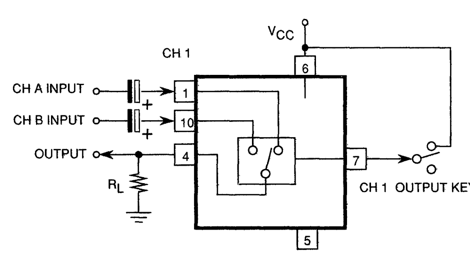
ORDERING INFORMATION

TK15110 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
Z : ZIP	C : -20 to +75 °C	BX : Bulk/Bag MG: Magazine

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

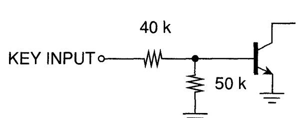
Supply Voltage V_{CC} .... 18 V
Power Dissipation (Note 1) .... 450 mW
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +75 °C
Lead Soldering Temp. (10 sec.) .... 300 °C
Junction Temperature .... 150 °C

ELECTRICAL CHARACTERISTICS

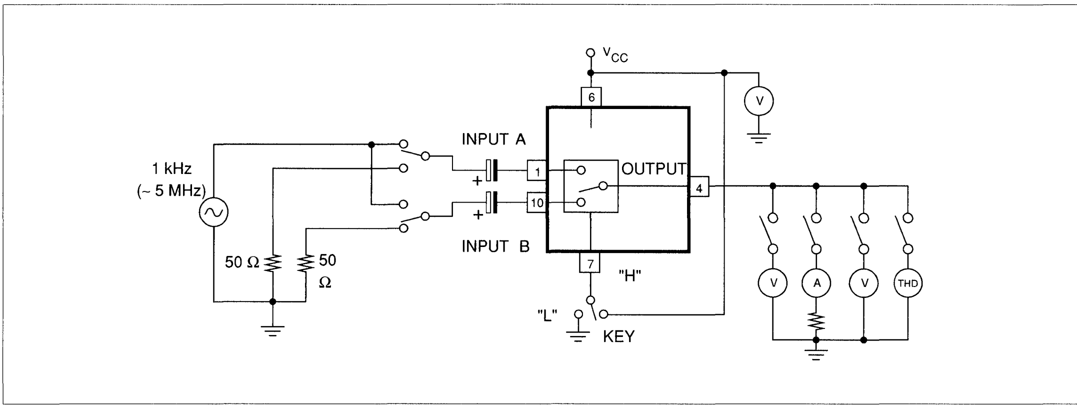
Test conditions: V_{CC} = 8.0 V, T_A = +25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{CC}	Operating Voltage Range		4.5	8	16.0	V
I_{CC}	Supply Current	$R_L = \infty$		15	18	mA
Key L	Low Input Level		0		0.9	V
Key H	High Input Level		1.8		V_{CC}	V
Key Z_{IN}	Key Input Impedance	Note 2		40		kΩ
F_{OP}	Frequency Bandwidth		10		10 x 10^6	Hz
THD	Total Harmonic Distortion	V_{IN} = 2 Vp-p, 1 kHz, R_L = 10 kΩ		.01	0.3	%
Dyn	Dynamic Range	F = 5 MHz, R_L=10 kΩ	2.0			Vp-p
V_G	Voltage Gain	F = 5 MHz, R_L=10 kΩ	-1.2	0	+1.2	dB
Crss	Crosstalk	V_{IN} = 2 Vp-p, 5 MHz, R_{IN} = 50 Ω		-50	-45	dB
IS_{OUT}	Output Current				2	mA
VDC_{OUT}	Output DC Voltage		3.5	4.0	4.6	V

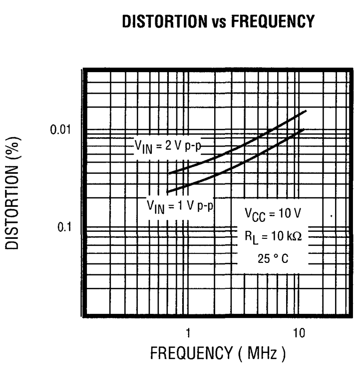
Note 1: Power dissipation must be derated at the rate of 4.5 mW/°C for operation at T_A = 25 °C and above.
Note 2:

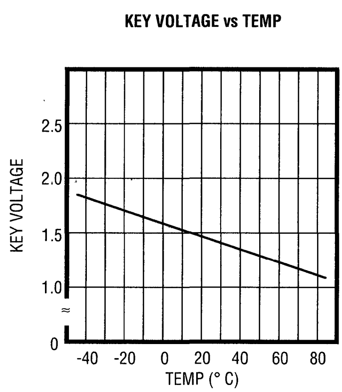


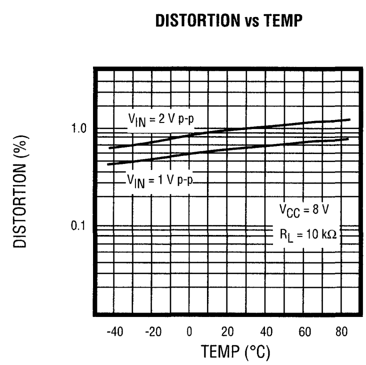
TEST CIRCUIT

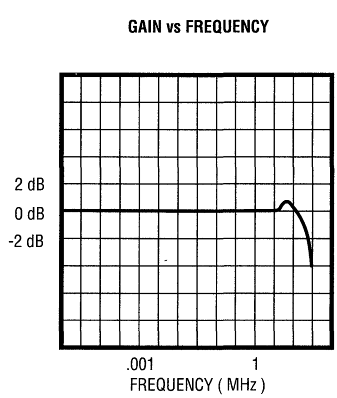


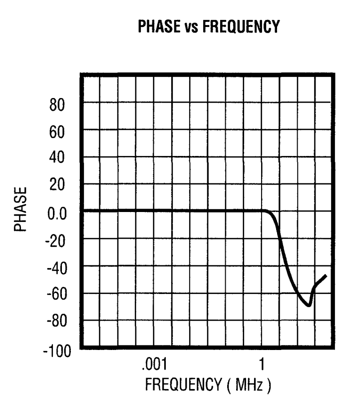
TYPICAL PERFORMANCE CHARACTERISTICS











NOTES

DUAL TWO-INPUT/SINGLE OUTPUT VIDEO ANALOG SWITCH

FEATURES

- **Wide Bandwidth Characteristic**
- **Wide Dynamic Range**
- **Wide Operating Voltage Range**
- **Minimum Peripheral Parts Required**
- **High Input Impedance Control**
- **MOS and TTL Compatible Control**

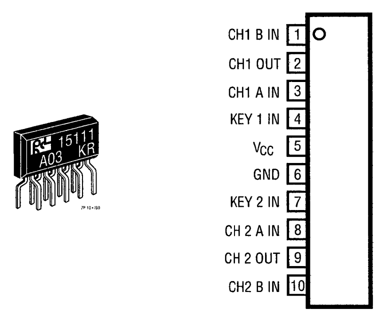
APPLICATIONS

- **VTR**
- **Television**
- **Special/Effects Generators**
- **Wide/Narrow IF Bandwidth Switch**

DESCRIPTION

The TK15111Z is an integrated circuit developed for electronic switching in video equipment. Features include low distortion, wide bandwidth and wide dynamic range. The TK15111 is available in a ZIP10 plastic zig zag package.

TK15111Z



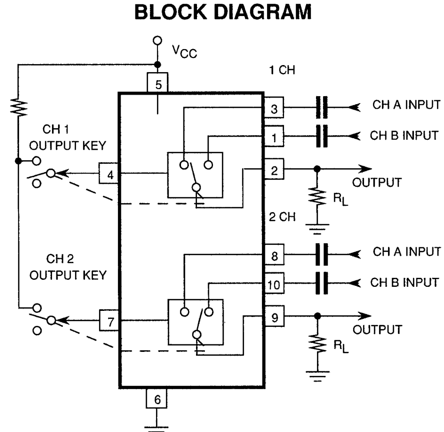
ORDERING INFORMATION

TK15111 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
Z : ZIP	C : -20 to +75 °C	BX : Bulk/Bag MG: Magazine

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

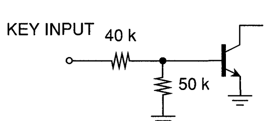
Supply Voltage V_{CC} .... 18 V
Power Dissipation (Note 1) .... 450 mW
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +75 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

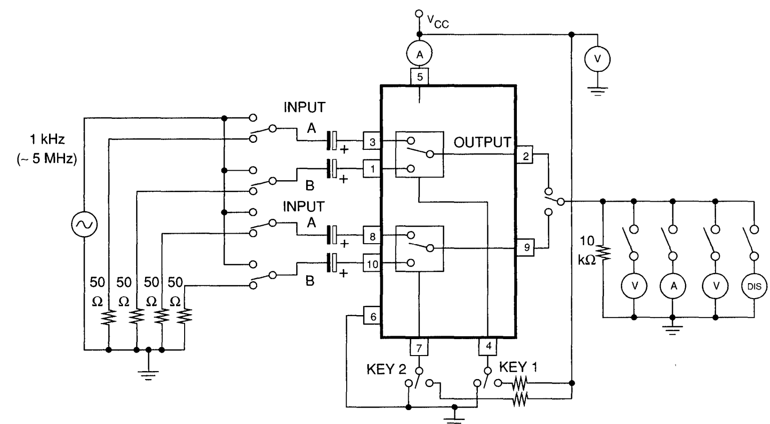
Test conditions: V_{CC} = 8.0 V, T_A = +25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{CC}	Operating Voltage Range		5.0		9.0	V
I_{CC}	Supply Current	$R_L = \infty$		30	35	mA
Key Control Section						
Key L	Input Low Level		0		0.9	V
Key H	Input High Level		1.8		V_{CC}	V
Key Z_{IN}	Key Input Impedance	(Note 2)		40		kΩ
Analog Switch Section						
F_{OP}	Frequency Bandwidth		10		10	MHz
THD	Total Harmonic Distortion	V_{IN} =2 Vp-p,1 kHz, R_L = 10 kΩ		.05	0.3	%
Dyn	Dynamic Range	f = 5 MHz, R_L=10 kΩ	2.0			Vp-p
V_G	Voltage Gain	f = 5 MHz, R_L=10 kΩ	-1.2	0	+1.2	dB
ISO	Switch Isolation	Crosstalk, between A input and B input. V_{IN} = 2 Vp-p, 5 MHz, R_{IN} = 50 Ω		-50	-45	dB
SEP	Channel Separation	Crosstalk, between 1 channel input and 2 channel. V_{IN} =2 Vp-p,5 MHz, R_{IN} = 50 Ω		-50	-45	dB
IS_{OUT}	Output Current				2	mA
VDC_{OUT}	Output DC Voltage Voltage		3.5	4.0	4.5	V

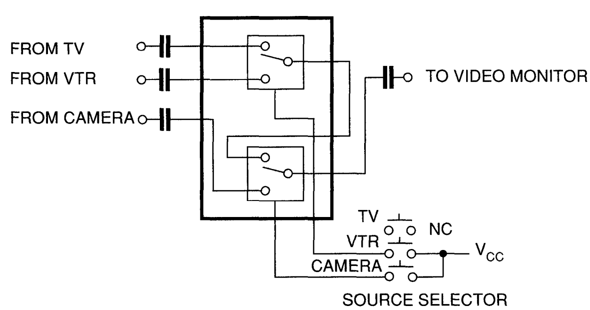
Note 1: Power dissipation must be derated at the rate of 4.5 mW/°C for operation at T_A = 25 °C and above.
Note 2:



TEST CIRCUIT

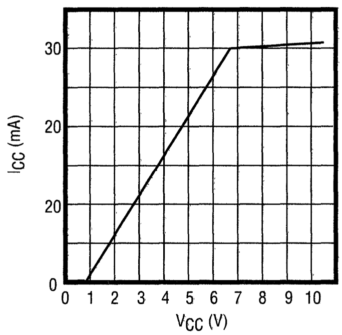


TYPICAL APPLICATION

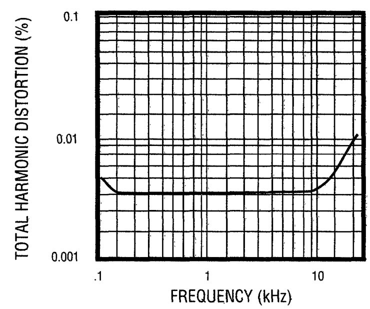


TYPICAL PERFORMANCE CHARACTERISTICS

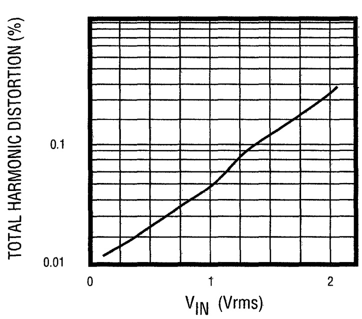
SUPPLY CURRENT vs SUPPLY VOLTAGE



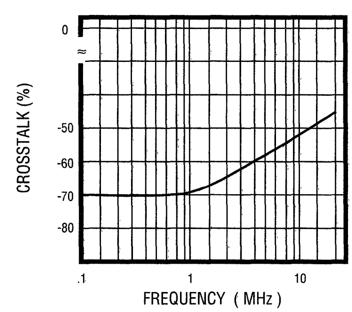
TOTAL HARMONIC DISTORTION vs FREQUENCY



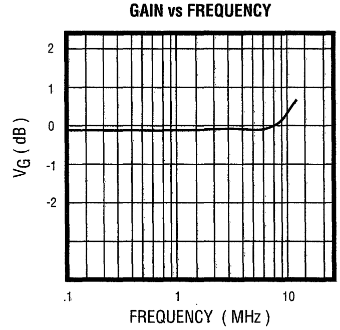
TOTAL HARMONIC DISTORTION vs INPUT VOLTAGE



CROSSTALK vs FREQUENCY



GAIN vs FREQUENCY



TWO-CHANNEL MUTING IC

1

FEATURES

- **Wide Operating Voltage**
- **Ground Muting Method**
- **Large Signal Attenuation**
- **Control of Large Signal Level**
- **Low Standby Current**
- **Attack/Release Control**

APPLICATIONS

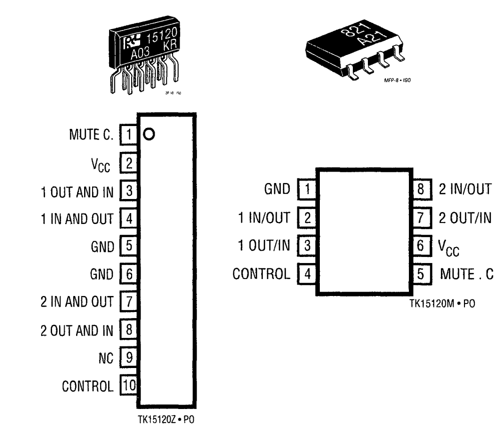
- **Audio Systems**
- **Audio Mixers**
- **Special Effects**
- **Musical Instruments**
- **Tape Recorders**

DESCRIPTION

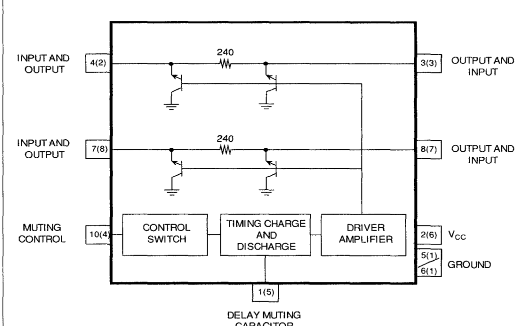
The TK15120 is a single supply, two-channel audio mute IC which will ground an AC signal without the pop or thump usually associated with IC switches. The input/output pins are bidirectional, and on/off time can be controlled by an external capacitor. The device has two separate audio channels with one control input.

The TK15120 is available in a ZIP10 plastic zig zag package and an MFP8 plastic surface mount package.

TK15120Z **TK15120M**



BLOCK DIAGRAM



NUMBERS IN ( ) ARE FOR MFP8 PACKAGE

ORDERING INFORMATION

TK15120 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
Z : ZIP	C : -20 to +60 °C	BX : Bulk/Bag
M: Surface Mount		TX : Paper Tape
		TR : Tape Right
		TL : Tape Left
		MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} ....11 V
Power Dissipation (Note 1) ....390 mW
Junction Temperature ....150 °C
Storage Temperature Range ....-55 to +150 °C
Operating Temperature Range ....-20 to +60 °C
Lead Soldering Temp. (10 sec.) ....300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 5 V, T_A = 25 °C, f = 1 kHz

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{CC}	Supply Voltage		4.5	5	10	V
Supply Current						
$I_{CC\ OFF}$	Muting OFF			0.5	0.7	mA
$I_{CC\ ON}$	Muting ON		7	11	15	mA
ATT	Attenuation	R_{IN} = 300 Ω	70	76		dB
CI_{ON}	Charge Current of Muting ON		7	10	13.5	µA
CI_{OFF}	Discharge Current of Muting OFF		1.7	2.7	4.0	µA
Muting Control SW						
SWV_{OFF}	Muting OFF		0	(1.2)	0.4	V
SWV_{ON}	Muting ON Voltage		2.4	(1.3)	V_{CC}	V
V_{OSAT}	Output Saturation Voltage	at muting ON		2.5	3.5	mV
THD	Total Harmonic Distortion	at muting OFF		0.0025	0.01	%
MR	Muting Attenuation Resistor		168	240	312	Ω
$V_{IN\ MAX}$	Maximum Input Voltage				5.0	Vp-p

Note 1: Power dissipation must be derated at the rate of 3.9 mW/°C for operation at T_A = 25 °C and above.

TEST CIRCUIT FOR M PACKAGE

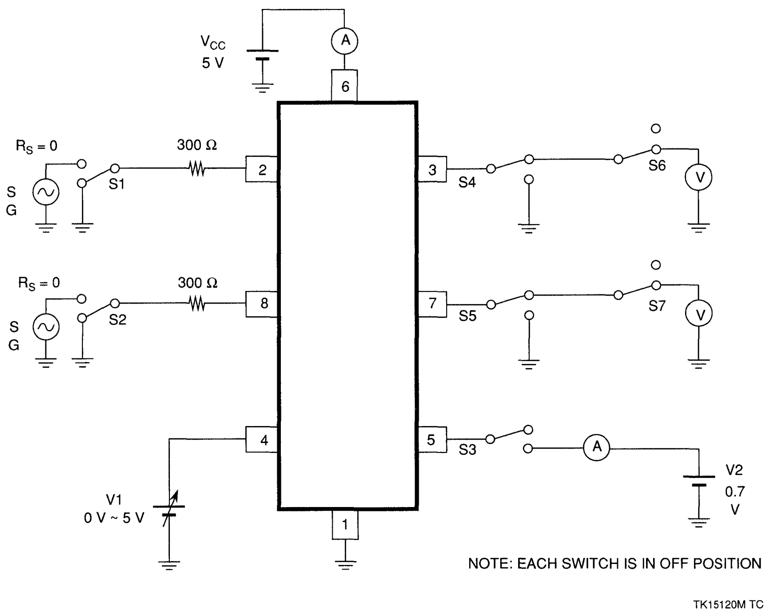


Figure 1.

APPLICATION INFORMATION FOR M PACKAGE

These conditions refer to Figure 1, switches S1 - S7, as shown.

1.) SUPPLY CURRENT

All switches off. Measure the Power Supply Current at V1 = 0 V and V1 = 5 V, respectively.

2.) MUTING ATTENUATION

Switches S1 and S2 are on. Measure the AC output voltage on pin 3 and 7 at V1 = 0 V and V1 = 5 V, respectively. (SG output f = 1 kHz, 5 Vp-p.)

Attenuation

$$ATT = 20LOG\left(\frac{(V1 = \text{VOLTAGE OF PIN 3 (PIN 7) WHEN 0 V })}{(V1 = \text{VOLTAGE OF PIN 3 (PIN 7) WHEN 5 V })}\right)$$

3.) CAPACITOR CURRENT

Switch S3 is on. When pin 4 voltage is lower than 0.4 V, the pin 5 capacitor discharge current is approximately 2.7 mA. When the pin 4 voltage is set higher than 2.4 V, the capacitor charge current becomes approximately 10 mA.

APPLICATION INFORMATION FOR M PACKAGE (CONT.)

4.) MUTE CONTROL THRESHOLD VOLTAGE

Switches S1 and S2 are on. When pin 4 voltage is increased from 0 V, the output of pin 3 (pin 7) is muted. The corresponding control voltage is the "mute on" voltage. When the mute control voltage decreases the muting will turn off. Measure pin 4 voltage when pin 3 (pin 7) output releases the mute. The measured voltage is the "mute off" voltage.

5.) MUTE SATURATED VOLTAGE

Measure pin 3 and pin 7 output voltage when the V1 of the pin 4 is turned to 5 V ("mute on" status).

6.) TOTAL HARMONIC DISTORTION

Switches S1 and S2 are on. Measure the Total Harmonic Distortion ratio of pin 3 and pin 7 output waveform when the V1 of pin 4 is turned to 0 V (mute off status).

7.) INTERNAL RESISTANCE IN "MUTE" MODE

Switches S1, S2, S4, S5, S6, and S7 are on. Set signal generator voltage to the normal input level or lower (5 Vp-p). Connect output pin 3 (pin 7) to the GND, and measure the voltage of pin 2 (pin 8).

$$\text{2-3(OR 7-8) IMPEDANCE} = \left(\frac{\text{(300 X PIN 2 (OR PIN 8) VOLTAGE)}}{\text{(SG OUTPUT VOLTAGE - PIN 2 (OR PIN 8) VOLTAGE}}\right)$$

8.) ATTENUATION

The typical value of attenuation in muted mode is 76 dB. The TK15120M has two channels and the attenuation is 76 dB when both circuits are operated simultaneously. If only one circuit is operated, the attenuation is 6 dB higher, and becomes approximately 82 dB.

To maximize attenuation, the signal input GND, the IC GND, and signal output GNDs are required to be connected to pin 1. It is best to connect the signal output GND to pin 1 as well.

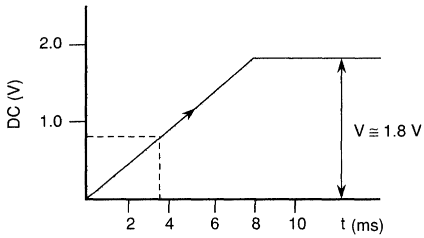
9.) OPERATION OF THE MUTING CIRCUIT

When pin 4 (Mute Control Switch) has an applied voltage greater than 2.4 V, pin 5 capacitor starts charging and pin 5 DC potential is raised. This current is the base current for the muting transistor and the muting operation is performed.

The capacitor DC voltage is clamped at 1.8 V.

APPLICATION INFORMATION FOR M PACKAGE (CONT.)

The relationship between the capacitor voltage and the time is as follows:



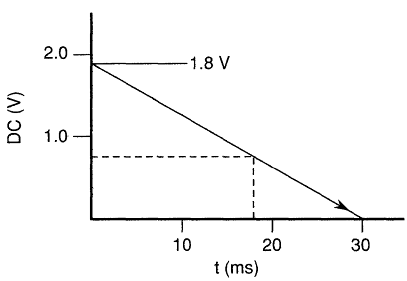
The time for the capacitor voltage to reach 1.8 V (mute on time) is:

$$t \cong \frac{\text{CAPACITOR (0.047 µF) X 1.8 V}}{\text{CHARGING CURRENT (2.7 µA)}}$$

Following "muting on," 90% of the maximum attenuation is reached at approximately 0.7 to 0.8 V capacitor voltage.

During "muting off" (release), the capacitor current discharges, and voltage across the capacitor drops to approximately 10 mV from 1.8 V. When pin 5 voltage is dropped, the muting transistor base current is decreased, and the status is changed to "muting off." (10 mV is the saturated voltage of the discharging current supply.)

$$\frac{\text{CAPACITOR (0.047 µF) X 1.8 V}}{\text{DISCHARGING CURRENT (10 µA)}} \cong 31.3 \text{ ms}$$



When the capacitor DC voltage is in the range between 1.8 V to approximately 0.75 V, only approximately 10% of the attenuation can be released. When the capacitor DC voltage is in the range between approximately 0.75 V to 0 V, the mute release is completed. It takes approximately 18 ms for the DC voltage to drop to approximately 0.75 ms from 1.8 V, and the condition approaches the "mute on" status.

TEST CIRCUIT FOR Z PACKAGE

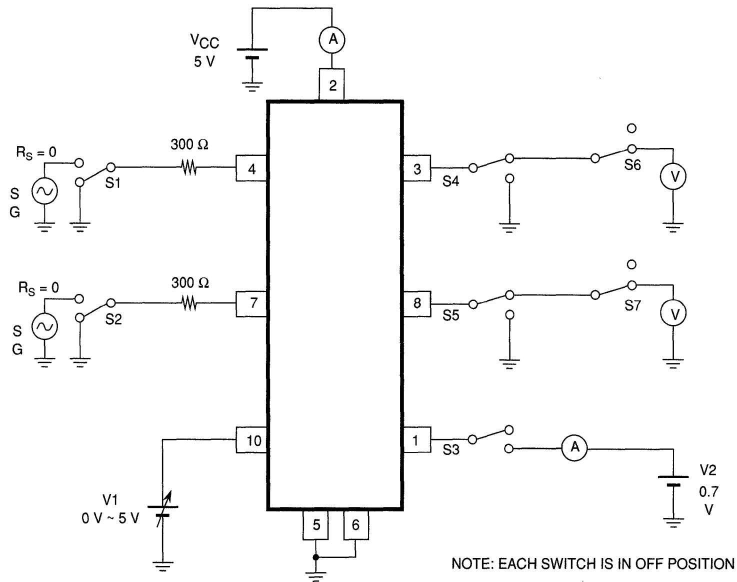


Figure 2.

APPLICATION INFORMATION FOR Z PACKAGE

1.) SUPPLY CURRENT

All switches off. Measure the Power Supply Current at V1 = 0 V and V1 = 5 V, respectively.

2.) MUTING ATTENUATION

Switches S1 and S2 are on. Measure the AC output voltage on pin 3 and 8 at V1 = 0 V and V1 = 5 V, respectively. (SG output f = 1 kHz, 5 Vp-p.)

Attenuation

$$ATT = 20LOG \left(\frac{(V1 = \text{VOLTAGE OF PIN 3 (PIN 8) WHEN 0 V})}{(V1 = \text{VOLTAGE OF PIN 3 (PIN 8) WHEN 5 V})} \right)$$

3.) CAPACITOR CURRENT

Switch S3 is on. When pin 10 voltage is lower than 0.4 V, pin 1 capacitor discharge current is approximately 2.7 mA. When the pin 10 voltage is set higher than 2.4 V, the capacitor charge current becomes approximately 10 mA.

APPLICATION INFORMATION FOR Z PACKAGE (CONT.)

4.) MUTE CONTROL THRESHOLD VOLTAGE

Switches S1 and S2 are on. When pin 10 voltage is increased from 0 V, the output of pin 3 (pin 8) is muted. The corresponding control voltage is the "mute on" voltage. When the mute control voltage decreases, the muting will turn off. Measure pin 4 voltage when pin 3 (pin 8) output releases the mute. The measured voltage is the mute off voltage.

5.) MUTE SATURATED VOLTAGE

Measures pin 3 and pin 8 output voltage when the V1 of the pin 10 is turned to 5 V ("mute on" status).

6.) TOTAL HARMONIC DISTORTION

Switches S1 and S2 are on. Measures the Total Harmonic Distortion ratio of pin 3 and pin 8 output waveform when the V1 of pin 10 is turned to 0 V ("mute off" status).

7.) INTERNAL RESISTANCE IN "MUTE" MODE

Switches S1, S2, S4, S5, S6, and S7 are on. Set the signal generator voltage to the normal input level (5 Vp-p) or lower. Connect output pin 3 (pin 8) to the GND and measure the voltage of pin 4 (pin 7).

$$\text{4-3(OR 7-8) IMPEDANCE} = \left(\frac{\text{(300 X PIN 4 (OR PIN 7) VOLTAGE)}}{\text{(SG OUTPUT VOLTAGE - PIN 4 (OR PIN 7) VOLTAGE}} \right)$$

8.) ATTENUATION

The typical value of attenuation in muted mode is 86 dB. The TK15120Z has two channels and the attenuation is 86 dB when both circuits are operated simultaneously. If only one circuit is operated, the attenuation is 4 dB higher, and becomes approximately 90 dB.

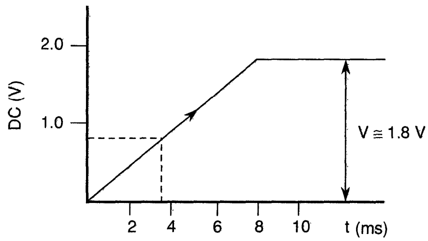
To maximize attenuation, the signal input GND, the IC GND and signal output GND are required to be connected near pin 5 and 6. It is best to connect the signal output GND to pin 5 and 6 as well.

9.) OPERATION OF THE MUTING CIRCUIT

When pin 10 (Mute Control Switch) has an applied voltage greater than 2.4 V, pin 1 capacitor starts charging and pin 1 DC potential is raised. This current is the base current for the muting transistor and the muting operation is performed.

The capacitor DC voltage is clamped at 1.8 V.

APPLICATION INFORMATION FOR Z PACKAGE (CONT.)



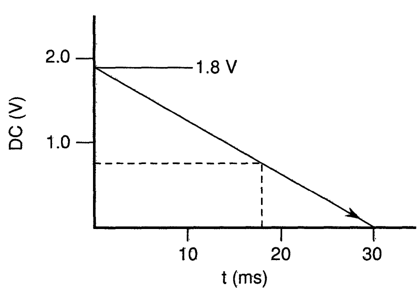
The time for the capacitor voltage to reach 1.8 V (mute on time) is:

$$t \cong \frac{\text{CAPACITOR (0.047 µF) X 1.8 V}}{\text{CHARGING CURRENT (2.7 µA)}}$$

Following "muting on," 90% of the maximum attenuation is reached at a capacitor voltage of approximately 0.7 to 0.8 V.

During "muting off" (release), the capacitor discharges current, and the voltage across the capacitor drops to approximately 10 mV from 1.8 V. When pin 1 voltage is dropped, the muting transistor base current is decreased, and the status is changed to "muting off." (10 mV is the saturated voltage of the discharging current supply.)

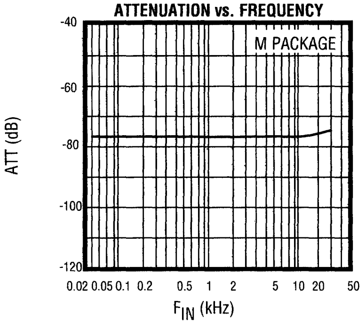
$$\frac{\text{CAPACITOR (0.047 µF) X 1.8 V}}{\text{DISCHARGING CURRENT (10 µA)}} \cong 31.3 \text{ ms}$$



When the capacitor DC voltage is in the range between 1.8 V to approximately 0.75 V, only approximately 10% of the attenuation can be released. When the capacitor DC voltage is in the range between approximately 0.75 V to 0 V, the mute release is completed. It takes approximately 18 ms for the DC voltage to drop to approximately 0.75 ms from 1.8 V and the condition approaches the "mute on" status.

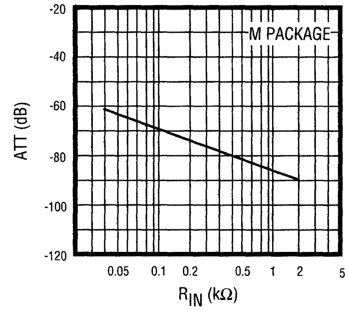
TYPICAL PERFORMANCE CHARACTERISTICS

ATTENUATION vs. FREQUENCY



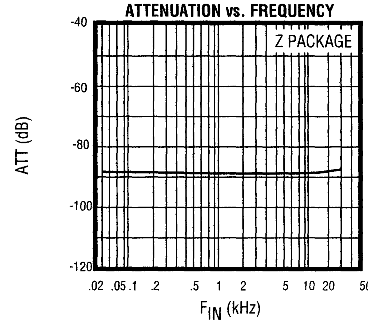
TK15120 TPC 01

ATTENUATION vs. EXTERNAL RESISTANCE



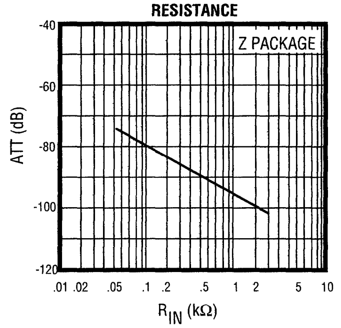
TK15120 TPC • 02

ATTENUATION vs. FREQUENCY



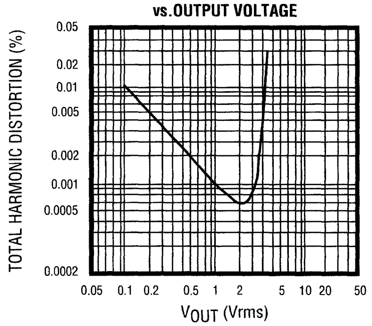
TK15120 TPC 16

ATTENUATION vs. EXTERNAL RESISTANCE



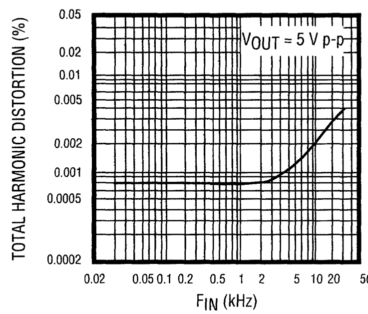
TK15120Z TPC 17

TOTAL HARMONIC DISTORTION vs.OUTPUT VOLTAGE



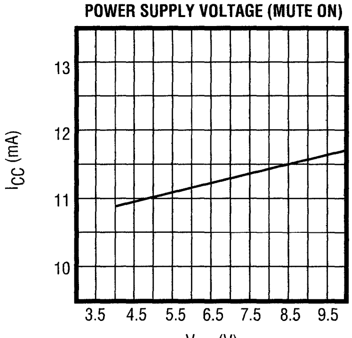
TK15120 TPC • 03

TOTAL HARMONIC DISTORTION vs. FREQUENCY



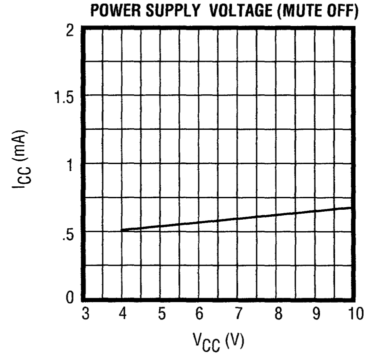
TK15120 TPC • 04

POWER SUPPLY CURRENTvs. POWER SUPPLY VOLTAGE (MUTE ON)



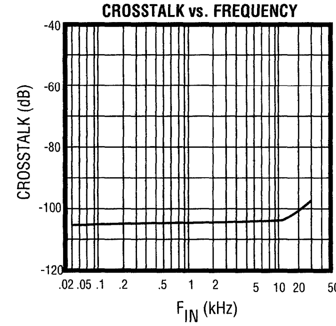
TK15120 TPC 10

POWER SUPPLY CURRENT vs. POWER SUPPLY VOLTAGE (MUTE OFF)



TK15120 TPC 11

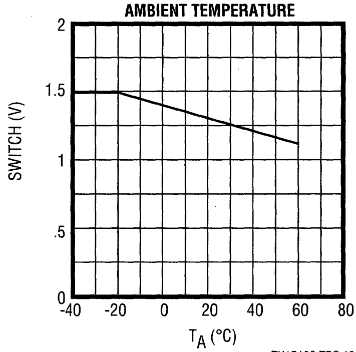
CROSSTALK vs. FREQUENCY



TK15120 TPC 12

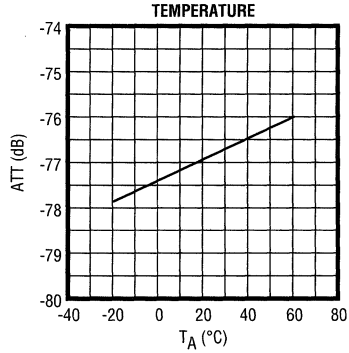
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

CONTROL LEVEL vs. AMBIENT TEMPERATURE



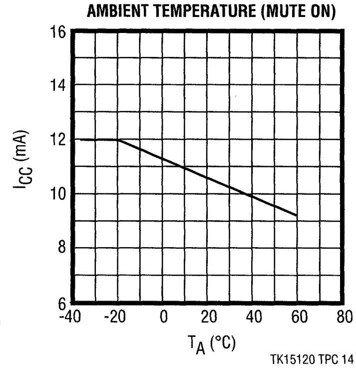
TK15120 TPC 13

ATTENUATION vs. AMBIENT TEMPERATURE



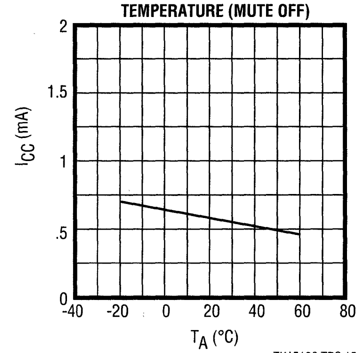
TK15120 TPC • 06

POWER SUPPLY CURRENT vs. AMBIENT TEMPERATURE (MUTE ON)



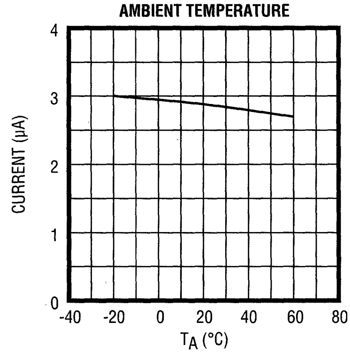
TK15120 TPC 14

POWER SUPPLY CURRENT vs. AMBIENT TEMPERATURE (MUTE OFF)

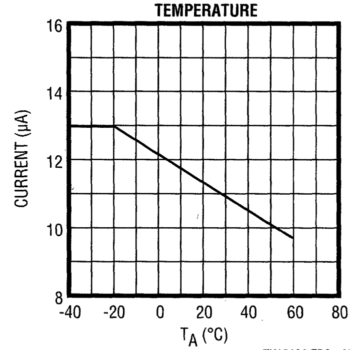


TK15120 TPC 18

DISCHARGE CURRENT vs. AMBIENT TEMPERATURE



CHARGE CURRENT vs. AMBIENT TEMPERATURE



TK15120 TPC • 07

FEATURES

- High Level Input (5 Vpp)
- Adjustable Attack/Release
- High Attenuation (-86 dB)
- Low Operating Current
- Bidirectional Inputs/Outputs

APPLICATIONS

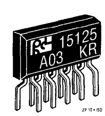
- Audio Equipment
- Musical Instruments
- TV/VCR
- Mixers/Effects

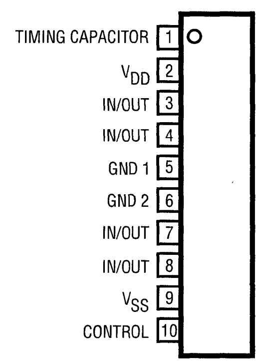
DESCRIPTION

The TK15125Z is a dual supply, two channel muting IC specially designed to eliminate popping and thumps when audio equipment is powered up. Features include adjustable attack and release, high signal handling capability and low operating current; ideal for battery operated equipment. The inputs and outputs are bidirectional and the device effectively grounds the input signal with an attenuation of -86 dB.

The TK15125 is available in a ZIP10 plastic zig zag package.

TK15125





TK15125Z • PO

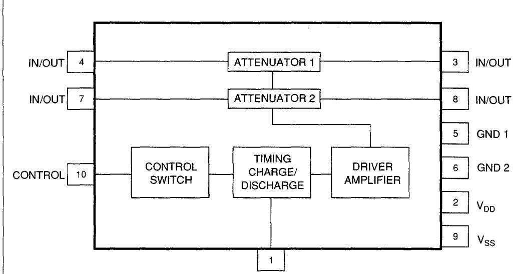
ORDERING INFORMATION

TK15125 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
Z: Zip	C : -20 to +60 °C	BX: Bulk/Bag MG: Magazine

BLOCK DIAGRAM



TK15125 BD

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} ....±6 V
Power Dissipation (Note1) ....490 mW
Junction Temperature ....150 °C
Storage Temperature Range....................-55 to +150 °C
Operating Temperature Range ....-20 to +60 °C
Lead Soldering Temp. (10 sec.) ....300 °C

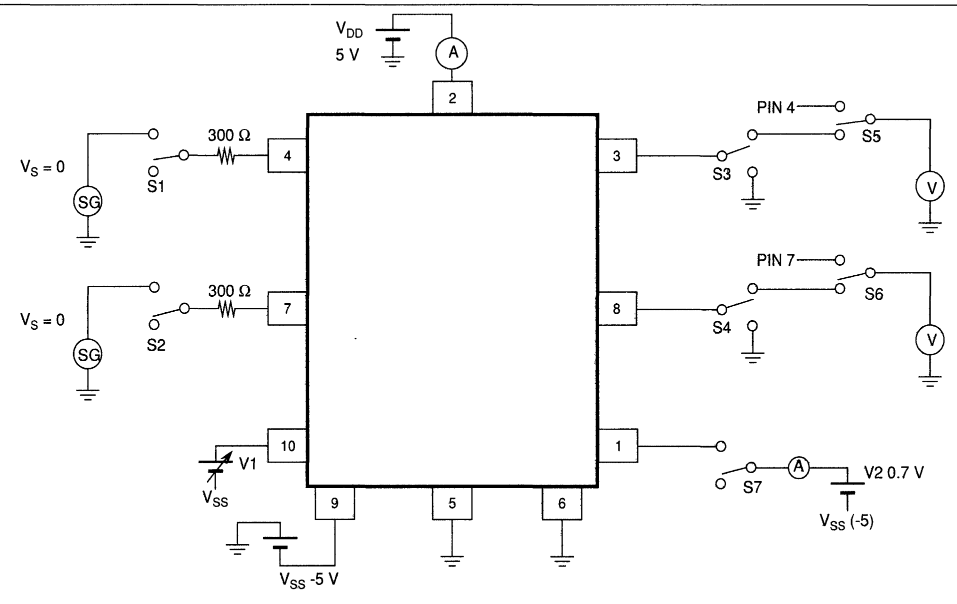
ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 5.0 V, V_{SS} = –5 V, V_{IN} = ±2.5 V_O-p, F = 1 kHz, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{DD}	Supply Voltage		+4.5	+5.0	+5.5	V
V_{SS}	Supply Voltage		-5.5	-5.0	-4.5	V
Current Consumption						
I_{DDOFF}	Mute Off			0.6	0.9	mA
I_{DDON}	Mute On			12.0	17.0	mA
A_{TT}	Mute Attenuation	R_{IN} = 300 Ω	80	86		dB
Capacitor Current						
I_{ON}	Charging Current	ATTACK	8.0	12.0	16.0	µA
I_{OFF}	Discharging Current	RELEASE	1.8	3.0	5.0	µA
Control Switch						
CV_{ON}	Mute ON Voltage		V_{SS} + 2.4	V_{SS} + 1.3	V_{DD}	V
CV_{OFF}	Mute OFF Voltage		V_{SS}	V_{SS} + 1.2	V_{SS} + 0.4	V
Output Saturated Voltage						
V_{OSAT}	When Mute is ON			2.4	3.7	mV
Total Harmonic Distortion						
THD	When Mute is OFF			0.0025	0.01	%
M.R	Mute Internal Resistance	Internal Resistance between I/O	168	240	312	Ω
V_{MAX}	Maximum Input Voltage		-2.5		+2.5	V_O-p

Note 1: Power dissipation must be derated at the rate of 3.92 mW/°C for operation at T_A = 25°C and above.

TEST CIRCUIT



TYPICAL APPLICATIONS

CURRENT CONSUMPTION

All switches are OFF. When –5 V (V_{SS}) is applied to pin 10, the device will be in the mute OFF. When +5 V (V_{DD}) is applied to pin 10, the device will be in the mute ON. Measure each power supply current under on these conditions.

MUTING ATTENUATION

Switches SW1 and SW2 are ON. Measure the output AC voltage of pin 3 (pin 8) when –5 V and +5 V are applied to V1. (SG output f = 1 kHz 5Vp-p.)

ATTENUATION

$$ATT = 20LOG \frac{(V1 = \text{PIN 3 (PIN 8) VOLTAGE WHEN -5 V IS APPLIED})}{(V1 = \text{PIN 3 (PIN 8) VOLTAGE WHEN 5 V IS APPLIED})}$$

TK15125 FORM 01

CAPACITOR CURRENT

Switch SW7 ON. When the V1 voltage of pin 10 is in the range of –5 V (V_{SS}) to –4.6 V, the current will be approximately 3 mA (discharge current). When V1 voltage is in the range of –2.6 V to +5 V (V_{DD}), the current will be approximately 12 mA (charge current). Measure the capacitor current value under these conditions.

MUTE CONTROL THRESHOLD VOLTAGE

Switches SW1 and SW2 are ON. Increase the V1 voltage of pin 10 from –5 V until each output appears; the corresponding voltage is the mute ON voltage. The mute OFF voltage occurs when the mute is OFF while V1 is decreasing from +5 V to 0 V. (The switching level is set approximately V_{SS} + 1.25 V.)

TYPICAL APPLICATIONS (CONT.)

MUTE SATURATED VOLTAGE

All switches are OFF. Measure pin 3 (pin 8) output DC voltage when the V1 of pin 10 is higher than –2.6 V (mute ON status).

TOTAL HARMONIC DISTORTION

Switches SW1 and SW2 are ON. Measure the total harmonic distortion of the output pin 3 (pin 8) when the V1 of pin 10 is lower than –4.6 V (mute OFF status).

INTERNAL RESISTANCE IN "MUTE" MODE

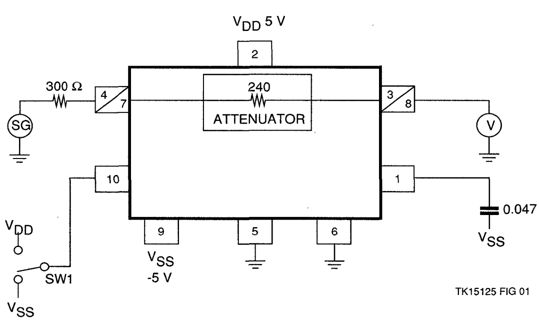
Switches S1, S2, S3, S4, S5, S6 are on. Set the signal generator voltage to the normal input level (5 Vp-p) or lower. Connect pin 3 (8) to GND. Measure voltage at pin 4 (7).

$$\text{INTERNAL RESISTANCE} = \frac{\text{(300 X 4 PIN (PIN 7) VOLTAGE)}}{\text{(SG OUTPUT VOLTAGE - PIN 4 (PIN 7) VOLTAGE)}}$$

TK15125 FORM 02

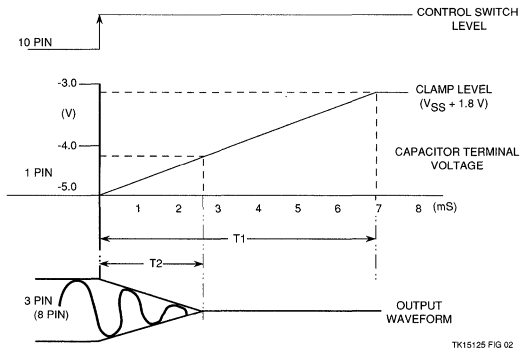
MUTING OPERATION

Muting ON (Attack)



TK15125 FIG 01

When the muting is "on" (pin 10 level high), pin 1 voltage gradually lowers from -2.6 V or higher to -3.2 V. When the voltage reaches approximately -3.2 V, the clamp circuit activates and the internal attenuator will mute the signal. The attenuated (muted) signal appears at the outputs.



TK15125 FIG 02

The attack time is calculated with the following formula:

$$T1 \approx 7.1\ \text{mS} \quad \frac{0.047\ \mu\text{F X } 1.8\ \text{V}}{12\mu\text{A (CHARGING CURRENT)}}$$

TK15125 FORM 03

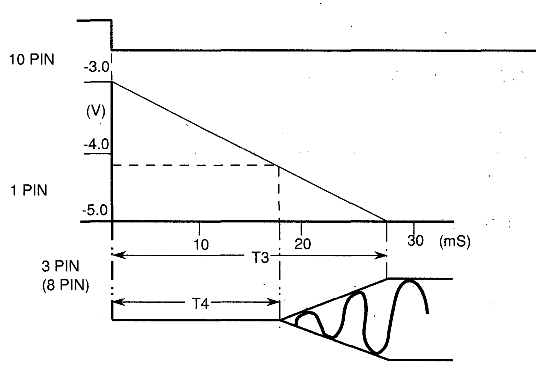
Actually, when the capacitor terminal voltage reaches about –4.25 V, almost 80% of the final attenuation is obtained, therefore T2 will be the real mute operation time.

$$\frac{0.047\ \mu\text{F X } 0.75\ \text{V}}{12\ \mu\text{A}} \approx 2.9\ \text{mS}$$

TK15125 FORM04

Muting OFF (Release)

The muting OFF (release) is performed as an opposite operation to the mute ON, when pin 10 control terminal has the mute OFF voltage applied. The output waveform will increase following the changing of pin 1 capacitor from –3.2 V to –5 V.



TK15125 FIG 03

TYPICAL APPLICATIONS (CONT.)

The release time is calculated with the following formula:

$$T3 \approx \frac{0.047\ \mu F \times 1.8\ V}{3.0\ \mu A\ \text{DISCHARGING CURRENT}} \qquad T3 \approx 28\ mS$$

TK15125 FORM 05

Approximately 28 mS later, the mute release is completed. However, the mute ON mode is continued during T4, the actual waveform starts the release operation after the T4 is completed.

Approximately 16 mS later, the waveform mute release operates.

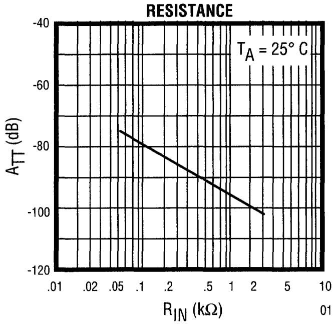
$$T4 \approx \frac{0.047\ \mu F \times 1.05\ V}{3.0\ mS} \qquad T4 \approx 16\ mS$$

TK15125 FOM5

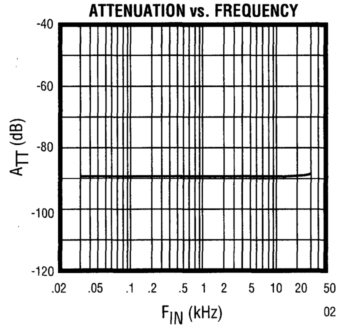
Note: To get the maximum attenuation, connect each input and output ground line to the nearest IC ground.

TYPICAL PERFORMANCE CHARACTERISTICS

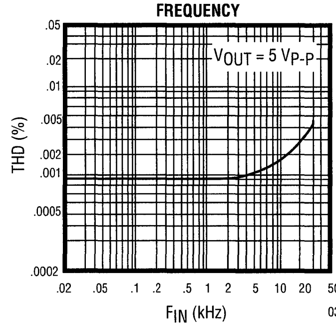
ATTENUATION vs. EXTERNAL RESISTANCE



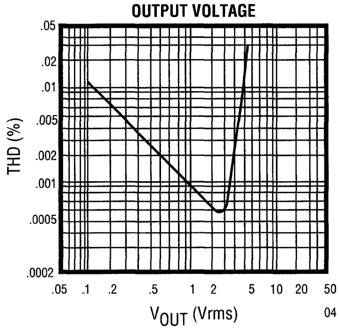
ATTENUATION vs. FREQUENCY



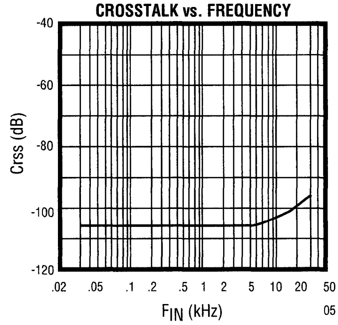
TOTAL HARMONIC DISTORTION vs. FREQUENCY



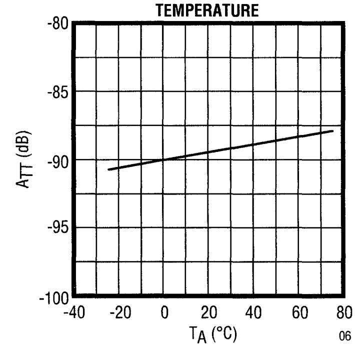
TOTAL HARMONIC DISTORTION vs. OUTPUT VOLTAGE



CROSSTALK vs. FREQUENCY

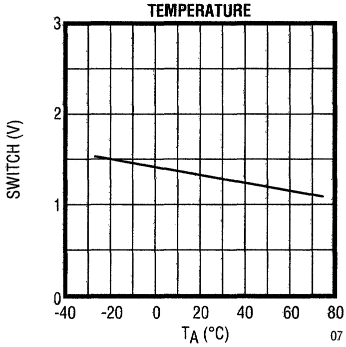


ATTENUATION vs. AMBIENT TEMPERATURE

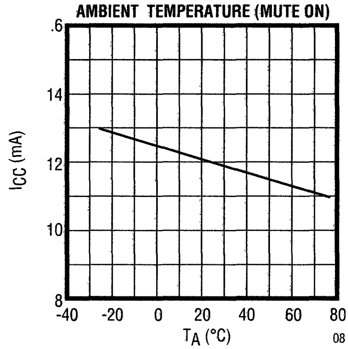


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

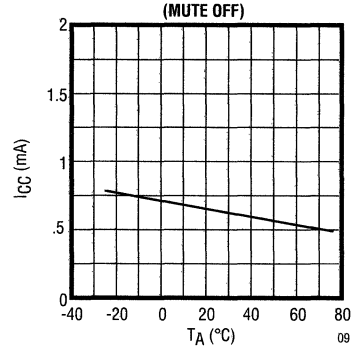
CONTROL LEVEL vs. AMBIENT TEMPERATURE



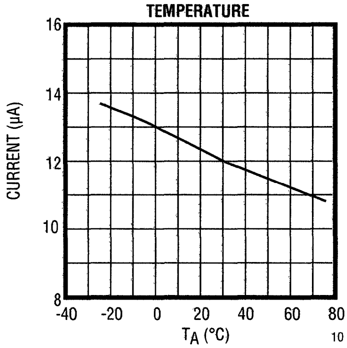
POWER SUPPLY CURRENT vs. AMBIENT TEMPERATURE (MUTE ON)



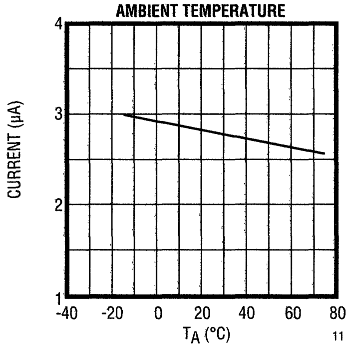
POWER SUPPLY CURRENT vs. AMBIENT TEMPERATURE (MUTE OFF)



CHARGING CURRENT vs. AMBIENT TEMPERATURE



DISCHARGING CURRENT vs. AMBIENT TEMPERATURE



TWO INPUT/SINGLE OUTPUT AUDIO ANALOG SWITCH

FEATURES

- **Low Supply Current**
- **TTL or CMOS Control**
- **Wide Operating Voltage Range**
- **Low Distortion (.004% TYP)**
- **High Input Impedance/Low Output Impedance**
- **Very Small Surface Mount Package**

APPLICATIONS

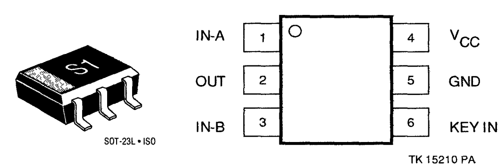
- **Audio Equipment**
- **Effects Pedals**
- **Mixers/Switchers**
- **Tape Recorders**

DESCRIPTION

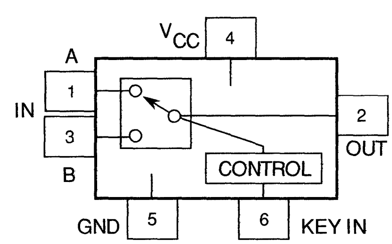
The TK15210 is an analog switch specially designed for the high fidelity applications in portable consumer equipment. The device features very low distortion and high isolation between the two inputs. Any one of the two inputs can be switched to one output. The control pin can be driven by TTL or CMOS logic levels. The analog switch is unidirectional.

The TK15210 is available in an SOT23L surface mount package.

TK15210M



BLOCK DIAGRAM



ORDERING INFORMATION

TK15210 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +75 °C	BX: Bulk/Bag TX: Paper Tape TR: Tape Right TL: Tape Left MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Supply Voltage .... 14 V
Operating Voltage Range .... 3.0 to 14 V
Input Voltage .... –0.3 V to V_{CC} +0.3 V
Power Dissipation (Note 1) .... 200 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +75 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

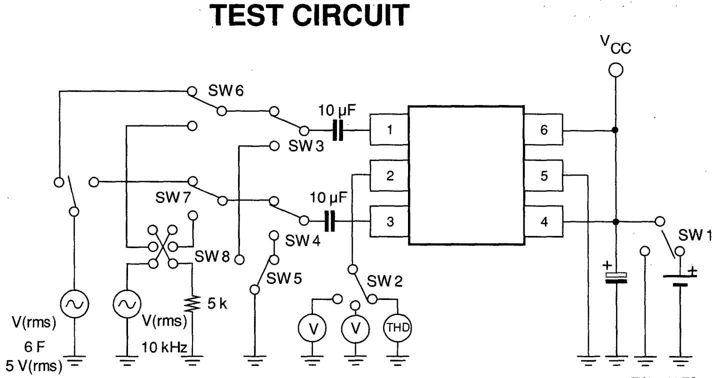
ELECTRICAL CHARACTERISTICS

Test Conditions: V_{CC} = 8.0 V, T_A = 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current			2.5	5.0	mA
V_{IL}	Input Low Control Voltage		-0.3		0.6	V
V_{IH}	Input High Control Voltage		2.0		V_{CC} + 0.3	V
THD	Total Harmonic Distortion	1 V(rms), f = 1 kHz		0.004	0.008	%
N_L	Residual Noise				10	μV(rms)
I_{SO}	Isolation	1 V(rms), f = 10 kHz		-80	-75	dB
DYN	Dynamic Range	0.1 %, f = ~ 20 kHz	3.0			V(rms)
V_{SENT}	In/Out Terminal Voltage			V_{CC}/2		V
ΔV_{SENT}	DC Center Point Potential Difference				18	mV
V_G	Voltage Gain		-0.2	0	+0.2	dB
Z_{IN}	Input Impedance	DC test		36		kΩ
Z_{OUT}	Output Impedance	DC test		20		Ω

Note 1: Power dissipation must be derated at the rate of 1.6 mW/°C for operation at T_A = 25 °C and above.

TEST CIRCUIT



1. Dynamic range and distortion of Channel A tested as shown.
2. SW5 is for the measurement of residual noise and output terminal voltage.
3. SW8 is for the measurement of isolation.

TABLE OF CONTENTS

INDUSTRIAL

TOKO

TOKO

INTERPOLATION COPROCESSOR

FEATURES

- High Speed of Interpolation Pulse Output
- Linear, Circular, Parabolic, Logarithmic and Exponential Interpolations Are Possible
- Reduces Software Design Necessary For Interpolation
- Can Be Interfaced Directly With An 8 Bit Microprocessor
- Interrupts the Microprocessor At the End of the Move
- Incorporates An Automatic Stop Function At the End Point and A Fixed Speed Control Function
- 24 Bit Data Length
- Up to 5 MHz Clock Frequency
- 28 Pin Plastic Dual In-Line Package
- Single +5 V Power Supply

APPLICATIONS

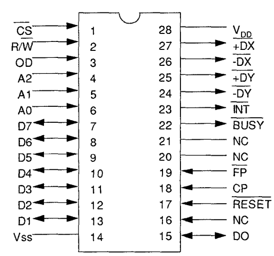
- Motion/Numerical Control Systems
- Robotics
- Drawing Machines
- Electrical Discharge Machines
- Special Machinery

**See KM3701AD Operation Manual for further detail.*

DESCRIPTION

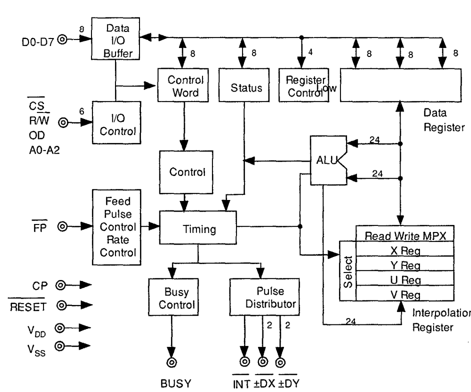
The KM3701AD is a CMOS LSI developed as an interpolation pulse generator for motion/numerical control systems. The KM3701AD incorporates linear and circular as well as parabolic, logarithmic and exponential interpolations. The functions and coordinate values for linear, circular or other interpolations are set by the microprocessor. Internal calculations are performed with the input of Feed Pulses. Interpolation pulses are then distributed to both the X and Y axes. The frequency of the output pulses from the KM3701AD does not depend on the slope of a particular move (when √2 control is enabled). Each KM3701AD generates pulses to interpolate 2 axes. When used with the KM3702AD/AQ (LSI for servo motor control), motion/numerical control systems can be built easily, thus reducing costs and enabling smaller units to be made.

KM3701AD



Signal	Explanation
CS	Chip Select
R/W	Read/Write
OD	Output Disable
A0~A2	Address
D0~D7	Data Bus
RESET	Reset
CP	Clock Pulse
FP	Feed Pulse
BUSY	Busy
INT	Interrupt
±DX	Output (X)
±DY	Output (Y)
V_{DD}	+5V
V_{SS}	Ground

BLOCK DIAGRAM



ORDERING INFORMATION

TK3701 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
D: Plastic Dip	A : -20 to +70 °C	BX: Bulk/Bag MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Supply Voltage .... V_{SS} -0.3 to V_{SS} + 7.0 V
Input Voltage .... V_{SS} -0.3 to V_{DD} + 0.3 V
Power Dissipation .... 1.25 W
Storage Temperature Range .... -65 to +150 °C
Operating Temperature Range .... -20 to +75 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS
D. C. CHARACTERISTICS

Test conditions: V_{SS} = 0 V, T_A = -20 to +70 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{DD}	Supply Voltage		4.75	5.0	5.25	V
I_{DD}	Supply Current	T_{CYC} = 0.5 µS, No Load			10	mA
Input Signal (Note 1)						
V_{IL}	Low Level Input Voltage	I_{IL} = -10 µA	-0.3		0.6	V
V_{IH}	High Level Input Voltage	I_{IH} = 10 µA	3.0		V_{DD}+0.3	V
Output Signal (Note 2)						
V_{OL}	Low Level Input Voltage	I_{OL} = 2.0 mA			0.4	V
V_{OH}	High Level Input Voltage	I_{OH} = -200 A	2.4			V
I/O Signal (Note 3)						
V_{IL}	Low Level Input Voltage	I_{IL} = -10 µA	-0.3		0.6	V
V_{IH}	High Level Input Voltage	I_{IH} = 10 µA	3.0		V_{DD}+0.3	V
I_{OL}	Low Level Output Current	V_{OL} = 0.4 V	5.5			mA
I_{OH}	High Level Output Current	V_{OH} = V_{DD} - 0.5 V High Impedance			10	µA

Note 1: $\overline{CS}$, R/$\overline{W}$, OD, A_2, A_1, A_0, $\overline{RESET}$, CP, $\overline{FP}$, D_7, D_6, D_5, D_4, D_3, D_2, D_1, D_0
Note 2: $\overline{BUSY}$, $\overline{INT}$, $\overline{+DX}$, $\overline{-DX}$, $\overline{+DY}$, $\overline{-DY}$
Note 3: Open drain output, D_7, D_6, D_5, D_4, D_3, D_2, D_1, D_0

ELECTRICAL CHARACTERISTICS
A. C. CHARACTERISTICS

Test conditions: V_{DD} = 5 V ± 5 %, T_A = -20 to +70 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Clock Signal (Note 1)						
T_{CYC}	Clock Pulse Period	Typically 1 MHz	0.2	1	10	µS
T_W	Clock Pulse Width		60		T_{CYC} -60	ns
T_{CR}	Clock Pulse Rise Time				10	ns
T_{CF}	Clock Pulse Fall Time				10	ns
Input Signal (Note 1)						
T_H	Data Hold Time		10			ns
T_{SU}	Data Hold Time		T_W +20			ns
Output Signal (Note 2)						
T_D	Output Delay Time	C_L = 60 pF			100	ns
Output Signal (Note 3)						
T_A	Access Time	C_L = 100 pF, R_{PU} = 1.5 kΩ			120	ns
T_{CO}	CS to Output	C_L = 100 pF			100	ns
T_{CO}	OD to Output	R_{PU} = 1.5 kΩ			100	ns
T_{OW}	Width of OD	C_L = 100 pF	120			ns
T_{RDH}	Data hold time after OD	R_{PU} = 1.5 kΩ	10			ns
T_{CA}	Address valid after Control		0			ns
T_{AC}	Address valid before Control		20			ns
T_{CH}	CS hold after Control		0			ns
T_{CSC}	CS valid before Control		0			ns
T_{CW}	CS to Write		120			ns
T_{CC}	Width of R/$\overline{W}$		120			ns
T_{WDS}	Data set-up time to Write		120			ns
T_{WDN}	Data hold time after R/$\overline{W}$		120			ns

Note 1: $\overline{CS}$, R/$\overline{W}$, OD, A_2, A_1, A_0, $\overline{RESET}$, CP, $\overline{FP}$, D_7, D_6, D_5, D_4, D_3, D_2, D_1, D_0

Note 2: $\overline{BUSY}$, $\overline{INT}$, $\overline{+DX}$, $\overline{-DX}$, $\overline{+DY}$, $\overline{-DY}$

Note 3: Open drain output, D_7, D_6, D_5, D_4, D_3, D_2, D_1, D_0

Maximum feed pulse and tooling speed for typical step sizes and clock rates.

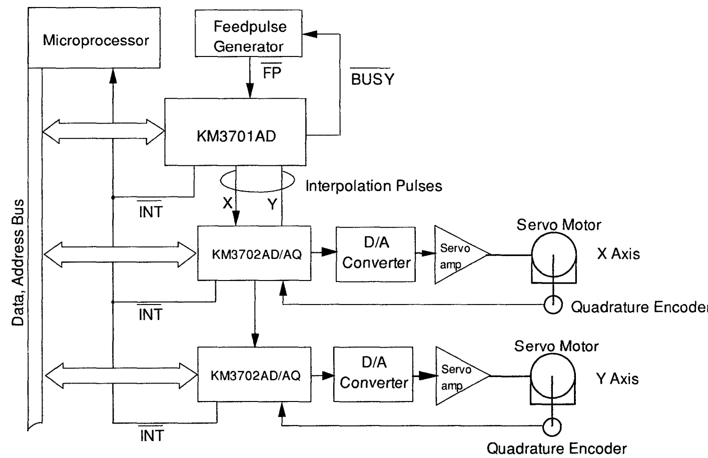
Step size and type of Interpolation	1.5 MHz Clock		5.0 MHz Clock	
	Maximum Pulse Rate	Maximum Tool Speed	Maximum Pulse Rate	Maximum Tool Speed
Unit: .001 mm **Linear** **All other**	136.3 K/sec 71.4 K/sec	8.38 m/min 4.39 m/min	454.5 K/sec 238.1 K/sec	27.3 m/min 14.3 m/min
Unit: .0001" **Linear** **All other**	136.3 K/sec 71.4 K/sec	838"/min 439"/min	454.5 K/sec 238.1 K/sec	2727"/min 1428"/min

PIN FUNCTION

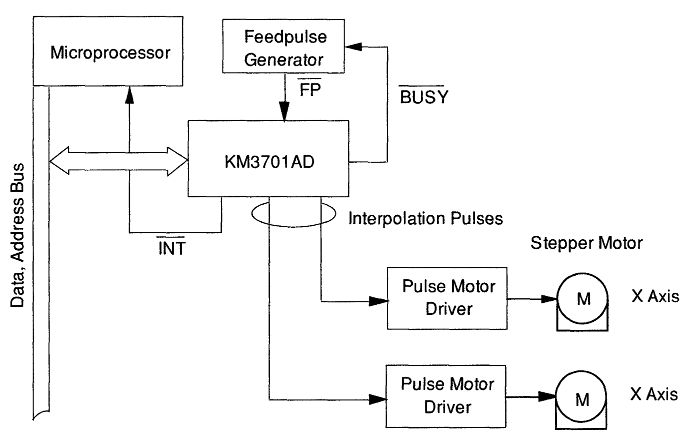
SIGNAL	SYMBOL	PIN NO.	I/O	DESCRIPTION
Power Supply	V_{DD}	28	—	+5 V±5%
Ground	V_{SS}	14	—	Ground
Chip Select	$\overline{CS}$	1	I	Device select signal
Write	$R/\overline{W}$	2	I	Write signal
Output Disable	OD	3	I	Read signal
Address	A2~A0	4~6	I	Address
Data	D7~D0	7~13 15	I/O	Read/Write data I/O common open drain
Clock Pulse	CP	18	I	Clock
Reset	$\overline{RESET}$	17	I	Reset signal
Feed Pulse	$\overline{FP}$	19	I	Interpolation feed pulse
Interpolation Busy	$\overline{BUSY}$	22	O	When active, it shows calculation is being done.
Interrupt	$\overline{INT}$	23	O	Completion of interpolation
+DX output	$\overline{+DX}$	27	O	X axis positive direction interpolation pulse
-DX output	$\overline{-DX}$	26	O	X axis negative direction interpolation pulse
+DY output	$\overline{+DY}$	25	O	Y axis positive direction interpolation pulse
-DY output	$\overline{-DY}$	24	O	Y axis negative direction interpolation pulse

TYPICAL APPLICATIONS

1. Control of 2 axes can be accomplished by using one KM3701AD and two KM3702AD/AQs.



1. One KM3701AD can control two stepper motors.



INTERPOLATION

The interpolation pulse distribution rate is in accordance with the rate of the clock pulse (CP) and the internal calculation time. The internal calculation requires 11 clocks in the case of linear interpolation and 21 clocks in the case of circular or other interpolations.

Interpolation	Interpolation Pulse Distribution Rate
Linear interpolation	454.4 KPPs
Circular or other	238.1 KPPs

NOTES

INTERPOLATION COPROCESSOR

FEATURES

- Interfaces Directly with an 8 Bit Microprocessor
- Wide Application Range
- Reduced Number of Counter ICs
- Reduced Parts Count
- 40 Pin Plastic Dual Inline Package
- 60 Pin Quad Flat Package
- + 5 V Single Power Supply
- 32 Bit Command Counter
- 24 Bit Error Counter
- Adjustable Output Rate to the D/A
- 10 MHz Clock

DESCRIPTION

The KM3702AD/AQ is a position control CMOS LSI which monitors the difference between the COMMAND (±COM) and FEEDBACK (±FB) pulses, under the conditions set by the CPU, and uses this position error to output a bit pattern to the D/A converter. The KM3702AD/AQ uses a single +5V power supply and has TTL-compatible input and output. Its system clock (CP) frequency is 10 MHz maximum. To keep track of the input pulses, there are two binary up/down counters: COMMAND COUNTER - 32 bits, cumulative value of +COM and -COM input pulses, and ERROR COUNTER - 24 bits, difference between +COM and -COM input and +FB and -FB input pulses. ±COM and ±FB pulses can be input either synchronously or asynchronously. Data can be preset into these counters, and the counter values can be read out by the host CPU. Commands from the CPU can be used to create a zero clamp condition or a floating state condition on the outputs to the D/A converter. Zero clamp means that for the purposes of the D/A converter, the output pattern will be zero even though the ERROR COUNTER continues to function normally.

ORDERING INFORMATION

KM3702A □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
D: Plastic Dip	C : -20 to +75 °C	BX: Bulk/Bag
Q: QFP		MG: Magazine

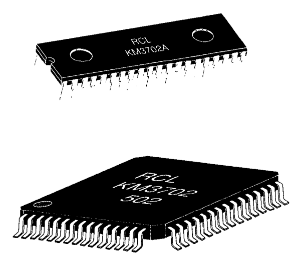
APPLICATIONS

- Motion Control Systems
- Robotics
- Drawing Machines
- Electrical Discharge Machines
- Special Machinery

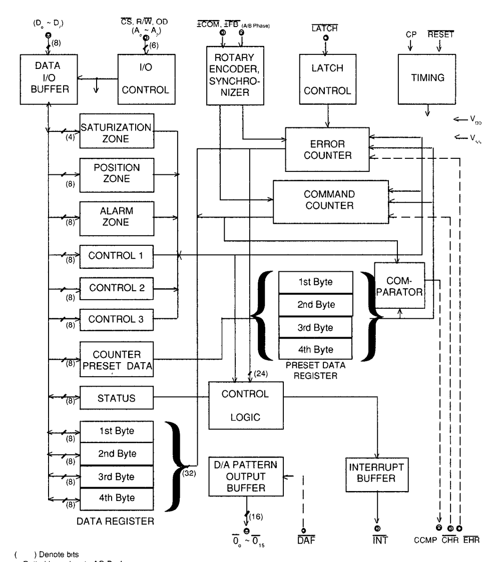
**See KM3702AD/AQ Operation Manual for further detail.*

2

KM3702A



BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Input Voltage .... V_{SS} -0.3 to V_{DD} +0.3 V
Supply Voltage .... V_{SS} -0.3 to V_{DD} +7.0 V
Power Dissipation (KM3702AD) .... 1.25 W
Power Dissipation (KM3702AQ) .... 1.00 W
Storage Temperature Range .... -65 to +150 °C
Operating Temperature Range .... -20 to +75 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

D. C. CHARACTERISTICS

Test conditions: V_{SS} = 0 V, T_A = -20 to +75 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{DD}	Supply Voltage		4.75	5.0	5.25	V
I_{DD}	Supply Current				5.0	mA
Input Signal 1 (Note 1)						
V_{IL}	Low Level Input Voltage		0.0		0.6	V
V_{IH}	High Level Input Voltage		3.0		V_{DD}	V
I_{LEAK}	Input Leak Current				±10	µA
Output Signal 2 (Note 2)						
I_{IL}	Low Level Input Current	V_{IL} = 0 V	-200		-10	µA
I_{IH}	High Level Input Current	V_{IH} = V_{DD}			±10	µA
Output Signal 3 (Note 3)						
V_{OL1}	Low Level Output Voltage	I_{OL1} = 2.0 mA			0.4	V
V_{OH1}	High Level Output Voltage	I_{OH1} = -200 µA	2.4			V
Output Signal 4 (Note 4)						
V_{OL2}	Low Level Output Voltage	I_{OL2} = 5.0 mA			0.4	V
V_{OH2}	High Level Output Voltage	I_{OH2} = -500 µA	2.4			V
I_{OFF2}	High Impedance Output Voltage				±10	µA

Note 1: $\overline{CS}$, R/$\overline{W}$, OD, A_2, A_1, A_0, $\overline{LATCH}$, $\overline{+COM}$, $\overline{-COM}$, $\overline{+FB}$, $\overline{-FB}$, $\overline{RESET}$, CP

Note 2: D_7, D_6, D_5, D_4, D_3, D_2, D_1, D_0, $\overline{CHR}$, $\overline{EHR}$, $\overline{DAF}$

Note 3: $\overline{INT}$, CCMP

Note 4: D_7, D_6, D_5, D_4, D_3, D_2, D_1, D_0

Note 5: $\overline{O_{15}}$, $\overline{O_{14}}$, $\overline{O_{13}}$, $\overline{O_{12}}$, $\overline{O_{11}}$, $\overline{O_{10}}$, $\overline{O_9}$, $\overline{O_8}$, $\overline{O_7}$, $\overline{O_6}$, $\overline{O_5}$, $\overline{O_4}$, $\overline{O_3}$, $\overline{O_2}$, $\overline{O_1}$, $\overline{O_0}$,

ELECTRICAL CHARACTERISTICS (CONT.)

A. C. CHARACTERISTICS

Test conditions: V_{DD} = 5 V + 5%, T_A = -20 to +75 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Output Signal 5 (Note 5)						
V_{OL3}	Low Level Output Voltage	I_{OL3} = 2.0 mA			0.4	V
V_{OH3}	High Level Output Voltage	I_{OH3} = -200 μA	2.4			V
I_{OFF3}	High Impedance Output Voltage				±10	μA
CLOCKED SIGNAL 1 (Note 2)						
T_{CYC}	Clock Pulse Period		0.1		10	μS
T_W	Clock Pulse Width		30		T_{CYC} -30	ns
T_{CR}	Clock Pulse Rise Time				30	ns
T_{CF}	Clock Pulse Fall Time				30	ns
INPUT SIGNAL 2 (Note 3)						
T_H	Data Hold Time For Input		10			ns
T_{SU}	Data Set Up Time For Input		T_W + 20			ns
t_{DAF}	DAF To OUTPUT (-5)				50	ns
OUTPUT SIGNAL 3 (Note 4)						
T_{D1}	Output Delay Time 1	C_L = 60 pF			25	ns
T_{D0}	Output Delay Time 2	C_L = 60 pF			50	ns
CPU INTERFACE 4 (Note 5)						
t_A	Access Time	C_L = 100 pF			120	ns
T_{CO}	$\overline{CS}$ To Output	C_L = 100 pF			100	ns
T_{OD}	OD To Output	C_L = 100 pF			100	ns
T_{OW}	Width Of OD		120			ns
T_{RDH}	Data Hold Time After OD		0			ns

Note 2: $\overline{CS}$, R/$\overline{W}$, $\overline{OD}$, A_2, A_1, A_0, $\overline{LATCH}$, $\overline{+COM}$, $\overline{-COM}$, $\overline{+FB}$, $\overline{-FB}$, $\overline{RESET}$, CP

Note 3: D_7, D_6, D_5, D_4, D_3, D_2, D_1, D_0, $\overline{CHR}$, $\overline{EHR}$, $\overline{DAF}$

Note 4: $\overline{INT}$, CCMP

Note 5: D_7, D_6, D_5, D_4, D_3, D_2, D_1, D_0

Note 6: $\overline{0_{15}}$, $\overline{0_{14}}$, $\overline{0_{13}}$, $\overline{0_{12}}$, $\overline{0_{11}}$, $\overline{0_{10}}$, $\overline{0_9}$, $\overline{0_8}$, $\overline{0_7}$, $\overline{0_6}$, $\overline{0_5}$, $\overline{0_4}$, $\overline{0_3}$, $\overline{0_2}$, $\overline{0_1}$, $\overline{0_0}$,

ELECTRICAL CHARACTERISTICS (CONT.)

A. C. CHARACTERISTICS

Test conditions: V_{DD} = 5 V + 5%, T_A = -20 to +75 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
CPU INTERFACE 4 (Note 5)						
t_{CA}	Address Valid After CONTROL		0			ns
t_{AC}	Address Valid Before CONTROL		40			ns
t_{CH}	CS Hold After CONTROL		0			ns
t_{CSC}	CS Valid Before Control		0			ns
t_{CW}	CS To WRITE		100			ns
t_{CC}	Width of $R/\overline{W}$		100			ns
t_{WDS}	Data Set Up Time		120			ns
t_{WDH}	Data Hold Time After $R/\overline{W}$		0			ns

Note 5: D_7, D_6, D_5, D_4, D_3, D_2, D_1, D_0

PIN FUNCTION (KM3702AD)

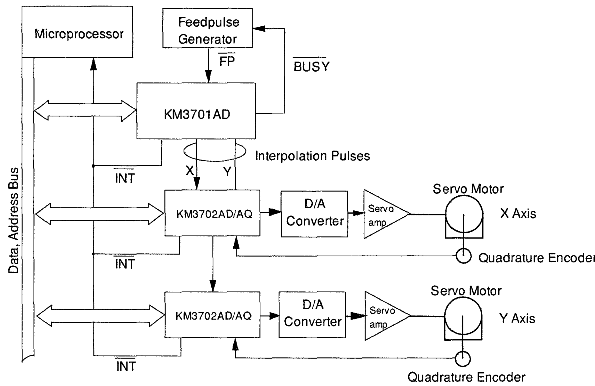
SIGNAL	SYMBOL	PIN NO.	I/O	DESCRIPTION
Power Supply	V_{DD}	40	--	+5V ± 5%
Ground	V_{SS}	20	--	Ground
Chip Select	$\overline{CS}$	1	I	Device select signal
Write	$R/\overline{W}$	2	I	Write control signal
Output Disable	OD	3	I	Output disable signal
Address	A_2~A_0	4~6	I	Address select signal
Data	D_7~D_0	7~14	I/O	Read/Write data I/O common 3-state I/O
Error Counter Latch	$\overline{LATCH}$	15	I	If more than 3 clock pulses then, ERROR COUNTER value are transferred to the DATA REGISTER.
+Command	$\overline{+COM}$	16	I	+Command pulse
-Command	$\overline{-COM}$	17	I	-Command pulse
+Feedback	$\overline{+FB}$	18	I	+Feedback pulse
-Feedback	$\overline{-FB}$	19	I	-Feedback pulse
Reset	$\overline{RESET}$	21	I	Reset signal
Clock Pulse	CP	22	I	System clock
Interrupt	$\overline{INT}$	23	O	CPU interrupt signal
Output for D/A Converter	$\overline{O}_0$~$\overline{O}_{15}$	24~39	O	Output pattern for D/A converter 3-state output

PIN FUNCTION (KM3702AQ)

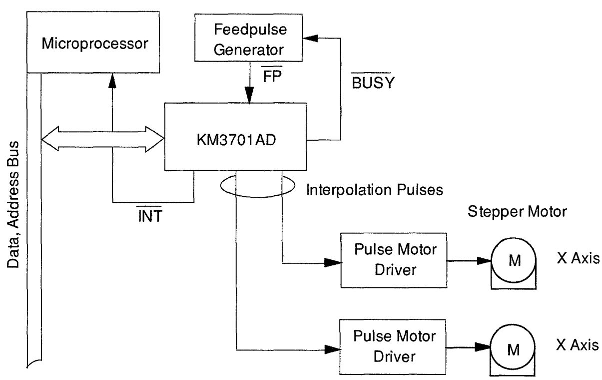
NAME	SYMBOL	PIN NO.	I/O	DESCRIPTION
Power Supply	V_{DD}	23, 53	–	+5 V ± 5%
Power Supply	V_{SS}	2,8,31,38,46	–	GND
Chip Select	$\overline{CS}$	49	I	Device Slect Signal
Write	$R/\overline{W}$	50	I	Write Signal
Output Disable	OD	51	I	Read Signal
Address	A_2- A_6	55 TO 57	I	Address Signal
Data	D_7 to D_6	1, 3 to 6, 58 to 60	I/O	Read/Write Data, I/O Common 3 State I/O
Error Counter Latch	$\overline{LATCH}$	11	I	If more than 3 clock pulses than, Error Counter Value are transferred to the data register
+ Command	$\overline{+COM}$	18	I	+ Command Pulse
- Command	$\overline{-COM}$	10	I	- Command Pulse
+ Feedback	$+\overline{FB}$	20	I	+ Feedback Pulse
- Feedback	$-\overline{FB}$	21	I	- Feedback Pulse
Reset	$\overline{RESET}$	10	I	Reset Signal
Clock Pulse	CP	9	I	Basic Clock
Interrupt	$\overline{INT}$	48	O	CPU Interrupt Error Counter
Output for D/A Converter	$\overline{0}_8$ to $\overline{0}_{15}$	25 to 30, 32 to 37, 40 to 43	O	D/A Converter Output
Command Counter Reset	$\overline{CHR}$	12	I	Command Counter Reset Signal
Error Counter Reset	$\overline{EHR}$	13	I	Error Counter Reset Signal
D/A Converter for Output	$\overline{DAF}$	22	I	D/A Converter Output Floating
Floating				
Command Counter Comparator Output	CCMP	47	O	Command Counter Data Over Preset Data Signal

APPLICATIONS

1. Control of 2 axes can be accomplished by using one KM3701AD and two KM3702AD/AQs.



1. One KM3701AD can control two stepper motors.



INTERPOLATION

The interpolation pulse distribution rate is in accordance with the rate of the clock pulse (CP) and the internal calculation time. The internal calculation requires 11 clocks in the case of linear interpolation and 21 clocks in the case of circular or other interpolations.

Interpolation	Interpolation Pulse Distribution Rate
Linear interpolation	454.4KPPs
Circular or other	238.1KPPs

TOKO

QUADRATURE ENCODER INTERFACE

FEATURES

- **Input Quadrature Frequency of Up to 2.5 MHz**
- **Built In Common Mode Noise Rejection Circuit**
- **Selectable Output Mode as Pulse and Direction or Pulse and Pulse (Normal Mode)**
- **Selectable Output Pulses in Multiples of x1, x2, and x4, and Even Frequency Division from 1/2 to 1/56**
- **Up to 10 MHz Clock Frequency**

APPLICATIONS

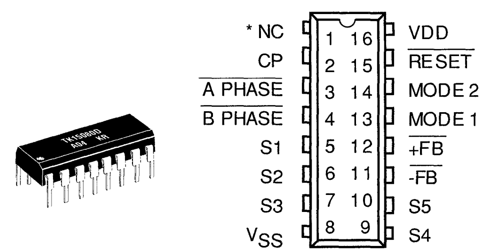
- **Quadrature Encoders**
- **Feedback Pulse Decoder**
- **For Use with any Application that Requires the Discrimination of Rotation by using a Quadrature Encoder**

See KM3703AD Operation Manual for further detail.

DESCRIPTION

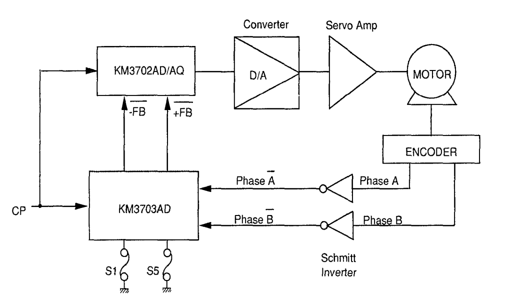
KM3703AD is a quadrature encoder interface designed for closed-loop systems which discriminates direction. The output can be selected as pulse and direction signals or pulse and pulse signals. The output pulses are synchronized with the clock pulse and used as feedback pulses, $\overline{+FB}$ and $\overline{-FB}$. S1 - S5 are used to determine the multiplication and division ratio settings.

KM3703AD



* NC : No Connections

APPLICATION



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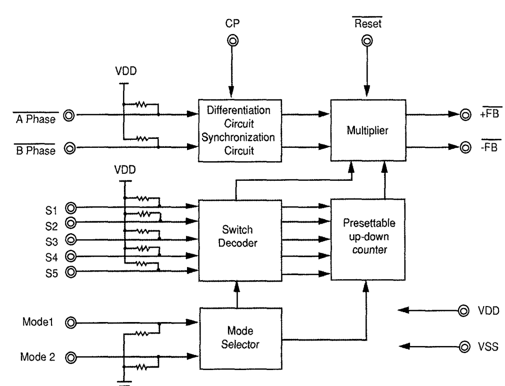


ORDERING INFORMATION

KM3703 □ □ □□

- **Tape/Reel Code**
- **Temp. Range**
- **Package Code**

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
D: Plastic Dip	A : -20 to +75 °C	BX: Bulk/Bag
		MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage .... V_{SS} -0.3 to V_{DD} +0.3V
Input Voltage .... V_{SS} -0.3 to V_{DD} +7.0V
Power Dissipation .... 460 mW
Junction Temperature .... 150 °C

Storage Temperature Range .... -65 to +150 °C
Operating Temperature Range .... -20 to +75 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

D. C. CHARACTERISTICS

Test conditions: V_{SS} = 0 V, T_A = -20 to +75 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{DD}	Supply Voltage		4.75	5.0	5.25	V
I_{DD}	Supply Current	V_{DD} = 5.0 V			5.0	mA
Input Signal 1 (Note 1)						
V_{IL1}	Low Level Input Voltage		0.0		0.8	V
V_{IH1}	High Level Input Voltage		2.0		V_{DD}	V
I_{LEAK}	Input Leak Current				±10	µA
Input Signal 2 (Note 2)						
V_{IL2}	Low Level Input Voltage		0.0		0.8	V
V_{IH2}	High Level Input Voltage		2.0		V_{DD}	V
Input Signal 3 (Note 3)						
I_{IL1}	Low Level Input Signal	V_{IN} + V_{SS}	-200		-10	µA
I_{IH1}	High Level Input Signal	V_{IN} = V_{DD}			±10	µA
Input Signal 4 (Note 4)						
I_{IL2}	Low Level Output Current	V_{IN} = V_{SS}			±10	µA
I_{IH2}	High Level Output Current	V_{IN} = V_{DD}	10		200	µA
Output Signal 5 (Note 5)						
V_{OL}	Low Level Output Voltage	I_{OL} = 1 mA			.4	V
V_{OH}	High Level Output Voltage	I_{OH} = -1 mA	2.4			V

Note 2: CP
Note 2: $\overline{\text{A PHASE}}$, $\overline{\text{B PHASE}}$, S1, S2, S3, S4, S5, $\overline{\text{MODE 1}}$, MODE 2, $\overline{\text{RESET}}$
Note 3: $\overline{\text{A PHASE}}$, $\overline{\text{B PHASE}}$, S1, S2, S3, S4, S5, $\overline{\text{RESET}}$
Note 4: $\overline{\text{MODE 1}}$, MODE 2
Note 5: +$\overline{\text{FB}}$, -$\overline{\text{FB}}$

ELECTRICAL CHARACTERISTICS (CONT.)

A. C. CHARACTERISTICS

Test conditions: V_{DD} = 5 V + 5%, T_A = -20 to +75 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
CLOCKED SIGNAL 1 (Note 1)						
T_{CYC}	Clock Pulse Period		0.1		10	μS
T_W	Clock Pulse Width		30		T_{CYC} -30	ns
T_{CR}	Clock Pulse Rise Time				30	ns
T_{CF}	Clock Pulse Fall Time				30	ns
Input Signal 2 (Note 2)						
$T/_W$	Input Pulse Width		2 T_{CYC}			ns
Reset Signal 3 (Note 3)						
T_{RW}	Reset Pulse Width		T_{CYC}			μs
Output Signal 4 (Note 4)						
T_{OD}	Output Delay Time	C_L = 60 pF			55	ns

Note 2: CP

Note 2: $\overline{\text{A PHASE}}$, $\overline{\text{B PHASE}}$, S1, S2, S3, S4, S5, $\overline{\text{MODE 1}}$, MODE 2, $\overline{\text{RESET}}$

Note 3: A PHASE, B PHASE, S1, S2, S3, S4, S5, RESET

Note 5: +FB, -FB

PIN FUNCTION

SIGNAL	PIN NO.	I/O	DESCRIPTION
VDD	16	--	Supply Voltage (+5 V ± 5%)
VSS	8	--	Ground
CP	2	I	Clock Input (10 MHz Max.)
$\overline{\text{A Phase}}$	3	I	A Phase and B Phase for position feedback signals from the encoder with 90° phase shift.
$\overline{\text{B Phase}}$	4	I	
S1 ~ S5	5~10	I	Multiplication or frequency division ratio switch
$\overline{\text{-FB}}$	11	O	- Direction feedback pulse output or direction signal output
$\overline{\text{+FB}}$	12	O	+ Direction feedback pulse output or feedback pulse
Mode 1	13	I	Multiplication/Frequency Division selection switch
Mode 2	14	I	Pulse and pulse or pulse and direction output mode switch
$\overline{\text{Reset}}$	15	I	Reset the internal status

NOTES

TOKO

TK16070

PRELIMINARY INFORMATION

SILICON MONOLITHIC DELAY LINE

FEATURES

- 50 ns Delay Time with Excellent Flatness
- Accurate Delay Time Adjustment (±12 %)
- Ultra-Miniature Package (SOT-23L)
- 5 V Operation
- Minimum External Parts

APPLICATIONS

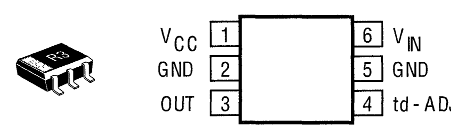
- VCR/TV
- Video Switchers
- Video Effects
- Video Memory

DESCRIPTION

The TK16070M is a miniature, low cost delay line for VCR and video equipment. The delay time is 50 ns and is adjustable to within ±12%. The device has a typical 0.6 dB insertion loss and the maximum ripple in the 0.1 to 6 MHz pass band is ±4 ns. The TK16070 can accept a signal of up to 700 mVp-p and the output level is ±0.2 dB flat within the -20 to +70 °C ambient temperature range. The device has been optimized for use in camcorders and portable video equipment.

The TK16070 is available in the very small SOT-23L surface mount package.

TK16070M



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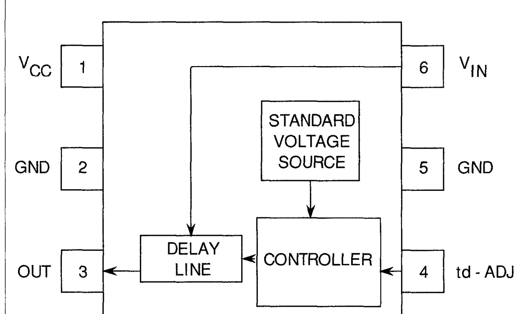


ORDERING INFORMATION

TK16070 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE
M : Surface Mount

TEMP. RANGE
C : 0 to + 70 °C

TAPE/REEL CODE
BX : Bulk/Bag
TX : Paper Tape
TR : Tape Right
TL : Tape Left
MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 7.5 V
Power Dissipation (Note 1) .... 200 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -40 to +150 °C
Operating Temperature Range .... 0 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

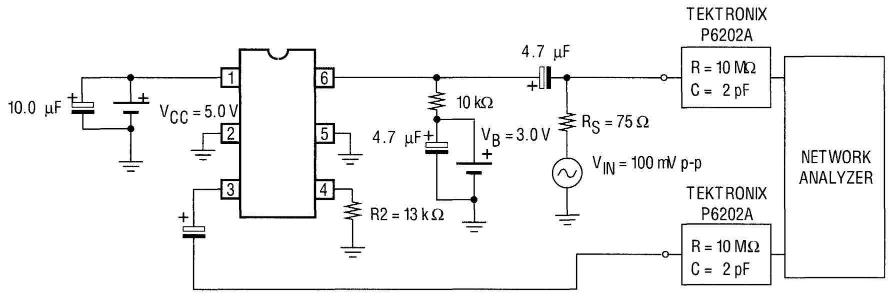
Test conditions: V_{CC} = 5.0 V, V_B = 3.0 V unless otherwise specified. T_A = 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
td	Delay Time	f = 0.1 to 6 MHz, V_{IN} = 100 mVp-p		50		ns
tdr	Delay Time Ripple	f = 0.1 to 6 MHz, V_{IN} = 100 mVp-p			±4	ns
Δtd	Varition Range of Delay Time	f = 0.1 to 6 MHz, V_{IN} = 100 mVp-p (against center value)	±10	±12		%
Gr	Amplitude Ripple	f = 0.1 to 6 MHz, V_{IN} = 100 mVp-p			±0.5	dB
GR	Insertion Loss	f = 1 MHz, V_{IN} = 100 mVp-p	0	0.5	1.0	dB
td/V	td Fluctuation by Supply Voltage	V_{CC} = 5.0±0.5 V at variable f = 0.1 to 6 MHz, V_{IN} = 100 mVp-p		±2	±5	ns
CT/∇	Level Fluctuation by Supply Voltage	V_{CC} = 5.0±0.5 V at variable f = 0.1 to 6 MHz, V_{IN} = 100 mVp-p		±0.1	±0.5	dB
td/T_A	td Fluctuation by Temp. Characteristic	T_A = -20 to + 70 °C f = 0.1 to 6 MHz, V_{IN} = 100 mVp-p		±2	±5	ns
G/T_A	Level Fluctuation by Temp. Characteristic	T_A = -20 to + 70 °C f = 0.1 to 6 MHz, V_{IN} = 100 mVp-p		±0.2	±0.5	dB
$V_{IN\ MAX}$	Maximum Input Level	APL = 50 %, VP = 3 °, V_G = 3 % or max distortion 1 % max at 1 MHz		1		Vp-p
DG	Differential Gain	APL = 50 %,V_{IN} = 1.0 Vp-p VB = 3.0 V		1	3	%
DP	Differential Phase	V_{IN} = 1.0 Vp-p, APL = 50% VB = 3.0 V		1	3	deg
Z_{IN}	Nominal Input Impedance	Depends upon external bias resistance		7		kΩ
Z_O	Nominal Output Impedance			200		Ω
I_{CC}	Supply Current	td Center		11	13.5	mA

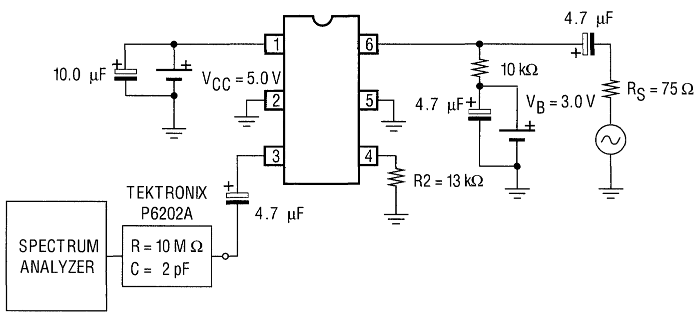
Note 1: Power dissipation must be derated at the rate of 1.6 mW/°C for operation at T_A = 25 °C and over.
Note 2: This IC is produced using a high frequency process, so some pins are easily damaged by static discharge.

TEST CIRCUITS

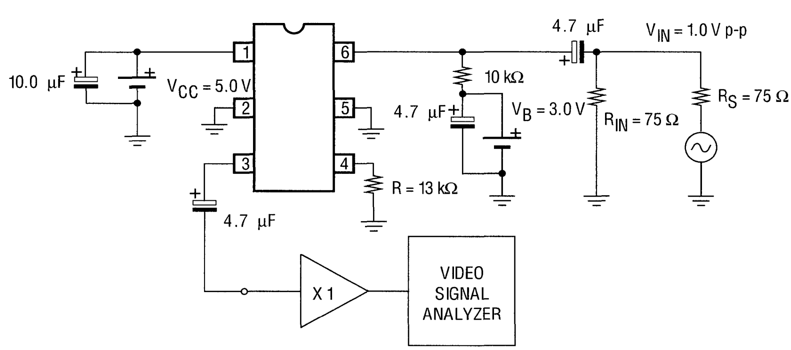
DELAY TIME, FREQUENCY RESPONSE TEST CIRCUIT



SECOND HARMONIC DISTORTION TEST CIRCUIT



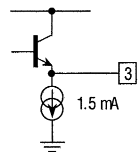
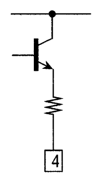
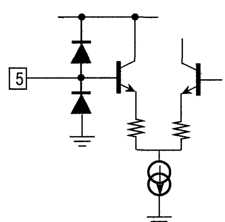
VIDEO ANALYSIS TEST CIRCUIT



APPLICATION INFORMATION

PIN FUNCTIONS

PIN DESCRIPTION

NO.	PIN NAME	VOLTAGE	EQUIVALENT CIRCUIT	DESCRIPTION
1	V_{CC}	5.0		Supply Voltage Pin V_{CC} = 5.0 V
2	GND	0		Ground
3	OUT			Output Same As #6
4	td-ADJ	1.7		Delay Time Fine Adjustment
5	GND	0		Ground
6	V_{IN}			Input Terminal Voltage is Based on VB (Outside Bias). VB = 2.5 - 3.4 V, VB = 3.0 V is recommended

PRECAUTIONS

Supply Voltage: V_{CC} = 5.0 V

An outside DC bias (VB) is required. This DC voltage effects dynamic range. Under the condition of V_{CC} = 5.0 V, input video signal V_{IN} = 1.0 Vp-p, VB = 2.5 V to 3.4 V is necessary if a wider dynamic range is required. Second Harmonic Distortion is 1% at V_{IN} = 1.0 Vp-p; f_{IN} = 1 MHz and V_{IN} = 0.4 Vp-p; f_{IN} = 5 MHz.

The resistor (R2) connected to td-ADJ terminal is for fine adjustment of the delay time. Delay time is 50 ns at R2 = 13 kΩ. Delay time fine adjustment of ±12% is available with R2, but a wide variation will influence delay time flatness and amplitude.

The delay time temperature characteristics vary depending upon the temperature characteristics of the resistor, connected to td-ADJ terminal (R2). Temperature variation is ±300 ppm/°C with zero T_C version. If a carbon film resistor is used, temperature variation is ±450 ppm/°C.

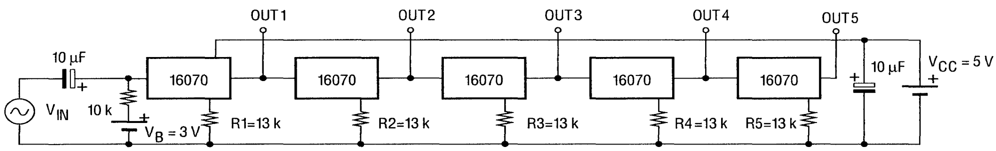
Output load capability is 10 kΩ or greater. Keep loaded capacitance under 40 pF as it may influence the amplitude characteristics.

This IC is implemented on a high frequency process, therefore some terminals are sensitive to ESD.

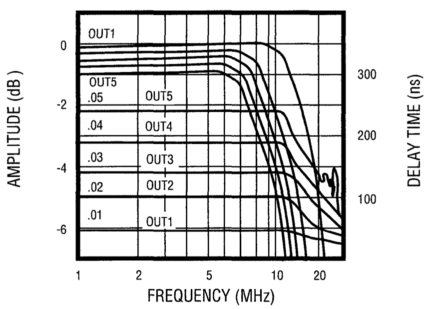
TYPICAL APPLICATIONS

CASCADE CONNECTION

TK16070M can be cascaded together. The following figures show the connection frequency characteristics of each output stage.



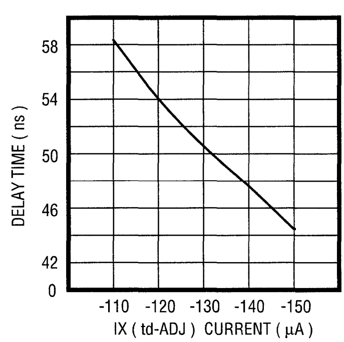
FREQUENCY CHARACTERISTICS
OF FIVE STAGE CASCADE CONNECTION
V_{CC} = 5.0 V, V_B = 3.0 V



DELAY TIME FINE ADJUSTMENT USING CURRENT SOURCE

Delay time fine adjustment is possible by connecting a current source to Terminal #4 (td-ADJ) instead of R2.

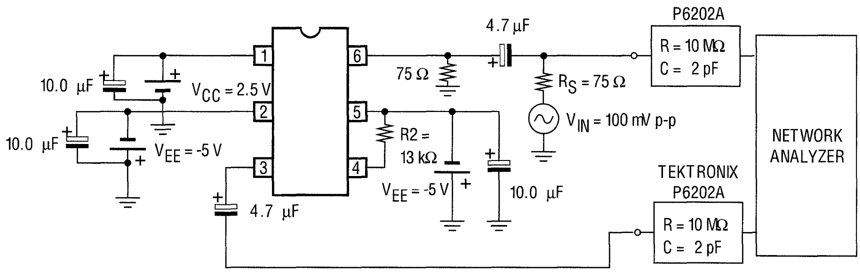
DELAY TIME vs. CURRENT
V_{CC} = 5.0 V, V_B = 3.0 V



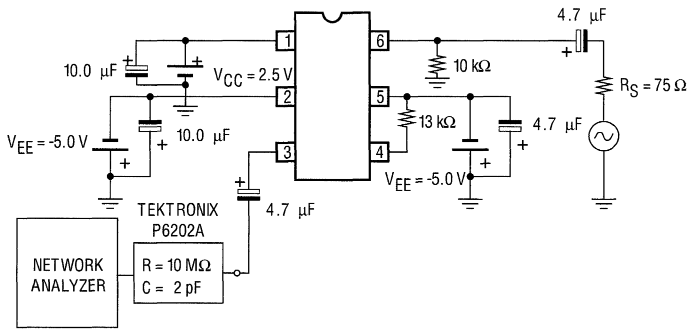
DUAL SUPPLY OPERATION

The following figures show the frequency response and second harmonic distortion test setup and test results when V_{CC} = 2.5 V, V_{EE} = –5.0 V is used.

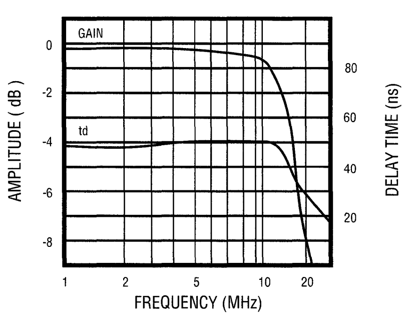
DELAY TIME, FREQUENCY RESPONSE TEST CIRCUIT



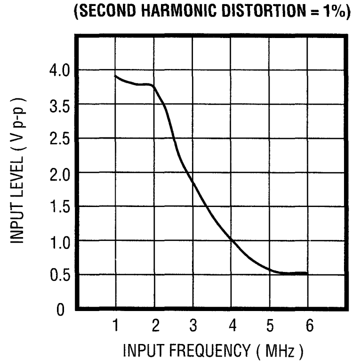
SECOND HARMONIC DISTORTION TEST CIRCUIT



FREQUENCY CHARACTERISTICS
V_{CC} = 2.5 V, V_{EE} = 5.0 V

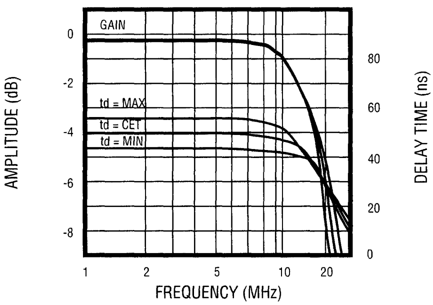


INPUT LEVEL vs. INPUT FREQUENCY
V_{CC} = 2.5 V, V_{EE} = -5.0 V
(SECOND HARMONIC DISTORTION = 1%)

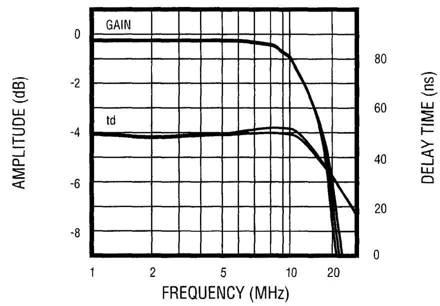


TYPICAL PERFORMANCE CHARACTERISTICS

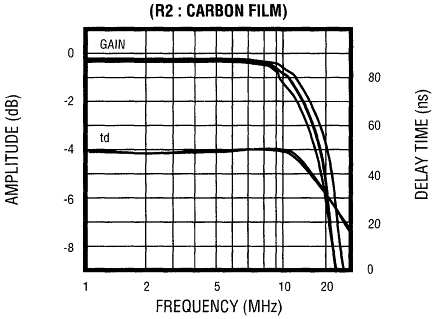
FREQUENCY CHARACTERISTICS (DELAY TIME +/- 12% VARIABLE)
V_{CC} = 5.0 V, V_B = 3.0 V, V_{IN} = 100 mV p-p



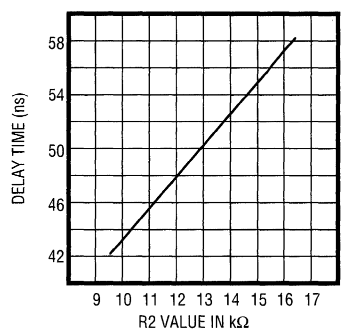
FREQUENCY CHARACTERISTICS (SUPPLY VOLTAGE VARIABLE)
V_{CC} = 4.5 V, 5.0 V, 5.5 V, V_B = 3.0
V_{IN} = 100 mV p-p



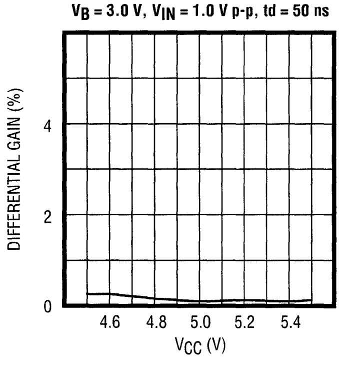
FREQUENCY CHARACTERISTICS vs. TEMP
TESTED AT T_A = 20, 0, 25, 40, 60, 80°C
V_{CC} = 5.0 V, V_B = 3.0, V_{IN} = 100 mV p-p
(R2 : CARBON FILM)



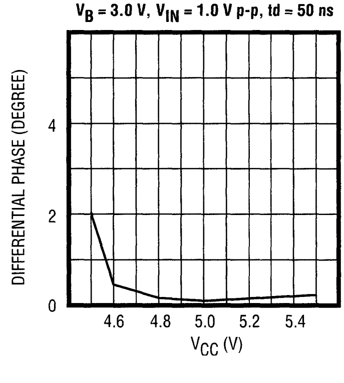
R2 vs. DELAY TIME
V_{CC} = 5 V, V_B = 3 V



DIFFERENTIAL GAIN vs. V_{CC}
V_B = 3.0 V, V_{IN} = 1.0 V p-p, td = 50 ns



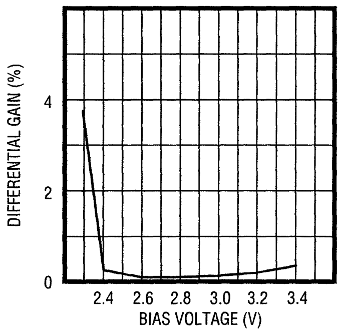
DIFFERENTIAL PHASE vs. V_{CC}
V_B = 3.0 V, V_{IN} = 1.0 V p-p, td = 50 ns



TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

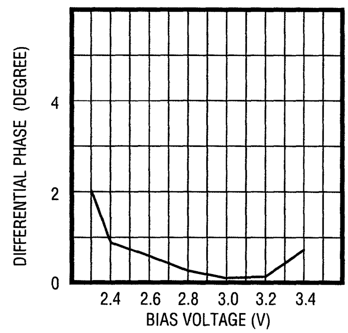
DIFFERENTIAL GAIN vs. BIAS VOLTAGE

V_{CC} = 5.0 V, V_{IN} = 1.0 V p-p, td = 50 ns



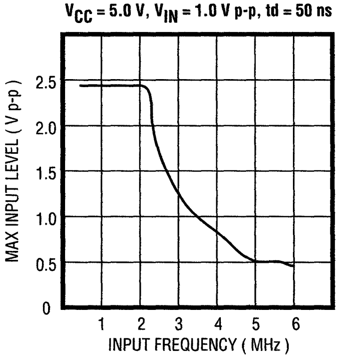
DIFFERENTIAL PHASE vs. BIAS VOLTAGE

V_{CC} = 5.0 V, V_{IN} = 1.0 V p-p, td = 50 ns



INPUT LEVEL vs. INPUT FREQUENCY
(SECONDARY DISTORTION 1%)

V_{CC} = 5.0 V, V_{IN} = 1.0 V p-p, td = 50 ns



PROGRAMMABLE MONOLITHIC DELAY LINE

FEATURES

- Programmable Delay
- 3 bit TTL or CMOS Control
- 15 MHz Max Operating Frequency
- 1.5 ns Rise/Fall Time

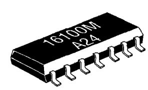
APPLICATIONS

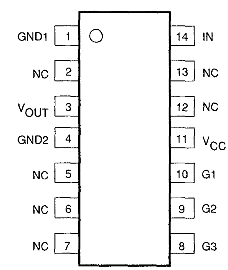
- Computer Hard Disk Drives
- Memory Management
- Digital Systems
- Digital Recorders

DESCRIPTION

The TK16100 is a programmable silicon monolithic delay line. It is designed for computer hard disk drives, digital recorders, and memory managment systems. The device can operate with an input pulse as short as 20 ns and at 15 MHz. The TK16100 has a three bit delay control input and can be controlled by either TTL or CMOS levels. The control range is from 5 ns to 35 ns of initial delay time. The TK16100 operates from a single 5 V supply and is available in a MFP14 surface mount package.

TK16100M





ORDERING INFORMATION

TK16100 □ □ □□

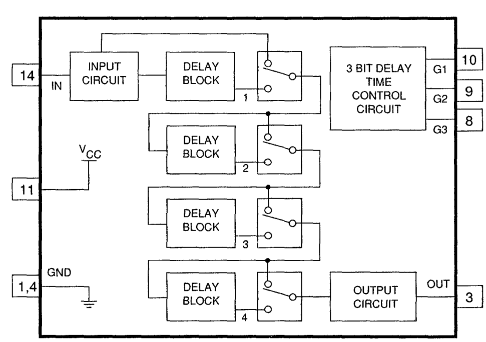
- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE
M: Surface Mount

TEMP. RANGE
C : -30 to +80 °C

TAPE/REEL CODE
BX: Bulk/Bag
TX: Paper Tape
TR: Tape Right
TL: Tape Left
MG: Magazine

BLOCK DIAGRAM



3 Bit Delay Time Control Circuit vs. Delay Time

G1 Input	Low	Open	Low	Open	Low	Open	Low	Open
G2 Input	Low	Low	Open	Open	Low	Low	Open	Open
G3 Input	Low	Low	Low	Low	Open	Open	Open	Open
T_D	T_{PD1}	T_{PD1} +5nS	T_{PD1} +10nS	T_{PD1} +15nS	T_{PD1} +20nS	T_{PD1} +25nS	T_{PD1} +30nS	T_{PD1} +35nS

ABSOLUTE MAXIMUM RATINGS

Input Voltage .... 7 V
Maximum Input Voltage .... 0 to V_{CC} V
Power Dissipation (Note 1) .... 680 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -30 to +80 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

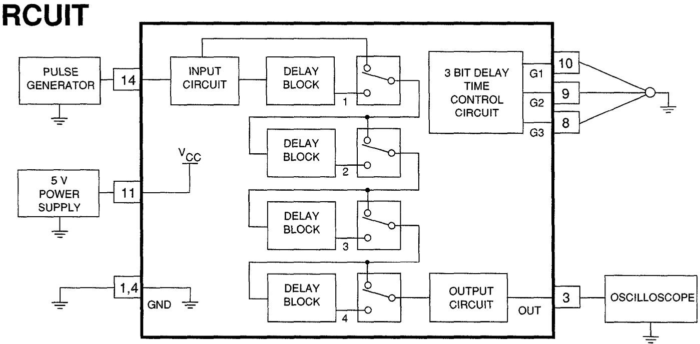
ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 5.0 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{CC}	Supply Voltage		4.75	5.0	5.25	V
V_{IN}	Input Voltage (High)		2.0			V
V_{IL}	Input Voltage (Low)				0.8	V
I_{IH}	Input Current (High)	V_R = 2.7 V			20	μA
I_{IL}	Input Current (Low)	V_R = 0.4 V			-400	μA
V_{OH}	Output Voltage (High)		2.7			V
V_{OL}	Output Voltage (Low)				0.4	V
T_R	Rise Time	(20 ~ 80%)		1.5		nS
T_F	Fall Time	(20 ~ 80%)		1.5		nS
T_{PD1}	Propagation Delay Time	G1, G2, G3 All Low	12	17	22	nS
T_{PD2}	Propagation Delay Time	G1, G2, G3 All Open	42	52	62	nS
T_D	Delay Time Width		2.5	5.0	7.5	nS
P_W	Input Pulse Width			20		nS
T_W	Input Period		64			nS
F_W	Input Frequency				15.6	MHz

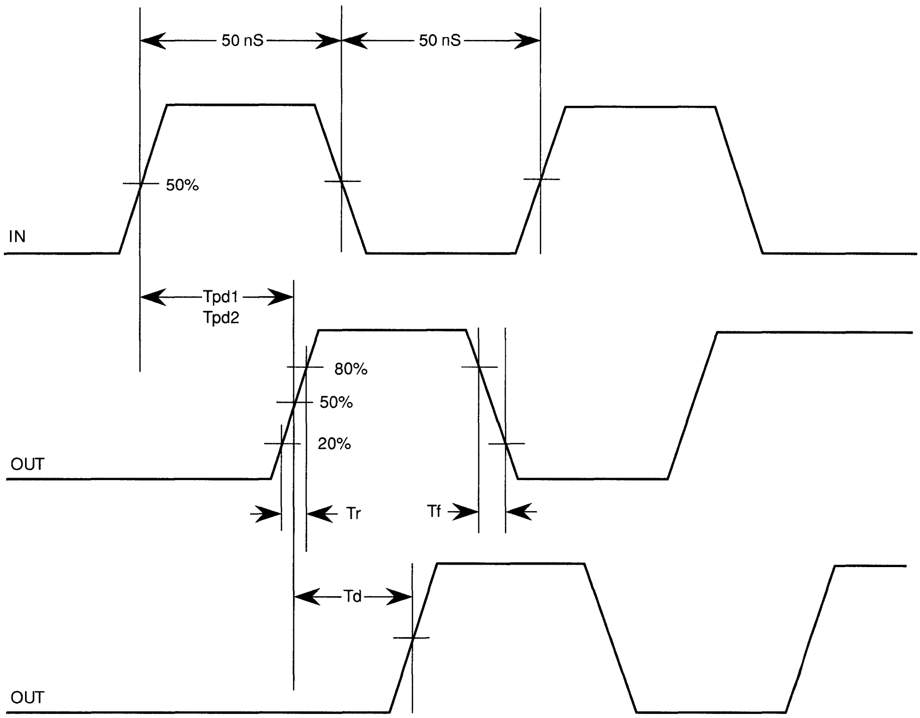
Note 1: Power dissipation must be derated at the rate of 5.44 mW/°C at T_A = 25 °C and above.

TEST CIRCUIT

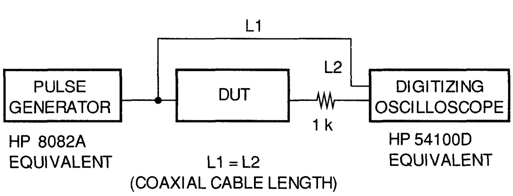


APPLICATIONS INFORMATION

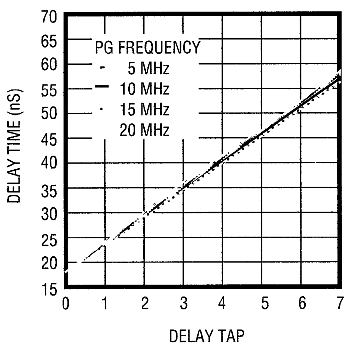
TIME DIAGRAM



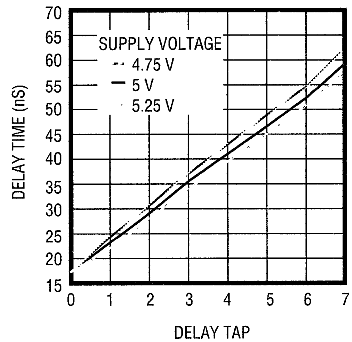
MEASUREMENT CIRCUIT



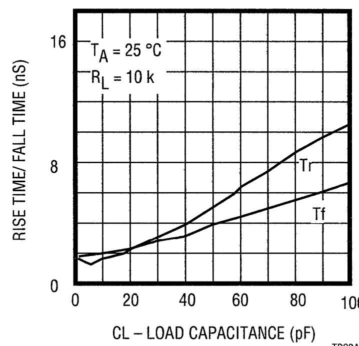
TYPICAL PERFORMANCE CHARACTERISTICS



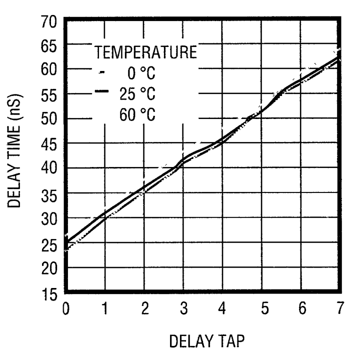
TPC1A



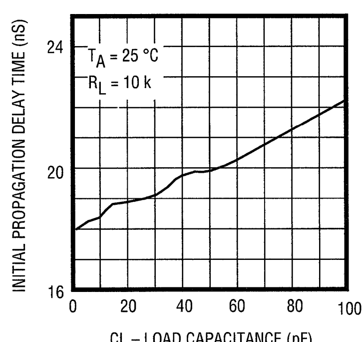
TPC2A



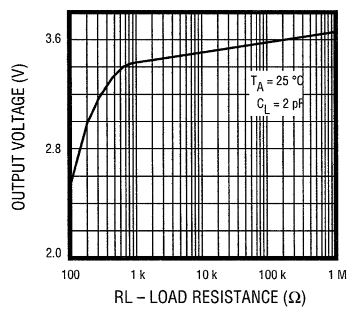
TPC3A



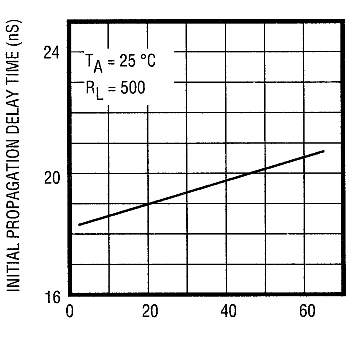
TPC4A



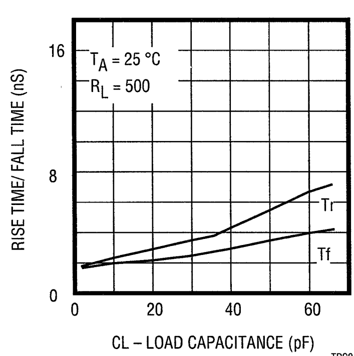
TPC5A



TPC6A

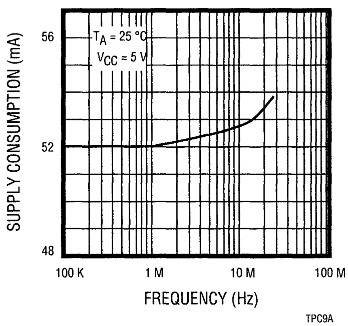


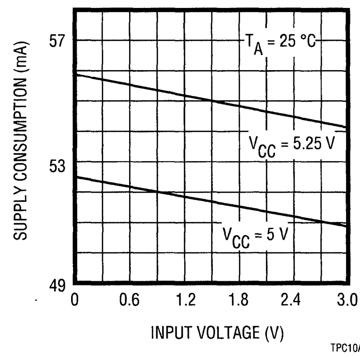
TPC7A



TPC8A

TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)





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NOTES

TABLE OF CONTENTS

POWER CONTROL

TOKO

REGULATOR/COMPARATOR

FEATURES

- Series Regulator/Compandor
- Low Voltage Operation to 0.9 V
- Low (600 µA) Current Consumption

APPLICATIONS

- Pagers
- Cordless Telephones
- Battery Operated Equipment

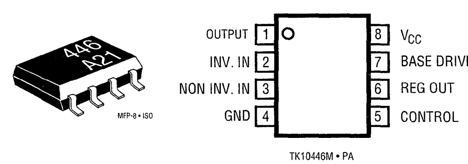
DESCRIPTION

The TK10446M is a low voltage, low power comparator/ voltage regulator IC suitable for battery operated equipment using a single AA cell. The comparator can be configured as a low battery detector, or used independently as a comparator or amplifier. It is especially well suited for use as a data amplifier in pagers and cordless phones.

The TK10446M is available in an MFP8 surface mount package.

3

TK10446M



ORDERING INFORMATION

TK10446 □ □ □□

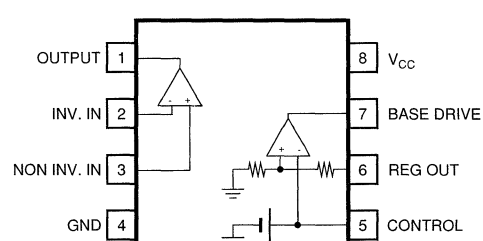
- Tape/Reel Code
- Temp. Range
- Package Code

Package Code
M : Surface Mount

Temp. Range
C : -30 to +70 °C

Tape/Reel Code
BX : Bulk/Bag
TX : Paper Tape
TR : Tape Right
TL : Tape Left
MG: Magazine

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CCMAX} .... 5.0 V
Power Dissipation (Note 1) .... 350 mW
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -30 to +70 °C
Operating Voltage Range .... 0.9 to 3.5 V
Data Amplifier Max Operating Frequency .... 1.0 MHz
Junction Temperature .... 150 °C
Lead Soldering Temp. (10 sec.) .... 240 °C

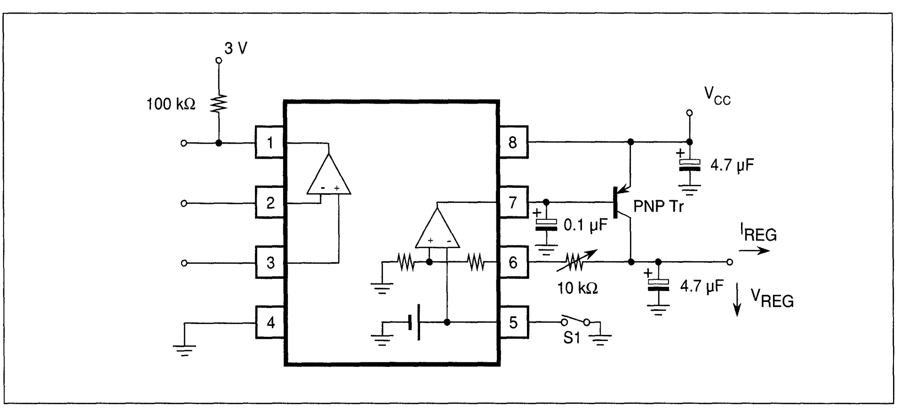
ELECTRICAL CHARACTERISTICS

Test conditions: $V_{REG\ OUT}$ = 1.05 V, T_A = 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	No Input		0.6		mA
Regulator Section (Note 2)						
V_{OUT1}	Output Voltage 1	V_{CC} = 1.1 V, I_{REG} = 10 mA		0.98		V
V_{OUT2}	Output Voltage 2	V_{CC} = 1.7 V, I_{REG} = 0 mA		1.02		V
V_{OUT3}	Output Voltage 3	V_{CC} = 0.9 V, I_{REG} = 1 mA		0.88		V
Data Amplifier Section						
Z_{IN}	Input Impedance			100		kΩ
V_{OUT4}	Output Voltage 4	Pull up to +3 V output at 100 kΩ		2.5		V_{pp}
DR	Duty Ratio	V_{IN} = 17 mV(rms), f_{IN} = 1 kHz		50		%

Note 1: Power dissipation must be derated at the rate of 3.3 mW/°C for operation at T_A = 25 °C and above.
Note 2: (V_{CC} = 1.35 V, I_{REG} = 0 mA) Measured with the regulated output voltage V_{REG} adjusted to 1.0 V

TEST CIRCUIT



VOLTAGE REGULATOR/POWER AMPLIFIER

FEATURES

- Linear Regulator
- Audio Amplifier
- Low Battery Indicator
- Low Power Standby Mode

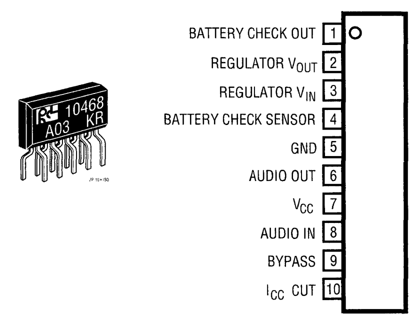
APPLICATIONS

- Cordless Telephones
- Tape Recorders
- Battery Operated Equipment
- Audio Equipment

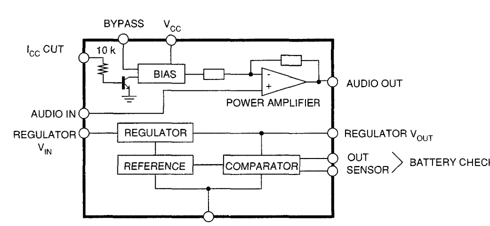
DESCRIPTION

The TK10468Z is a bipolar IC which includes an audio power amplifier, voltage regulator, and battery check circuit. In addition, a low power standby mode is provided. The device is specifically designed for cordless phones, small tape recorders or other battery operated audio or communications equipment. The power amplifier can drive a 32 Ω speaker and has a 44 mW output capability. The regulator section output is 3.1 V at 10 mA load. The low battery indicator is internally set to 3.5 V, but external resistors can set this to other voltages. The battery check output can directly drive an LED. The TK10468Z is available in a 10 pin zig-zag in line package (ZIP10).

TK10468Z



BLOCK DIAGRAM



ORDERING INFORMATION

TK10468 ☐ ☐ ☐☐

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
Z : ZIP	C : -30 to +70 °C	BX : Bulk/Bag
		MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Supply Voltage .... 12 V
Output Current .... 15 mA
Output Power .... 70 V
Power Dissipation (Note 1) .... 490 mW
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +75 °C
Operating Voltage Range .... 2.0 to 6.0 V
Maximum Input Frequency .... 20 kHz
Lead Temperature .... 150 °C

ELECTRICAL CHARACTERISTICS

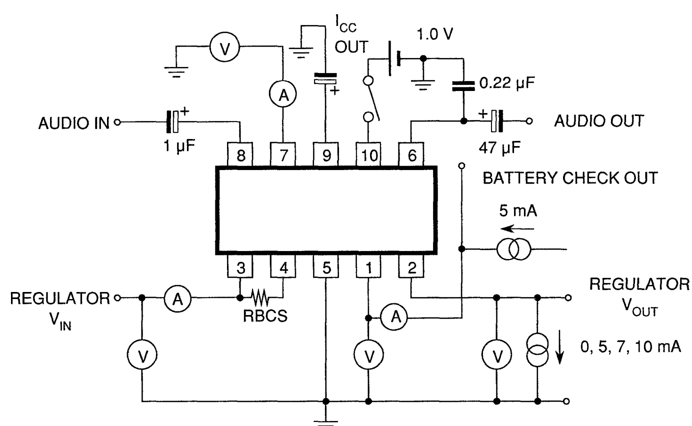
Test conditions: T_A = 25 °C, f_{IN} = 1 kHz, R = 32 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	I_{OUT} = 0 mA		2.40	3.20	mA
V_{OUT}	Output Voltage	I_{OUT} = 0 mA	3.13	3.31	3.71	V
V_{OUT1}	V_{OUT1}	I_{OUT} = 5 mA	2.97	3.15	3.55	V
V_{OUT2}	V_{OUT2}	I_{OUT} = 7 mA	2.92	3.10	3.50	V
V_{OUT3}	V_{OUT3}	I_{OUT} = 10 mA	2.87	3.05	3.45	V
I_{OUT}	Output Current				10	mA
V_{DROP}	In/Out Voltage Drop	I_{OUT} = 0 mA (Note 2)		0.04	0.07	V
V_{DROP1}	Voltage Drop 1	I_{OUT} = 5 mA (Note 2)		0.08	0.12	V
V_{DROP2}	Voltage Drop 2	I_{OUT} = 7 mA (Note 2)		0.09	0.16	V
V_{DROP3}	Voltage Drop 3	I_{OUT} = 10 mA (Note 2)		0.11	0.18	V
V_{LVD}	Low Supply Detection Voltage	(Note 2)	3.3	3.5	3.7	V
$\Delta V_{LVD}/\Delta T$	Temperature Characteristic of V_{LVD}	V_{IN} = 4.0 V→3.0 V, T = 0 to +50 °C		0.47		mV/°C
I_{OH}	High Output Current	V_{IN} = 4.0, V_{OUT} = 6.0 V		0.01	10	µA
V_{OL}	Low Output Voltage	V_{IN} = 3.0 V		209	300	mV
Power Amplifier		V_{CC} = 3.8 V, V10 = 1.0 V				
I_{CQ1}	Quiescent Supply Current 1	V_{IN} = 0 V(rms) (Note 4)		3.90	5.20	mA
I_{CQ2}	Quiescent Supply Current 2	V_{IN} = 0 V(rms) (Note 5)		0.2	0.9	mA
V_G	Voltage Gain	V_{OUT} = 0.1 V(rms)	32	34	36	dB
P_O	Output Power	THD = 10%, R_L = 32 Ω		44.9		mW
Z_{IN}	Input Impedance		14	22		kΩ
V_{NO}	Output Noise Voltage	Rg = 10 kΩ (Note 6)		180	500	µV

Note 1: Power Dissipation must be derated at the rate of 4 mW/°C for operation at T_A = 25 °C and above.

Note 2: V_{DROP} is the difference between the input and output voltage, when the output voltage drops 0.1 V as input voltage is decreased. Standard is the output voltage at V_{IN} = 3.8 V.
Note 3: A resistor (180 kΩ) between V_{IN} and battery check sensor (pin 4). Low supply detection voltage is variable.
Note 4: Quiescent Supply Current as impressing +1.0 V to I_{CC} cut pin.
Note 5: Quiescent Supply Current at I_{CC} out pin open mode.
Note 6: Use a filter of 20 Hz to 20 kHz to test the output noise voltage.

TEST CIRCUIT



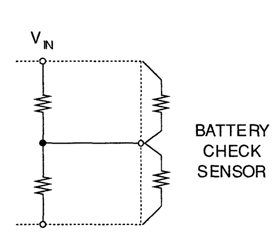
NOTE: BATTERY CHECK SENSOR RBCS = 108 kΩ

LOW SUPPLY DETECTION VOLTAGE

- V_{LVD} Is adjustable by attaching a resistor.

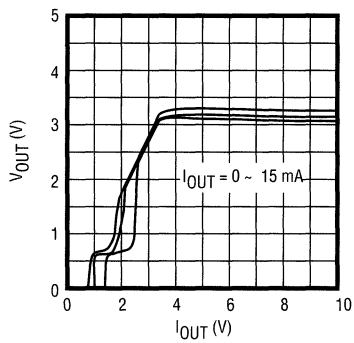
A.) Connect a resistor between GND and battery check sensor to raise V_{LVD}.
V_{LVD} = 4.0 V←33 kΩ
V_{LVD} = 4.2 V←20 kΩ

B.) Connect a resistor between V_{IN} and battery check sensor to reduce V_{LVD}
V_{LVD} = 3.5 V←180 kΩ
V_{LVD} = 3.0 V←30 kΩ
V_{LVD} = 2.5 V←10 kΩ

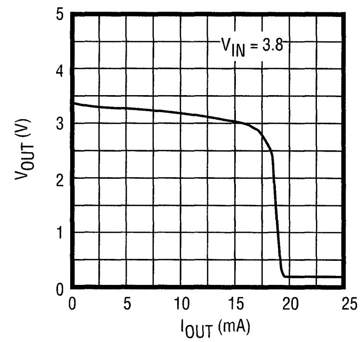


TYPICAL PERFORMANCE CHARACTERISTICS

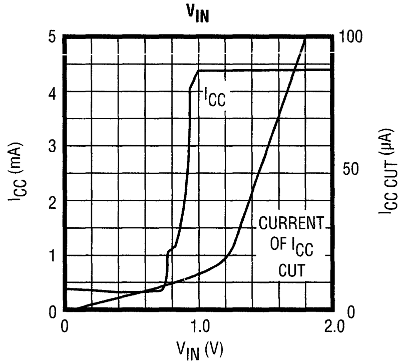
OUTPUT VOLTAGE vs LOAD CURRENT



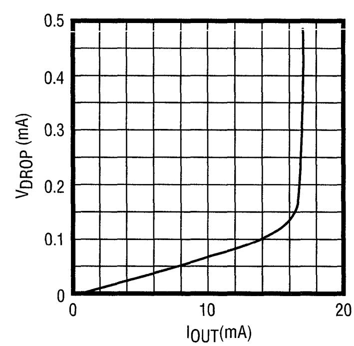
SHORT CIRCUIT PROTECTION vs LOAD CURRENT



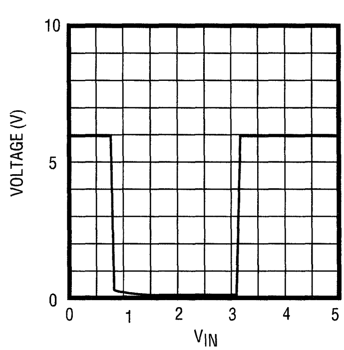
SUPPLY CURRENT vs LOW BATTERY VIN



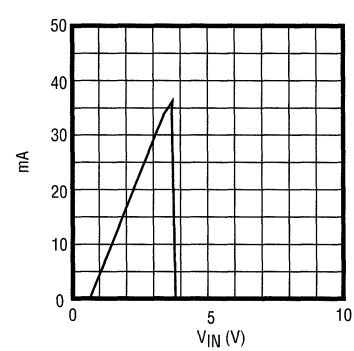
VOLTAGE DROP vs OUTPUT CURRENT



LOW BATTERY SENSE vs VIN

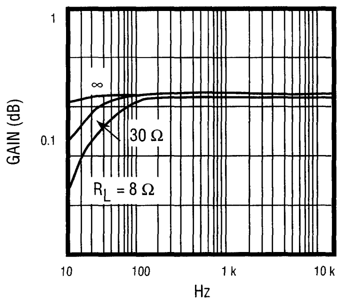


LOW BATTERY CURRENT vs VIN

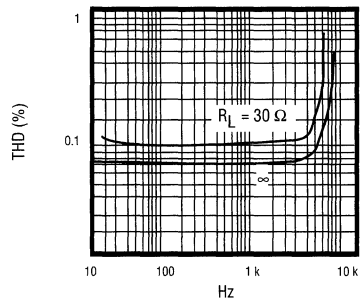


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

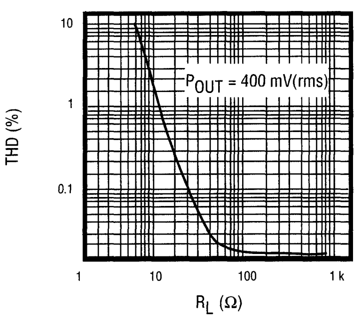
GAIN vs FREQUENCY



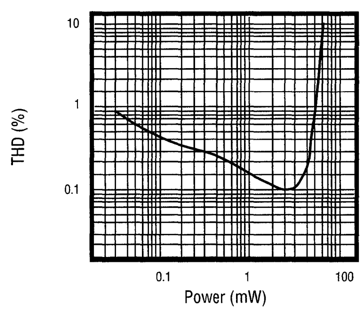
TOTAL HARMONIC DISTORTION vs FREQUENCY



TOTAL HARMONIC DISTORTION vs R. LOAD



TOTAL HARMONIC DISTORTION vs OUTPUT POWER



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TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

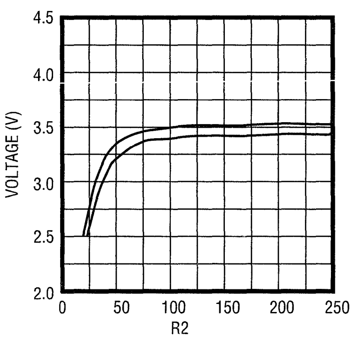
The low battery detection voltage is set by an internal voltage divider. The internal divider has a resistance of 180 kΩ between the V_{IN} and the battery checker sensor pin, and it is set to 3.5 V. However, it is adjustable by using an external resistor. If a higher detection voltage is required, connect a resistor between the GND and the battery checker sensor.

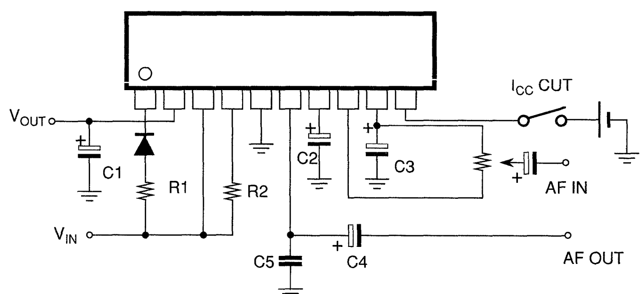
Detection Voltage = 4.0 V ← 33 kΩ
Detection Voltage = 4.2 V ← 20 kΩ

If a lower detection voltage is required, connect a resistor between the V_{IN} battery checker sensor.

Detection Voltage = 3.0 V ← 30 kΩ
Detection Voltage = 2.5 V ← 10 kΩ

LOW BATTERY DETECTION VOLTAGE vs EXTERNAL RESISTOR VALUE





POWER SYSTEM CONTROLLER

FEATURES

- **Auto Power ON/OFF**
- **Watch Dog Timer w/ Reset**
- **Two Independent Regulator Circuits**
- **Wave Shaper Circuit**
- **BTL Audio Power Amplifier**
- **Low Battery Indicator**
- **Power On Reset**
- **Power Save Function**

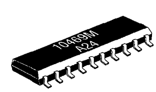
APPLICATIONS

- **Portable Instrumentation**
- **Portable Computers**
- **µP Based Test Equipment**
- **Cordless/Cellular Telephones**

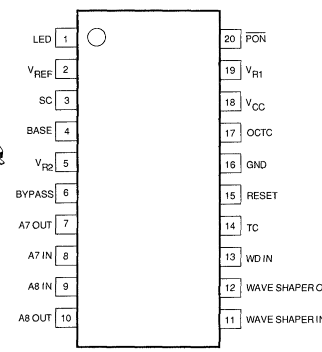
DESCRIPTION

The TK10469 is a power system control IC for cordless and cellular telephones that use a microprocessor. In addition to two separately regulated outputs, a watch dog timer, power on reset, data wave shaper and BTL amplifier is also included. The TK10469 also has automatic power on/off and power save function. The supply current is low in order to achieve an extended battery life.

The TK10469 is available in a MFP20 surface mount package.



TK10469



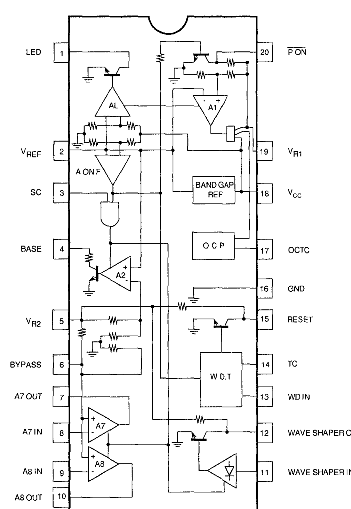
ORDERING INFORMATION

TK10469 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +70 °C	BX: Bulk/Bag TX: Paper Tape TR: Tape Right TL: Tape Left MG: Magazine

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 10 V
Power Dissipation (Note 1) .... 410 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

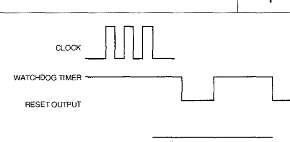
ELECTRICAL CHARACTERISTICS

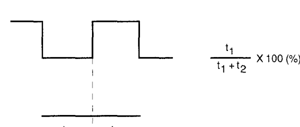
Test conditions: V_{CC} = 5.0 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC1}	Supply Current 1	V_{CC} = 3.5 V, SC = 0 V		30	50	µA
I_{CC2}	Supply Current 2	V_{CC} = 5.0 V, SC = 0 V		2.5	5.0	mA
I_{CC3}	Supply Current 3	V_{CC} = 5.0 V, SC = 2.4 V		4.2	9.0	mA
I_{CC4}	Supply Current 4	V_{CC} = 4.3 V, SC = 0 V		3.3	8.0	mA
I_{CC5}	Supply Current 4	V_{CC} = 4.3 V, SC = 2.4 V		13	20	mA
V_{START}	Start-Up Voltage		4.35	4.6	4.85	V
V_{HYS}	Start-Up Hysteresis Voltage		0.4	0.6	0.8	V
Voltage Regulator Output 1 (V_{R1}, Pin 19)						
V_{O1}	Output Voltage	V_{CC} = 5 V, I_{O1} = 0 mA	4.27	4.5	4.73	V
LI_{REG1}	Input Regulation Level	V_{CC} = 5 V → 10 V		6	50	mV
LD_{REG1}	Load Regulation Level	I_{O1} = 0 mA → 10 mA		3	50	mV
$\Delta V_{O1}/\Delta T_A$	Temperature Dependance	V_{CC} = 5.5 V, I_{O1} = 5 mA		0.4		mV/ °C
RR1	Ripple Removal 1	100 mV(rms), f = 400 Hz, V_{CC} = 6 V, I_{O1} = 10 mA		55		dB
V_{N1}	Output Noise Voltage	10 Hz < f < 100 kHz, I_{O1} = 5 mA		150		µA
V_{DROP}	Input/Output Voltage Drop	I_{O1} = 10 mV		90	200	mV
I_{O1}	Output Current	V_{CC} = 5.0 V	15	27	50	mA
Voltage Regulator Output 2 (V_{R2}, Pin 5)						
V_{O2}	Output Voltage	V_{CC} = 5.0 V, I_{O2} = 0 mA	4.36	4.5	4.64	V
LI_{REG2}	Input Regulation Level	V_{CC} = 5 V → 10 V		23	100	mV
LD_{REG2}	Load Regulation Level	I_{O2} = 0 mA → 60 mA		10	50	mV
$\Delta V_{O2}/\Delta T_A$	Temperature Dependence	V_{CC} = 5.5 V, I_{O2} = 10 mA		0.4		mV/ °C

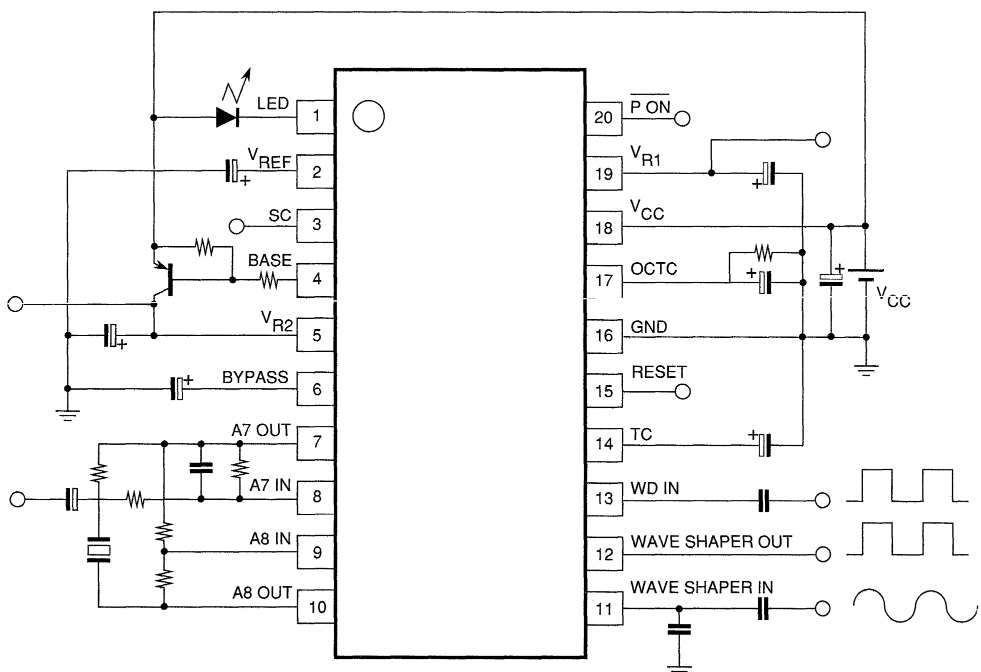
Note 1: Power dissipation must be derated at the rate of 3.3 mW/°C for operation at T_A = 25 °C and above.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{N2}	V_{R2} Output Noise Voltage	10 Hz < f < 100 kHz, I_{O2} = 10 mA		60		µV
I_B	V_{R2} Base Terminal Current	V_{CC} = 5.0 V	8	13		mA
SC Power Save Terminal (SC, Pin 3)						
I_{SC}	SC Terminal Current	SC = 2.4 V		20	100	µA
V_{SC1}	SC Terminal Voltage 1	Note 1	0		0.6	V
V_{SC2}	SC Terminal Voltage 2	Note 1	2.4		V_{CC}	V
BTL Amplifier (Pins 7 and 10)						
V_{OPP}	Output Voltage	V_{CC} = 4.5 V, THD = 5 %, f = 3 kHz	4.0	5.2		Vp-p
V_N	Ouput Noise Voltage	R_G = 620 Ω		100		µV(rms)
V_{OO}	Output Offset Voltage	V_{CC} = 5 V		3	50	mV
THD	Total Harmonic Distortion	V_{CC} = 4.5 V, I_O= 50 mV(rms), f = 3 kHz		0.1	1.0	%
Watchdog Circuit (WD IN, Pin 13)						
T_{OFF}	Clock Off Reset Time	V_{CC} = 5 V	100	310	500	mS
T_{RL}	Reset Pulse Low-Level Time	V_{CC} = 5 V	40	130	300	mS
T_{RH}	Reset Pulse High-Level Time	V_{CC} = 5 V	70	210	400	mS
V_{OL}	Reset Term. Low-Level Volt.		0		0.6	V
Low Battery Detection Circuit						
I_{LED1}	Terminal Current 1	V_{CC} = 4.6 V	0.2	1.4	3.5	mA
I_{LED2}	Terminal Current 2	V_{CC} = 4.3 V	3.0	6.0	9.0	mA
Power On Reset (RESET, Pin 15)						
V_{OL}	Reset Term. Low-Level Volt.		0		0.6	V
Wave Shaper Circuit (WAVE SHAPER OUT, Pin 12)						
DUTY	Duty Factor	Input Signal, f = 1 kHz	40	50	60	%





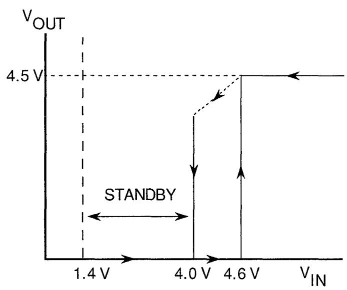
TYPICAL APPLICATION



APPLICATION INFORMATION

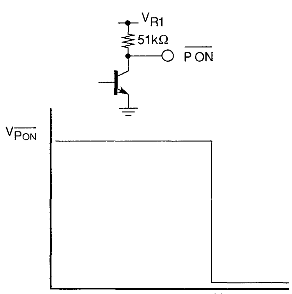
1. Power Supply Voltage Monitoring Circuit (Automatic ON/OFF)

When V_{CC} is greater than 1.4 V, the IC will operate in the standby state. When power is turned off due to low battery power, the current in this standby state is extremely small (TYP = 35 µA). As shown in the diagram below, the IC will leave the standby state when V_{CC} rises above 4.6 V start-up voltage. It will return to the standby state if V_{CC} falls below 4.0 V again. This signal is the initialization signal for the entire chip and controls the operation of voltage regulator, V_{R1}.



2. Power On Reset ($\overline{\text{P ON}}$, Pin 15)

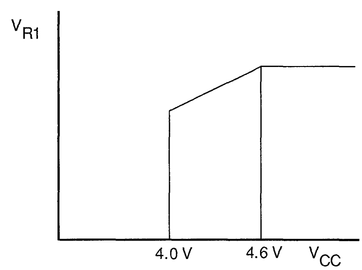
The automatic ON/OFF signal output is connected to voltage reference V_{R1}, through a 51 kΩ resistor. A high-level signal indicates no operation, and a low-level signal indicates operation. When there is a battery backup and the power supply starts up after being off, the signal goes from high to low. It is easy to backup the battery by using this output together with V_{R1}.

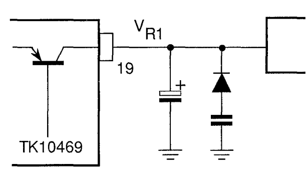


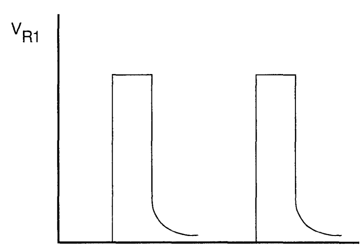
3. Voltage Regulator 1 (V_{R1}, Pin 19)

The output voltage of V_{R1} is 4.5 V. It is linked to the automatic ON/OFF circuit and goes on at 4.6 V and off at 4.0 V. The power transistor is an internal PNP, so it has low saturation. Also, the reverse leakage current is kept near zero, so the charge of capacitors on the output side will not drop in the standby state. The microprocessor can be backed up easily.

Overcurrent protection is provided. If an overcurrent condition occurs, the V_{R1} output switches on and off at a fixed frequency. If the microprocessor has latched up and a large current flows, the circuit should go off and release the latch up. The frequency at which the V_{R1} output oscillates is determined by the capacitance connected to the OCTC terminal. (Pin 17)



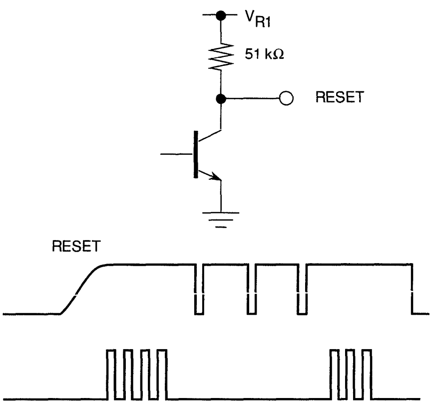




APPLICATION INFORMATION (CONT.)

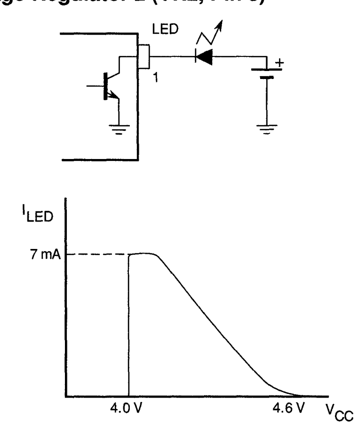
4. Watchdog Timer (WD IN, Pin 13)

The watchdog timer is used to confirm that the microprocessor is operating. The output is pulled up by the V_{R1} output connected through a 51 kΩ resistor. The output oscillates between high and low when no signal is received from the microprocessor. When a clock input is received from the microprocessor, the RESET terminal is set at the high voltage.



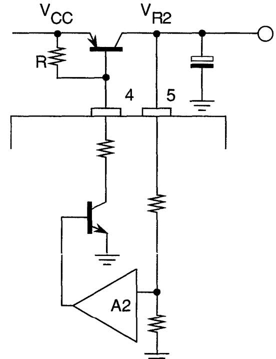
5. LED Indicator (LED, Pin 1)

When the power supply voltage drops below 4.6 V, the current will flow and the LED will be lighted. The current increases as the voltage drops, but goes to zero at 4.0 V. It is an open collector output.



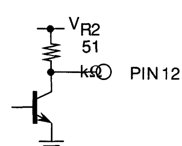
6. Voltage Regulator 2 (VR2, Pin 5)

Connect a PNP transistor and resistor externally. The output voltage is typically 4.5 V with a variation of less than ±3%. The output current will depend upon the PNP transistor connected externally. Output noise can be reduced by connecting a capacitor to the V_{REF} terminal, pin 2. There is no overcurrent protection in this circuit, so care should be taken not to short the output to ground.



7. Wave Shaper Circuit (Wave Shaper Out, Pin 12)

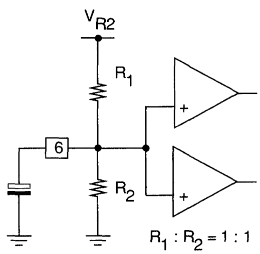
This circuit converts sine or other waves connected to the Wave Shaper Input (Pin 11) to square waves. The output is pulled up by a 51 kΩ resistor connected to V_{R2}.



APPLICATION INFORMATION (CONT.)

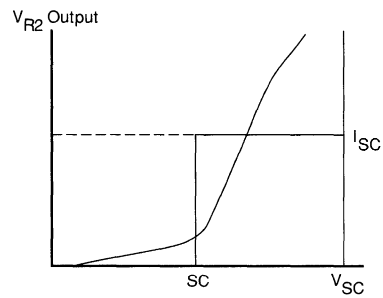
8. BTL Amplifier (Pins 6 through 10)

There are two built in power opamps. The positive input of each opamp is biased by one-half of V_{R2} (about 2.25 V). The BTL amplifier can drive ceramic transducers.



9. SC (Power Save Terminal, Pin 3)

This terminal turns V_{R2}, the wave shaper, and the BTL amplifier on and off. It is active high. When the circuits are not needed, it is possible to save power by setting it to low.



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NOTES

NOTES

LOW-POWER MOTOR CONTROL

FEATURES

- Forward, Reverse, Brake, And Free Run Mode
- CMOS or TTL Compatible
- Built-In Speed Control Circuit
- Wide Operating Voltage Range
- Internal Voltage Reference
- Low Current Consumption
- Low Standby Current

APPLICATIONS

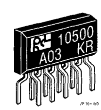
- Small Motor Control
- Robotics
- Autofocus
- Toys
- Motion Control

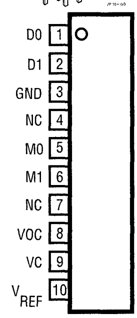
DESCRIPTION

The TK10500 is a bidirectional controller for driving small motors. Direct control of the rotation with CMOS ICs, etc., is possible for small motors used for autofocusing in VCRs, audio reproducing sets, etc. Stable operation and speed control are provided for variations in the battery supply voltage.

The TK10500 is available in a MFP 8-pin surface mount package and a ZIP10-pin zigzag inline plastic package.

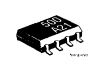
TK10500Z

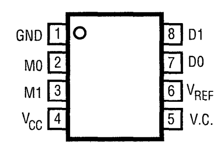




TK10500Z • PA

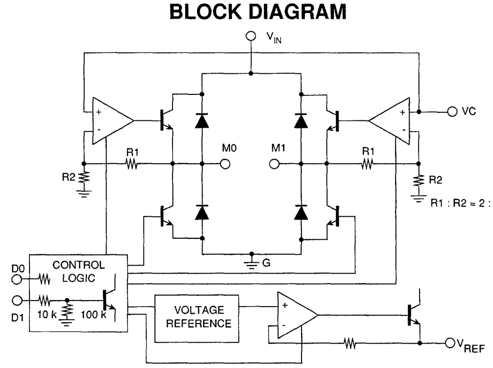
TK10500M





TK10500M • PO

BLOCK DIAGRAM



TK 10500 FIG 05

ORDERING INFORMATION

TK10500 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M : Surface Mount	C : -20 to + 70 °C	BX : Bulk/Bag
Z : ZIP		TX : Paper Tape
		TR : Tape Right
		TL : Tape Left
		MG: Magazine

ABSOLUTE MAXIMUM RATINGS

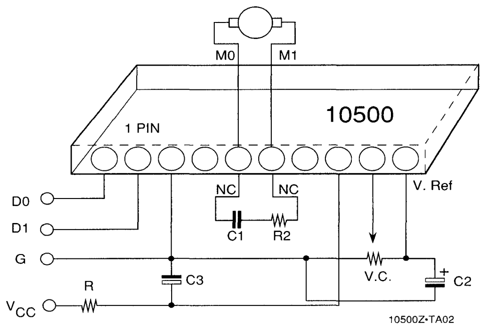
Input Voltage V_{CCMAX} .... 16 V
Power Dissipation MFP8 (Note 1) .... 390 mW
Power Dissipation ZIP10 (Note 2) .... 490 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -15 to +75 °C
Lead Soldering Temp. (10 sec.) .... 240 °C
Output Current (Max) .... 100 mA
Output Voltage .... 15 V
Applicable Voltage to D0 & D1 .... -0.3 to +7.0 V
Applicable Voltage to VC Terminals .... -0.3 to +7.0 V

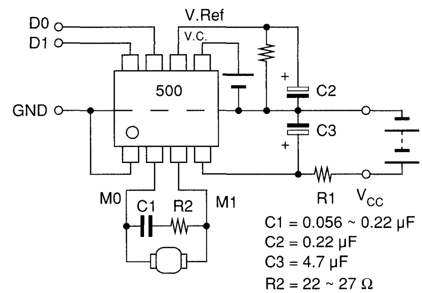
ELECTRICAL CHARACTERISTICS

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Operating Voltage		4.0		14	V
I_O	Output Current	Use within the range of P_O derating curve			100	mA
I_{CC1}	Current Consumption	D1, D0 = 0 V, V_{IN} = 14 V		0.15	2.0	µA
I_{CC2}	Current Consumption	D1, D0 = 2.4 V, V_{IN} = 14 V		8	13	mA
V_{SAT}	Output Saturation Voltage	I_M = 60 mA, Between GND-M0 & M1		150	250	mV
L_{REG1}	Output Voltage Regulation	I_M = 10 to 60 mA, between GND-M0 & M1		100	200	mV
L_{REG2}	Output Voltage Regulation	I_M = 10 to 100 mA, between GND-M0 & M1		160	350	mV
V_{REF}	Reference Voltage	I_{REF} = 1 mA	2.03	2.20	2.30	V
D_{HIGH}	D0, D1 Logic Level: H		2.4			V
D_{LOW}	D0, D1 Logic Level: L				0.6	V
IC_{IN}	D0 Input Current	Voltage applied to D0 terminal: 5 V		70	150	µA
V_{O1}	M0, M1 Setting Voltage	VC = Control Voltage (Note 3)		3X VC		
V_{OUT}	Output Voltage Setting Range	(Note 4)	2.4		$V_{IN-1.1}$	V

Note 1: Power dissipation must be derated at the rate of 3.12 mW/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 4 mW/°C for operation at T_A = 25 °C and above.
Note 3: The voltage between M0, M1 and GND is 3 times the control voltage. (I_M = 0 mA) The value is the same when an external voltage is applied instead of the internal reference.
Note 4: When V_{OS} is set higher than 6 V, use an external voltage. Be sure not to exceed 7 V for the VC terminal voltage. (VC must be equal to or lower than V_{IN}.)

TEST CIRCUITS





Using the D0 and D1 terminals, V_{OUT} 0 and V_{OUT} 1 can be set at ON and Off. The output voltage can be set with the voltage at the VC terminal.

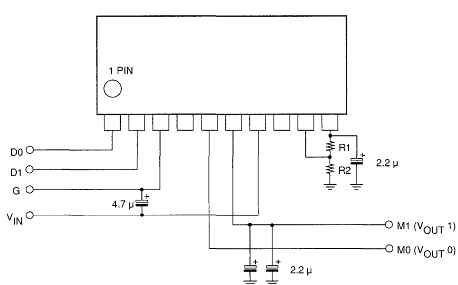
This IC can be used as a regulator of the center-zero type transferred output using the V_{OUT} 0 and 1 connections as follows:

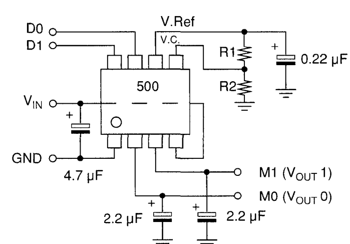
V_{OUT} 0: for output	V_{OUT} 1: zero
V_{OUT} 0: zero	V_{OUT} 1: for output

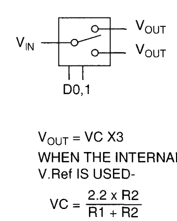
The maximum supply current is 100 mA. Attention must be paid to the package power dissipation limits.

3

TYPICAL APPLICATIONS







APPLICATION INFORMATION

The TK10500 is a monolithic IC for a motor drive which has clockwise and counter-clockwise control functions. The clockwise and counter-clockwise control of motors such as VTR autofocus motors, record player arm controls, and tape recorder set motor drives, can be controlled directly from a CMOS IC.

The device has a logic section to control the clockwise and counter-clockwise revolution and receive four values: clockwise, counter-clockwise, brake, and free. The power section can provide up to 100 mA output as set by the logic section. The IC has a 2.20 V stabilized power supply to operate with a single supply and can control motor speed responding to even a large voltage fluctuation when using a battery. Moreover, when both D0 and D1 are set to low, the current can be decreased to nearly zero.

The control terminals D0 and D1 have thresholds of 0.6 V≤ DTH≤ 2.4 V to be compatible with TTL and CMOS levels. (DTH: The D terminal threshold level is approximately 1.4 V.)

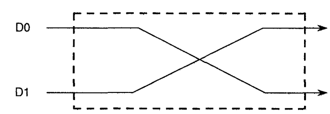
D0 and D1 have pull down resistors of 100 to 150 Ω, therefore external pull down resistors are not required.

Output terminals M0 and M1 are connected to the motor drive power transistor. (The power transistor forms the H bridge.)

TRUTH TABLE

The current flows high to low.

D0	L	H	L	H
D1	L	L	H	H
M0	L	H	L	L
M1	L	L	H	L
MOTOR	FREE	M0→M1	M0←M1	BRAKE



Avoid D0 and D1 being in the transition region simultaneously. The arrow shows the direction of current.

The power transistor is parallel connected to a surge protection diode.

When D0 and D1 are set low, no current flows at all, even if the power supply voltage is applied.

When D0 and D1 are set to low, the reference voltage is also zero.

When D0 and D1 is set to high, leading speed is equal to or less than 50 μs.

APPLICATION NOTE

When starting a motor or changing motor revolution, a large current flows. Keep the power supply impedance low.

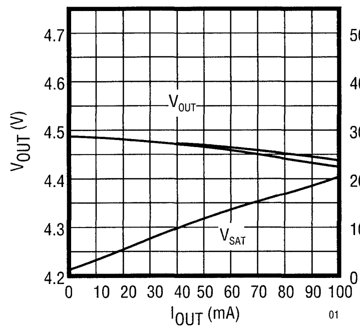
Power losses in the IC depend on the output current and the supply voltage. When setting the supply voltage, be sure to consider package power dissipation rating.

Connect a resistor in series with the V_{CC} terminals to reduce power consumption.

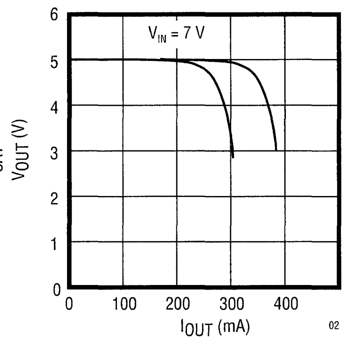
Since the MFP-8 maximum package power dissipation is low, use the PCB copper foil as a heat sink.

TYPICAL PERFORMANCE CHARACTERISTICS

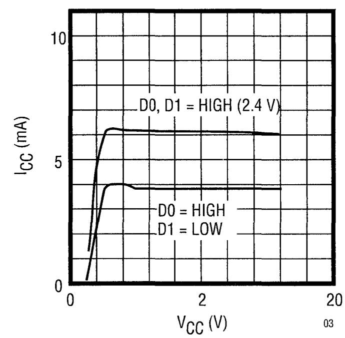
OUTPUT CURRENT vs SATURATION VOLTAGE



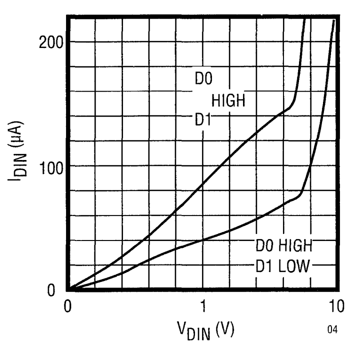
OUTPUT CURRENT vs OUTPUT VOLTAGE



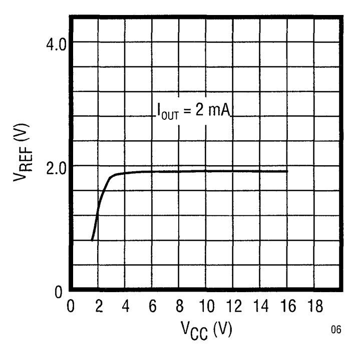
INPUT CURRENT vs INPUT VOLTAGE



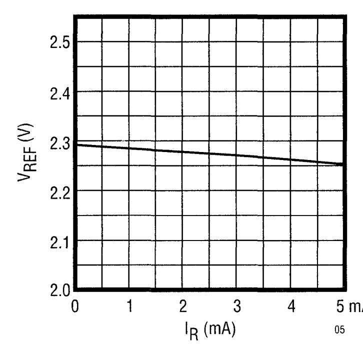
D-TERMINAL INPUT CURRENT vs D-TERMINAL INPUT VOLTAGE



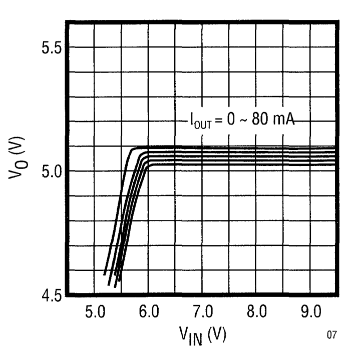
REFERENCE VOLTAGE vs INPUT VOLTAGE



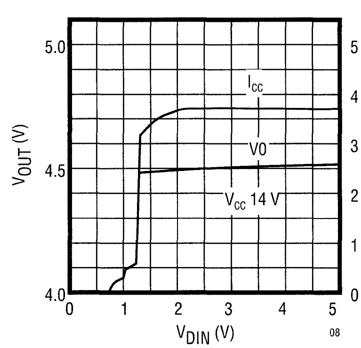
REFERENCE VOLTAGE vs REFERENCE CURRENT



INPUT VOLTAGE vs OUTPUT VOLTAGE



OUTPUT VOLTAGE AND INPUT CURRENT vs D-TERMINAL INPUT VOLTAGE



Pulsed measurements in order to minimize the effects of heating. Data is also available for conditions when the package power is exceeded. The data given above is to demonstrate the capabilities of the device. In the actual application, the package power dissipation limits must be taken into consideration.

NOTES

TOKO

TK10501

LOW-POWER MOTOR CONTROL

FEATURES

- Forward, Reverse, Brake, And Free Run Mode
- CMOS and TTL Control
- Built-In Speed Control Circuit
- Wide Operating Voltage Range
- Internal Voltage Reference
- Low Current Consumption
- Low Standby Current
- Overload And Overheat Protection

APPLICATIONS

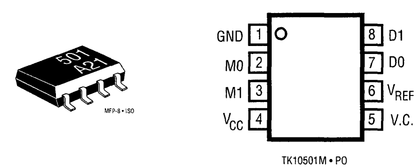
- Small Motor Control
- Robotics
- Autofocus
- Toys
- Motion Control

DESCRIPTION

The TK10501 is a bidirectional controller for driving small motors. Direct control of the rotation with CMOS ICs, etc., is possible for small motors used for autofocusing in VCRs, audio reproducing sets, etc. Stable operation and speed control are provided for regardless of variations in the battery supply voltage. The TK10501 has short circuit protection and thermal overload protection circuitry.

The TK10501 is available in an MFP 8-pin surface mount package.

TK10501



ORDERING INFORMATION

TK10501 □ □ □□

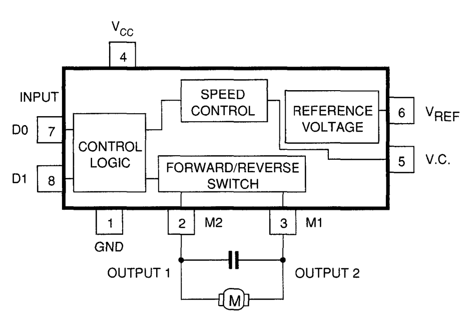
- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE
M : Surface Mount

TEMP. RANGE
C : -15 to +75 °C

TAPE/REEL CODE
BX : Bulk/Bag
TX : Paper Tape
TR : Tape Right
TL : Tape Left
MG: Magazine

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

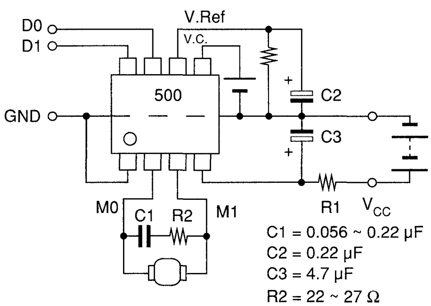
Input Voltage V_{CCMAX} ....16 V
Power Dissipation (Note 1) ....390 mW
Junction Temperature ....150 °C
Storage Temperature Range....................-55 to +150 °C
Operating Temperature Range ....-15 to +75 °C
Lead Soldering Temp. (10 sec.) .... 240 °C
Output Current (Max) ....100 mA
Applicable Voltage to D0 & D1 ....-0.3 to +7.0 V
Applicable Voltage to VC Terminals ....-0.3 to +7.0 V

ELECTRICAL CHARACTERISTICS

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Operating Voltage		4.0		14	V
I_{CC1}	Current Consumption	D1, D0 = 0 V, V_{IN} = 14 V		0.15	2.0	µA
I_{CC2}	Current Consumption	D1, D0 = 2.4 V, V_{IN} = 14 V		8	13	mA
V_{SAT}	Output Saturation Voltage	I_M = 60 mA, between GND-M0 & M1		150	250	mV
L_{REG1}	Output Voltage Regulation 1	I_M = 10 to 60 mA, between GND-M0 & M1		100	200	mV
L_{REG2}	Output Voltage Regulation 2	I_M = 10 to 100 mA, between GND-M0 & M1		160	350	mV
V_{REF}	Reference Voltage	I_{REF} = 1 mA	2.03	2.20	2.30	V
D_{HIGH}	D0, D1 Logic Level: H		2.4			V
D_{LOW}	D0, D1 Logic Level: L				0.6	V
ID_{IN0}	D0 Input Curent	Voltage applied to D0 terminal: 5 V		70	150	µA
ID_{IN1}	D1 Input Curent	Voltage applied to D0 terminal: 5 V		70	150	µA
V_{O1}	M0, M1 Setting Voltage	VC = Control Voltage (Note 2)		3X VC		
V_{OUT}	Output Voltage Setting Range	(Note 3)	2.4		$V_{IN-1.1}$	V

Note 1: Power dissipation must be derated at the rate of 3.12 mW/°C for operation at T_A = 25 °C and above.
Note 2: The voltage between M0, M1 and GND is 3 times the control voltage. (I_M = 0 mA) The value is the same when an external voltage is applied instead of the internal reference.
Note 3: When V_{OUT} is set to higher than 6 V, use an external voltage source. The voltage at the VC terminals should not exceed 7 V. (VC ≤ V_{IN})

TEST CIRCUIT



Using the D0 and D1 terminals, V_{OUT0} and V_{OUT1} can be set ON and OFF. The output voltage can be set with the voltage at the VC terminal.

This IC can be used as a positive or negative regulator using the V_{OUT0} and V_{OUT1} connections as follows:

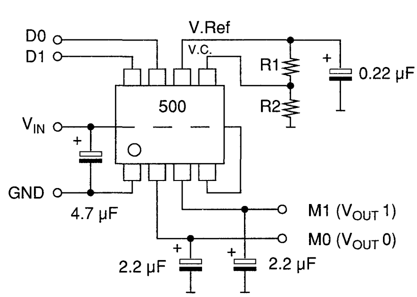
$V_{OUT\ 0}$: for output	$V_{OUT\ 1}$: zero
$V_{OUT\ 0}$: zero	$V_{OUT\ 1}$: for output

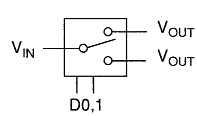
The maximum supply current is 100 mA. Attention must be paid to the package powerdissipation limits.

TRUTH TABLE

D0	L	H	L	H
D1	L	L	H	H
M0	L	H	L	L
M1	L	L	H	L
MOTOR	FREE	M0→M1	M0←M1	BRAKE

TYPICAL APPLICATIONS



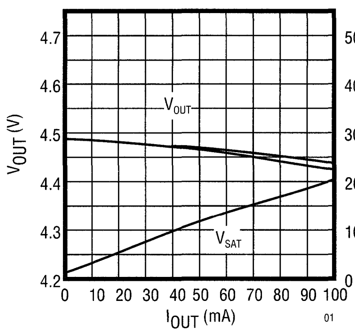


V_{OUT} = VC X3
WHEN THE
INTERNAL V_{REF}
IS USED -

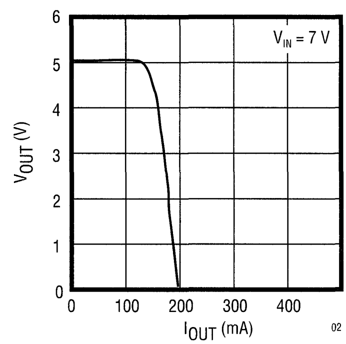
$$VC = \frac{2.2 \times R2}{R1 + R2}$$

TYPICAL PERFORMANCE CHARACTERISTICS

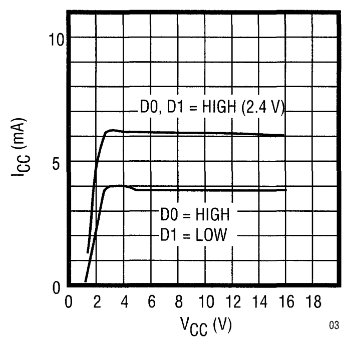
OUTPUT SATURATION vs VOLTAGE OUTPUT CURRENT



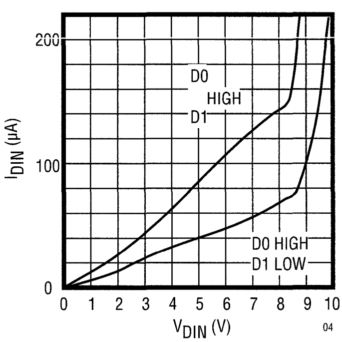
OUTPUT VOLTAGE vs OUTPUT CURRENT



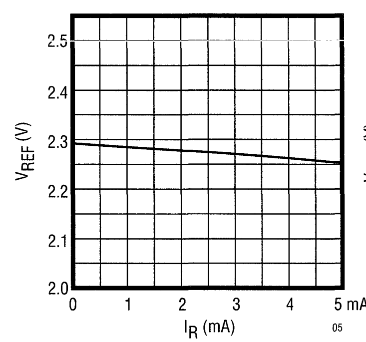
INPUT CURRENT vs INPUT VOLTAGE



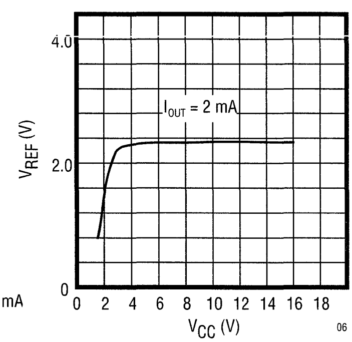
D-TERMINAL INPUT CURRENT vs D-TERMINAL INPUT VOLTAGE



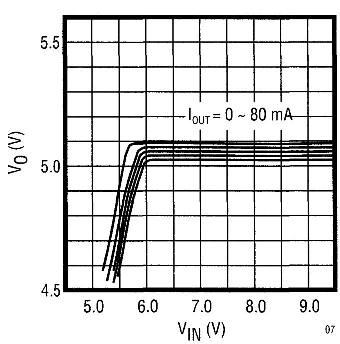
REFERENCE VOLTAGE vs REFERENCE CURRENTS



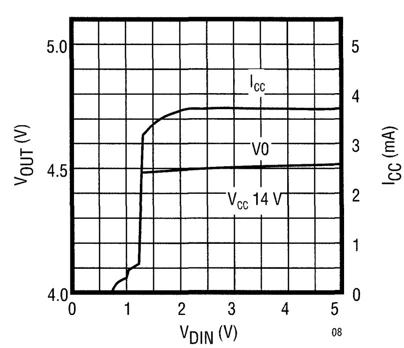
REFERENCE VOLTAGE vs INPUT VOLTAGE



OUTPUT VOLTAGE vs INPUT VOLTAGE



OUTPUT VOLTAGE AND INPUT CURRENT vs D-TERMINAL INPUT VOLTAGE



Pulsed measurements in order to minimize the effects of heating. Data is also available for conditions when the package power is exceeded. The data given above is to demonstrate the capabilities of the element. In the application, package power dissipation must be taken into consideration.

LOW-POWER MOTOR CONTROL

FEATURES

- Forward, Reverse, Brake, And Free Run Mode
- CMOS And TTL Compatible
- Built-In Speed Control Circuit
- Wide Operating Voltage Range
- Internal Voltage Reference
- Low Current Consumption
- Low Standby Current
- Overload And Overheat Protection

APPLICATIONS

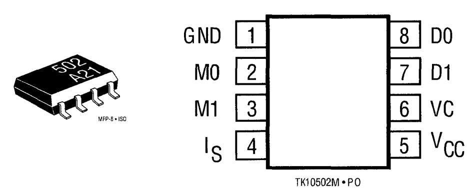
- Small Motor Control
- Robotics
- Autofocus
- Toys
- Motion Control

DESCRIPTION

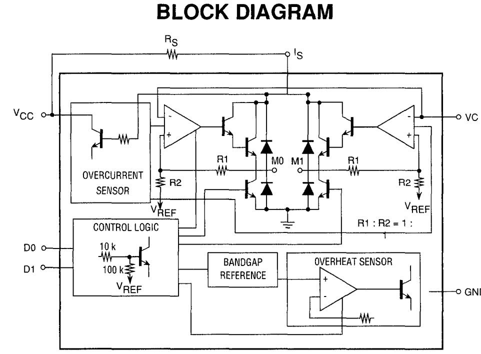
The TK10502 is a bidirectional controller for driving small motors. Direct control of the rotation with CMOS ICs, etc., is possible for small motors used for autofocusing in VCRs, audio reproducing sets, etc. Stable operation and speed control are provided, regardless of variations in the battery supply voltage. The TK10502 has short circuit protection circuitry and internal thermal overload protection as well.

The TK10502 is availabe in an MFP 8-pin surface mount package.

TK10502



BLOCK DIAGRAM



ORDERING INFORMATION

TK10502 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M : Surface Mount	C : -15 to +75 °C	BX : Bulk/Bag TX : Paper Tape TR : Tape Right TL : Tape Left MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 16 V
Power Dissipation (Note 1) .... 600 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -15 to +75 °C
Lead Soldering Temp. (10 sec.) .... 240 °C
Output Current .... 600 mA
Output Voltage .... 15 V
Applicable Voltage to D0 & D1 .... -0.3 to +7.0 V
Applicable Voltage to VC Terminals .... -0.3 to +7.0 V
Overheat Sensor Operating Temp. .... 140 °C

ELECTRICAL CHARACTERISTICS

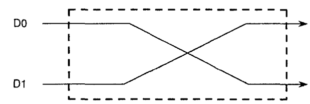
V_{IN} = 6.0 V, V_O = 4.5 V, T_A = 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Operating Voltage		4.0		14	V
I_O	Output Current	Note 2	500			mA
I_{CC1}	Supply Current 1	D1, D0 = 0 V, V_{IN} = 12 V			5.0	µA
I_{CC2}	Supply Current 2	D1 or D0 High, D0 = H, D1 = L, or D0 = L, D1 = H	6	8.5	13	mA
I_{CC3}	Supply Current 3	D1, D0 = 2.4 V, V_{IN} = 8 V	12	18.0	24	mA
V_{SAT}	Output Saturation Voltage	I_M = 300 mA, (GND-M0 & M1)		230	350	mV
L_{REG1}	Output Voltage Regulation 1	I_M = 100 mA, (GND-M0 & M1)		40	120	mV
L_{REG2}	Output Voltage Regulation 2	I_M = 300 mA, (GND-M0 & M1)		140	350	mV
D_{HIGH}	D0, D1 Logic Level: H		2.4			V
D_{LOW}	D0, D1 Logic Level: L		-0.3		0.5	V
IL_{IH}	D0, D1 Input Curent	D0, D1 impressed is 5 V		100	300	µA
V_{O1}	M0, M1 Setting Voltage	VC = Control Voltage (Note 3)	-3.5	2X VC	+3.5	%
V_{OUT}	Output Voltage Setting Range		2.4		$V_{IN-1.1}$	V
Tr	M0, M1 Rise Time	I_O = 300 mA, Resistor loaded, Cl = 0.22 µF	10		200	µS

Note 1: Power dissipation must be derated at the rate of 4.8 mW/°C for operation at T_A = 25 °C and above.
Note 2: Use within the derating curve of Power Dissipation.
Note 3: Control voltage times 2 equals the voltage between GND and M0 and M1. I_M = 0 mA

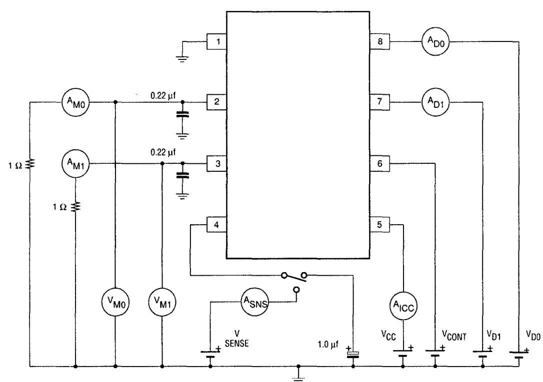
TRUTH TABLE

D0	L	H	L	H
D1	L	L	H	H
M0	L	H	L	L
M1	L	L	H	L
MOTOR	FREE	M0→M1	M0←M1	BRAKE

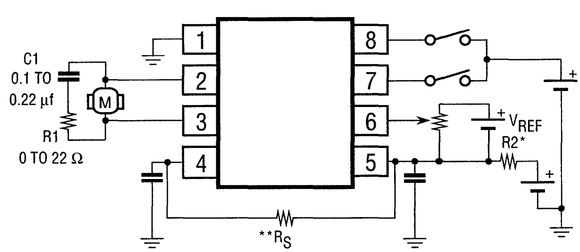


Arrows show current direction. D0, D1 must not be in the transition region at the same time.

TEST CIRCUIT



TYPICAL APPLICATIONS



$$I_{LIM} = \frac{0.60}{R_S}$$

*R2 IS USED WHEN THE POWER LOSS IS LARGE DUE TO HIGHER SUPPLY VOLTAGES.

**R_S IS USED WHEN THE OVERCURRENT SENSOR IS IN OPERATION.

NOTES

VOLTAGE REGULATOR WITH ON/OFF SWITCH

FEATURES

- Low Dropout Voltage
- CMOS/TTL Compatible ON/OFF Switch
- Very Low Standby Current 180 μA (ON, No Load)
- Internal Thermal Shutdown
- Short Circuit Protection
- Very Low (0.1 μA) Current in OFF Mode
- Low Noise with External Bypass Capacitor
- 130 mA Current Capability

APPLICATIONS

- Battery Powered Systems
- Cellular Telephones
- Pagers
- Personal Communications Equipment
- Portable Instrumentation
- Portable Consumer Equipment
- Radio Control Systems
- Toys
- Low Voltage Systems

DESCRIPTION

The TK112XX is a low power, linear regulator with a built-in electronic switch. The internal electronic switch can be controlled by TTL or CMOS logic levels. The device is in the ON state when the control pin is pulled to a high logic level. A pin for a bypass capacitor is provided, which connects to the internal circuitry, to lower the overall output noise level.

An internal PNP pass-transistor is used in order to achieve low dropout voltage (typically 100 mV at 30 mA load current). The device has very low quiescent current (180 μA) in the ON mode with no load and 1 mA with 30 mA load. The quiescent current is typically 2.5 mA at 60 mA load. When the device is in standby mode (V_{CONT} = 0) , the quiescent current is typically 100 nA. An internal thermal shutdown circuit limits the junction temperature to below 150 °C. The load current is internally monitored and the device will shut down in the presence of a short circuit at the output.

Custom versions of the IC are available and the regulated output voltage may be specified in 0.5 V increments between 2.0 to 5.5 V. Additionally, 3.25 V, 6.0 V and 8.0 V versions can be obtained.

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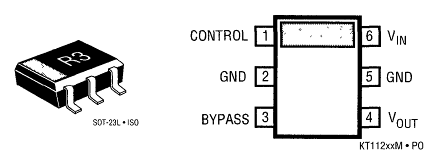
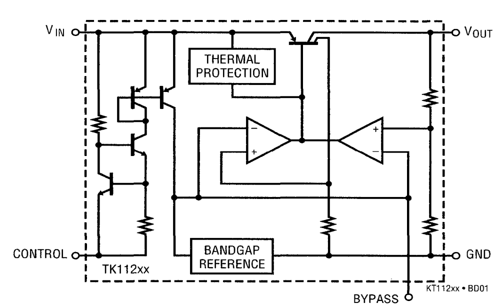
TK112XXM



BLOCK DIAGRAM



ORDERING INFORMATION

TK112 □□ □ □ □□

- Voltage Code
- Package Code
- Temp. Range
- Tape/Reel Code

VOLTAGE CODE

20 = 2.0 V	27 = 2.75 V	40 = 4.0 V
21 = 2.1 V	30 = 3.0 V	45 = 4.5 V
22 = 2.25 V	32 = 3.25 V	47 = 4.75 V
25 = 2.5 V	35 = 3.5 V	50 = 5.0 V
		55 = 5.5 V

PACKAGE CODE
T : Surface Mount

TEMP. RANGE
I : -40 to +85 °C

TAPE/REEL CODE
BX : Bulk/Bag
TX : Paper Tape
TR : Tape Right
TL : Tape Left
MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Supply Voltage .... 16 V
Output Voltage .... V_{OUT} x1.15 V
Output Current .... 220 mA
Power Dissipation (Note 1) .... 200 mW
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range (Note 2) ..... -40 to +85 °C
Lead Soldering Temp. (10 sec.) .... 240 °C
Junction Temperature .... 15 °C

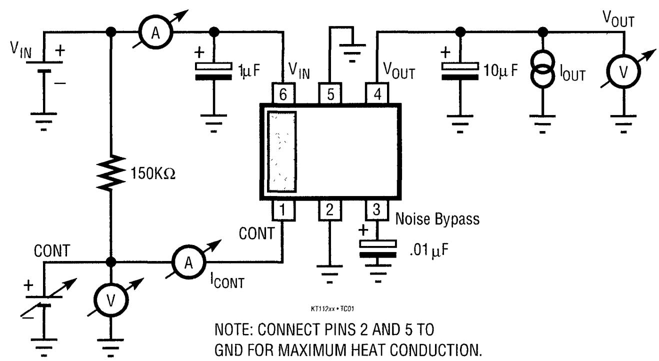
ELECTRICAL CHARACTERISTICS

Test conditions: T_A = 25 °C, unless otherwise specified.

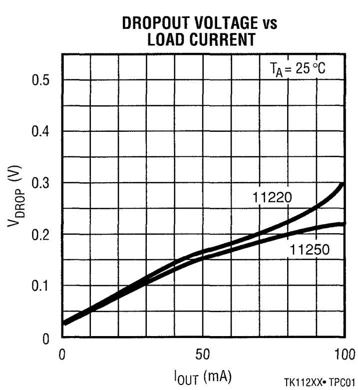
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC1}	Supply Current 1	I_O = 0 mA, Except I_{CONT}		180.0		µA
I_{CC2}	Supply Current 2	V_{IN} = 8 V, Output off			100	nA
V_O	Output Voltage	$V_{IN} = V_O$ + 1 V, I_O = 30 mA	-3	V_O	+3	%
V_O	Output Voltage	$V_{IN} = V_O$ = 030 mA	-100	V_O	+100	%
V_{DROP}	In/Out Voltage Drop	I_O = 30 mA		0.1		V
I_O	Output Current	Note 3	150	180		mA
I_{OR}	Recommended Output Current				130.0	mA
LinReg	Line Regulation	$V_{IN} = V_O$ + (1~ 6)			0.12	%/V
LoaReg	Loading Regulation 1	I_O = 0 mA ~ 60 mA, Note 4			0.03	%/mA
RR	Ripple Rejection Temperature Coefficient	100 mV(rms), f = 400 Hz, I_O = 10 mA, V_O + 1.5 V		60.0		dB
$\Delta V_O/\Delta T_A$	Temperature Dependency of V_O	I_O = 10 mA, V_O + 1.5 V T_A = -25 ~ + 75 °C		0.2		mV/ °C
V_{NO}	Output Noise Voltage	10 Hz < f < 80 kHz, I_O = 10 mA		30.0		µV(rms)
Control Terminal Specification						
I_{CONT}	Control Terminal Current	Output on, V_{CONT} = 2.4 V		15.0	40.0	µA
V_{CONT1}	Control Terminal Voltage 1	Output on	2.4			V
V_{CONT2}	Control Terminal Voltage 2	Output off			0.6	V
T_R	Output Rise Time	I_O = 60 mA, V_{CONT} = O V ~ 2.4 V		0.2	1.0	ms
	Bypass Terminal Voltage			1.25		V

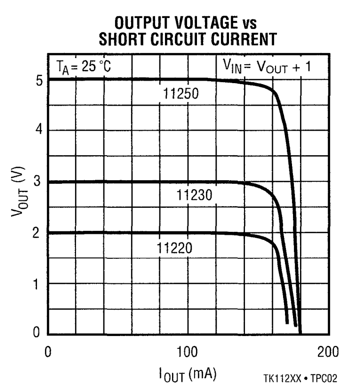
Note 1: Power dissipation must be derated at rate of 1.6 mW/°C for operation at 25 °C and over. Power dissipation = 400 mW (When mounted as recommended.)
Note 2: Output side capacitor should have low ESR at low temperatures if used below 0 °C.
Note 3: I_O (Load Current) is the measured current when V_O drops 0.3 V with respect to (V_O at I_O = 30 mA).
Note 4: This measurement (pulse measurement) is with a constant T_J. The output change due to temperature change is not included.

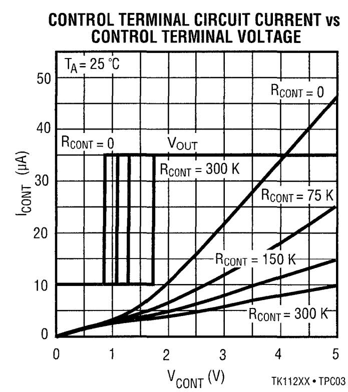
TEST CIRCUIT

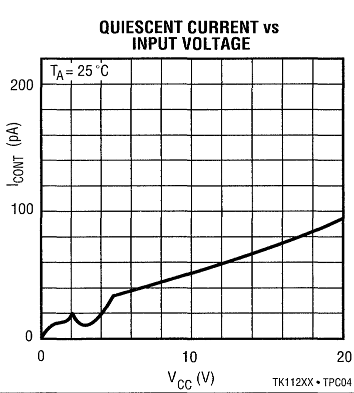


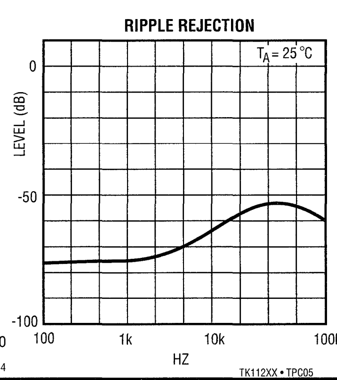
TYPICAL PERFORMANCE CHARACTERISTICS

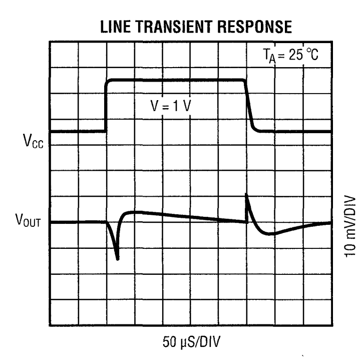






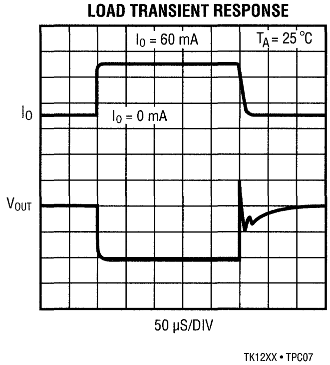




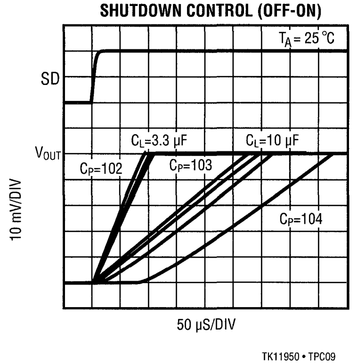


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

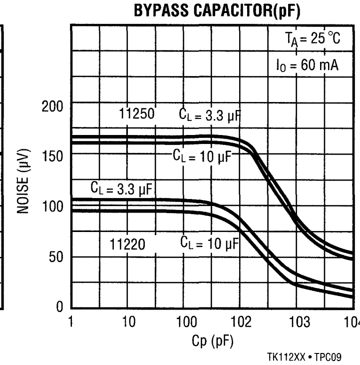
LOAD TRANSIENT RESPONSE



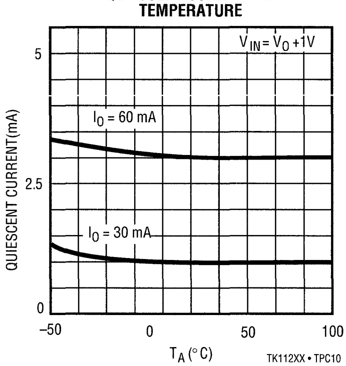
SHUTDOWN CONTROL (OFF-ON)



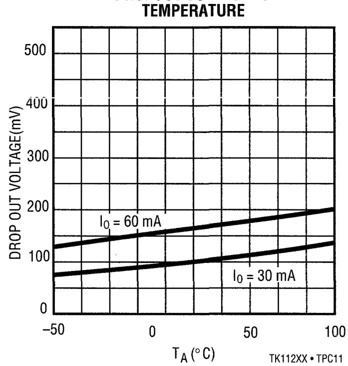
NOISE LEVEL vs BYPASS CAPACITOR(pF)



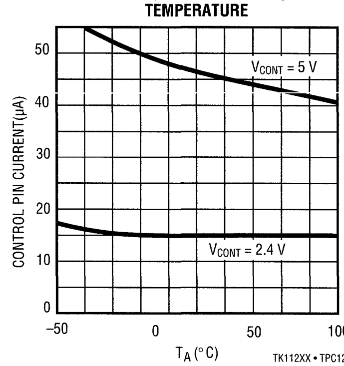
QUIESCENT CURRENT vs TEMPERATURE



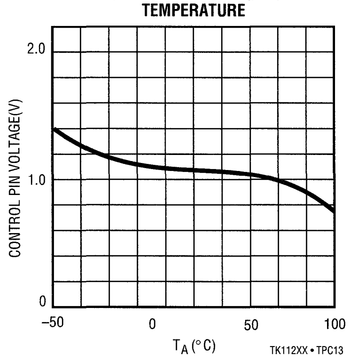
DROPOUT VOLTAGE vs TEMPERATURE



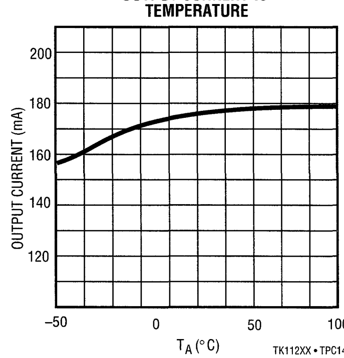
CONTROL PIN CURRENT vs TEMPERATURE



CONTROL PIN VOLTAGE vs TEMPERATURE



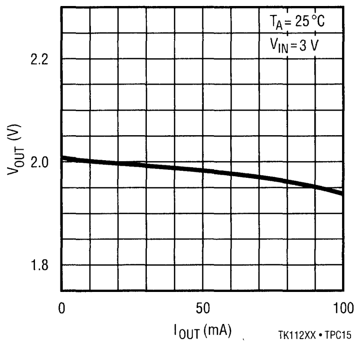
OUTPUT CURRENT vs TEMPERATURE



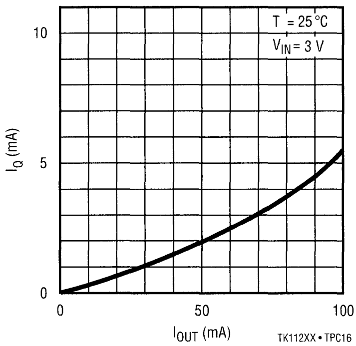
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11220

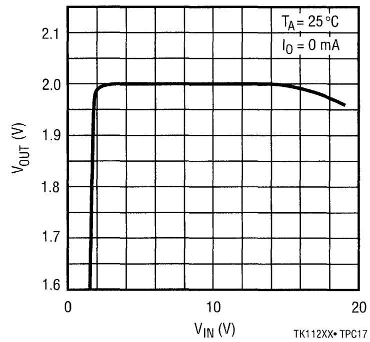
OUTPUT VOLTAGE vs OUTPUT CURRENT



QUIESCENT CURRENT vs LOAD CURRENT



OUTPUT VOLTAGE vs INPUT VOLTAGE



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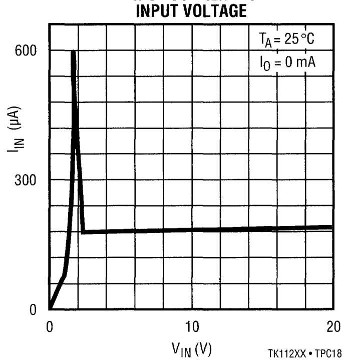
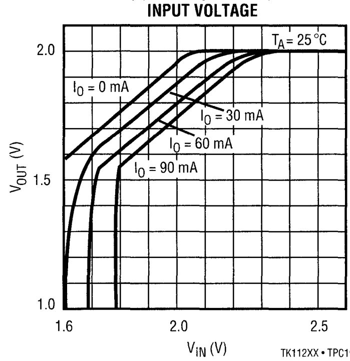
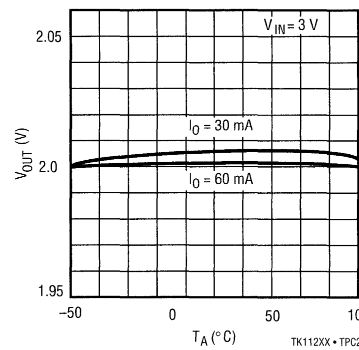
INPUT CURRENT vs INPUT VOLTAGE



OUTPUT VOLTAGE vs INPUT VOLTAGE

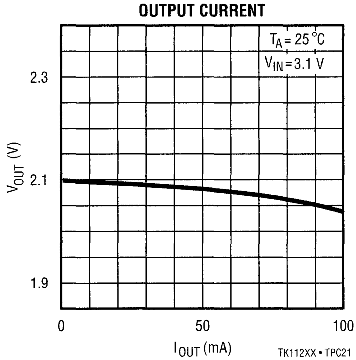


OUTPUT VOLTAGE vs TEMPERATURE

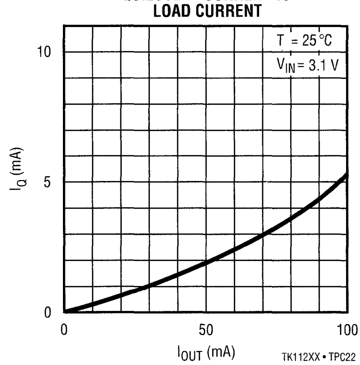


TK11221

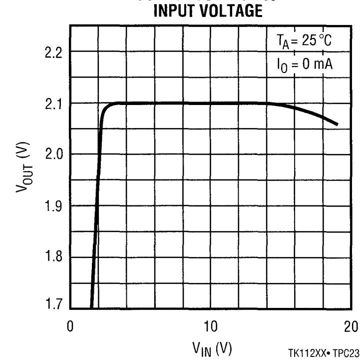
OUTPUT VOLTAGE vs OUTPUT CURRENT



QUIESCENT CURRENT vs LOAD CURRENT



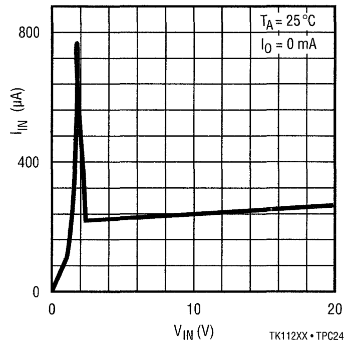
OUTPUT VOLTAGE vs INPUT VOLTAGE



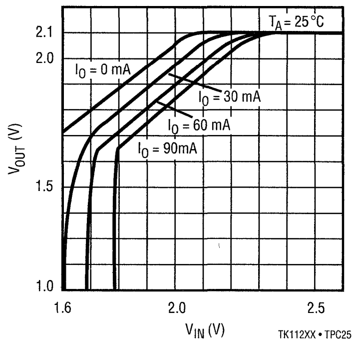
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11221 (CONT.)

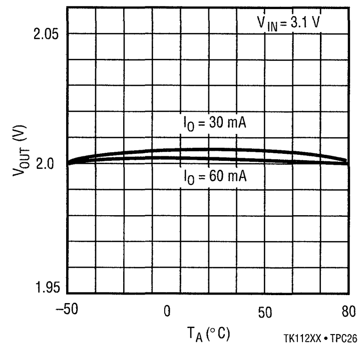
INPUT CURRENT vs INPUT VOLTAGE



OUTPUT VOLTAGE vs INPUT VOLTAGE

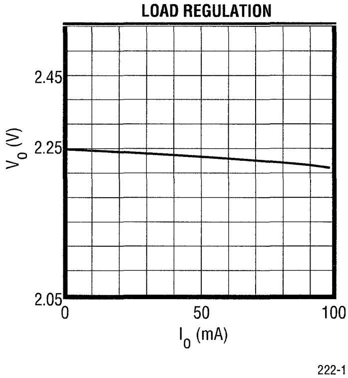


OUTPUT VOLTAGE vs TEMPERATURE

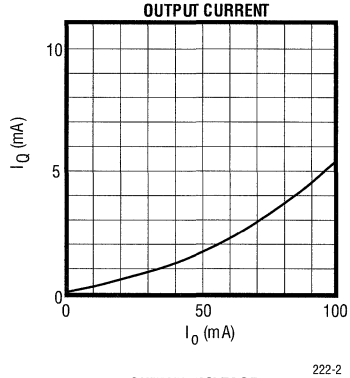


TK11222

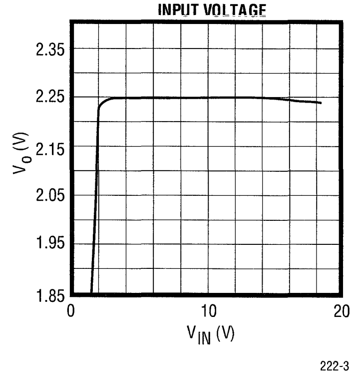
LOAD REGULATION



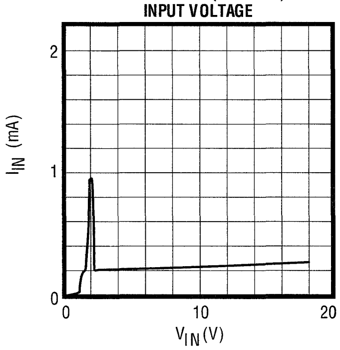
QUIESCENT CURRENT vs OUTPUT CURRENT



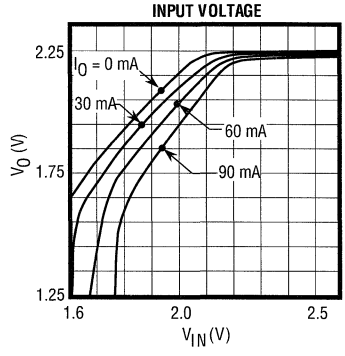
OUTPUT VOLTAGE vs INPUT VOLTAGE



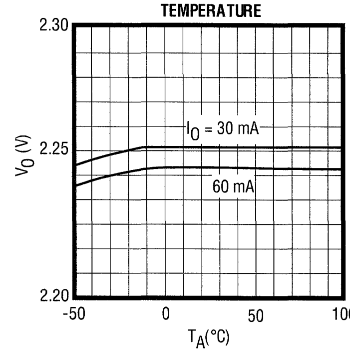
INPUT CURRENT (NO LOAD) vs INPUT VOLTAGE



OUTPUT VOLTAGE vs INPUT VOLTAGE



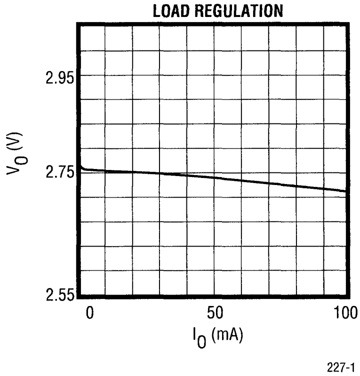
OUTPUT VOLTAGE vs TEMPERATURE



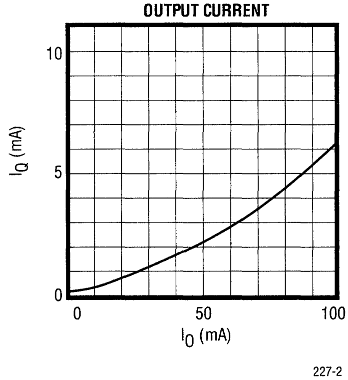
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11227

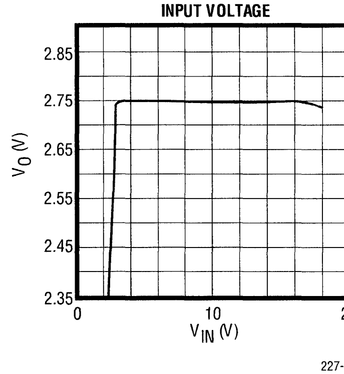
LOAD REGULATION



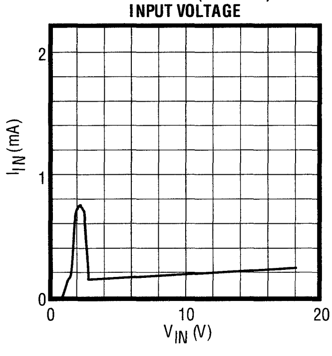
QUIESCENT CURRENT vs OUTPUT CURRENT



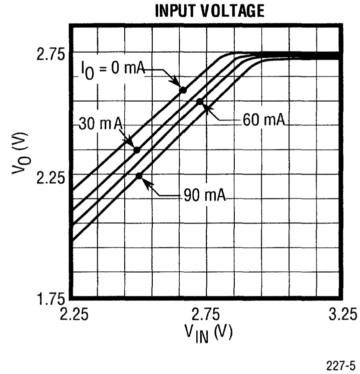
OUTPUT VOLTAGE vs INPUT VOLTAGE



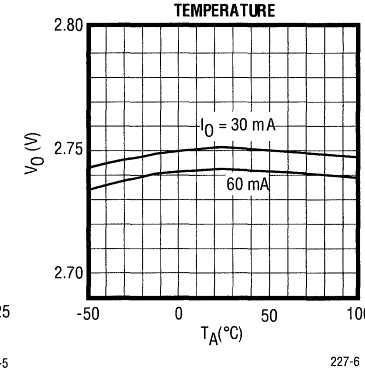
INPUT CURRENT (NO LOAD) vs INPUT VOLTAGE



OUTPUT VOLTAGE vs INPUT VOLTAGE

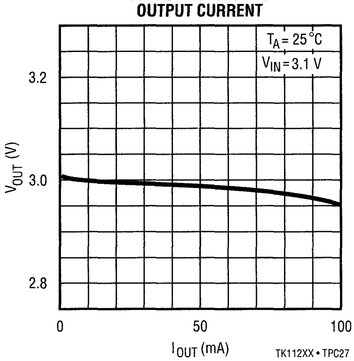


OUTPUT VOLTAGE vs TEMPERATURE

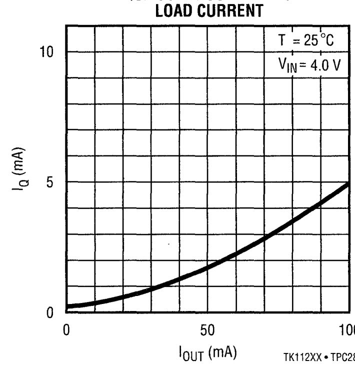


TK11230

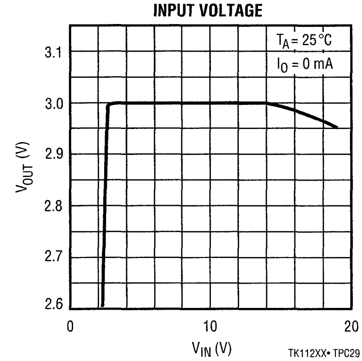
OUTPUT VOLTAGE vs OUTPUT CURRENT



QUIESCENT CURRENT vs LOAD CURRENT



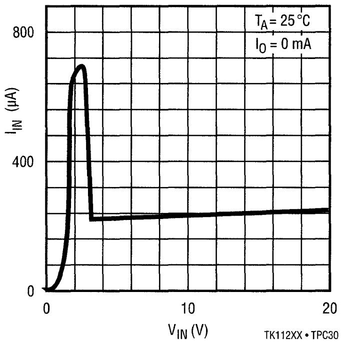
OUTPUT VOLTAGE vs INPUT VOLTAGE



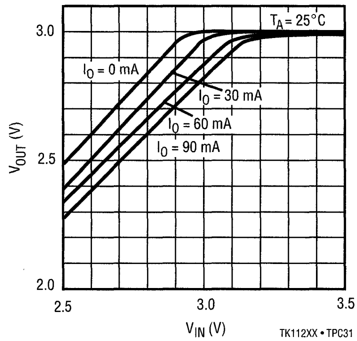
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11230 (CONT.)

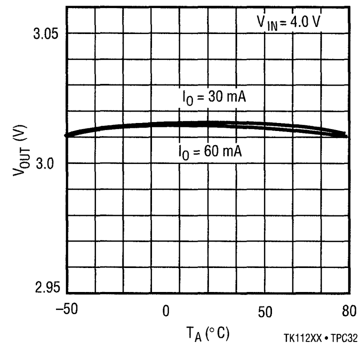
INPUT CURRENT vs INPUT VOLTAGE



OUTPUT VOLTAGE vs INPUT VOLTAGE

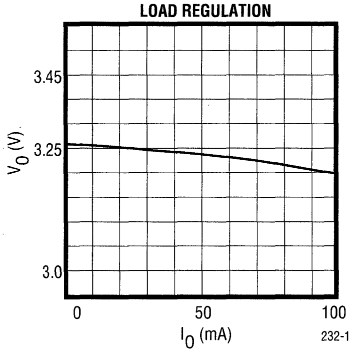


OUTPUT VOLTAGE vs TEMPERATURE

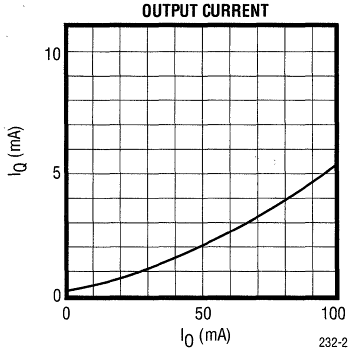


TK11232

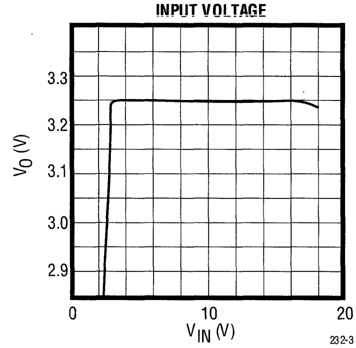
LOAD REGULATION



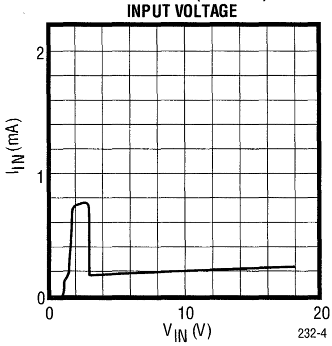
QUIESCENT CURRENT vs OUTPUT CURRENT



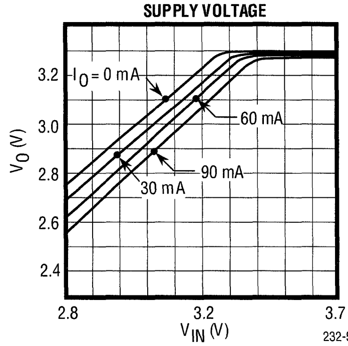
OUTPUT VOLTAGE vs INPUT VOLTAGE



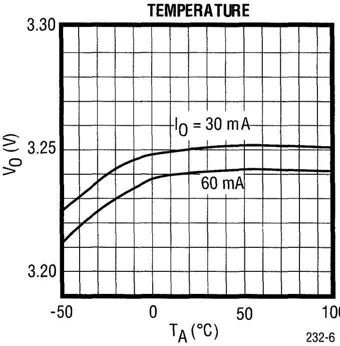
INPUT CURRENT (NO LOAD) vs INPUT VOLTAGE



OUTPUT VOLTAGE vs SUPPLY VOLTAGE

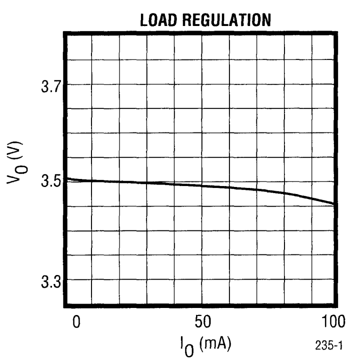


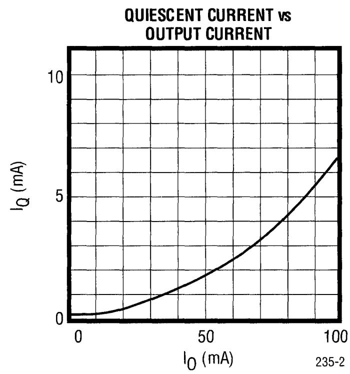
OUTPUT VOLTAGE vs TEMPERATURE

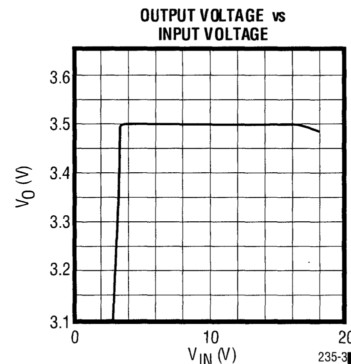


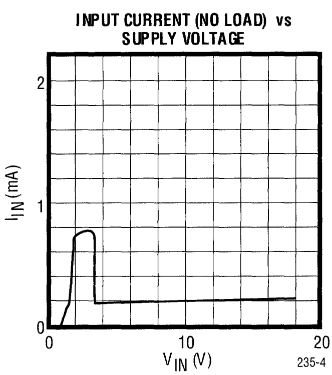
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

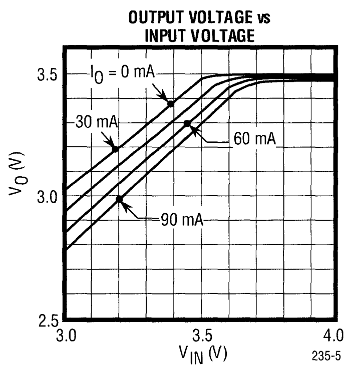
TK11235

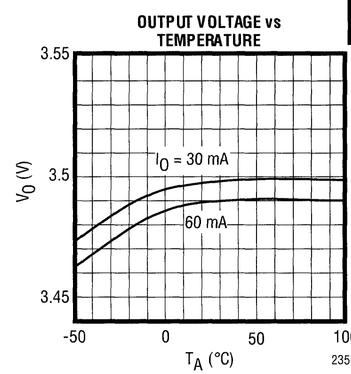












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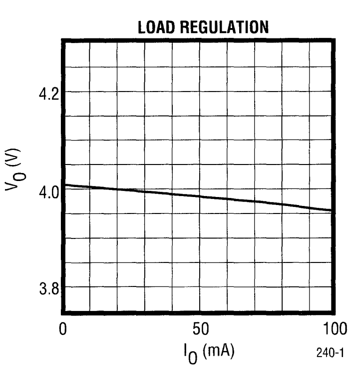
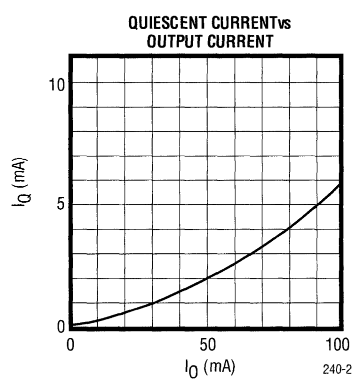
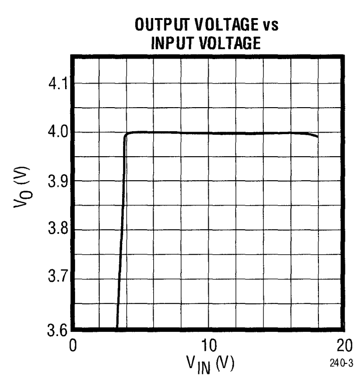
TK11240



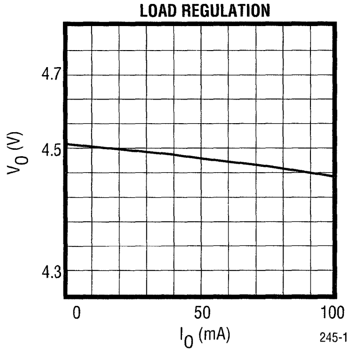




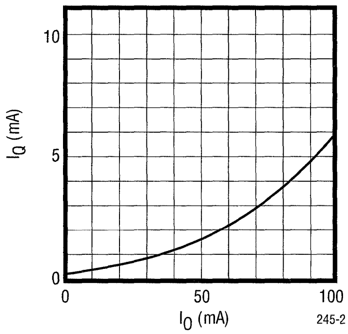
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11245

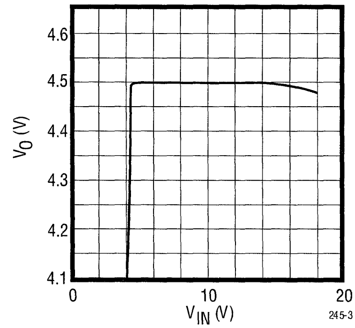
LOAD REGULATION



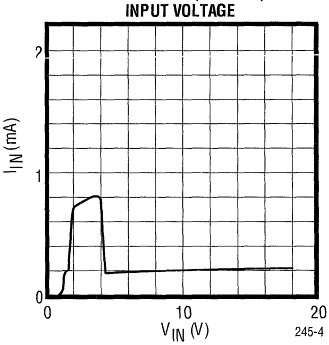
QUIESCENT CURRENT vs OUTPUT CURRENT



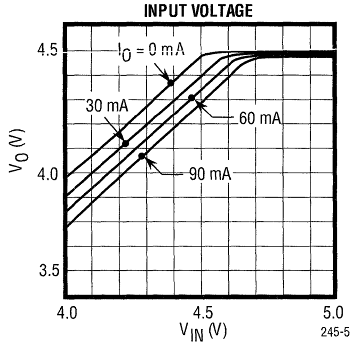
OUTPUT VOLTAGE vs INPUT VOLTAGE



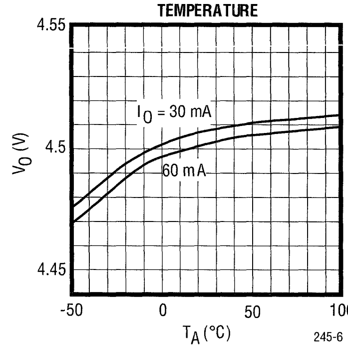
INPUT CURRENT (NO LOAD) vs INPUT VOLTAGE



OUTPUT VOLTAGE vs INPUT VOLTAGE

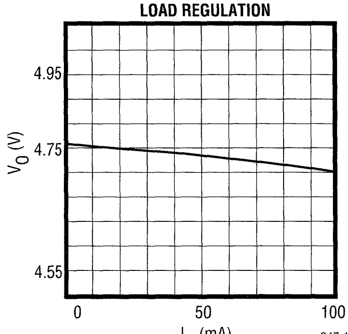


OUTPUT VOLTAGE vs TEMPERATURE

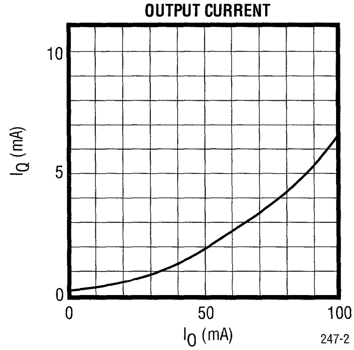


TK11247

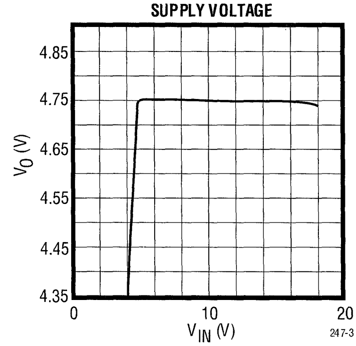
LOAD REGULATION



QUIESCENT CURRENT vs OUTPUT CURRENT

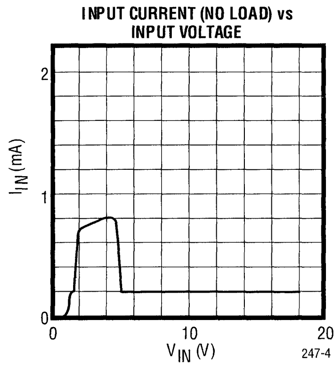


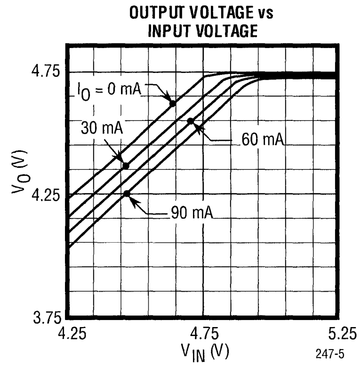
OUTPUT VOLTAGE vs SUPPLY VOLTAGE

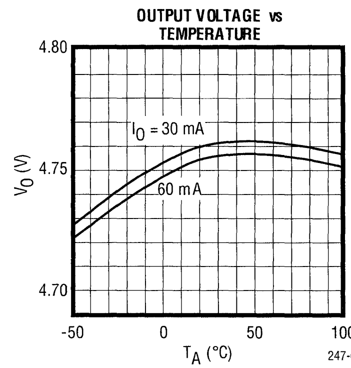


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

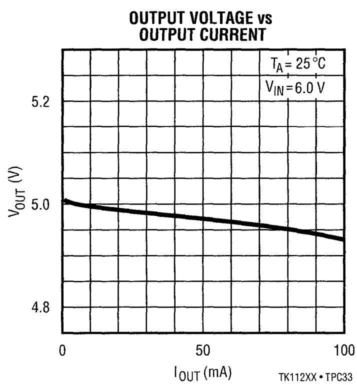
TK11247 (CONT.)

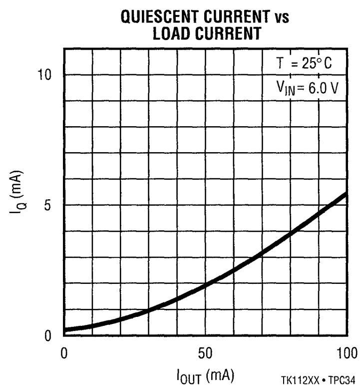


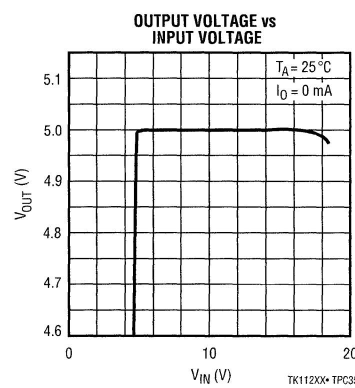


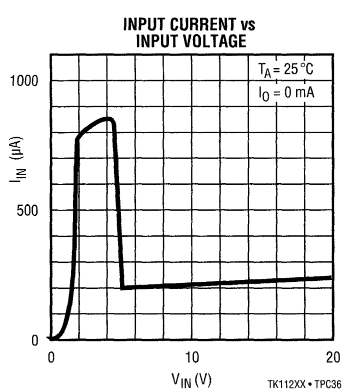


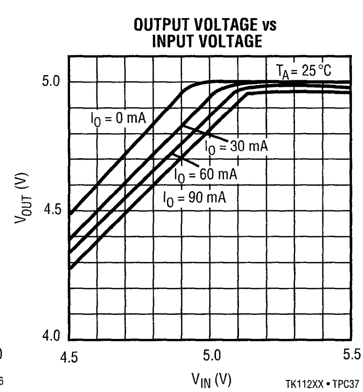
TK11250

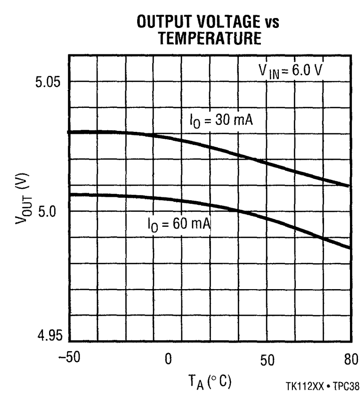








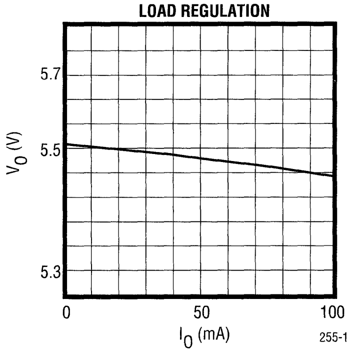




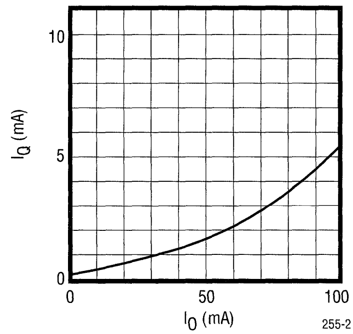
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11255

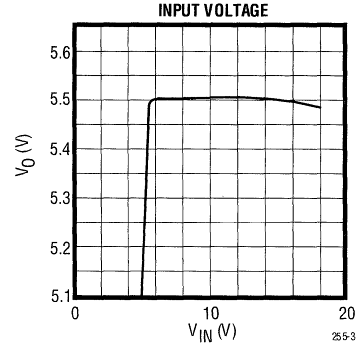
LOAD REGULATION



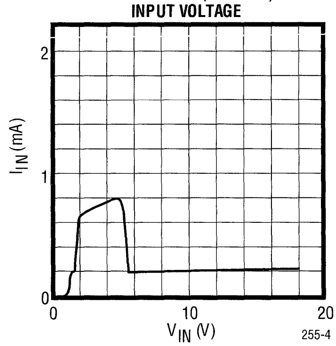
QUIESCENT CURRENT vs OUTPUT CURRENT



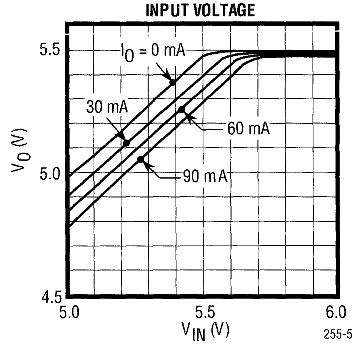
OUTPUT VOLTAGE vs INPUT VOLTAGE



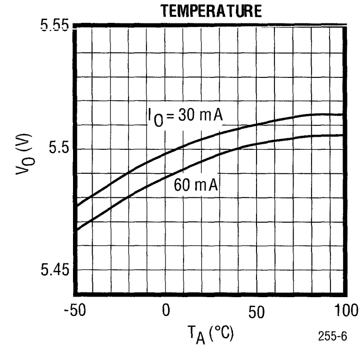
INPUT CURRENT (NO LOAD) vs INPUT VOLTAGE



OUTPUT VOLTAGE vs INPUT VOLTAGE



OUTPUT VOLTAGE vs TEMPERATURE



APPLICATIONS INFORMATION

1.) DISABLING THE CONTROL PIN

Connect control terminal to V_{CC} through R. Higher resistance values are good for reducing quiescent current but can cause the regulator to drop out at a higher voltage. (0 Ω <R< 300 kΩ.) See Figure A.

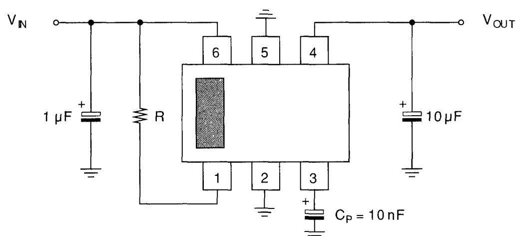


Figure A.

2.) USING THE CONTROL FUNCTION

Turn on the regulator by setting the control pin voltage to the same level as V_{IN}. Turn off the regulator by grounding the control pin. See Figure B.

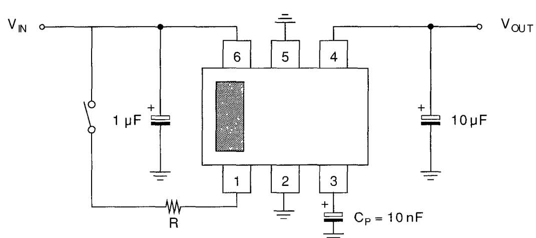


Figure B.

3.) HEAT DISSIPATION

Make the copper pattern as large as possible to provide good heat dissipation (pin 5 is the heatsink).
P_D = 400 mW (When mounted as recommended)
See Figure C.

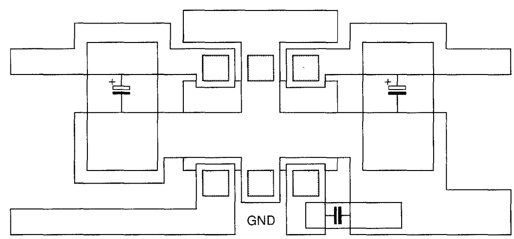


Figure C.

4.) BYPASS CAPACITOR

Connect the bypass capacitor as close as possible to the GND terminal of IC (Pin 5,2), otherwise oscillation may occur. Use a 3.3 µF tantalum capacitor, or 5.6 µF electrolytic to ensure stability. (T_A = 25 C) For low temperatures, select a capacitor with low ESR at the desired temperature range. Use as large a capacitor as needed to meet transient, output impedance, and noise requirements. The noise bypass pin has high impedance, and it is sensitive to external noise if C_P is not used.

5. Handling Molded Resin Packages

All Plastic molded packages absorb some moisture from the air. If moisture absorption occurs prior to soldering the devise into the printed circuit board, increased separation of the lead from the plastic molding may occur, degrading the moisture barrier characteristics of the device.
This property of plastic molding compounds should not be overlooked, particularly in the case of very small packages, where the plastic is very thin.
In order to preserve the original moisture barrier properties of the package, devices are stored and shipped in moisture proof bags, filled with dry air. The bags should not be opened or damaged prior to the actual use of the devices. If this is unavoidable, the devices should be stored in a low relative humidity environment (40 to 65%) or in an enclosed environment with desiccant.

3

NOTES

VOLTAGE REGULATOR WITH ON/OFF SWITCH

FEATURES

- Low Dropout Voltage
- Electronic ON/OFF Switch
- Very Low Standby Current (ON, No Load)
- Internal Thermal Shutdown
- Short Circuit Protection
- Very Low (<100 nA) Current in OFF Mode
- 100 mA Load Capability
- Customized Versions Are Available

APPLICATIONS

- Battery Powered Systems
- Cellular Telephones
- Pagers
- Personal Communications Equipment
- Portable Instrumentation
- Portable Consumer Equipment
- Radio Control Systems
- Toys
- Low Voltage Systems

DESCRIPTION

The TK114xx is a low power, linear regulator with a built-in electronic switch. The internal electronic switch can be controlled by an external pull-up resistor and an open drain or open collector transistor. The device is in the OFF state when the control pin is biased from V_{IN} through the pull-up resistor.

An internal PNP pass-transistor is used in order to achieve low dropout voltage (typically 200 mV at 50 mA load current). The device has very low quiescent current (500 µA) in the ON mode with no load and 2 mA with 30 mA load. The quiescent current is typically 4 mA at 60 mA load. An internal thermal shutdown circuit limits the junction temperature to below 150 °C. The load current is internally monitored and the device will shut down (no load current) in the presence of a short circuit at the output. The regulated output voltage may be specified in 0.5 V increments between 2.0 to 5.5 V. Additionally, 3.25 V, 6.0 V and 8.0 V versions are also available. Separate data sheets are provided for the various options.

The device is available in a plastic SOT-23L package. Tape and reel mounted devices are also available.

3

ORDERING INFORMATION

TK114 □□ □ □ □□

- Voltage Code
- Package Code
- Temp. Range
- Tape/Reel Code

VOLTAGE CODE

20 = 2.0 V	40 = 4.0 V
25 = 2.5 V	45 = 4.5 V
30 = 3.0 V	50 = 5.0 V
32 = 3.25 V	60 = 6.0 V
35 = 3.5 V	80 = 8.0 V

PACKAGE CODE

M : Surface Mount

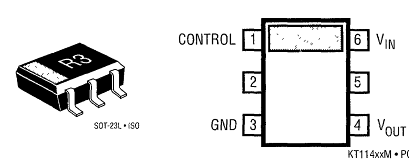
TEMP. RANGE

C : -20 - 70 °C
I : -40 - 85 °C

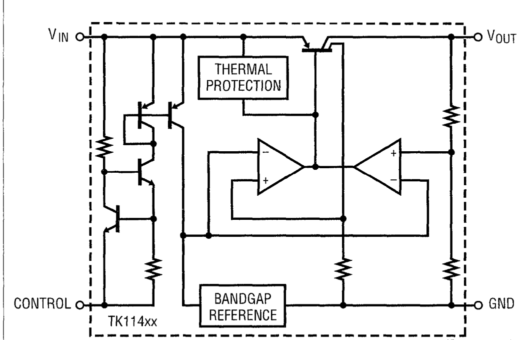
TAPE/REEL CODE

BX : Bulk/Bag
TX : Paper Tape
TR : Tape Right
TL : Tape Left

TK114xxM



BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Supply Voltage .... 14 V
Output Voltage .... V_{OUT}x1.15 V
Load Current .... 180 mA
Power Dissipation (Note 1) .... 200 mW

Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range (I Version) . -40 to +85 °C
Operating Temperature Range (C Version) -20 to +70 °C
Lead Soldering Temp. (10 sec.) .... 240 °C
Junction Temperature .... 150 °C

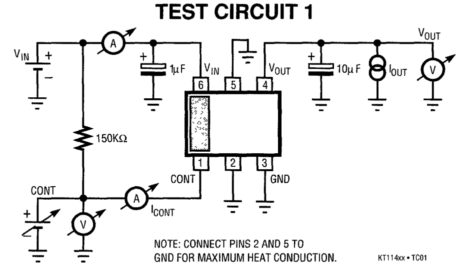
ELECTRICAL CHARACTERISTICS

Due to the common format used here, some specifications may not apply to all versions of output voltages. Detailed specifications are available for each version.

SYMBOL	PARAMETER	TEST CONDITION	-20 to +70 °C			-40 to +85 °C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IN}	Supply Voltage Range		2.5		14	2.5		14	V
I_{IN1}	Supply Current 1	$V_{IN} = V_O + 1$ V, $I_O = 0$ mA		500	900		500	900	µA
I_{IN2}	Supply Current 2	$V_{IN} = V_O$ -(1 V to 0.1 V), $I_O = 0$ mA		1.0	2.5		1.0	2.5	mA
I_{IN3}	Supply Current 3	$V_{IN} = 10$ V, V_{OUT} = Off mode		0.1	2		0.1	3	mA
V_O	Regulated Output Voltage	$V_{IN} = V_O + 1$V, $I_O = 30$ mA, $T_A = 25$	±3.5% or ±100						mV
V_O	Regulated Output Voltage	$V_{IN} = V_O + 1$V, $I_O = 30$ mA	±4.5% or 130			±5% or 140			mV
V_{DROP1}	Dropout Voltage 1	$I_O = 30$ mA		0.12	0.3		0.12	0.3	V
I_O	Output Current			110			100		mA
I_{OR}	Recommended Output Current				70			70	mA
LI_{REG}	Line Regulation	$V_{OUT} + 1\text{ V} \leq V_{IN} \leq V_{OUT} + 6$ V		2	20		2	20	mV
LD_{REG}	Load Regulation	$V_{IN} = V_O + 1$ V, $I_O = 0$ to 60 mA		35	110		35	110	mV
I_{CONT}	Control Pin Current			35	120		35	120	µA
V_{Coff}	Control Pin Voltage	Off Mode	V_{IN}-0.2		V_{IN}	V_{IN}-0.2		V_{IN}	V
V_{Con}	Control Pin Voltage	On Mode	0		V_{IN}-1.0	0		V_{IN}-1.0	V
RR	Ripple Rejection	100 mV(rms), f = 400 Hz $V_{IN} = V_O + 1.5$ V, $I_O = 10$ mA		55			55		dB
$\Delta V/\Delta T$	V_O Temperature Coefficient	$V_{IN} = V_O + 1.5$ V, $I_O = 10$ mA		0.6			0.6		mV/°C
V_N	Output Noise Voltage	$V_{IN} = V_O + 1.5$ V, $I_O = 10$ mA $C_L = 10$ µF		180			180		µV(rms)

Note 1: Power dissipation must be derated at the rate of 1.6 mW/ °C for operation at $T_A = 25$ °C and above. Power dissipation = 400 mW when mounted as recommended.

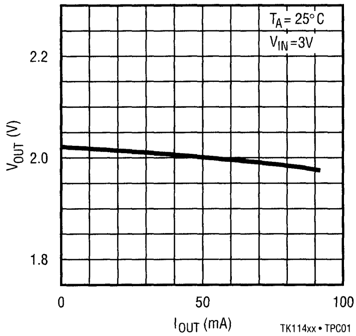
TEST CIRCUIT 1



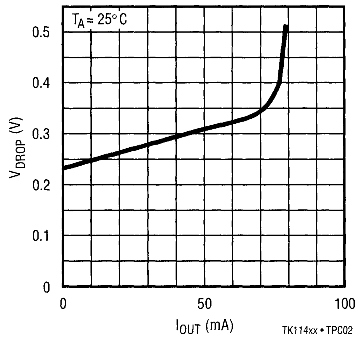
TYPICAL PERFORMANCE CHARACTERISTICS

TK11420

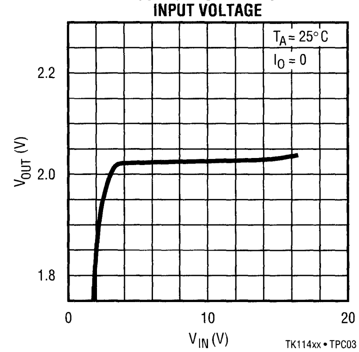
OUTPUT VOLTAGE vs OUTPUT CURRENT



DROPOUT VOLTAGE vs LOAD CURRENT



OUTPUT VOLTAGE vs INPUT VOLTAGE



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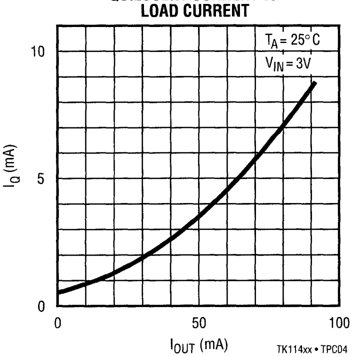
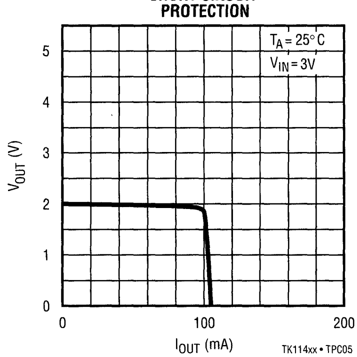
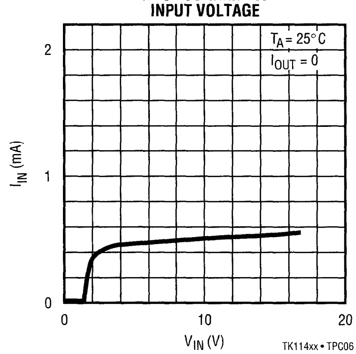
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

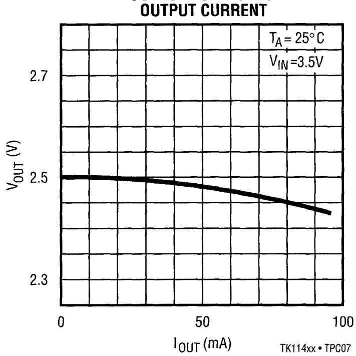


INPUT CURRENT vs INPUT VOLTAGE

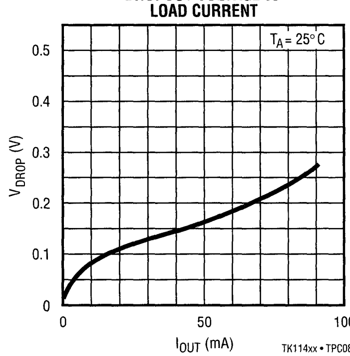


TK11425

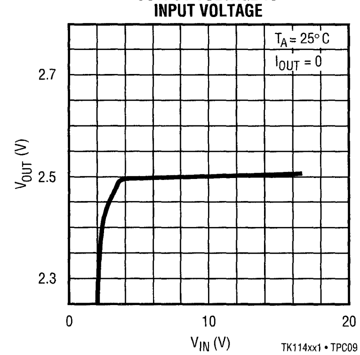
OUTPUT VOLTAGE vs OUTPUT CURRENT



DROPOUT VOLTAGE vs LOAD CURRENT



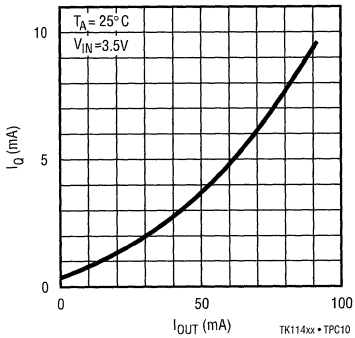
OUTPUT VOLTAGE vs INPUT VOLTAGE



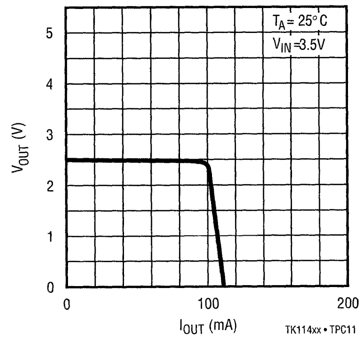
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11425 (CONT.)

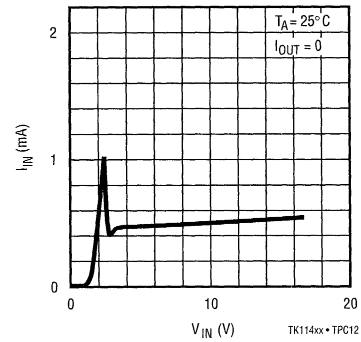
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

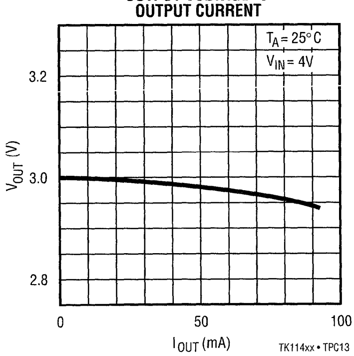


INPUT CURRENT vs INPUT VOLTAGE

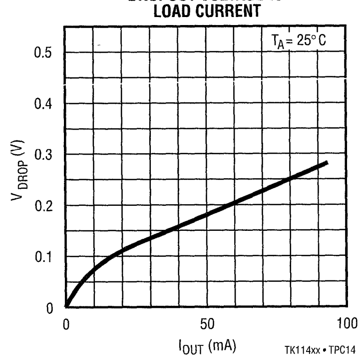


TK11430

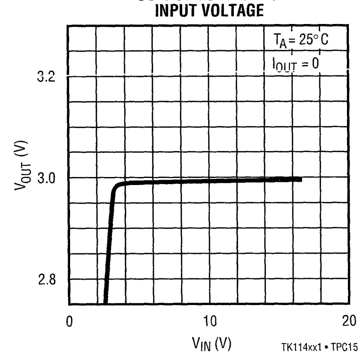
OUTPUT VOLTAGE vs OUTPUT CURRENT



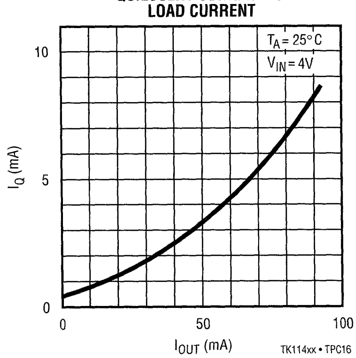
DROPOUT VOLTAGE vs LOAD CURRENT



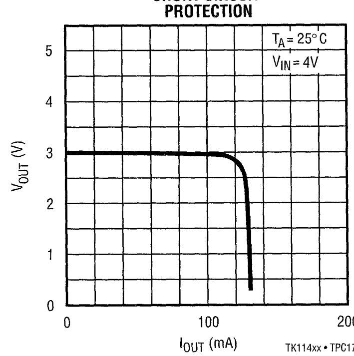
OUTPUT VOLTAGE vs INPUT VOLTAGE



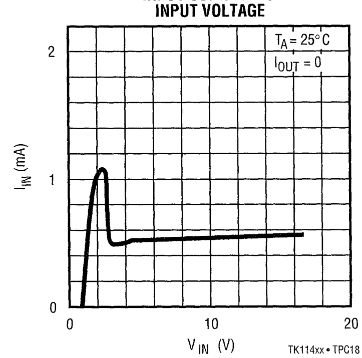
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION



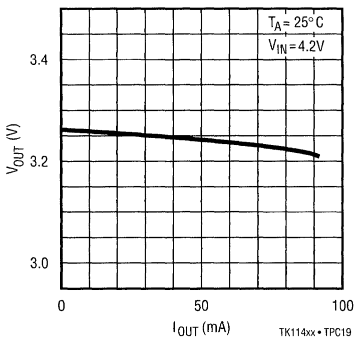
INPUT CURRENT vs INPUT VOLTAGE



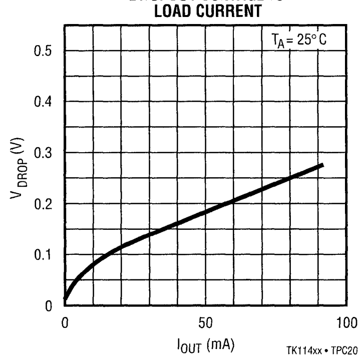
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11432

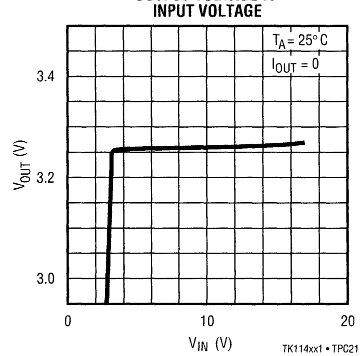
OUTPUT VOLTAGE vs OUTPUT CURRENT



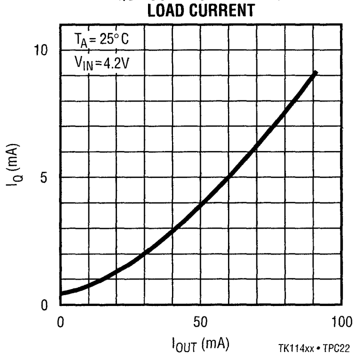
DROPOUT VOLTAGE vs LOAD CURRENT



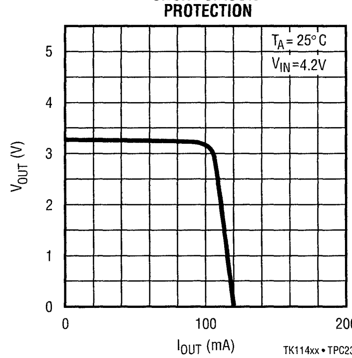
OUTPUT VOLTAGE vs INPUT VOLTAGE



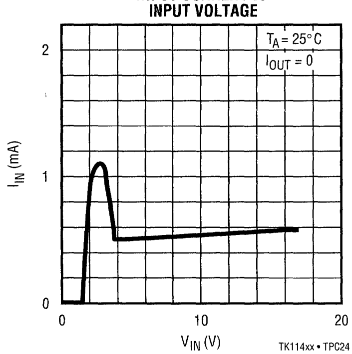
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

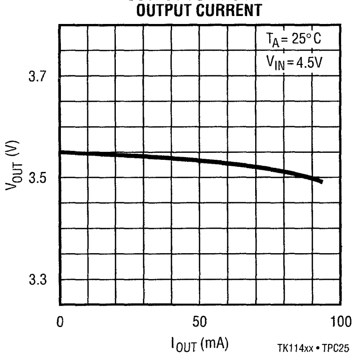


INPUT CURRENT vs INPUT VOLTAGE

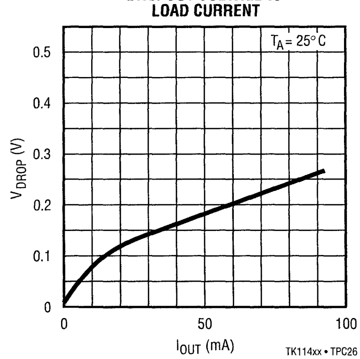


TK11435

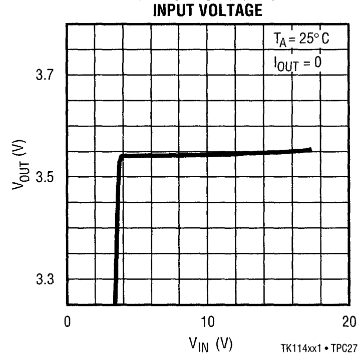
OUTPUT VOLTAGE vs OUTPUT CURRENT



DROPOUT VOLTAGE vs LOAD CURRENT



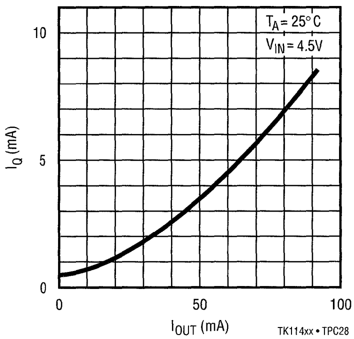
OUTPUT VOLTAGE vs INPUT VOLTAGE



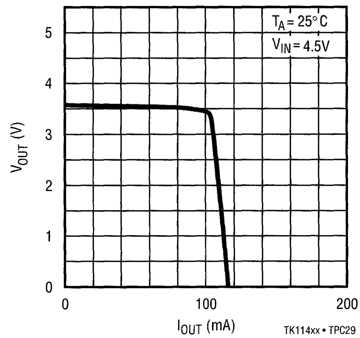
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11435 (CONT.)

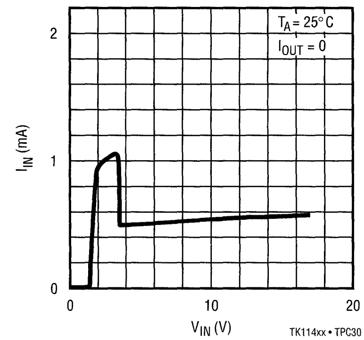
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

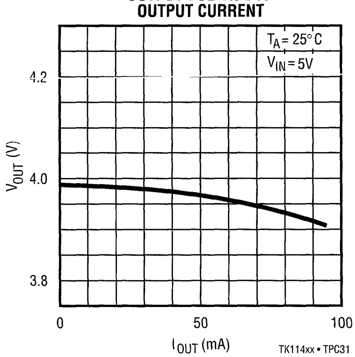


INPUT CURRENT vs INPUT VOLTAGE

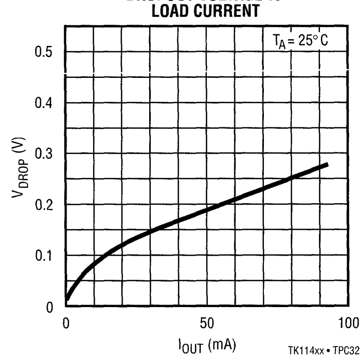


TK11440

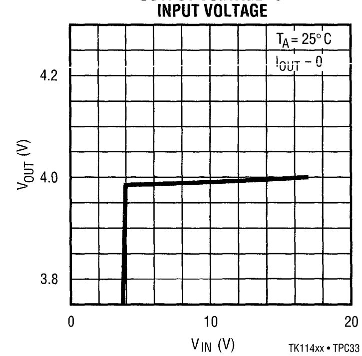
OUTPUT VOLTAGE vs OUTPUT CURRENT



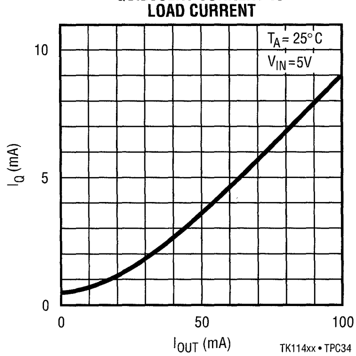
DROPOUT VOLTAGE vs LOAD CURRENT



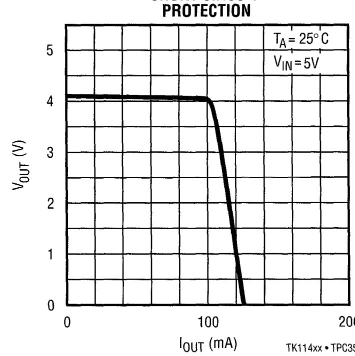
OUTPUT VOLTAGE vs INPUT VOLTAGE



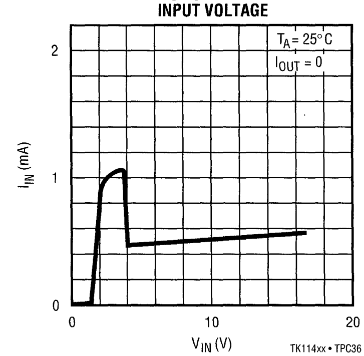
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION



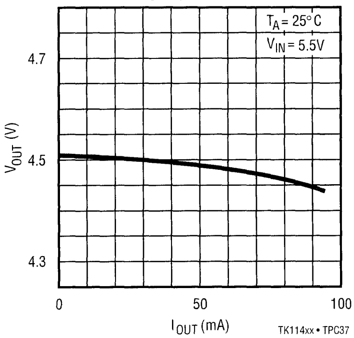
INPUT CURRENT vs INPUT VOLTAGE



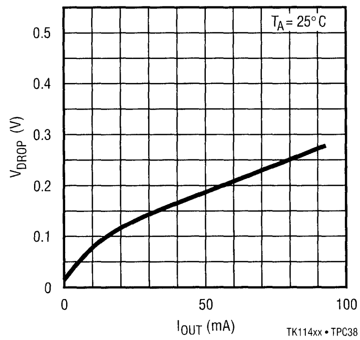
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11445

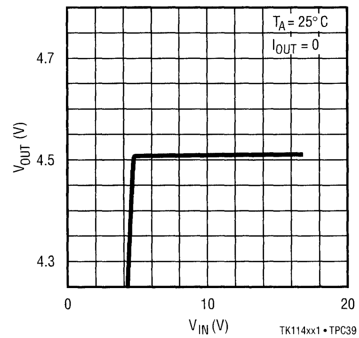
OUTPUT VOLTAGE vs OUTPUT CURRENT



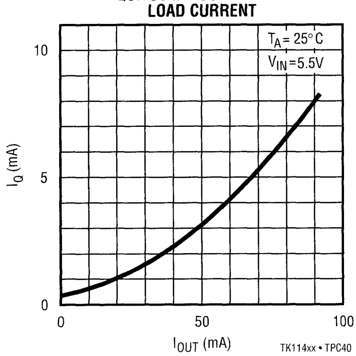
DROPOUT VOLTAGE vs LOAD CURRENT



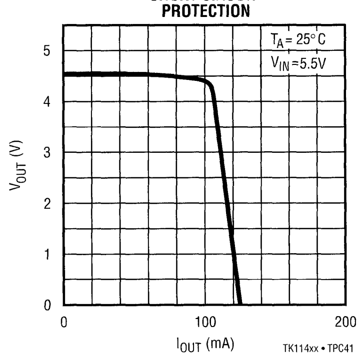
OUTPUT VOLTAGE vs INPUT VOLTAGE



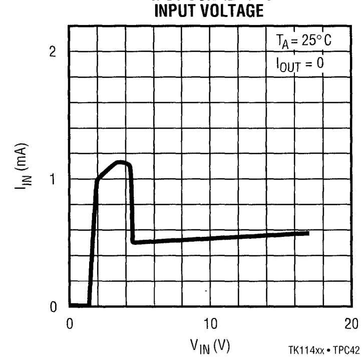
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

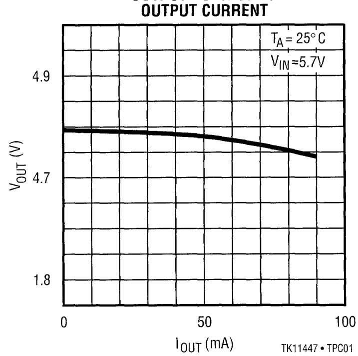


INPUT CURRENT vs INPUT VOLTAGE

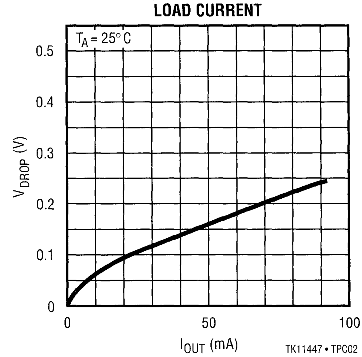


TK11447

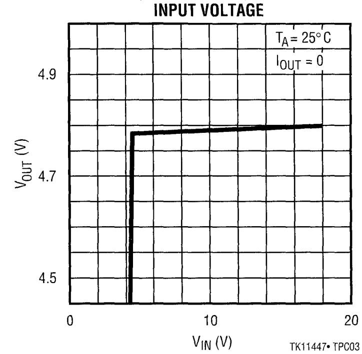
OUTPUT VOLTAGE vs OUTPUT CURRENT



DROPOUT VOLTAGE vs LOAD CURRENT



OUTPUT VOLTAGE vs INPUT VOLTAGE



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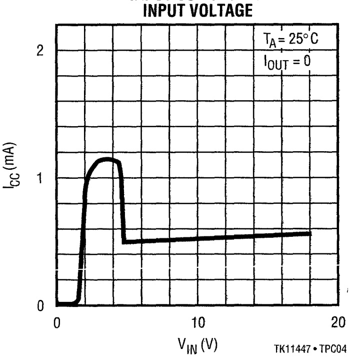
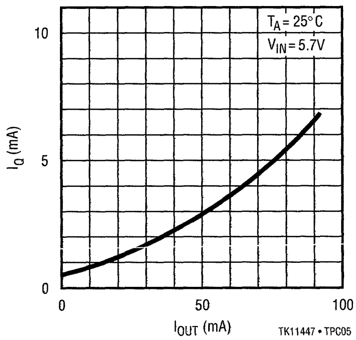
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11447 (CONT.)

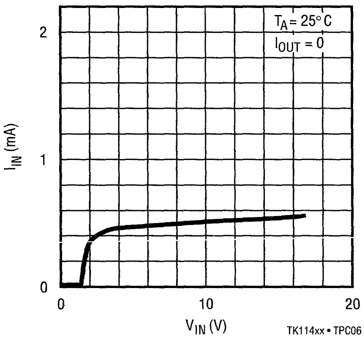
INPUT CURRENT vs INPUT VOLTAGE



QUIESCENT CURRENT vs LOAD CURRENT

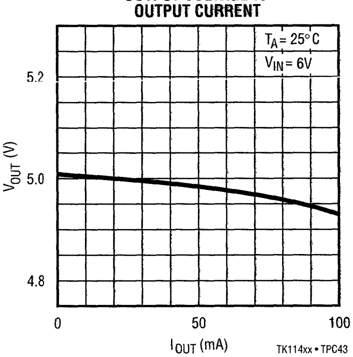


INPUT CURRENT vs INPUT VOLTAGE

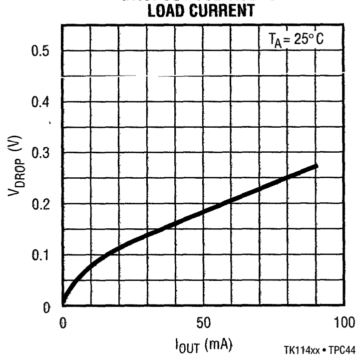


TK11450

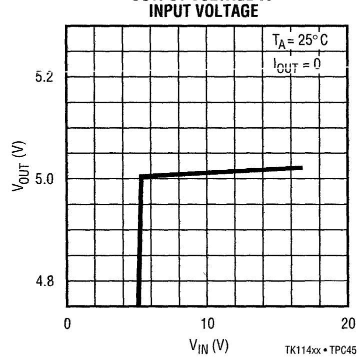
OUTPUT VOLTAGE vs OUTPUT CURRENT



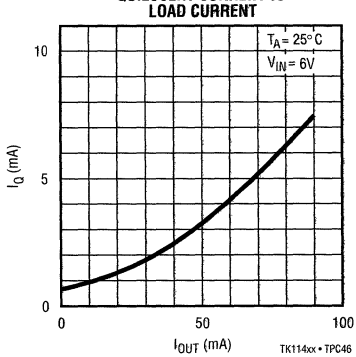
DROPOUT VOLTAGE vs LOAD CURRENT



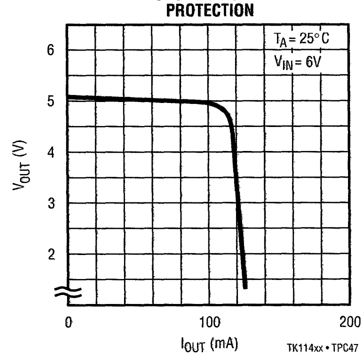
OUTPUT VOLTAGE vs INPUT VOLTAGE



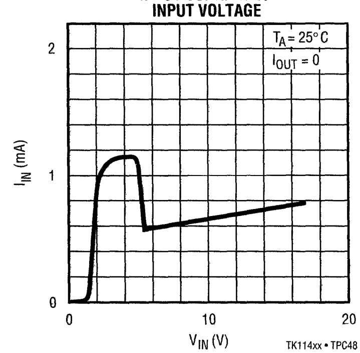
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION



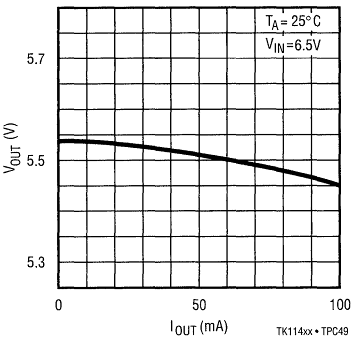
INPUT CURRENT vs INPUT VOLTAGE



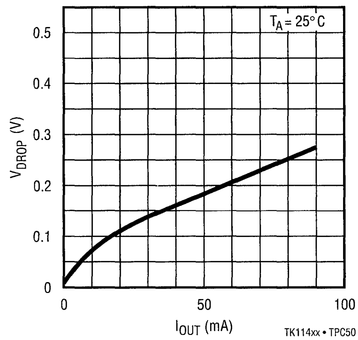
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11455

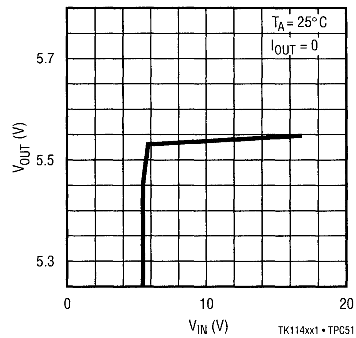
OUTPUT VOLTAGE vs OUTPUT CURRENT



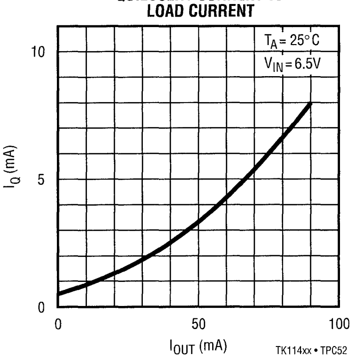
DROPOUT VOLTAGE vs LOAD CURRENT



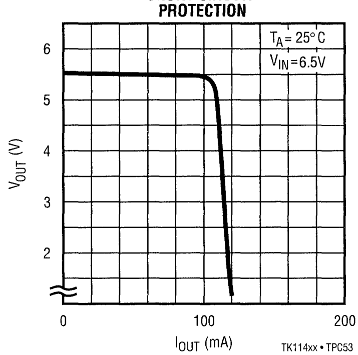
OUTPUT VOLTAGE vs INPUT VOLTAGE



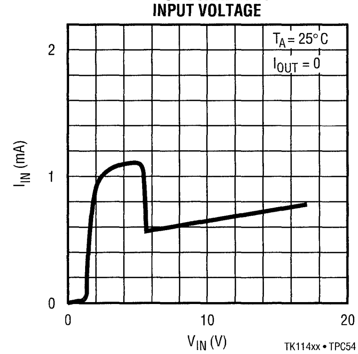
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION



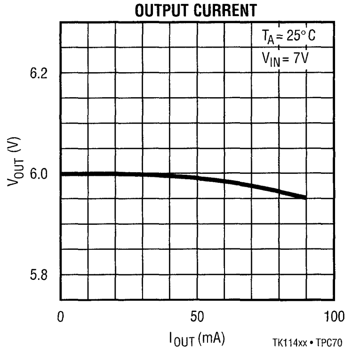
INPUT CURRENT vs INPUT VOLTAGE



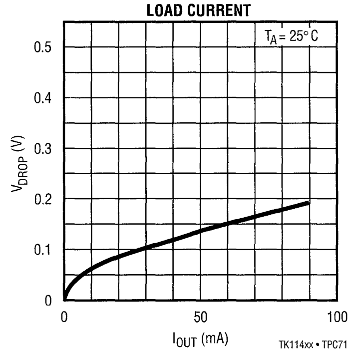
3

TK11460

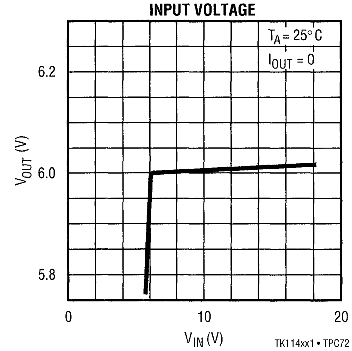
OUTPUT VOLTAGE vs OUTPUT CURRENT



DROPOUT VOLTAGE vs LOAD CURRENT



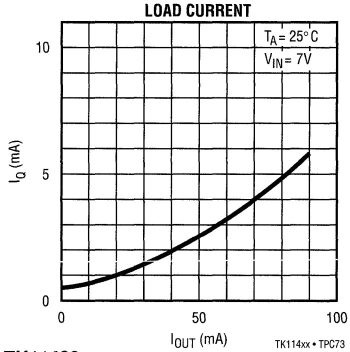
OUTPUT VOLTAGE vs INPUT VOLTAGE



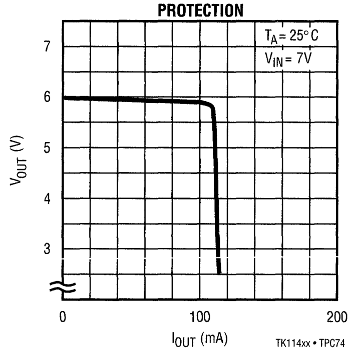
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11460 (CONT.)

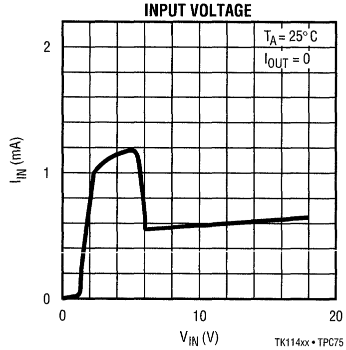
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

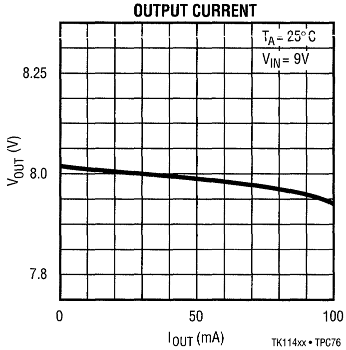


INPUT CURRENT vs INPUT VOLTAGE

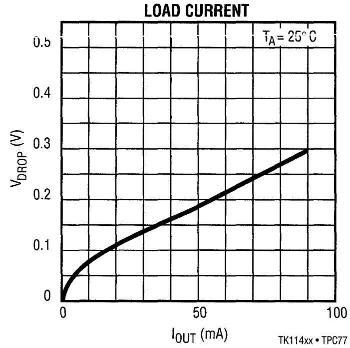


TK11480

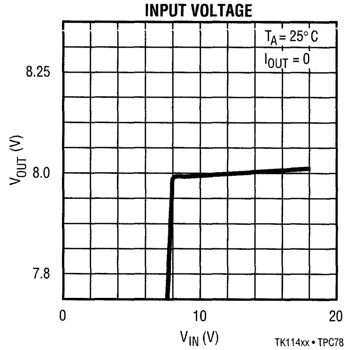
OUTPUT VOLTAGE vs OUTPUT CURRENT



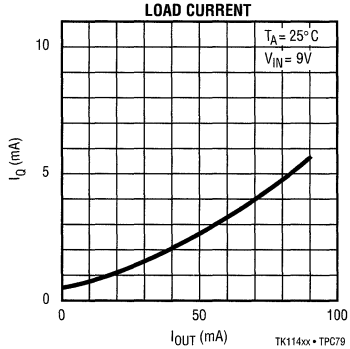
DROPOUT VOLTAGE vs LOAD CURRENT



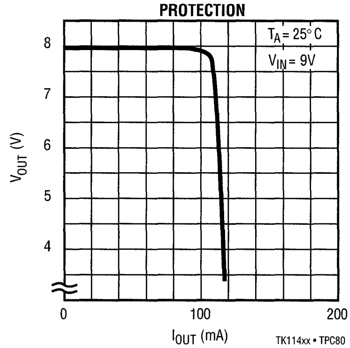
OUTPUT VOLTAGE vs INPUT VOLTAGE



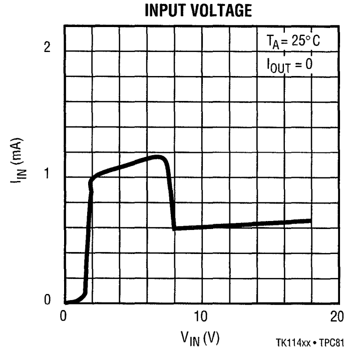
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

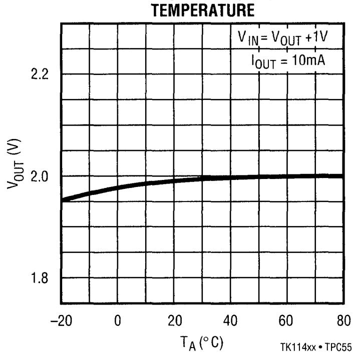


INPUT CURRENT vs INPUT VOLTAGE

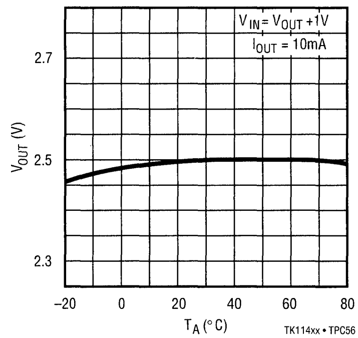


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

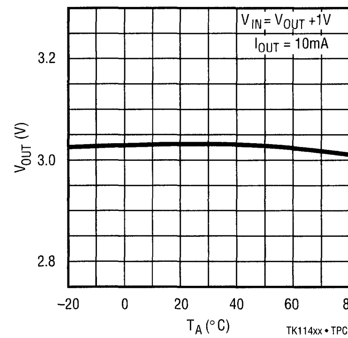
TK11420
OUTPUT VOLTAGE vs TEMPERATURE



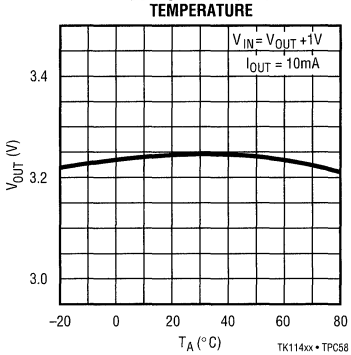
TK11425
OUTPUT VOLTAGE vs TEMPERATURE



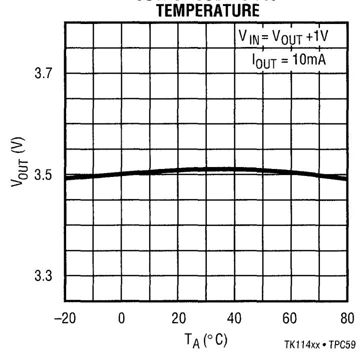
TK11430
OUTPUT VOLTAGE vs TEMPERATURE



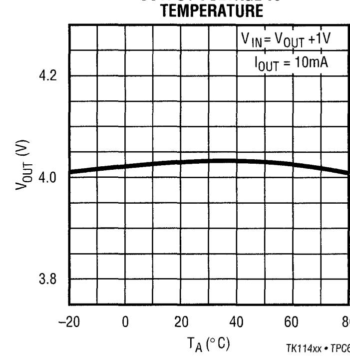
TK11432
OUTPUT VOLTAGE vs TEMPERATURE



TK11435
OUTPUT VOLTAGE vs TEMPERATURE

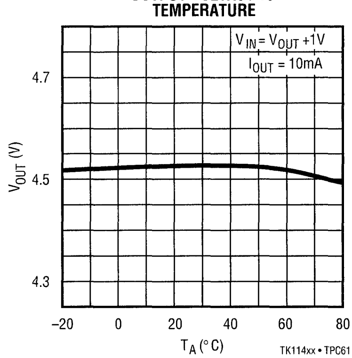


TK11440
OUTPUT VOLTAGE vs TEMPERATURE

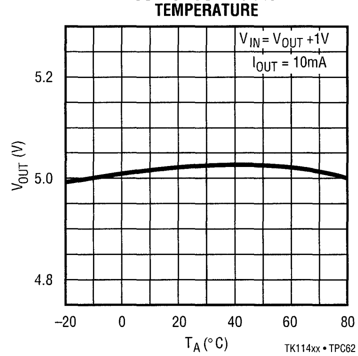


3

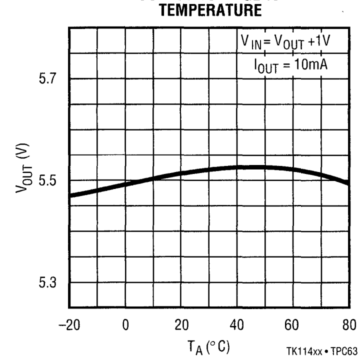
TK11445
OUTPUT VOLTAGE vs TEMPERATURE



TK11450
OUTPUT VOLTAGE vs TEMPERATURE

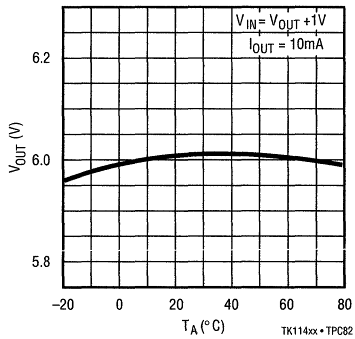


TK11455
OUTPUT VOLTAGE vs TEMPERATURE

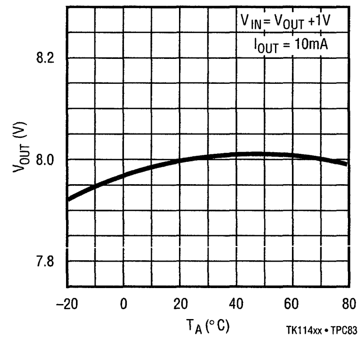


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11460
OUTPUT VOLTAGE vs TEMPERATURE



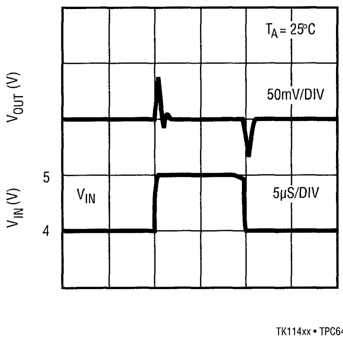
TK11480
OUTPUT VOLTAGE vs TEMPERATURE



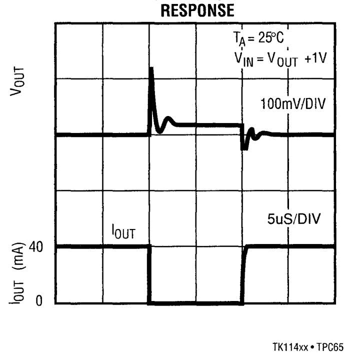
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

COMMON CHARACTERISTICS

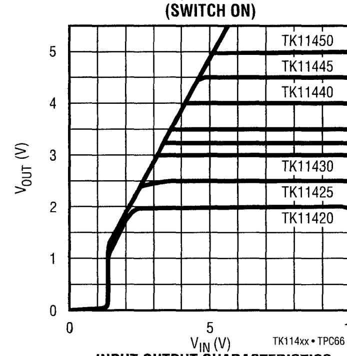
LINE TRANSIENT RESPONSE



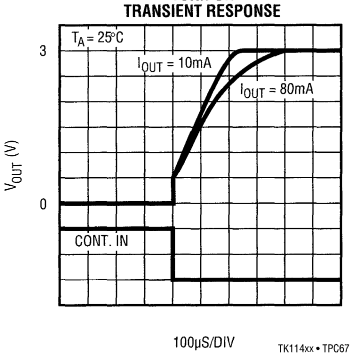
LOAD TRANSIENT RESPONSE



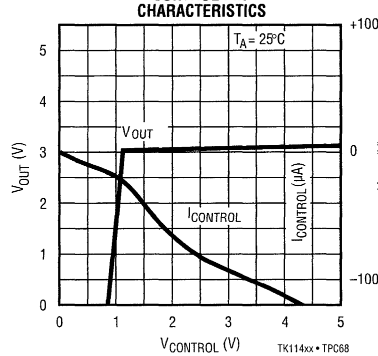
INPUT OUTPUT CHARACTERISTICS (SWITCH ON)



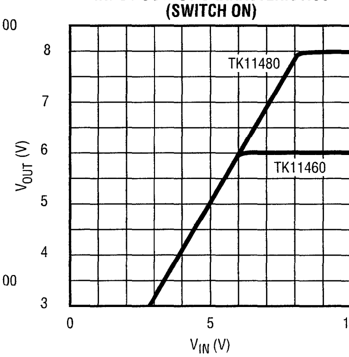
TURN ON TRANSIENT RESPONSE



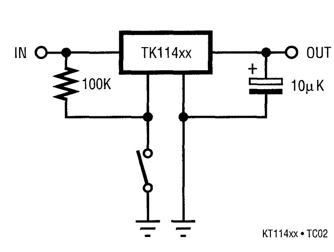
CONTROL PIN CHARACTERISTICS



INPUT OUTPUT CHARACTERISTICS (SWITCH ON)

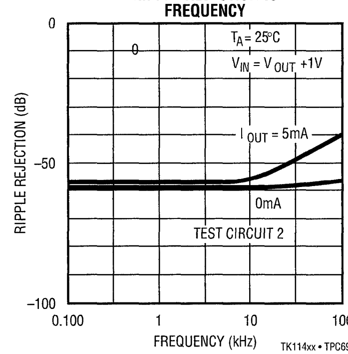


TEST CIRCUIT 2



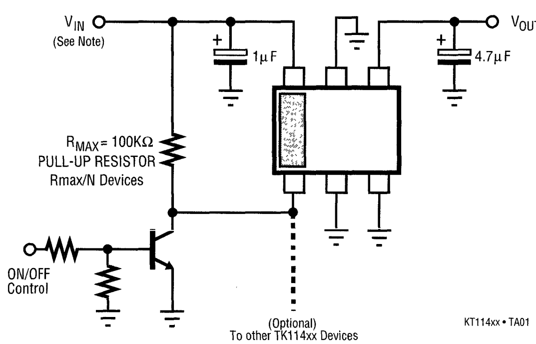
RIPPLE REJECTION TEST CIRCUIT

RIPPLE REJECTION vs FREQUENCY

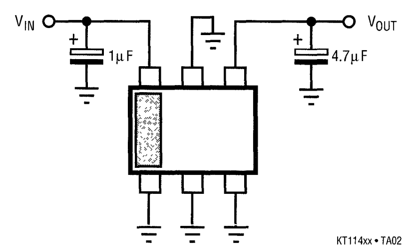


TYPICAL APPLICATIONS

CONTROL FUNCTION UTILIZED

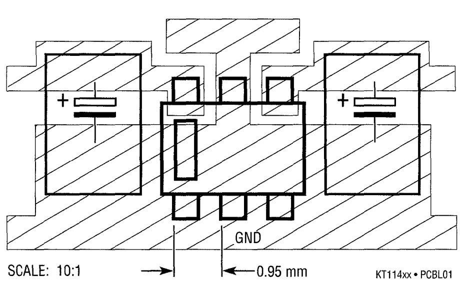


CONTROL FUNCTION NOT UTILIZED



Note: Parallel connection of control pins is allowed if all devices use identical input voltage.

PRINTED CIRCUIT BOARD LAYOUT



Application Hints

Maximize copper foil area connecting to all IC pins for optimum performance. Place input and output bypass capacitors close to the GND pin. For best transient behavior and lowest output impedance, use as large a capacitor value as possible. The temperature coefficient of the capacitance and Equivalent Series Resistance (ESR) should be taken into account. These parameters can influence power supply noise and ripple rejection. In extreme cases, oscillation may occur. In order to maintain stability, the output bypass capacitor value should be minimum 2.2 µF for a Tantalum electrolytic or 4.7 µF for an Aluminum electrolytic.

Handling Molded Resin Packages

All plastic molded packages absorb some moisture from the air. If moisture absorption occurs prior to soldering the device into the printed circuit board, increased separation of the lead from the plastic molding may occur, degrading the moisture barrier characteristics of the device.

This property of plastic molding compounds should not be overlooked, particularly in the case of very small packages, where the plastic is very thin.

In order to preserve the original moisture barrier properties of the package, devices are stored and shipped in moisture proof bags, filled with dry air. The bags should not be opened or damaged prior to the actual use of the devices. If this is unavoidable, the devices should be stored in a low relative humidity environment (40 to 65%) or in an enclosed environment with desiccant.

TOKO

TK115xx

VOLTAGE REGULATOR WITH ON/OFF SWITCH

FEATURES

- Low Dropout Voltage
- Pass Transistor Terminals Available
- Very Low Standby Current (ON, No Load)
- Very Low (<100 nA) Current in OFF Mode
- Low Output Noise
- Internal Thermal Shutdown
- Short Circuit Protection
- Available on Tape and Reel
- Customized Versions Are Available

APPLICATIONS

- Cordless Telephones
- Pagers
- Battery Powered Systems
- Personal Communications Equipment
- Portable Instrumentation
- Radio Control Systems
- Toys
- Low Voltage Systems
- Portable Consumer Equipment

DESCRIPTION

The TK115xx series devices are low power, linear regulators with electronic ON/OFF switches. Both active HIGH and active LOW control pins are provided.

An internal PNP pass-transistor is used in order to achieve low dropout voltage (typically 200 mV at 80 mA load current). The base of the internal pass transistor is available at pin 7 for parallel connection of an external pass transistor in case higher current (up to 1 A) or lower dropout voltage is required.

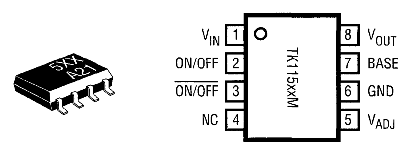
The regulated output voltage may be specified in 0.5 V increments between 2.5 to 5.5 V. Additionally, 3.2 V, 4.7 V and 8 V output versions are also available. Separate data sheets are available for the various options.

The devices operate at very low (500 µA) quiescent current with no load, 2 mA with 40 mA load, and 3 mA with 60 mA load. An internal thermal shutdown circuit limits the junction temperature to below 150 °C. The load current is internally monitored, and the device will shut down in the presence of a short circuit at the output.

The TK115xx series is available in plastic surface mount (MFP-8) packages. Tape and reel mounted devices are also available.

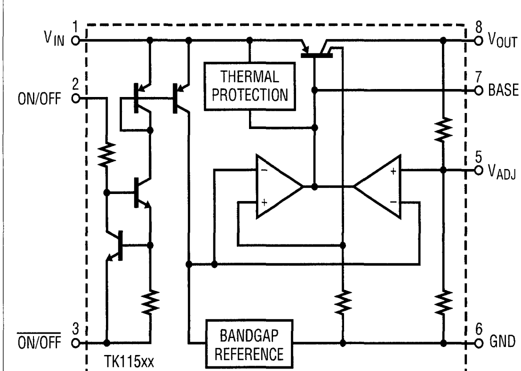
3

TK115xxM



KT115xxM • PO

BLOCK DIAGRAM



KT115xx • BD01

ORDERING INFORMATION

TK115 □□ □ □ □□

- Voltage Code
- Package Code
- Temp. Range
- Tape/Reel Code

Voltage Code
25 = 2.5V 45 = 4.5V
30 = 3.0V 47 = 4.7V
32 = 3.2V 50 = 5.0V
35 = 3.5V 55 = 5.5V
40 = 4.0V 80 = 8.0V

Package Code
M : Surface Mount

Temp. Range
C : -20 to +70 °C

Tape/Reel Code
BX : Bulk/Bag
TX : Paper Tape
TR : Tape Right
TL : Tape Left
MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Supply Voltage .... 14 V
Output Voltage .... V_{OUT}x1.15 V
Load Current .... 180 mA
Power Dissipation (Note 1) .... 600 mW
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range (C Version) .. -20 to +70 °C
Operating Temperature Range (I Version) ... -40 to +85 °C
Lead Soldering Temp. (10 sec.) .... 260 °C
Junction Temperature .... 150 °C

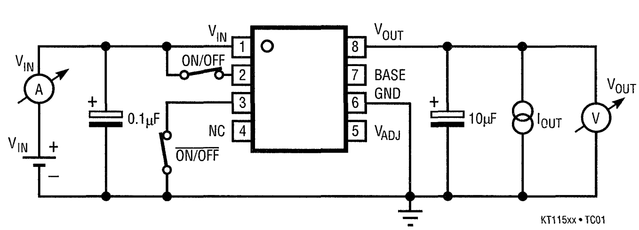
ELECTRICAL CHARACTERISTICS

Due to the common format used here, some specifications may not apply to all versions of output voltage.
Example: V_{OUT} tolerance is ±4% for TK11520, TK11525 and TK11530. Detailed specifications are available for each version.

SYMBOL	PARAMETER	TEST CONDITION	-20 to +70 °C			-40 to +85 °C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{OP}	Supply Voltage Range		2.5		14	2.5		14	V
I_{IN1}	Supply Current 1	$V_{CC} = V_{OUT} + 1$ V, $I_{OUT} = 0$ mA		500	900		500	900	µA
I_{IN2}	Supply Current 2	OFF Mode $V_{IN} = (V_O - 2\text{ V}) < 10$		0.1	2.0		0.1	2.0	µA
V_O	Regulated Output Voltage	$V_{IN} = V_O + 1$V, $I_O = 30$ mA, $T_A = 25$	V_{OUT} ±3.5% or ±100						mV
V_O	Regulated Output Voltage	Operating Temp. Range	±4.5% or 120			±5.0% or 130			mV
V_{DROP}	Dropout Voltage	$I_O = 60$ mA		170	350		170	350	mV
I_O	Output Current		100			100			mA
Line Reg	Line Regulation	$(V_{OUT} + 1\text{V}) \leq V_{IN} \leq V_O + 6.0$ V		5	50		5	50	mV
Loa Reg	Load Regulation	$I_O = 0$ to 60 mA		30	120		30	120	mV
RR	Ripple Rejection	$V_{IN} = V_{OUT} + 1.5$ V, 100 mV(rms), f = 400 Hz, $I_O = 10$ mA		55			55		dB
$\Delta V/\Delta T$	V_O Temperature Coefficient			±0.35			±0.35		mV/°C
V_O	Output Noise Voltage	10 Hz ~ 100 kHz, $I_O = 10$ mA			180		180		µV(rms)
I_B	Base Sink Current (Pin 7)			10			10		mA
Output ON/OFF Control									
	High Level Control	(Connect 3 pin to GND) OFF as used 2 pin ON	 2.4		0.5 V_{IN}	 2.4		0.5 V_{IN}	V V
	Low Level ON/OFF Control	Connect 2 pin to V_{CC} OFF as used 3 pin ON	V_{CC}-0.2		V_{IN} V_{CC}-2.4	V_{CC}-0.2		V_{IN} V_{CC}-2.4	V V

Note 1: Power dissipation must be derated at the rate of 4.8 mW/°C for operation at T_A= 25 °C and above.

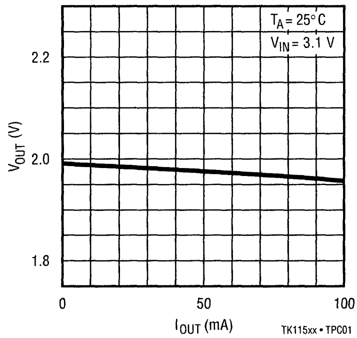
TEST CIRCUIT 1



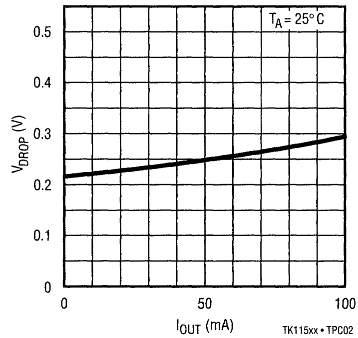
TYPICAL PERFORMANCE CHARACTERISTICS

TK11520

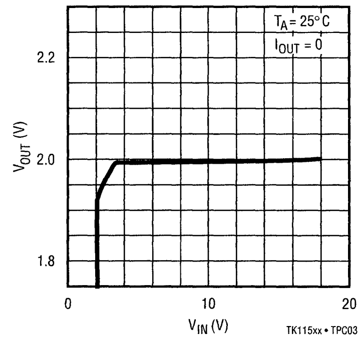
OUTPUT VOLTAGE vs OUTPUT CURRENT



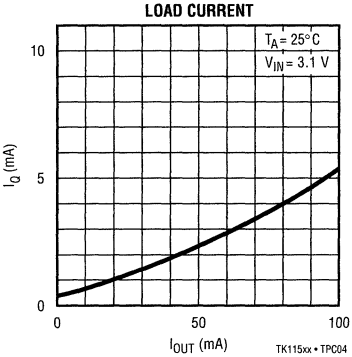
DROPOUT VOLTAGE vs LOAD CURRENT



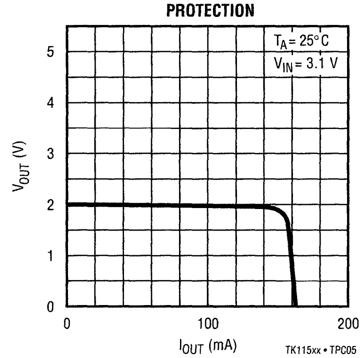
OUTPUT VOLTAGE vs INPUT VOLTAGE



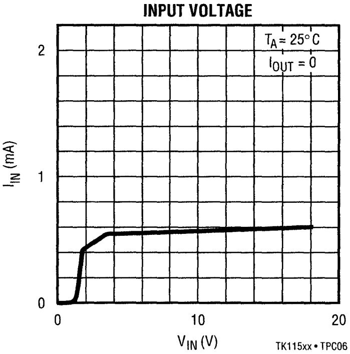
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

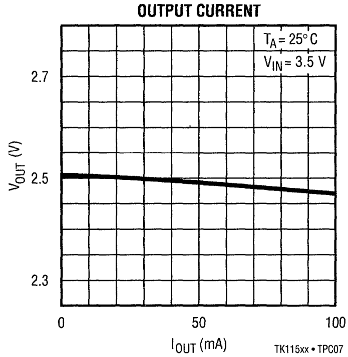


INPUT CURRENT vs INPUT VOLTAGE

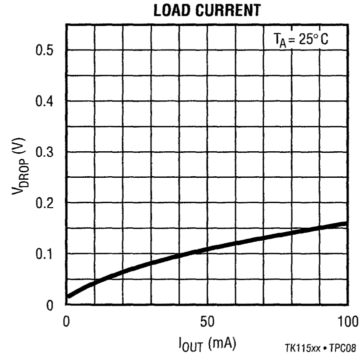


TK11525

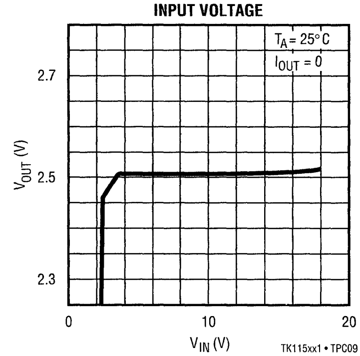
OUTPUT VOLTAGE vs OUTPUT CURRENT



DROPOUT VOLTAGE vs LOAD CURRENT



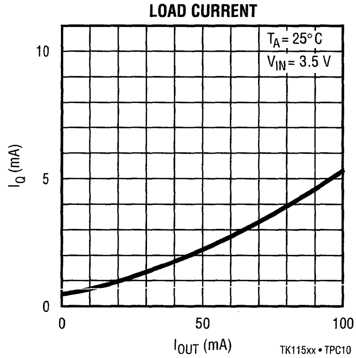
OUTPUT VOLTAGE vs INPUT VOLTAGE



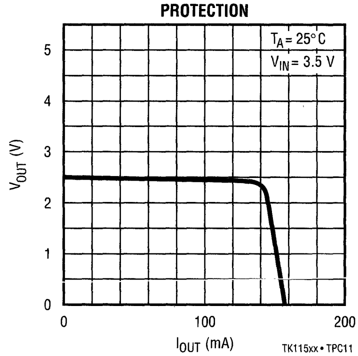
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11525 (CONT.)

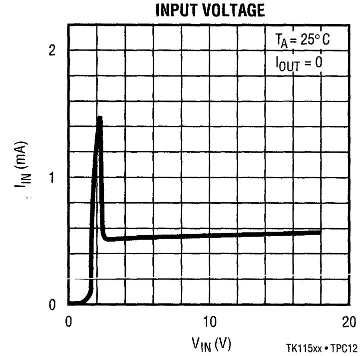
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

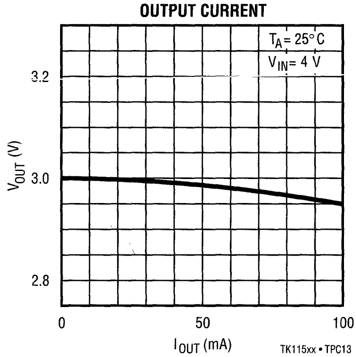


INPUT CURRENT vs INPUT VOLTAGE

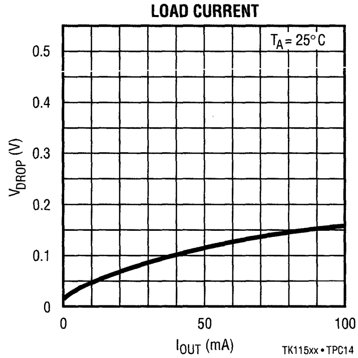


TK11530

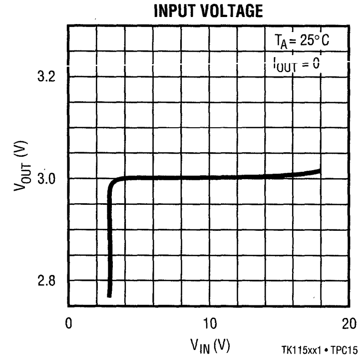
OUTPUT VOLTAGE vs OUTPUT CURRENT



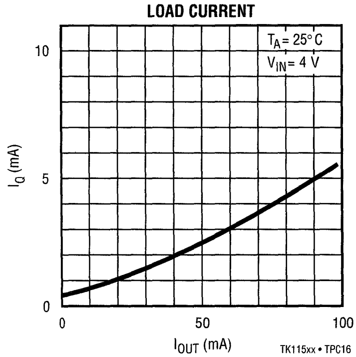
DROPOUT VOLTAGE vs LOAD CURRENT



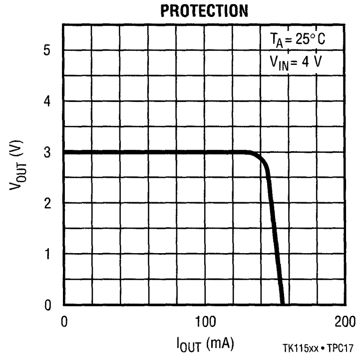
OUTPUT VOLTAGE vs INPUT VOLTAGE



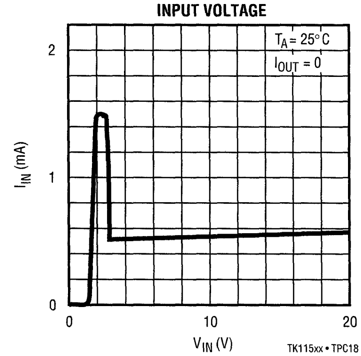
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION



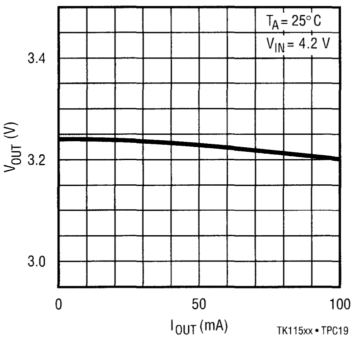
INPUT CURRENT vs INPUT VOLTAGE



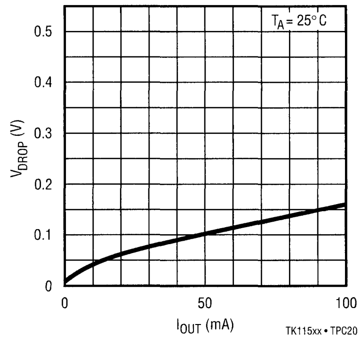
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11532

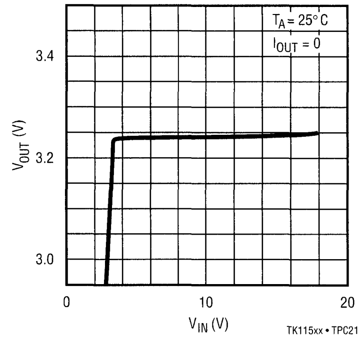
OUTPUT VOLTAGE vs OUTPUT CURRENT



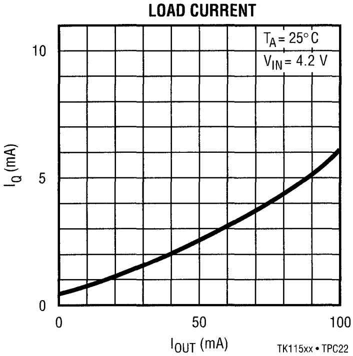
DROPOUT VOLTAGE vs LOAD CURRENT



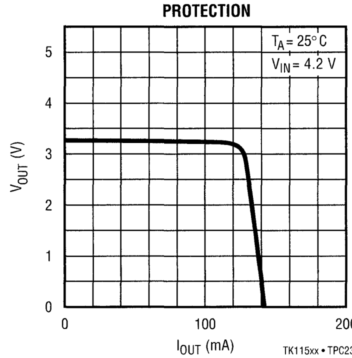
OUTPUT VOLTAGE vs INPUT VOLTAGE



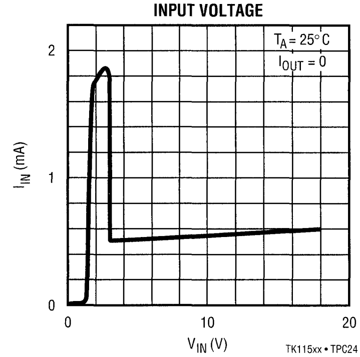
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

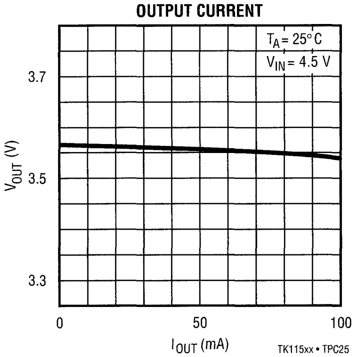


INPUT CURRENT vs INPUT VOLTAGE

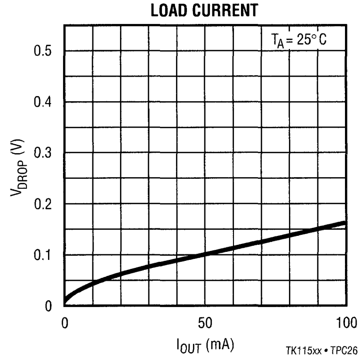


TK11535

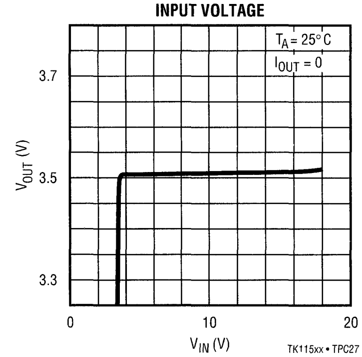
OUTPUT VOLTAGE vs OUTPUT CURRENT



DROPOUT VOLTAGE vs LOAD CURRENT



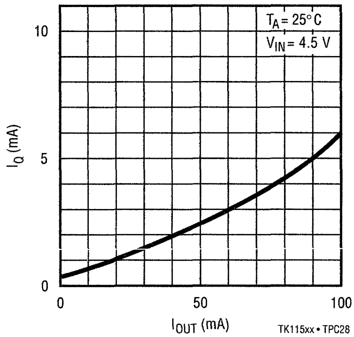
OUTPUT VOLTAGE vs INPUT VOLTAGE



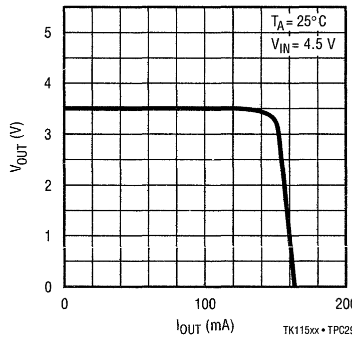
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11535 (CONT.)

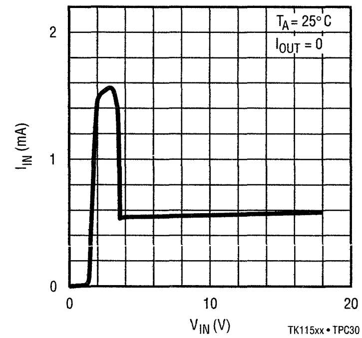
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

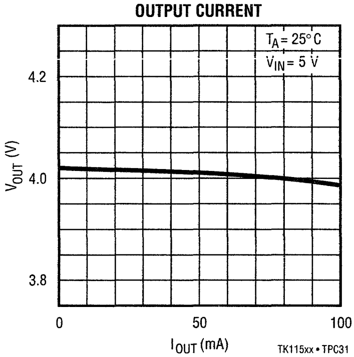


INPUT CURRENT vs INPUT VOLTAGE

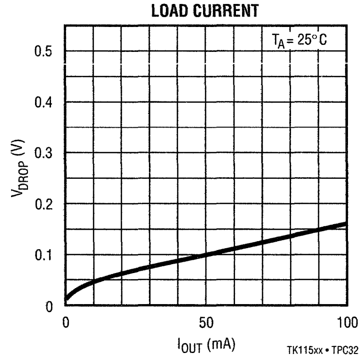


TK11540

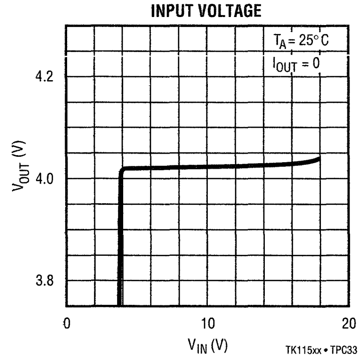
OUTPUT VOLTAGE vs OUTPUT CURRENT



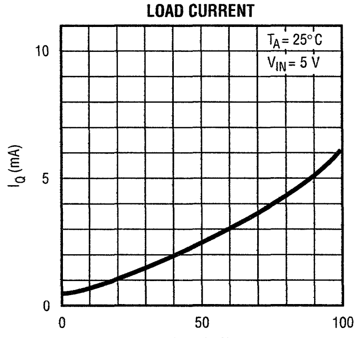
DROPOUT VOLTAGE vs LOAD CURRENT



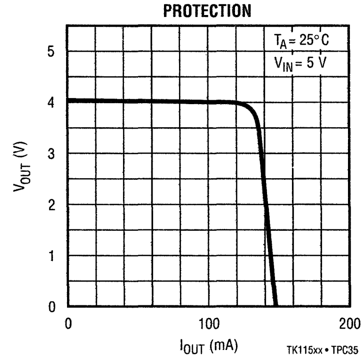
OUTPUT VOLTAGE vs INPUT VOLTAGE



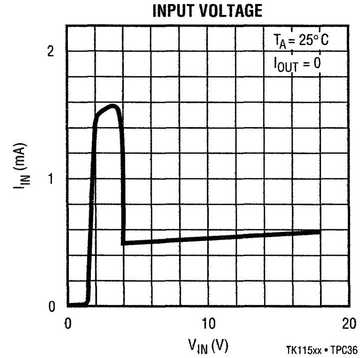
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION



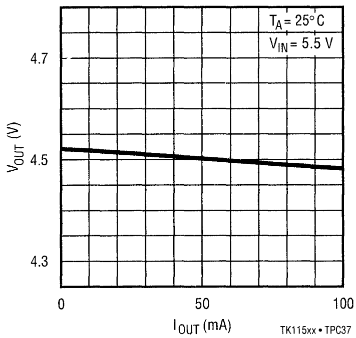
INPUT CURRENT vs INPUT VOLTAGE



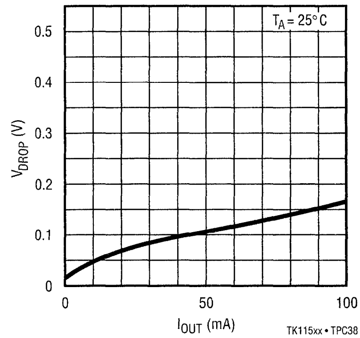
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11545

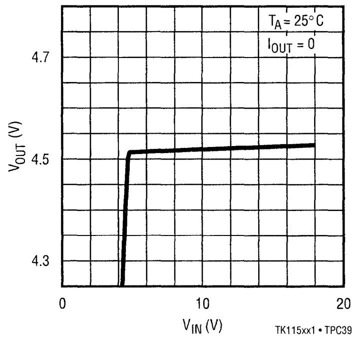
OUTPUT VOLTAGE vs OUTPUT CURRENT



DROPOUT VOLTAGE vs LOAD CURRENT

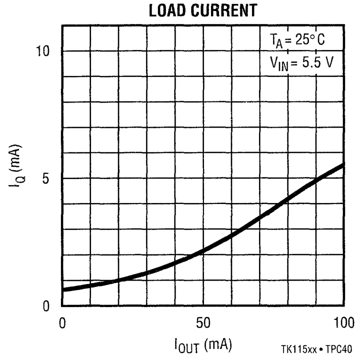


OUTPUT VOLTAGE vs INPUT VOLTAGE

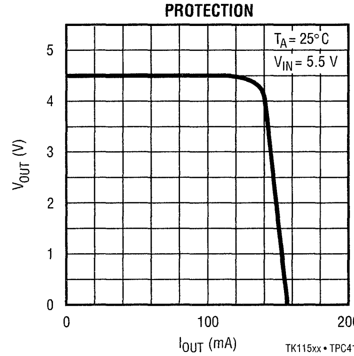


3

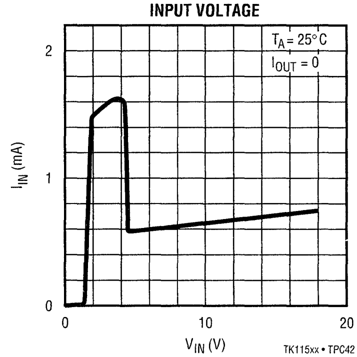
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

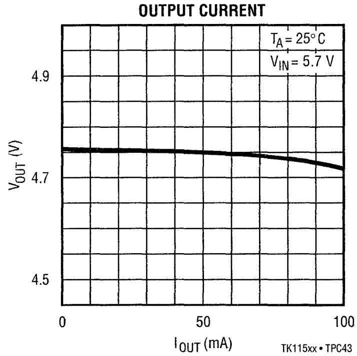


INPUT CURRENT vs INPUT VOLTAGE

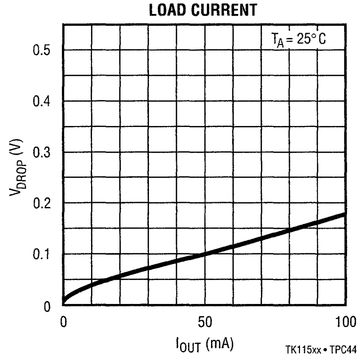


TK11547

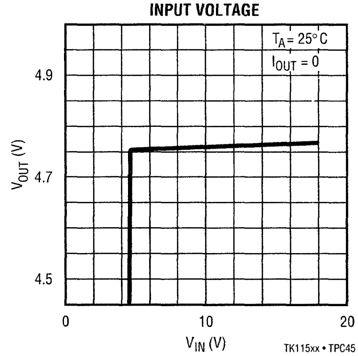
OUTPUT VOLTAGE vs OUTPUT CURRENT



DROPOUT VOLTAGE vs LOAD CURRENT

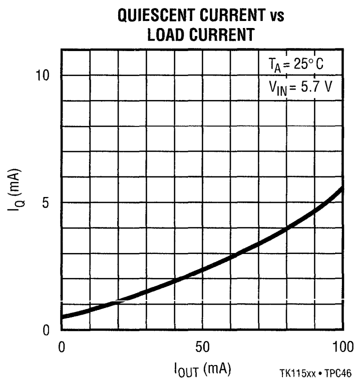


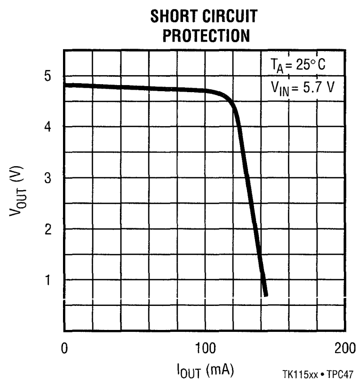
OUTPUT VOLTAGE vs INPUT VOLTAGE

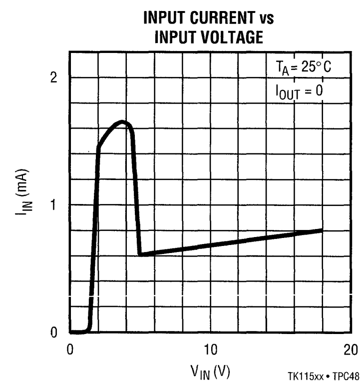


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

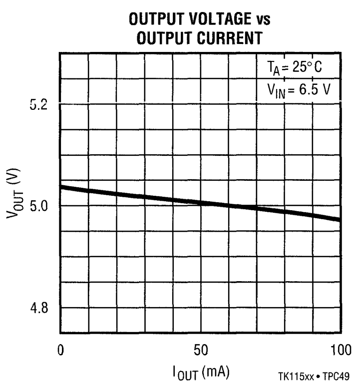
TK11547 (CONT.)

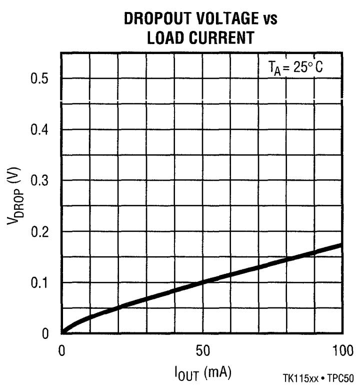


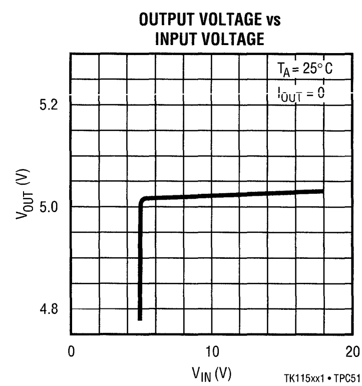


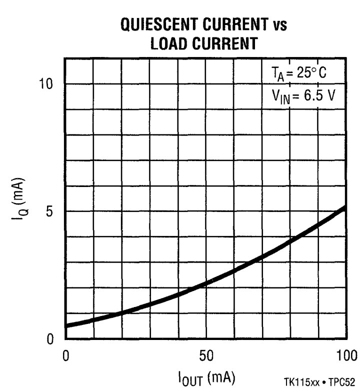


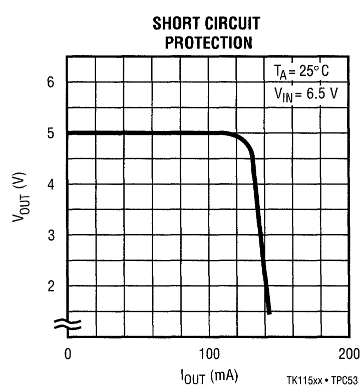
TK11550

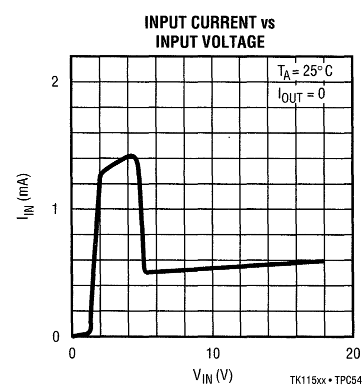








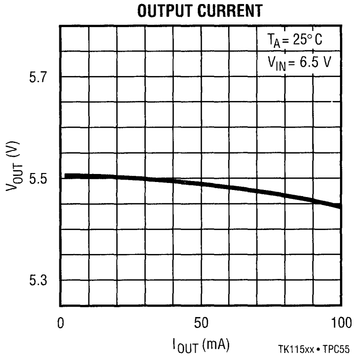




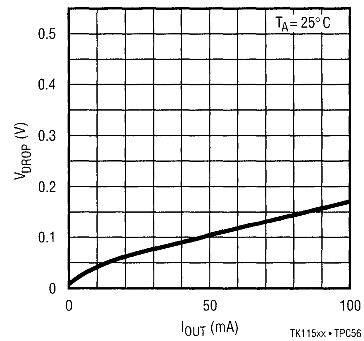
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11555

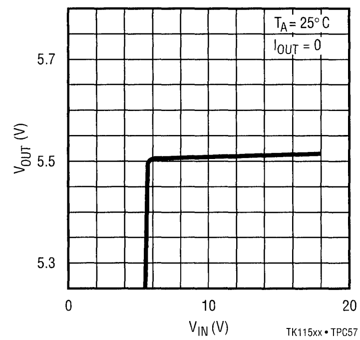
OUTPUT VOLTAGE vs OUTPUT CURRENT



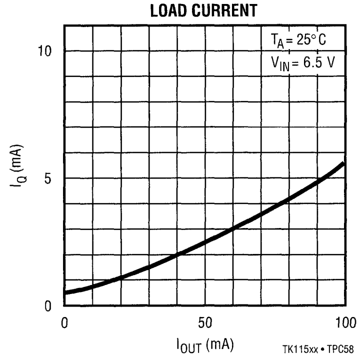
DROPOUT VOLTAGE vs LOAD CURRENT



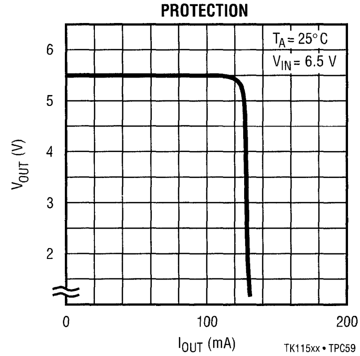
OUTPUT VOLTAGE vs INPUT VOLTAGE



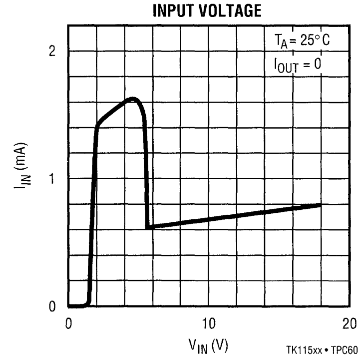
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

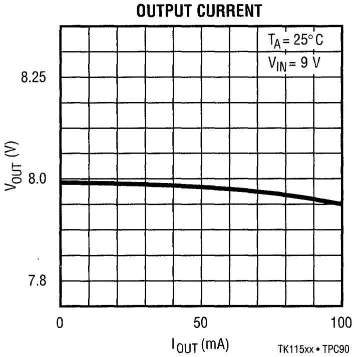


INPUT CURRENT vs INPUT VOLTAGE

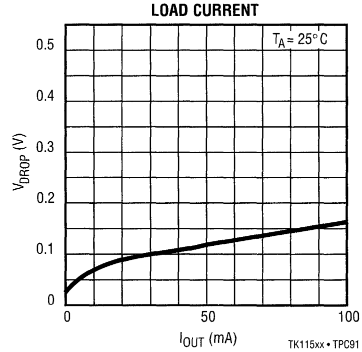


TK11580

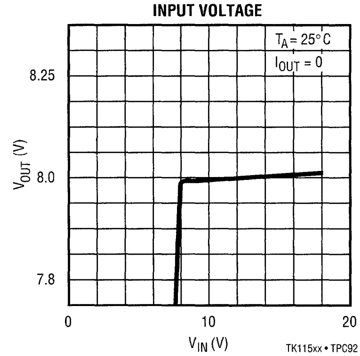
OUTPUT VOLTAGE vs OUTPUT CURRENT



DROPOUT VOLTAGE vs LOAD CURRENT



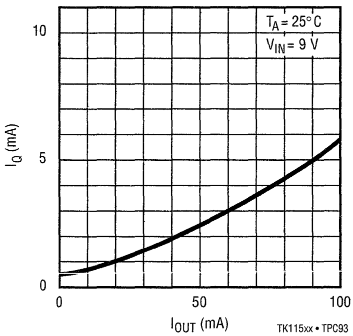
OUTPUT VOLTAGE vs INPUT VOLTAGE



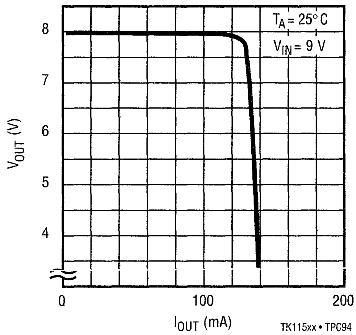
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11580 (CONT.)

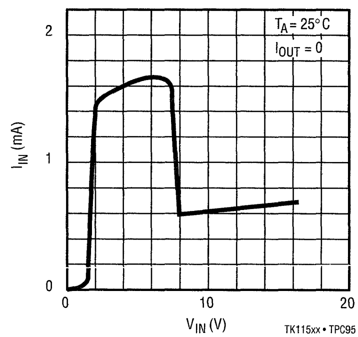
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

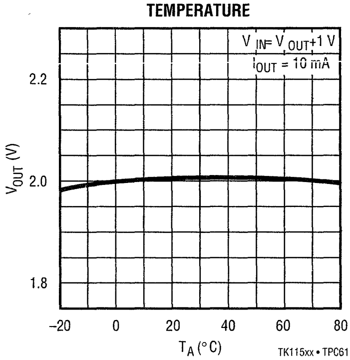


INPUT CURRENT vs INPUT VOLTAGE

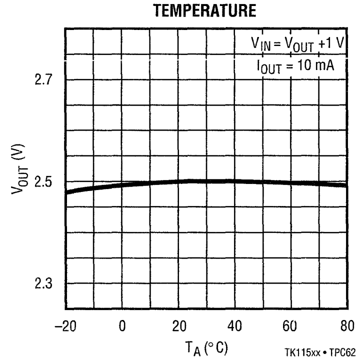


TEMPERATURE CHARACTERISTICS

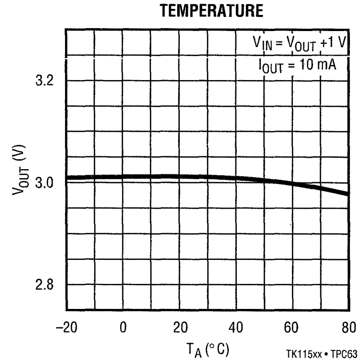
TK11520 OUTPUT VOLTAGE vs TEMPERATURE



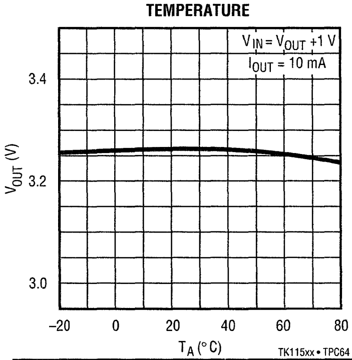
TK11525 OUTPUT VOLTAGE vs TEMPERATURE



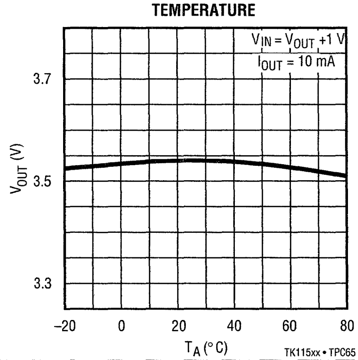
TK11530 OUTPUT VOLTAGE vs TEMPERATURE



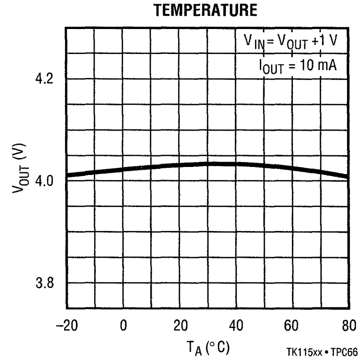
TK11532 OUTPUT VOLTAGE vs TEMPERATURE



TK11535 OUTPUT VOLTAGE vs TEMPERATURE



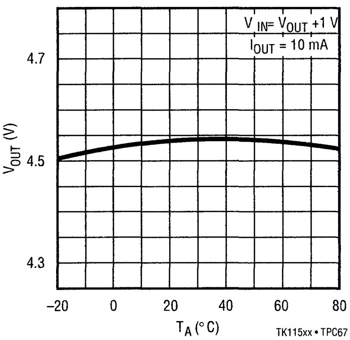
TL11540 OUTPUT VOLTAGE vs TEMPERATURE



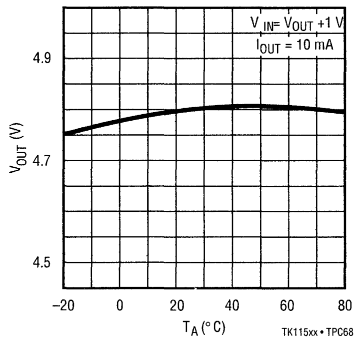
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TEMPERATURE CHARACTERISTICS (CONT.)

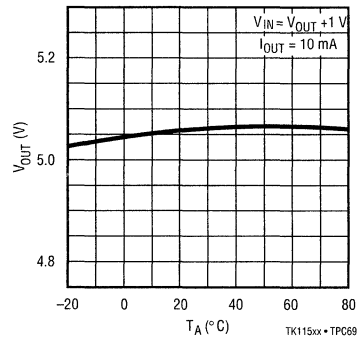
TK11545 OUTPUT VOLTAGE vs TEMPERATURE



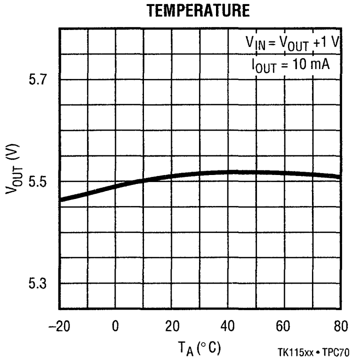
TK11547 OUTPUT VOLTAGE vs TEMPERATURE



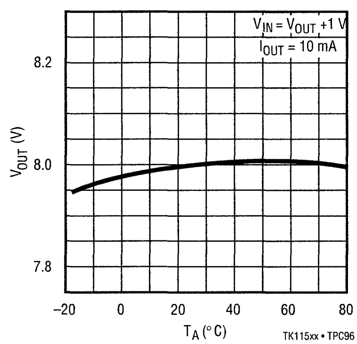
TK11550 OUTPUT VOLTAGE vs TEMPERATURE



TK11555 OUTPUT VOLTAGE vs TEMPERATURE

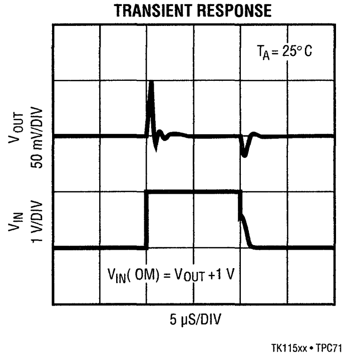


TK11580 OUTPUT VOLTAGE vs TEMPERATURE

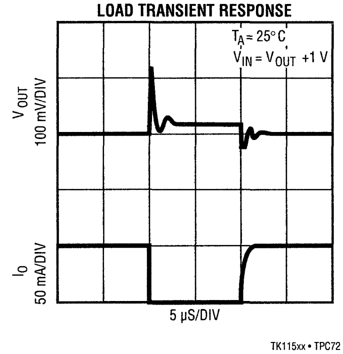


COMMON CHARACTERISTICS

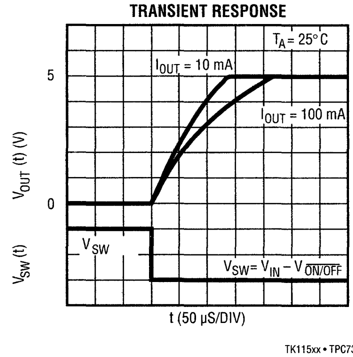
LINE TRANSIENT RESPONSE



LOAD TRANSIENT RESPONSE



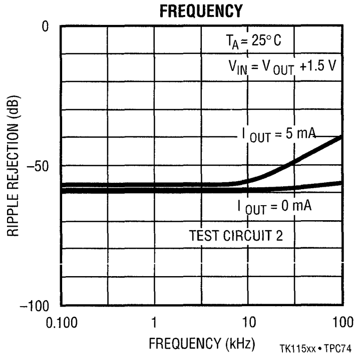
TURN ON TRANSIENT RESPONSE



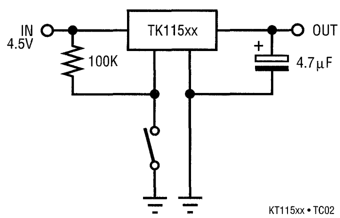
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

COMMON CHARACTERISTICS (CONT.)

RIPPLE REJECTION vs FREQUENCY

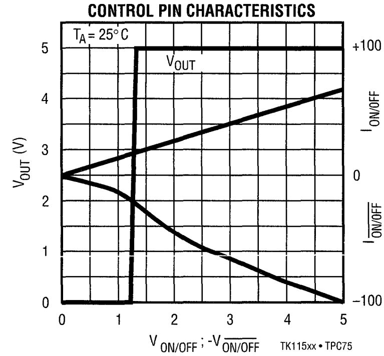


TEST CIRCUIT 2

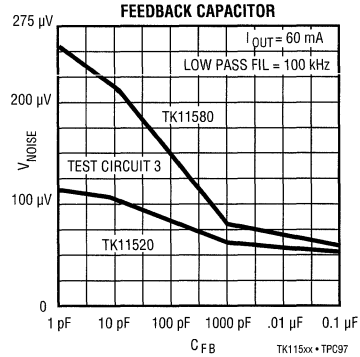


RIPPLE REJECTION TEST CIRCUIT

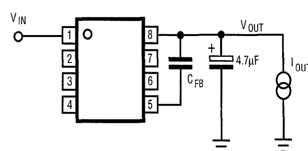
CONTROL PIN CHARACTERISTICS



NOISE LEVEL vs FEEDBACK CAPACITOR

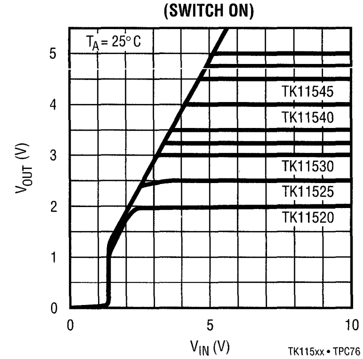


TEST CIRCUIT 3



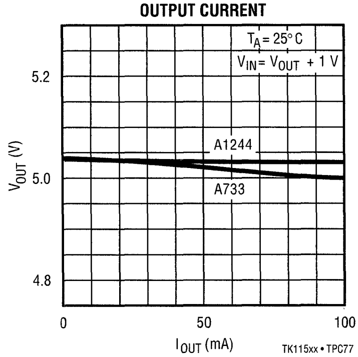
NOISE LEVEL TEST CIRCUIT

INPUT OUTPUT CHARACTERISTICS (SWITCH ON)

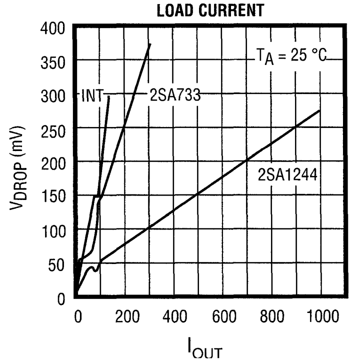


COMMON CHARACTERISTICS WITH EXTERNAL CURRENT BOOST TRANSISTOR (NEC 2SA733 OR TOSHIBA 2SA1244) TK11550

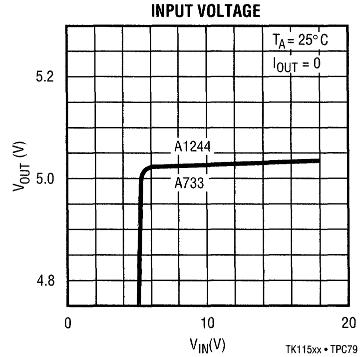
OUTPUT VOLTAGE vs OUTPUT CURRENT



DROPOUT VOLTAGE vs LOAD CURRENT



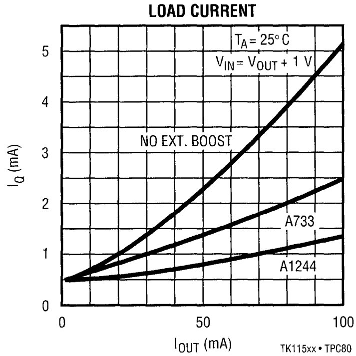
OUTPUT VOLTAGE vs INPUT VOLTAGE



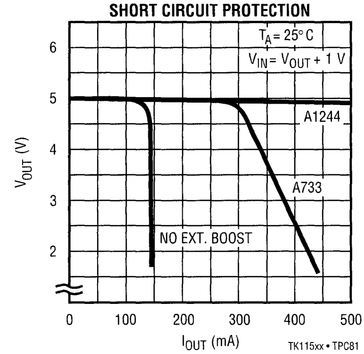
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

COMMON CHARACTERISTICS WITH EXTERNAL CURRENT BOOST TRANSISTOR (NEC 2SA733 OR TOSHIBA 2SA1244)
TK11550 (CONT.)

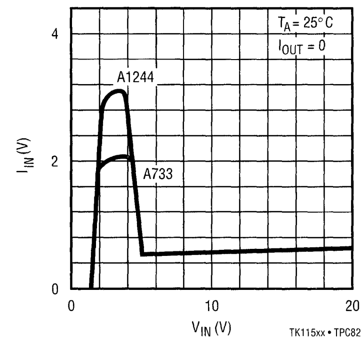
QUIESCENT CURRENT vs LOAD CURRENT



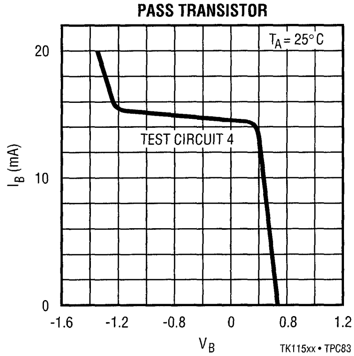
SHORT CIRCUIT PROTECTION



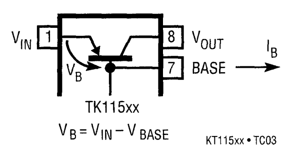
INPUT CURRENT vs INPUT VOLTAGE



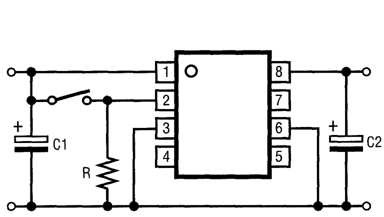
TK115xx INTERNAL PASS TRANSISTOR



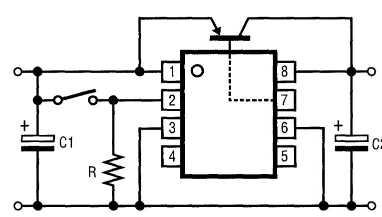
TEST CIRCUIT 4



TYPICAL APPLICATIONS



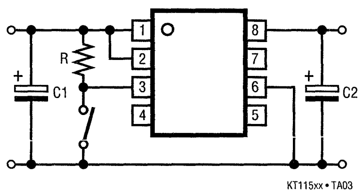
ACTIVE HIGH CONTROL



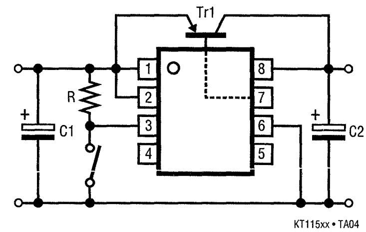
ACTIVE HIGH CONTROL WITH CURRENT BOOST

3

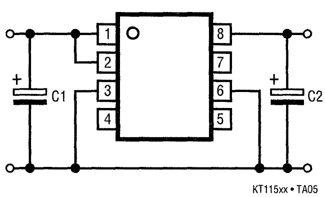
TYPICAL APPLICATIONS (CONT.)



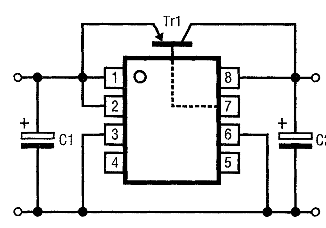
ACTIVE LOW CONTROL



ACTIVE LOW CONTROL WITH CURRENT BOOST



NO SWITCH CONTROL

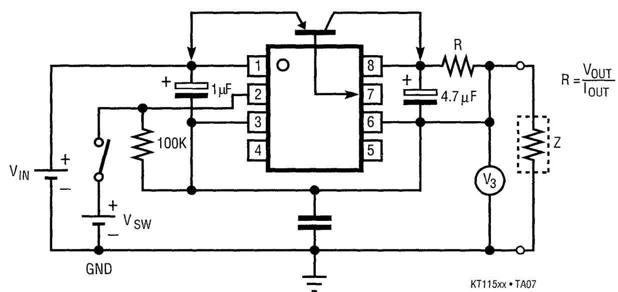


NO SWITCH CONTROL WITH CURRENT BOOST

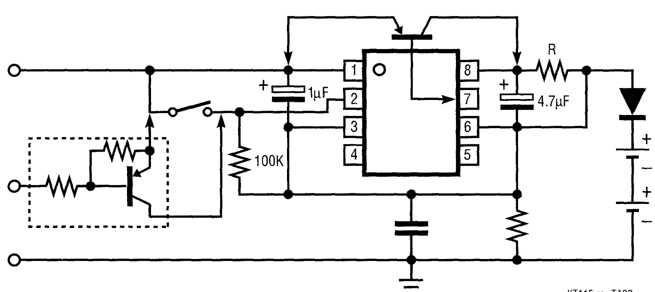
APPLICATION HINTS

Maximize copper foil area connecting to all IC pins for optimum performance. Place input and output bypass capacitors close to the GND pin. For best transient behavior and lowest output impedance, use as large a capacitor value as possible. The temperature coefficient of the capacitance and Equivalent Series Resistance (ESR) should be taken into account. These parameters can influence power supply noise and ripple rejection. In extreme cases, oscillation may occur. In order to maintain stability, the output bypass capacitor value should be minimum 1 μF for Tantalum electrolytic or 4.7 μF for Aluminum electrolytic at T_A= 25 °C.

TYPICAL APPLICATIONS (CONT.)



CURRENT MODE REGULATOR WITH ON/OFF CONTROL AND CURRENT BOOST



BATTERY CHARGER WITH ON/OFF CONTROL AND CURRENT BOOST

3

NOTES

TOKO

THREE-TERMINAL VOLTAGE REGULATOR

FEATURES

- Low Dropout Voltage
- Very Low Standby Current (No Load)
- Good Load Regulation
- Internal Thermal Shutdown
- Short Circuit Protection
- 3% Output Voltage Accuracy
- Available On Paper Tape
- Customized Versions Are Available

APPLICATIONS

- Battery Powered Systems
- Portable Consumer Equipment
- Cordless Telephones
- Personal Communications Equipment
- Portable Instrumentation
- Radio Control Systems
- Toys
- Low Voltage Systems

DESCRIPTION

The TK116xx series devices are low power, linear three-terminal regulators.

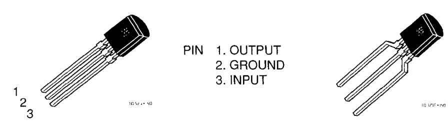
An internal PNP pass-transistor is used in order to achieve low dropout voltage (typically 200 mV at 80 mA load current).

The regulated output voltage may be specified in 0.5 V increments between 2.0 to 5.5 V. Separate data sheets are available for the various options. The device has very low (400 μA) quiescent current with no load and 2 mA with 60 mA load.

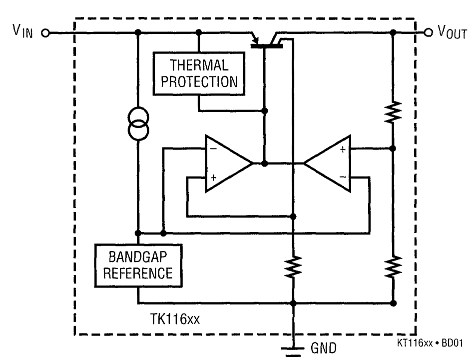
An internal thermal shutdown circuit limits the junction temperature to below 150 °C. The load current is internally monitored and the device will shut down in the presence of a short circuit at the output.

The TK116xx series is available in plastic TO-92J and plastic tape and reel TO-92N packages.

TK116xxJ **TK116xxN**



BLOCK DIAGRAM



ORDERING INFORMATION

TK116 □□ □ □ □□

- Voltage Code
- Package Code
- Temp. Range
- Tape/Reel Code

VOLTAGE CODE

20 = 2.0V	40 = 4.0V
25 = 2.5V	45 = 4.5V
30 = 3.0V	50 = 5.0V
32 = 3.25V	80 = 8.0V
35 = 3.5V	90 = 9.0V

PACKAGE CODE

J : T0-92 (Straight Lead)
N : T0-92 (Bend Lead)

TEMP. RANGE

C : -20 to + 75 °C
I : -40 to + 85 °C

TAPE/REEL CODE

BX : Bulk/Bag
TX : Paper Tape
TR : Tape Right
TL : Tape Left

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ABSOLUTE MAXIMUM RATINGS

Supply Voltage .... 18 V
Output Voltage .... V_{OUT}x1.15 V
Load Current .... 180 mA
Power Dissipation (Note1) .... 500 mW
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range (C Version) -20 to +70 °C
Operating Temperature Range (I Version) -40 to +85 °C
Lead Soldering Temp. (10 sec.) .... 240 °C
Junction Temperature .... 150 °C

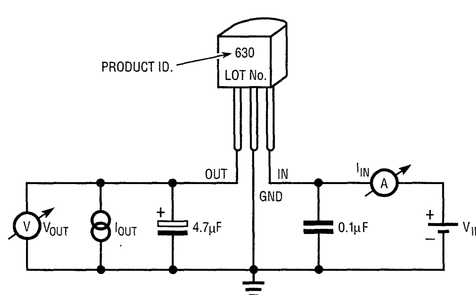
ELECTRICAL CHARACTERISTICS

Due to the common format used here, some specifications may not apply to all versions of output voltage. Detailed specifications are available for each version.

SYMBOL	PARAMETER	TEST CONDITION	-20 to +70 °C			-40 to +85 °C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IN}	Supply Voltage Range		2.5		16	2.5		16	V
I_{IN1}	Supply Current 1	$V_{IN} = V_O + 1$ V, $I_O = 0$ mA		400	800		400	800	µA
I_{IN2}	Supply Current 2	$V_{IN} = V_O + 1$ V, $I_O = 0$ mA		0.8	2.0		0.8	2.0	mA
V_O	Regulated Output Voltage	$V_{IN} = V_O + 1$V, $I_O = 10$ mA, $T_A = 25$	±3% or ±100						mV
V_O	Regulated Output Voltage	$V_{IN} = V_O + 1$ V, $I_O = 10$ mA	±4% or 130			±5% or 150			mV
V_{DROP1}	Dropout Voltage 1	$I_O = 0$ mA		25	80		25	80	mV
V_{DROP2}	Dropout Voltage 2	$I_O = 60$ mA		150	300		150	300	mV
I_O	Output Current	$V_{IN} = V_{OUT} + 1$V		130			130		mA
I_{OR}	Recommended Output Current	$V_{IN} = V_{OUT} + 1$V			100			100	mA
Lin Reg	Line Regulation	$V_{IN} = V_O + 1$ V ~V_O + 6 V		2	30		2	30	mV
Loa Reg1	Load Regulation 1	$I_O = 1$ to 30 mA		15	70		15	70	mV
Loa Reg2	Load Regulation 2	$I_O = 1$ to 60 mA		30	120		30	120	mV
RR	Ripple Rejection	$V_{IN} = V_O + 1.5$ V		55			55		dB
ΔV/ΔT	Temperature Coefficient	$V_{IN} = V_{OUT} + 1.5$ V, $I_{OUT} = 10$ mA		±0.3			±0.3		mV/°C
V_O	Output Noise Voltage	$V_{IN} = V_O + 1.5$ V, $I_O = 10$ mA			150		150		µV(rms)

Note 1: Power dissipation must be derated at the rate of 1.6 mW/°C for operation at T_A = 25 °C and above.

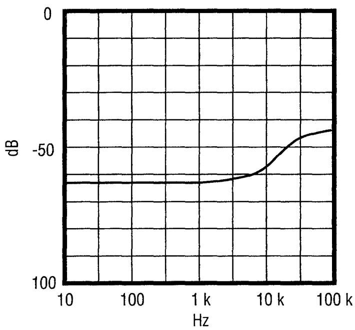
TEST CIRCUIT 1



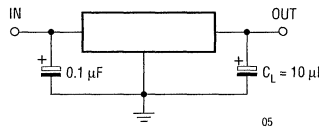
TYPICAL PERFORMANCE CHARACTERISTICS

TK116XX

RIPPLE REJECTION

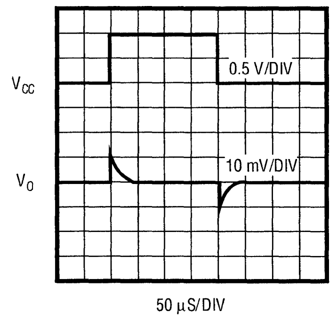


02



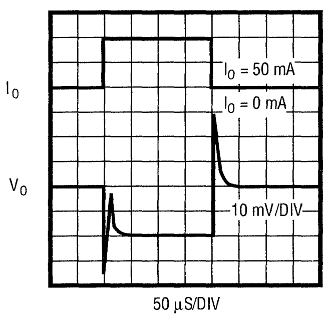
05

LINE TRANSIENT RESPONSE



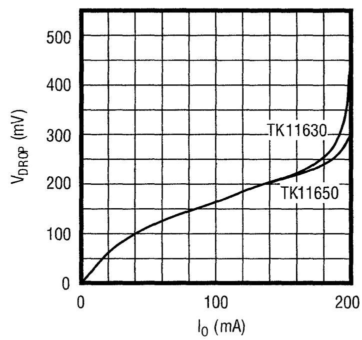
03

LOAD TRANSIENT RESPONSE



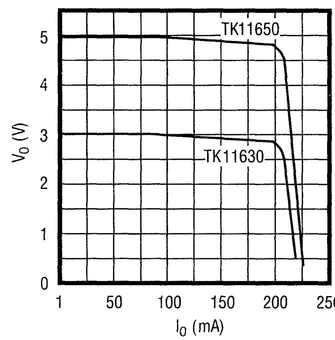
04

DROPOUT VOLTAGE vs LOAD CURRENT



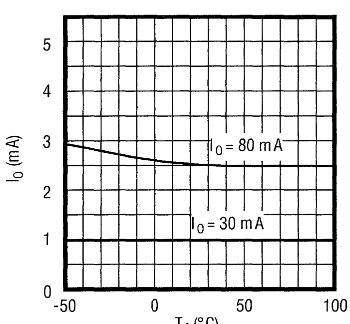
05

SHORT CIRCUIT PROTECTION



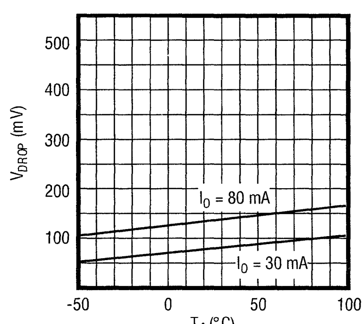
06

QUIESCENT CURRENT vs TEMPERATURE



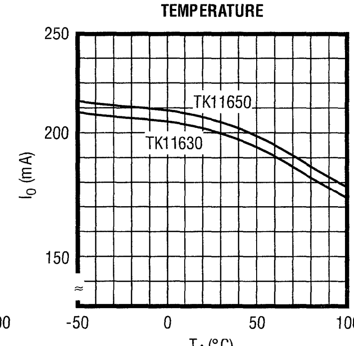
07

DROPOUT VOLTAGE vs TEMPERATURE



08

OUTPUT CURRENT I_{OUT} MAX vs TEMPERATURE



09

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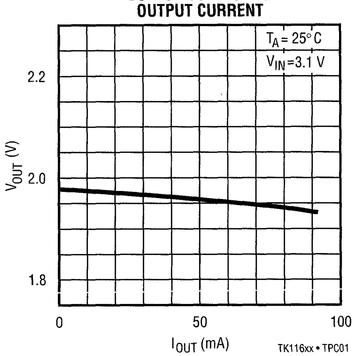
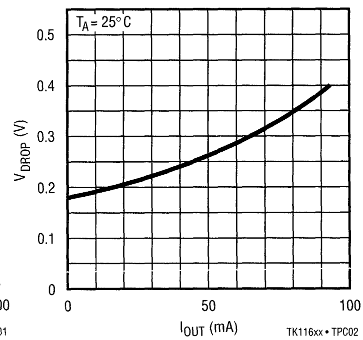
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11620

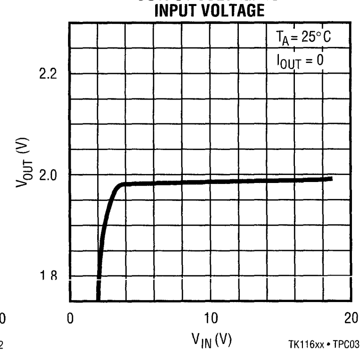
OUTPUT VOLTAGE vs OUTPUT CURRENT



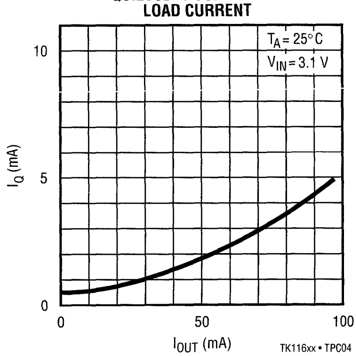
DROPOUT VOLTAGE vs LOAD CURRENT



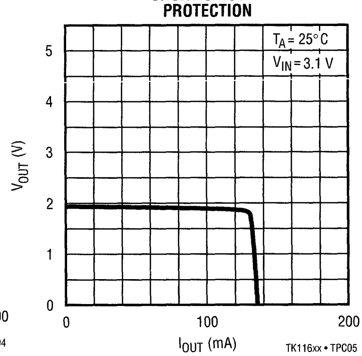
OUTPUT VOLTAGE vs INPUT VOLTAGE



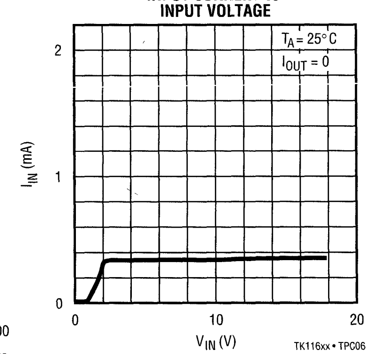
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

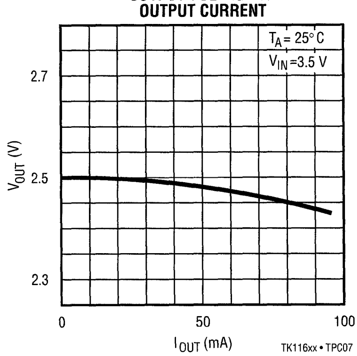


INPUT CURRENT vs INPUT VOLTAGE

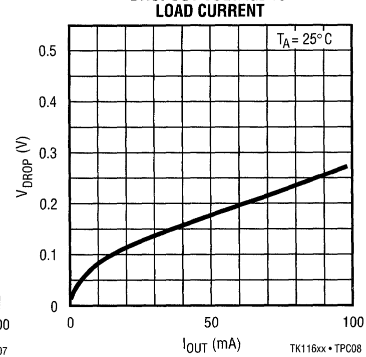


TK11625

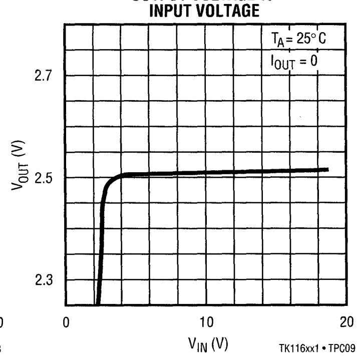
OUTPUT VOLTAGE vs OUTPUT CURRENT



DROPOUT VOLTAGE vs LOAD CURRENT

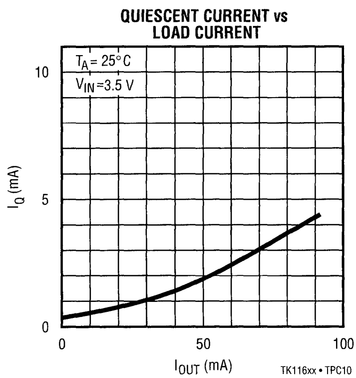


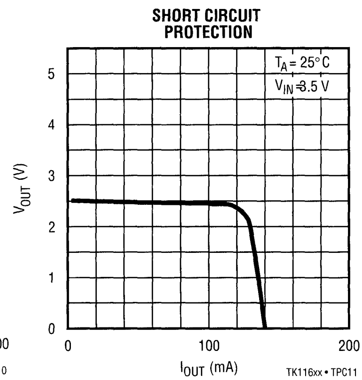
OUTPUT VOLTAGE vs INPUT VOLTAGE

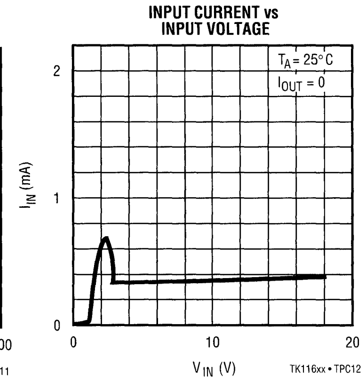


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

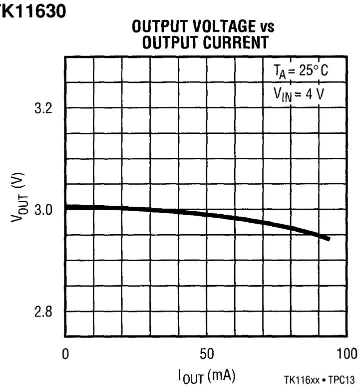
TK11625 (CONT.)

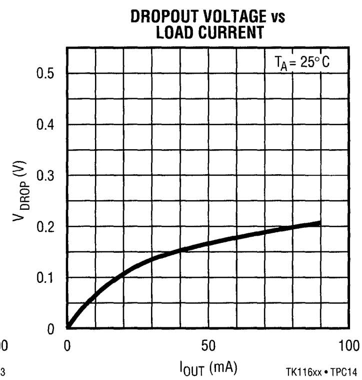


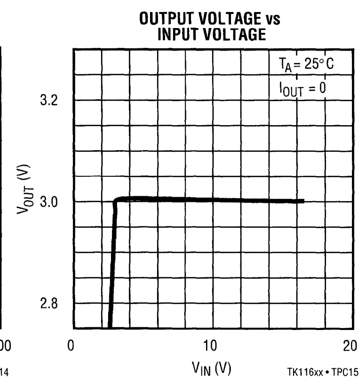


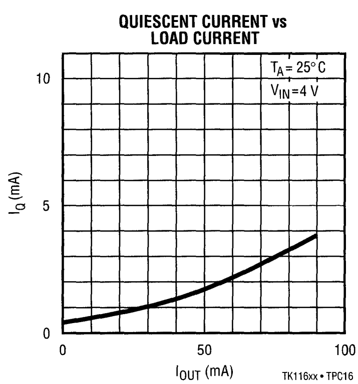


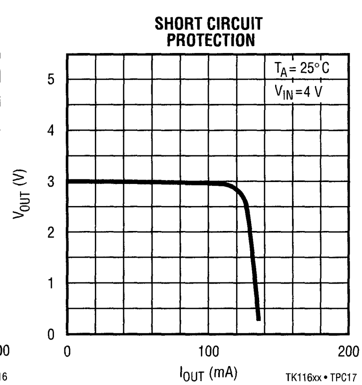
TK11630

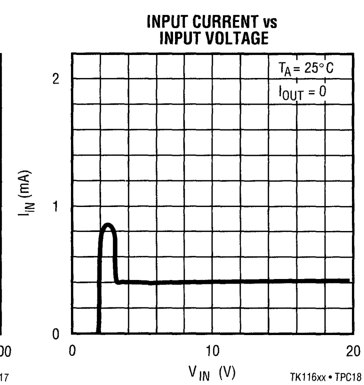








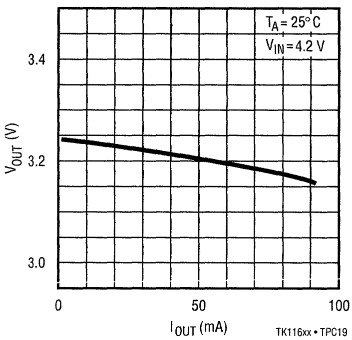




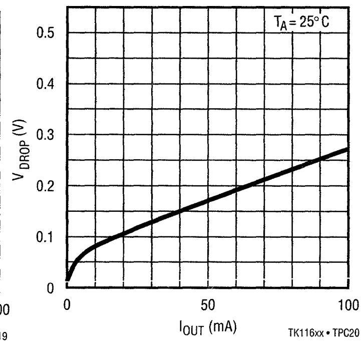
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11632

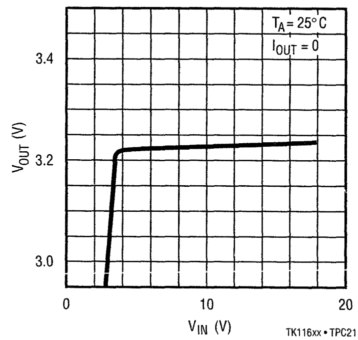
OUTPUT VOLTAGE vs OUTPUT CURRENT



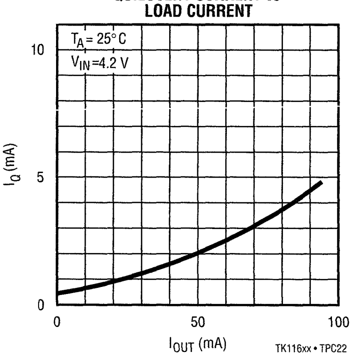
DROPOUT VOLTAGE vs LOAD CURRENT



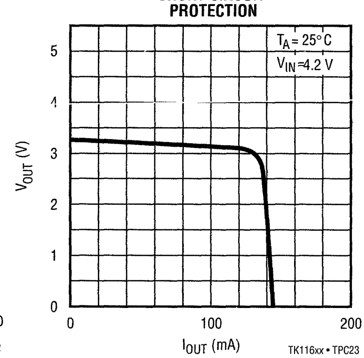
OUTPUT VOLTAGE vs INPUT VOLTAGE



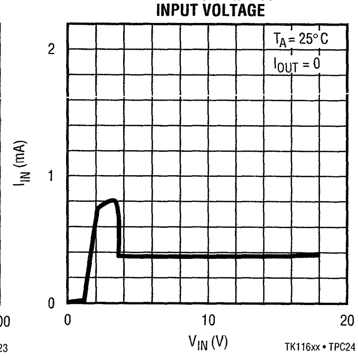
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

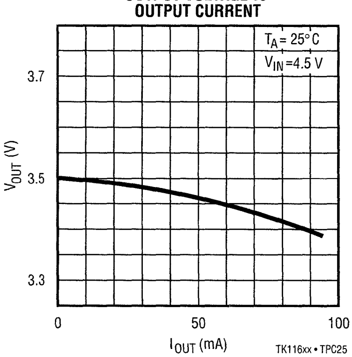


INPUT CURRENT vs INPUT VOLTAGE

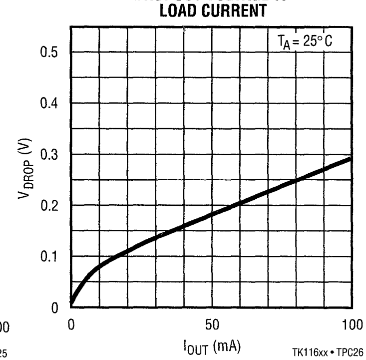


TK11635

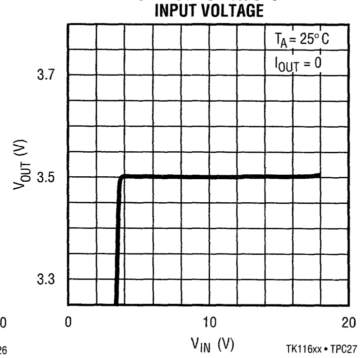
OUTPUT VOLTAGE vs OUTPUT CURRENT



DROPOUT VOLTAGE vs LOAD CURRENT



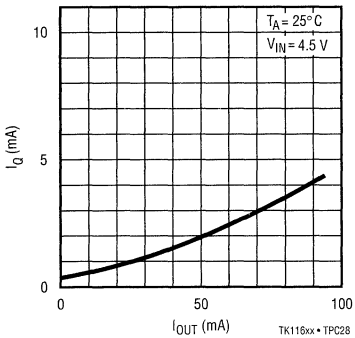
OUTPUT VOLTAGE vs INPUT VOLTAGE



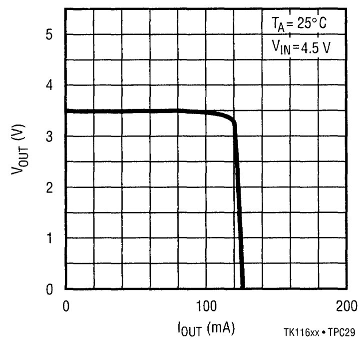
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11635 (CONT.)

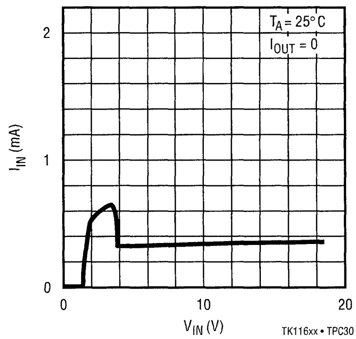
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

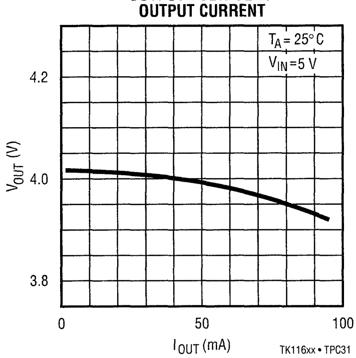


INPUT CURRENT vs INPUT VOLTAGE

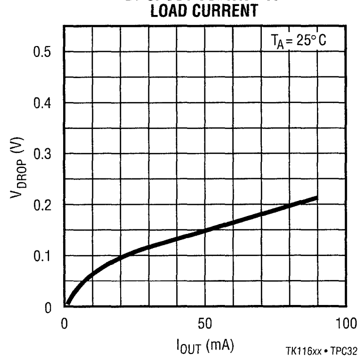


TK11640

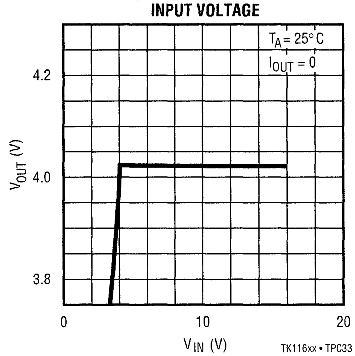
OUTPUT VOLTAGE vs OUTPUT CURRENT



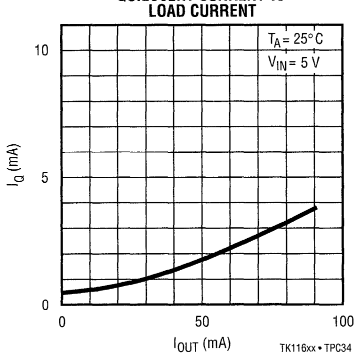
DROPOUT VOLTAGE vs LOAD CURRENT



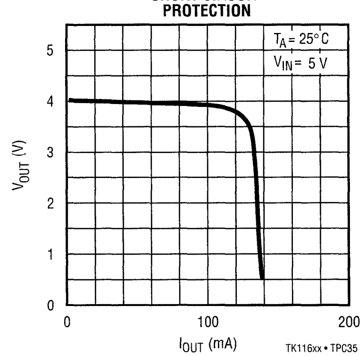
OUTPUT VOLTAGE vs INPUT VOLTAGE



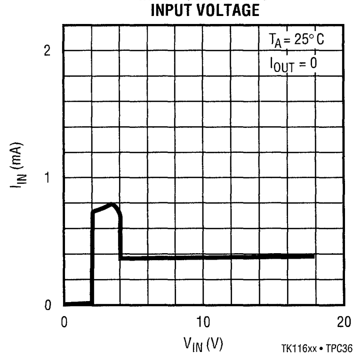
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION



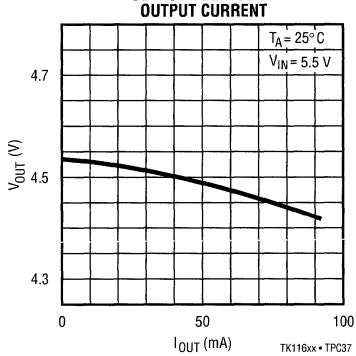
INPUT CURRENT vs INPUT VOLTAGE



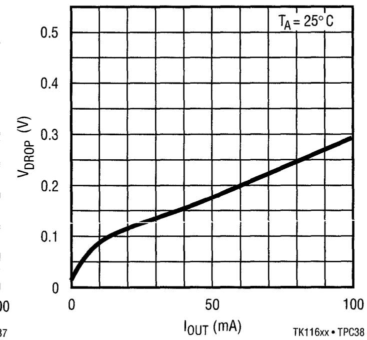
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11645

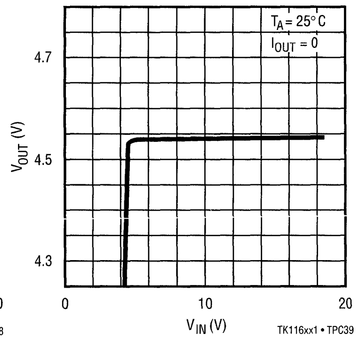
OUTPUT VOLTAGE vs OUTPUT CURRENT



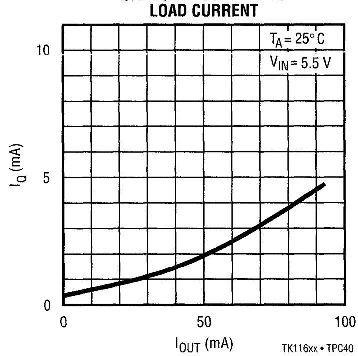
DROPOUT VOLTAGE vs LOAD CURRENT



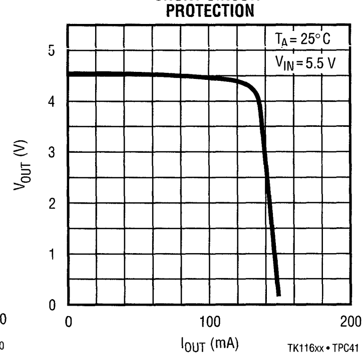
OUTPUT VOLTAGE vs INPUT VOLTAGE



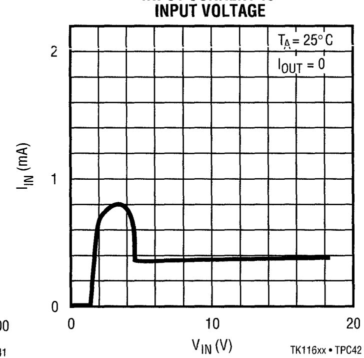
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

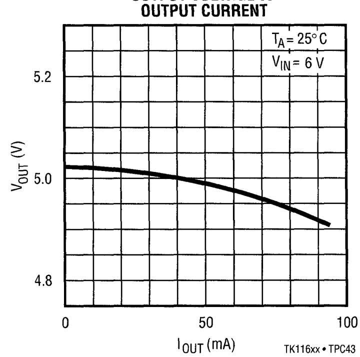


INPUT CURRENT vs INPUT VOLTAGE

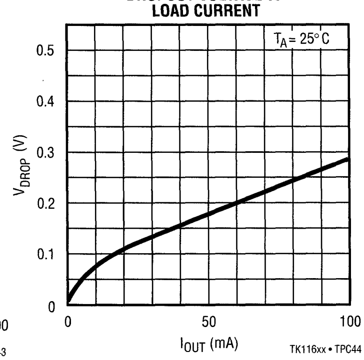


TK11650

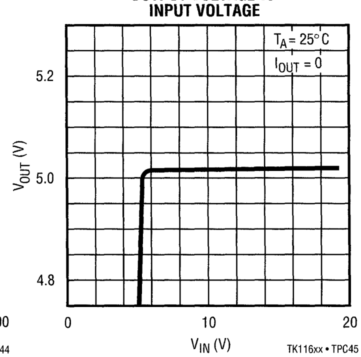
OUTPUT VOLTAGE vs OUTPUT CURRENT



DROPOUT VOLTAGE vs LOAD CURRENT



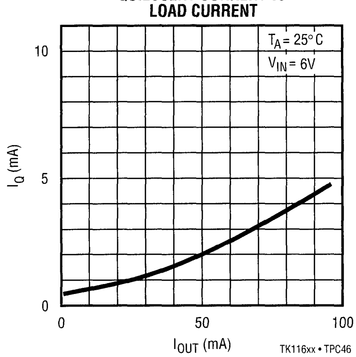
OUTPUT VOLTAGE vs INPUT VOLTAGE



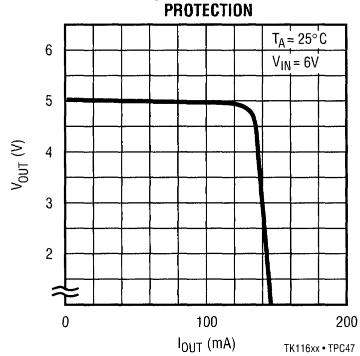
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11650 (Continued)

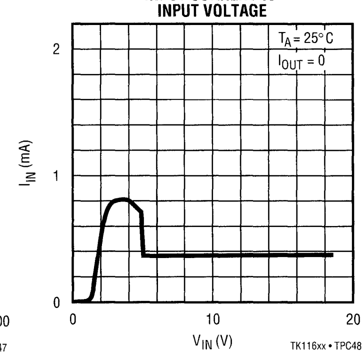
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION

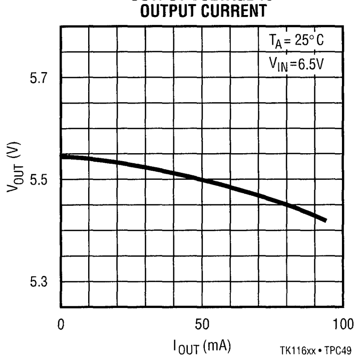


INPUT CURRENT vs INPUT VOLTAGE

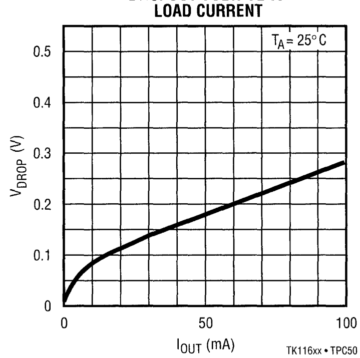


TK11655

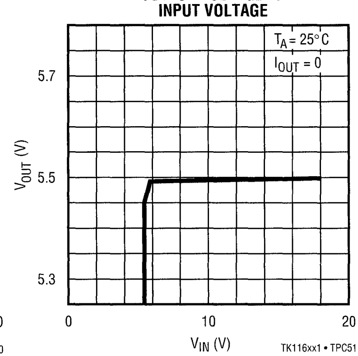
OUTPUT VOLTAGE vs OUTPUT CURRENT



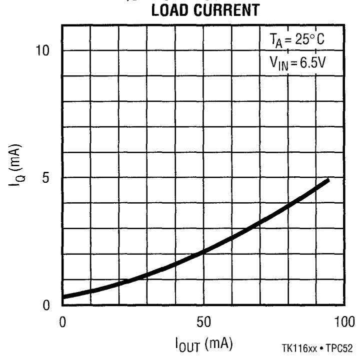
DROPOUT VOLTAGE vs LOAD CURRENT



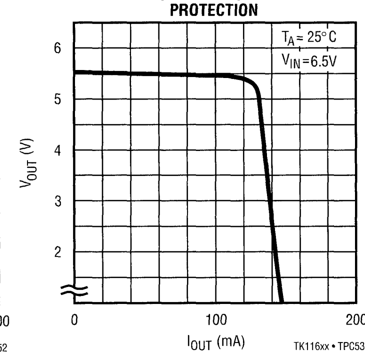
OUTPUT VOLTAGE vs INPUT VOLTAGE



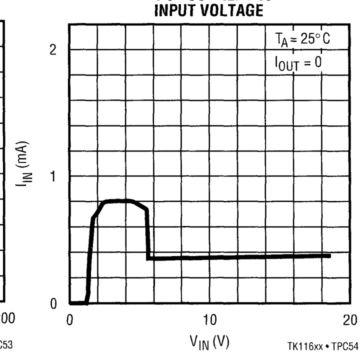
QUIESCENT CURRENT vs LOAD CURRENT



SHORT CIRCUIT PROTECTION



INPUT CURRENT vs INPUT VOLTAGE



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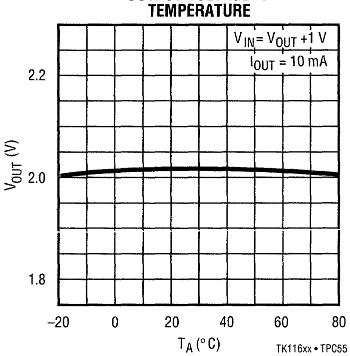
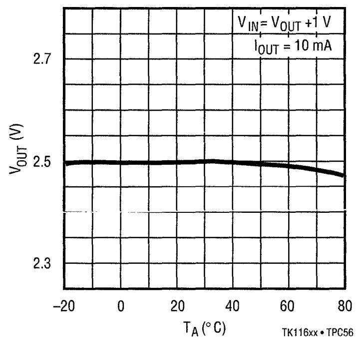
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

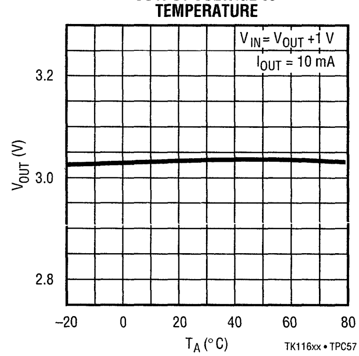
TK11620 OUTPUT VOLTAGE vs TEMPERATURE



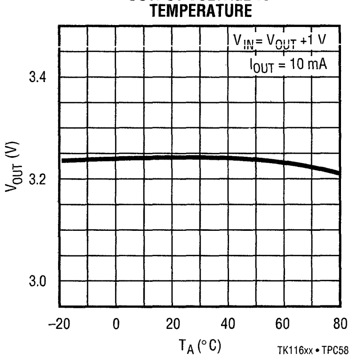
TK11625 OUTPUT VOLTAGE vs TEMPERATURE



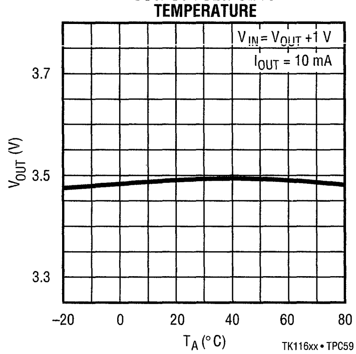
TK11630 OUTPUT VOLTAGE vs TEMPERATURE



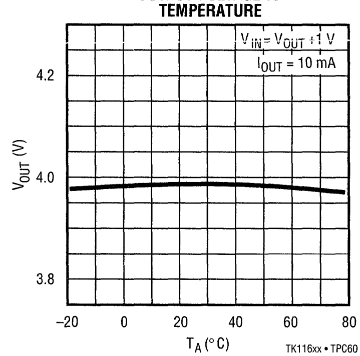
TK11632 OUTPUT VOLTAGE vs TEMPERATURE



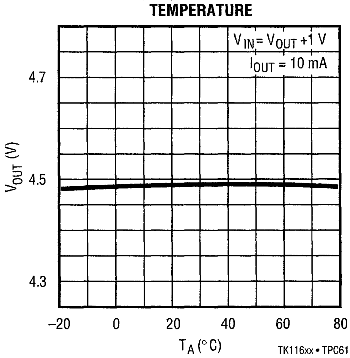
TK11635 OUTPUT VOLTAGE vs TEMPERATURE



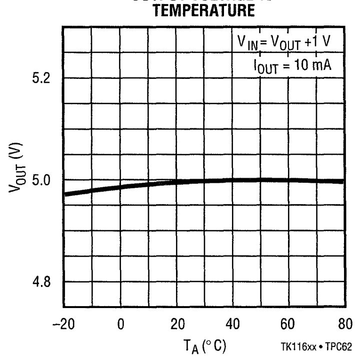
TK11640 OUTPUT VOLTAGE vs TEMPERATURE



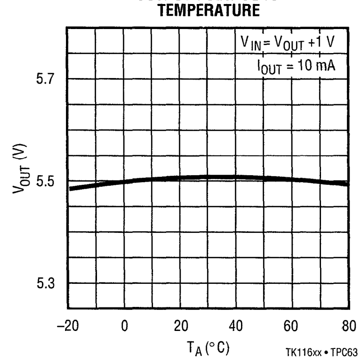
TK11645 OUTPUT VOLTAGE vs TEMPERATURE



TK11650 OUTPUT VOLTAGE vs TEMPERATURE



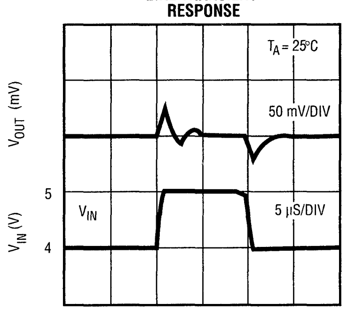
TK11655 OUTPUT VOLTAGE vs TEMPERATURE



TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

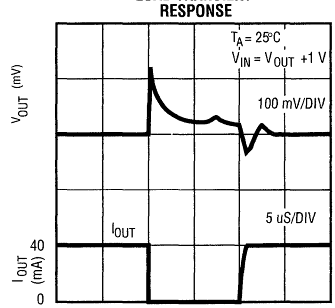
COMMON CHARACTERISTICS

LINE TRANSIENT RESPONSE



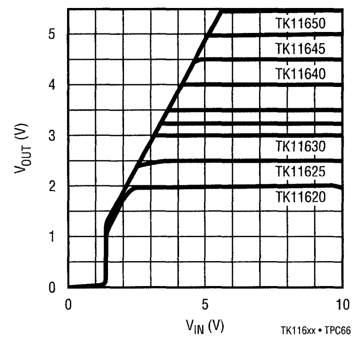
TK116xx • TPC64

LOAD TRANSIENT RESPONSE



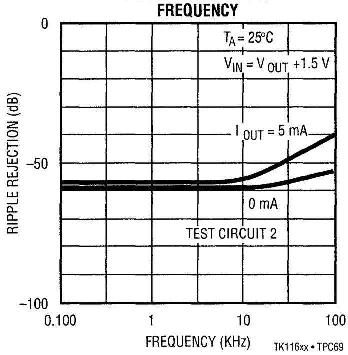
TK116xx • TPC65

INPUT/OUTPUT CHARACTERISTICS



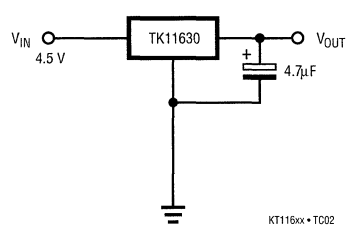
TK116xx • TPC66

RIPPLE REJECTION vs FREQUENCY



TK116xx • TPC69

TEST CIRCUIT 2



KT116xx • TC02

RIPPLE REJECTION TEST CIRCUIT

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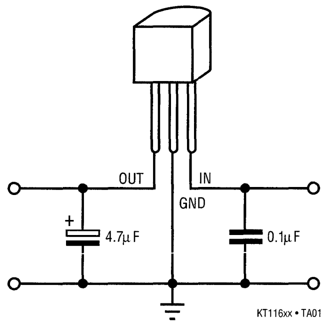
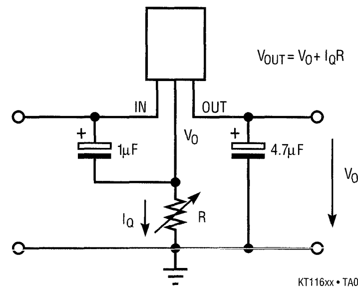
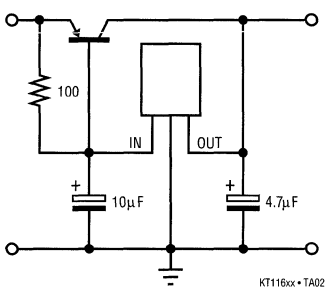
TYPICAL APPLICATIONS



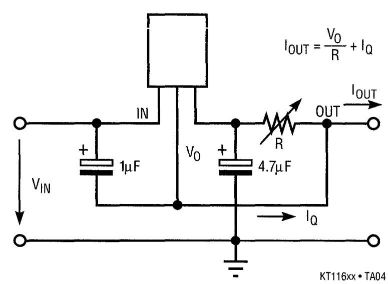
VOLTAGE REGULATOR CIRCUIT



VOLTAGE BOOST CIRCUIT



CURRENT BOOST CIRCUIT



CURRENT REGULATOR CIRCUIT

APPLICATION HINTS

Maximize copper foil area connecting to all IC pins for optimum heat conduction. Place input and output bypass capacitors close to the GND pin. For best transient behavior and lowest output impedance, use as large a capacitor value as possible. The temperature coefficient of the capacitance and Equivalent Series Resistance (ESR) should be taken into account, as these parameters can influence power supply noise and ripple rejection. In extreme cases, oscillation may occur. In order to maintain stability, the output bypass capacitor value should be minimum 1 µF for Tantalum electrolytic or 4.7 µF for Aluminum electrolytic at T_A=25 °C.

THREE-TERMINAL VOLTAGE REGULATOR

FEATURES

- Low Dropout Voltage
- Very Low Standby Current (No Load)
- Good Load Regulation
- Internal Thermal Shutdown
- Short Circuit Protection
- 150 mA Load Current
- 3% Output Voltage Accuracy
- Customized Versions Are Available

APPLICATIONS

- Battery Powered Systems
- Portable Consumer Equipment
- Cordless Telephones
- Personal Communications Equipment
- Portable Instrumentation
- Radio Control Systems
- Toys
- Low Voltage Systems

DESCRIPTION

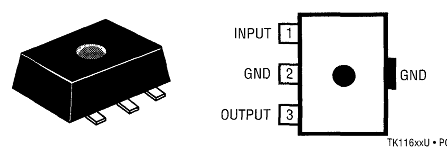
The TK116xxU series devices are low power, linear 3-terminal regulators.

An internal PNP pass-transistor is used in order to achieve low dropout voltage (typically 160 mV at 80 mA load current).

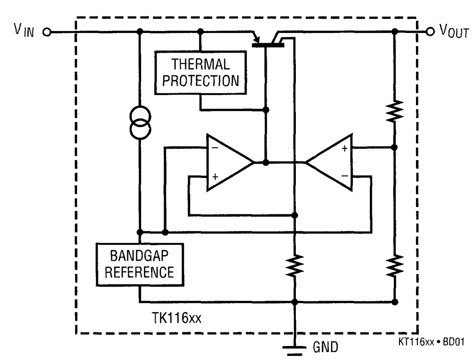
The regulated output voltage may be specified in 0.5 V increments from 2.0 V. Separate data sheets are available for the various options. The device has very low (400 µA) quiescent current with no load and 2 mA with 60 mA load.

An internal thermal shutdown circuit limits the junction temperature to below 150 °C. The load current is internally monitored and the device will shut down in the presence of a short circuit at the output.

TK116xxU



BLOCK DIAGRAM



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ORDERING INFORMATION

TK116 □□ □ □ □□

- Voltage Code
- Package Code
- Temp. Range
- Tape/Reel Code

VOLTAGE CODE
30 = 3.0 V
50 = 5.0 V

PACKAGE CODE
U : Upack

TEMP. RANGE
C : -20 to +70 °C
I : -40 to +85 °C

TAPE/REEL CODE
TL : Tape Left

ABSOLUTE MAXIMUM RATINGS

Supply Voltage .... 18 V
Output Voltage .... V_{OUT}x1.15 V
Load Current .... 250 mA
Power Dissipation (Note1) .... 1000 mW

Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range (C version) -20 to +70 °C
Operating Temperature Range (I version) -40 to +85 °C
Lead Soldering Temp. (10 sec.) .... 240 °C
Junction Temperature .... 150 °C

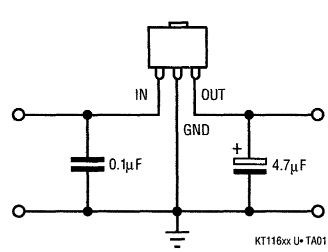
ELECTRICAL CHARACTERISTICS

Due to the common format used here, some specifications may not apply to all versions of output voltages. Detailed specifications are available for each version.

SYMBOL	PARAMETER	TEST CONDITION	-20 to +70 °C			-40 to +85 °C			
			MIN	TYP	MAX	MIN	TYP	MAX	UNITS
V_{IN}	Supply Voltage Range		2.5		16	2.5		16	V
I_{IN1}	Supply Current 1	$V_{IN} = V_{OUT} + 1$ V, $I_O = 0$ mA		400	800		400	800	µA
I_{IN2}	Supply Current 2	$V_{IN} = V_{OUT} - 1$ V, $I_O = 0$ mA		0.8	2.0		0.8	2.0	mA
V_O	Regulated Output Voltage	$V_{IN} = V_O + 1$ V, $I_O = 10$ mA,	±3% or ±100						mV
		$T_A = 25$ °C	±4.5% or 130			±5% or 140			mV
ΔV/ΔT	Temperature Coefficient	$V_{IN} = V_{OUT} + 1.5$ V, $I_O = 10$ mA		±.35			±.35		mV/°C
V_{DROP1}	Dropout Voltage 1	$I_O = 30$ mA		80	150		80	150	mV
V_{DROP2}	Dropout Voltage 2	$I_O = 60$ mA		130	280		130	280	mV
V_{DROP3}	Dropout Voltage 3	$I_O = 100$ mA		170	330		170	330	mV
I_{OUT}	Output Current	$V_{IN} = V_O + 1$ V		190			190		mA
I_{OR}	Recommended Output Current	$V_{IN} = V_O + 1$ V			150			150	mA
I_Q	Quiescent Current	$V_{IN} = 6$ V, $I_O = 60$ mA		2	4.5		2	4.5	mA
Lin Reg	Line Regulation	$V_{IN} = V_O + 1$ V $\leq V_{OUT} + 6$ V		2	30		2	30	mV
Loa Reg1	Load Regulation 1	$I_O = 1$ to 30 mA		15	60		15	60	mV
Loa Reg2	Load Regulation 2	$I_O = 1$ to 100 mA		40	140		40	140	mV
RR	Ripple Rejection	100 mV(rms), f = 400 Hz		55			55		dB

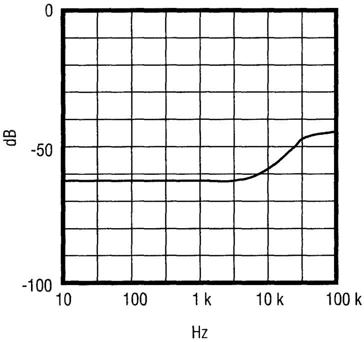
Note 1: Power dissipation must be derated at the rate of 8 mW/°C for operation at $T_A = 25$ °C and above.

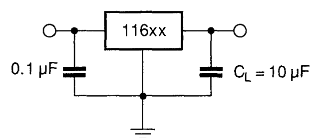
TEST CIRCUIT 1



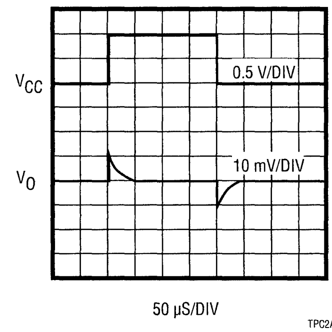
TYPICAL PERFORMANCE CHARACTERISTICS

RIPPLE REJECTION vs. FREQUENCY

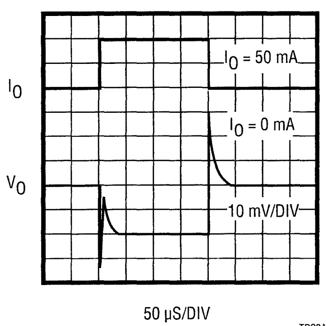




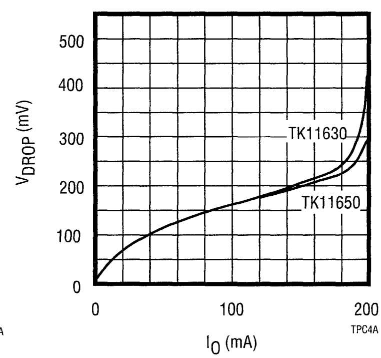
LINE TRANSIENT RESPONSE



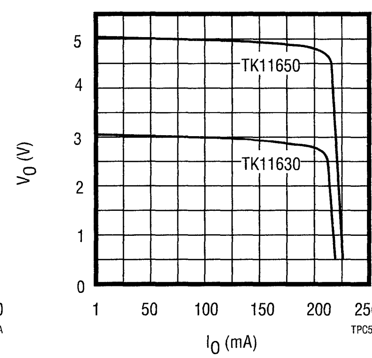
LOAD TRANSIENT RESPONSE



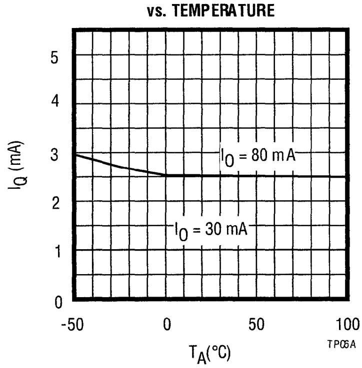
DROPOUT VOLTAGE vs. LOAD CURRENT



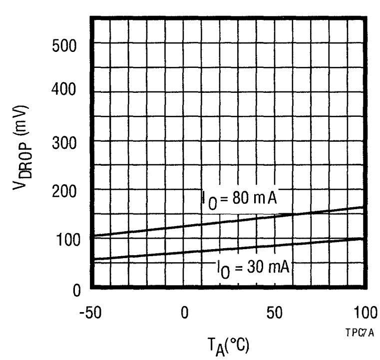
SHORT CIRCUIT PROTECTION



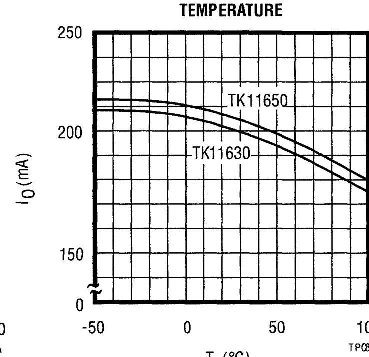
QUIESCENT CURRENT vs. TEMPERATURE



DROPOUT VOLTAGE vs. TEMPERATURE



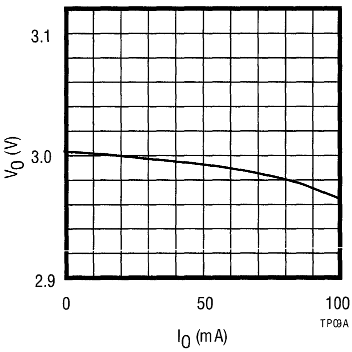
OUTPUT CURRENT MAX vs. TEMPERATURE



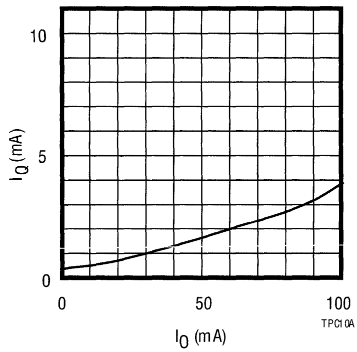
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

11630

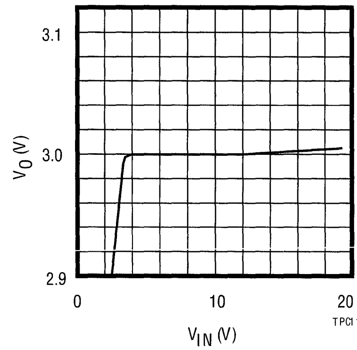
OUTPUT VOLTAGE vs. OUTPUT CURRENT



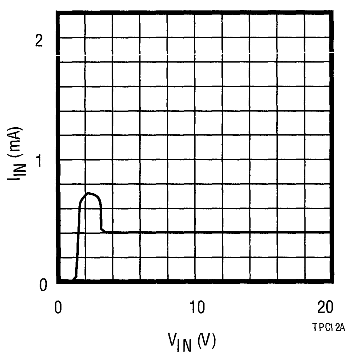
QUIESCENT CURRENT vs. LOAD CURRENT



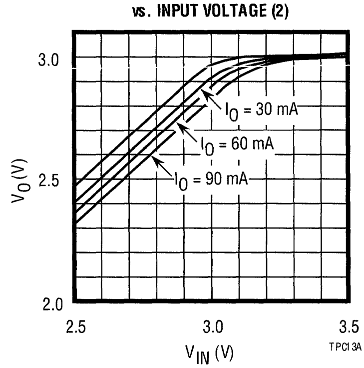
OUTPUT VOLTAGE vs. INPUT VOLTAGE (1)



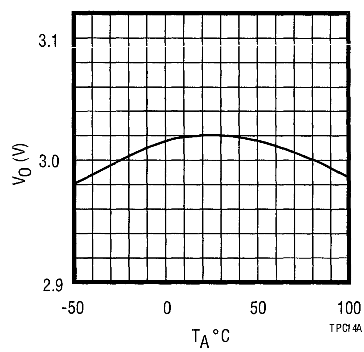
INPUT CURRENT vs. INPUT VOLTAGE



OUTPUT VOLTAGE vs. INPUT VOLTAGE (2)

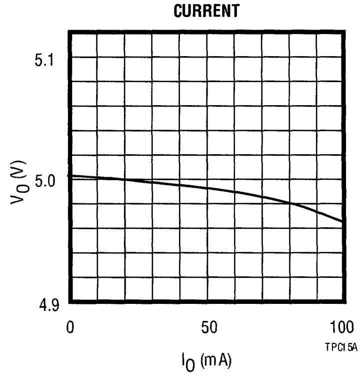


OUTPUT VOLTAGE vs. TEMPERATURE

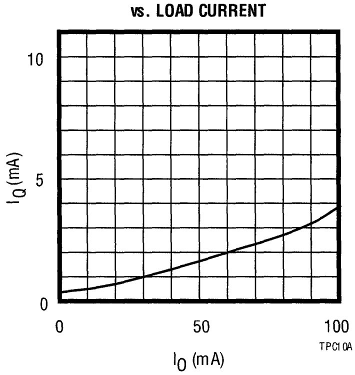


11650

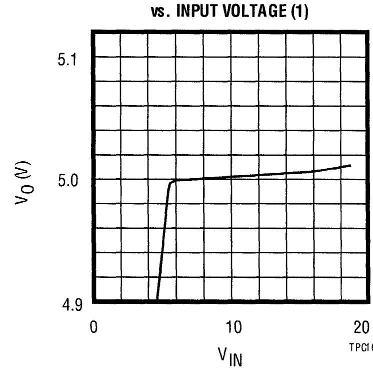
OUTPUT VOLTAGE vs. OUTPUT CURRENT



QUIESCENT CURRENT vs. LOAD CURRENT

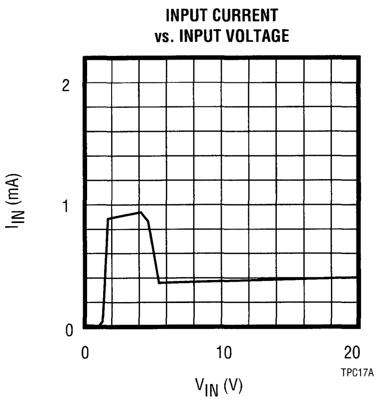


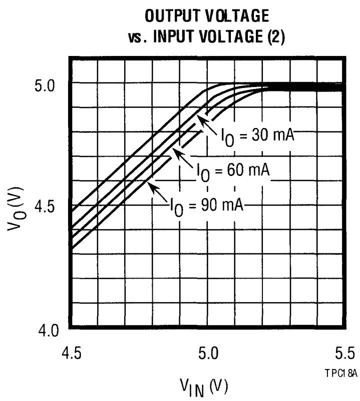
OUTPUT VOLTAGE vs. INPUT VOLTAGE (1)

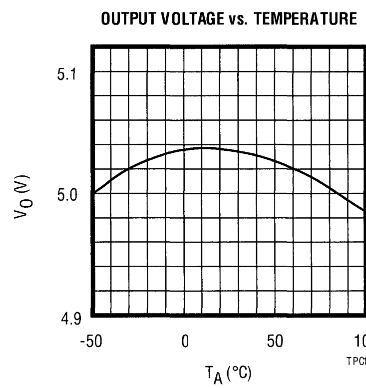


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

11650 (CONT.)







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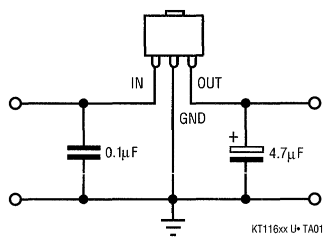
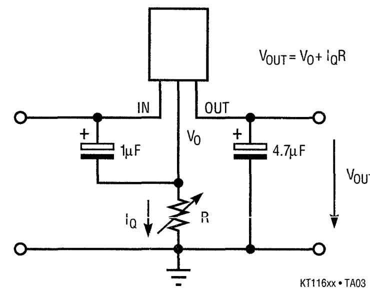
NOTES

TYPICAL APPLICATIONS

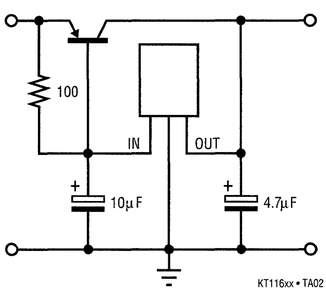
VOLTAGE REGULATOR CIRCUIT



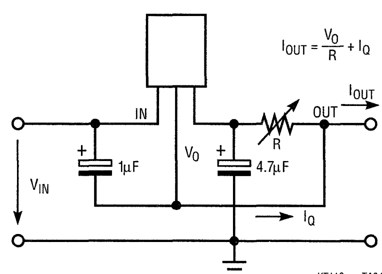
VOLTAGE BOOST CIRCUIT



CURRENT BOOST CIRCUIT



CURRENT REGULATOR CIRCUIT



APPLICATION HINTS

Maximize copper foil area connecting to all IC pins for optimum heat conduction. Place input and output bypass capacitors close to the GND pin.

For best transient behavior and lowest output impedance, use as large a capacitor value as possible. The temperature coefficient of the capacitance and Equivalent Series Resistance (ESR) should be taken into account. These parameters can influence power supply noise and ripple rejection. In extreme cases, oscillation may occur. In order to maintain stability, the output bypass capacitor value should be minimum 1 µF for Tantalum electrolytic or 4.7 µF for Aluminum electrolytic at T_A=25 °C.

TOKO

PROGRAMMABLE VOLTAGE REGULATOR

FEATURES

- Low Dropout Voltage
- Wide Operation Voltage Range
- 1.5 V to 9.25 V of Variable Output Voltage is Available (Step 0.25 V)
- Low Quiescent Current
- Current Limit Circuit
- Short Circuit Protection

APPLICATIONS

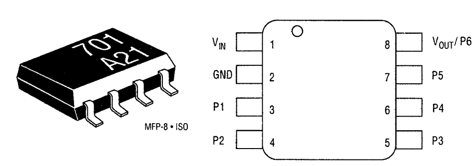
- Battery Operated Equipment
- Cordless Telephone
- Test Equipment
- Consumer Equipment

DESCRIPTION

The TK11701 is a programmable low dropout regulator IC. The output is adjustable from 1.5 V to 9.25 V in 0.25 V steps by connecting a jumper to the programming pins as shown in Table 1. A potentiometer can be used to fine adjust the output voltage. The TK11701 has a built in overcurrent and short circuit protection circuitry.

The TK11701 is available in an MFP-8 surface mount package.

TK11701



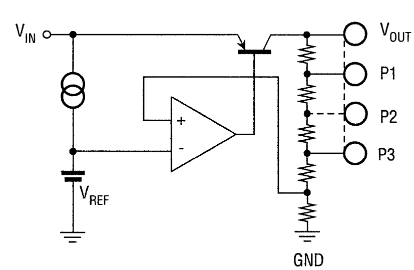
ORDERING INFORMATION

TK11701 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +75 °C	BX: Bulk/Bag
		TX: Paper Tape
		TR: Tape Right
		TL: Tape Left
		MG: Magazine

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 18 V
Power Dissipation .... 350 mW
Output Voltage .... 10.1 V
Output Current .... 150 mA
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +75 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

Test Conditions: T_A = 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
$I_{IN\,1}$	Input Current 1	I_O = 0 mA, V_{IN} = 12 V		2.5	4.0	mA
$I_{IN\,2}$	Input Current 2	I_O = 0 mA, (V_O - 1) V			6.0	mA
V_O	Output Voltage	I_O = 0 mA	See Table 1			
V_{OE}	Output Voltage Error	$V_{IN} \geq 3.5$ V	See Table 2		4.5%/V	
V_{DROP}	Voltage Drop	I_O = 60 mA			350	mV
RR	Ripple Rejection	V_O = 1.5 V, V_{IN} = 3 V		45		dB
I_O	Output Current	Note 2			100	mA
Line Reg	Line Regulation	$V_{IN} = (V_O + 2.5) \rightarrow +1$ V		7		mV
Loa Reg	Load Regulation	$V_{IN} = (V_O + 2.5)$ I_O = 1 ~ 80 mA			150	mV
$\Delta V_O / T_A$	Output Voltage vs. Temp	V_O = 1.5 V, V_{IN} = 7 V		0.3		mV/°C
V_{NO}	Output Noise Voltage	10 Hz < f < 100 kHz		150		µV(rms)

Note 1: Power dissipation must be derated at the rate of 3.0 W/°C at T_A = 25 °C and above.
Note 2: Use with the power dissipation derating curve.

TEST CIRCUIT

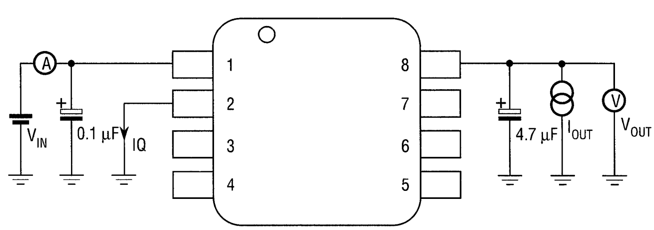
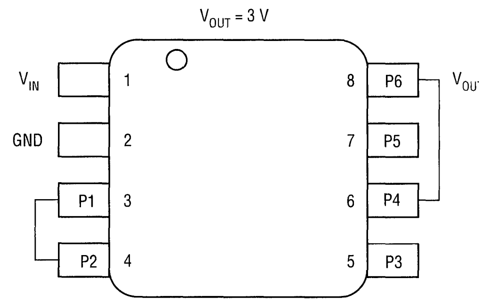


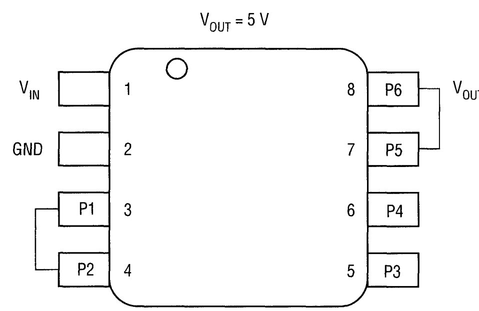
TABLE 1: PIN WIRE CONNECTION vs. V_{OUT}

V_{OUT} (V) \ PIN No.	P1	P2	P3	P4	P5	P6
1.50	●	—	—	—	—	●
1.75		●	—	—	—	●
2.00	●	●	●	—	—	●
2.25			●	—	—	●
2.50	●	—	●	●	—	●
2.75		●	●	●	—	●
3.00	●	●		●	—	●
3.25				●	—	●
3.50	●	—	—	●	●	●
3.75		●	—	●	●	●
4.00	●	●	●	●	●	●
4.25			●	●	●	●
4.50	●	—	●		●	●
4.75		●	●		●	●
5.00	●	●			●	●
5.25					●	●
5.50	●	—	—	—	●	
5.75		●	—	—	●	
6.00	●	●	●	—	●	
6.25			●	—	●	
6.50	●	—	●	●	●	
6.75		●	●	●	●	
7.00	●	●		●	●	
7.25				●	●	
7.50	●	—	—	●		
7.75		●	—	●		
8.00	●	●	●	●		
8.25			●	●		
8.50	●	—	●			
8.75		●	●			
9.00	●	●				
9.25						

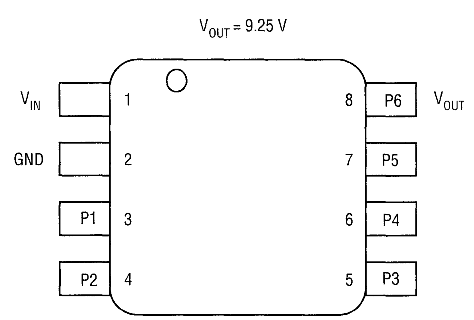
01



01

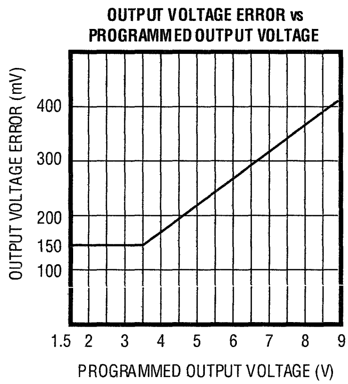


02



03

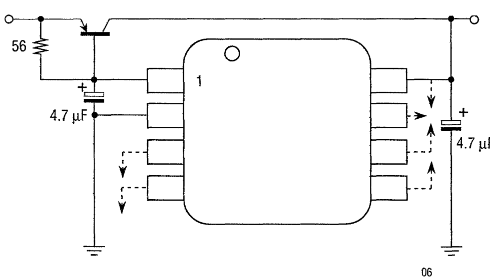
TABLE 2



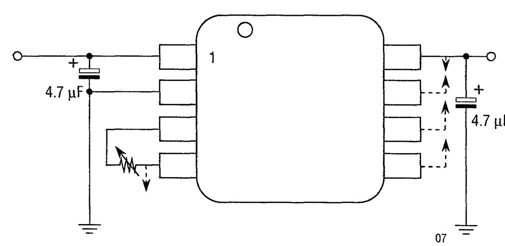
Output voltage accuracy depends on the selected output voltage due to the cumulative tolerances of the internal resistor divider network.

TYPICAL APPLICATIONS

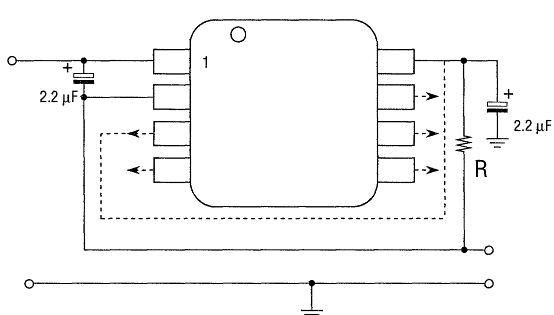
CURRENT BOOST



VOLTAGE FINE ADJUST



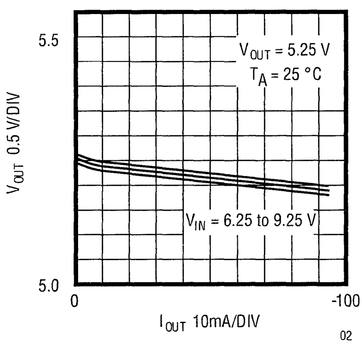
CURRENT REGULATOR



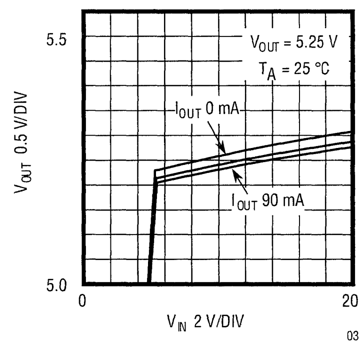
$$I_{OUT} = \frac{V_{OUT}}{R} + IQ$$

TYPICAL PERFORMANCE CHARACTERISTICS

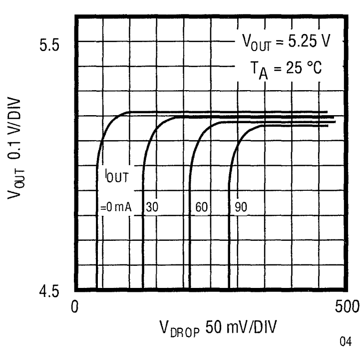
LOAD REGULATION



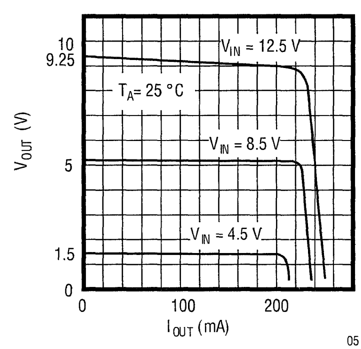
LINE REGULATION



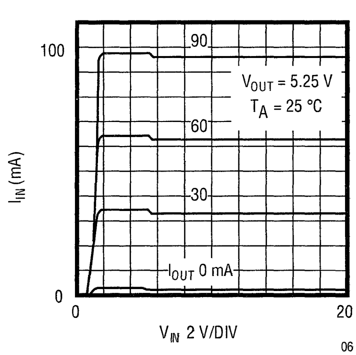
DROPOUT VOLTAGE



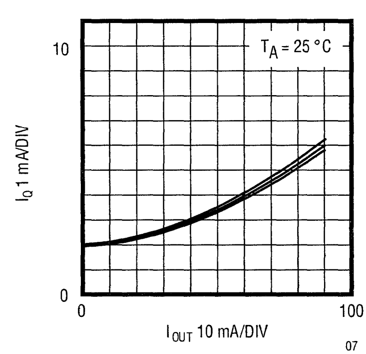
SHORT CIRCUIT PROTECTION



INPUT CURRENT vs INPUT VOLTAGE



QUIESCENT CURRENT vs LOAD CURRENT



3

NOTES

TOKO

TK11900

ADJUSTABLE LOW DROPOUT REGULATOR

FEATURES

- Low Supply Current
- Low Power Shutdown Mode
- Low Noise Output
- Low Drop Out Voltage
- Extremely Small Package
- Extemely High Stability
- High Speed On/Off Transient (Typ. 50 μS)

APPLICATIONS

- Portable Instrumentation
- Cordless Telephones
- Pagers
- Toys
- Cellular Phones
- Test Equipment

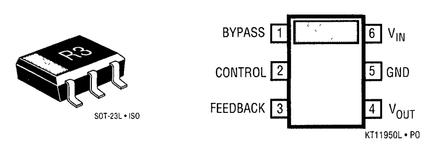
DESCRIPTION

The TK11900 is a low dropout voltage regulator with external voltage adjustment. The output can be set between 1.5 V and 6 V by an external pair of resistors in a divider configuration. The device has a bypass pin for an external capacitor to reduce output noise to a typical 50 μV(rms). In addition a shutdown pin is provided that is active high (a high level turns on the output). In the off mode (control pin low) the device draws only 65 μA of quiescent current.

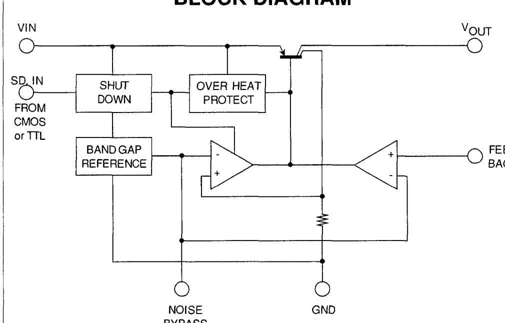
The TK11900 is available in a SOT23L surface mount package.

3

TK11900M



BLOCK DIAGRAM



ORDERING INFORMATION

TK11900 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +75 °C	BX: Bulk/Bag
	M: - 40 to +85 °C	TR: Tape Right
		TL: Tape Left

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 17 V
Operating Voltage Range .... 1.8 to 16 V
Power Dissipation (Note 1) .... 200 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range (C version) -20 to +70 °C
Operating Temperature Range (I version) . -40 to +85 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

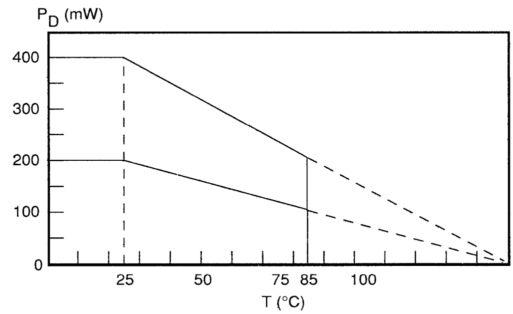
ELECTRICAL CHARACTERISTICS

Test conditions: T_A = 25 °C, $V_{IN} = (V_O + 1)$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC1}	Supply Current 1	I_O = 0 mA, $V_{IN} = (V_O + 1)$ V		140	300	μA
I_{CC2}	Supply Current 2	I_O = 0 mA, $V_{IN} = (V_O + 1)$ V		400	900	μA
I_{CC3}	Supply Current 3	Such as the shut down		65	150	μA
V_{OUT}	Output Voltage			1.5 ~ 6		V
V_{DROP}	Voltage Difference Between I/O	I_O = 30 mA		160	350	mV
I_O	Output Current	Note 1			100	mA
LinReg	Input Stability	$V_{IN} = (V_O + 1) \sim (V_O + 10) \leq V_{CC\ MAX}$		±5	±50	mV
LoaReg	Load Stability	I_O = 1 ~ 80 mA		25	150	mV
$\Delta V_O/\Delta T_A$	V_O Peripheral Temp. Dep.					mV/ °C
RR	Ripple Elimination Ratio	C_L = 10 μF, 400 Hz		68		dB
V_{NO}	Output Noise Voltage	10 Hz < f < 100 kHZ, C_L = 10 μF		50		μV(rms)
V_{REF}	Standard Voltage			1.25		V
ΔV_{REF}	Voltage Error		-2		+2	%
Shut Down						
C_{CONT1}	Shut down Voltage 1	V_{OUT} - ON			0.8	V
C_{CONT2}	Shut down Voltage 2	V_{OUT} - OFF	2.4			V
I_{OFF}	Current When Off Status			65	130	μA
I_{CONT1}	Control Current 1	V_{CONT} = 5 V		25	100	μA
I_{CONT2}	Control Current 2	V_{CONT} = 16 V		45	150	μA
	T_R OFF → ON	I_{OUT} = 30 mA, C_L = 0.1 μF		50		μS

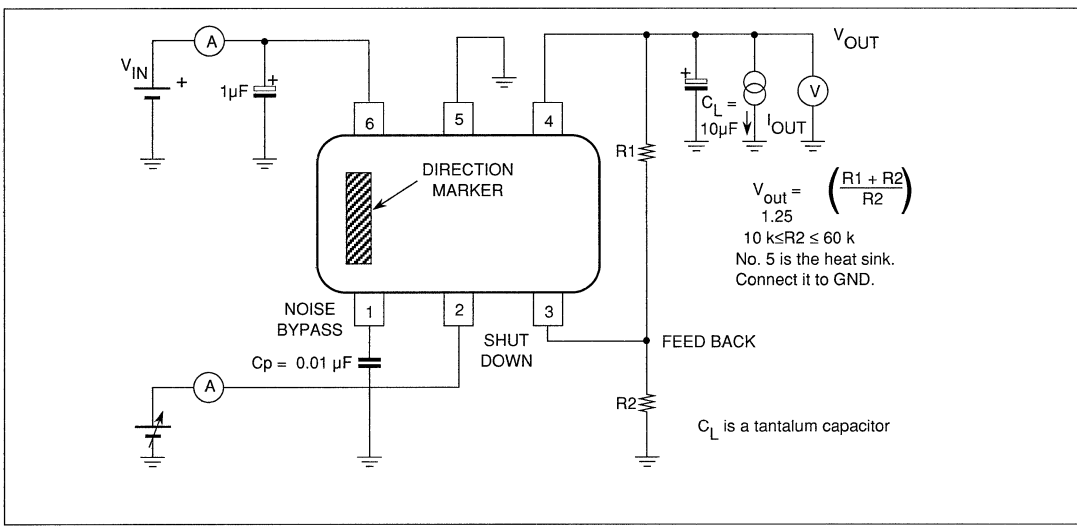
Note 1: Power dissipation must be derated at the rate of 1.6 mW/°C for operation at T_A = 25°C and above. The power dissipation will increase to 400 mW when the device is mounted on to a PC board that has adequate copper pads to conduct heat away from the device.

ELECTRICAL CHARACTERISTICS (CONT.)



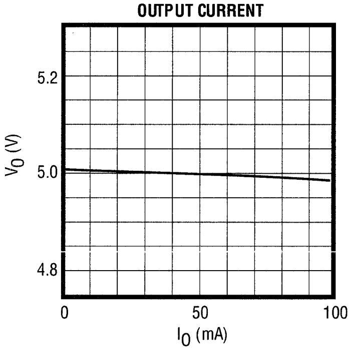
TK11900-Fig 1

TEST CIRCUIT

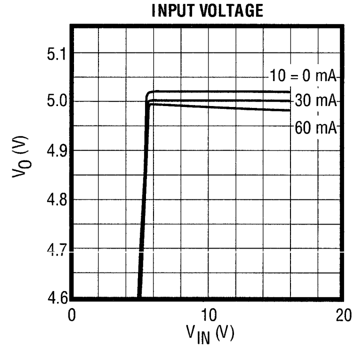


TYPICAL PERFORMANCE CHARACTERISTICS

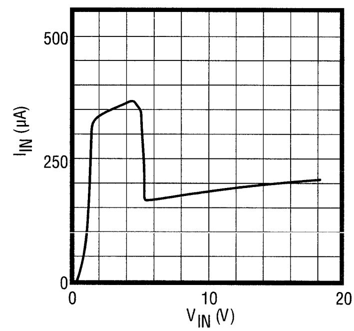
OUTPUT VOLTAGE vs. OUTPUT CURRENT



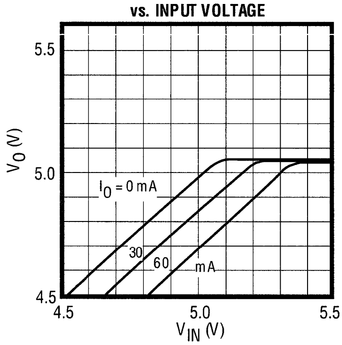
OUTPUT VOLTAGE vs. INPUT VOLTAGE



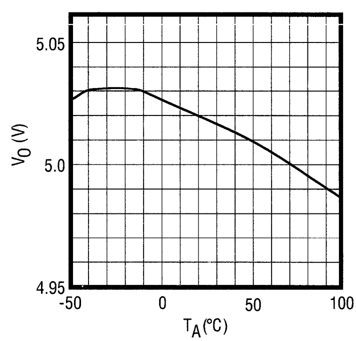
INPUT CURRENT (NO LOAD) vs. INPUT VOLTAGE



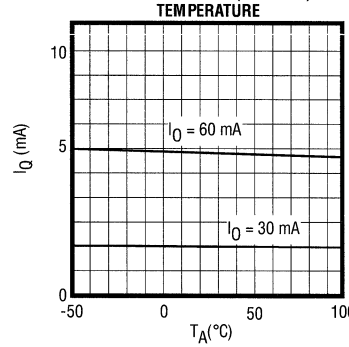
OUTPUT VOLTAGE CHARACTERISTICS vs. INPUT VOLTAGE



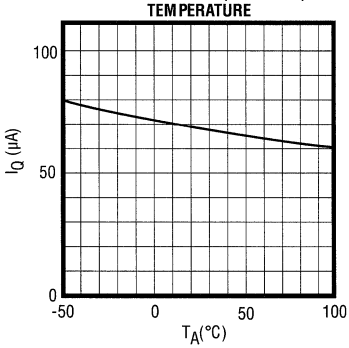
OUTPUT VOLTAGE vs. TEMPERATURES



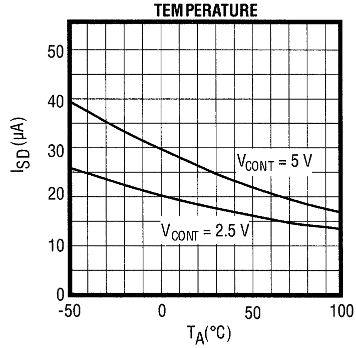
QUIESCENT CURRENT (ON MODE) vs. TEMPERATURE



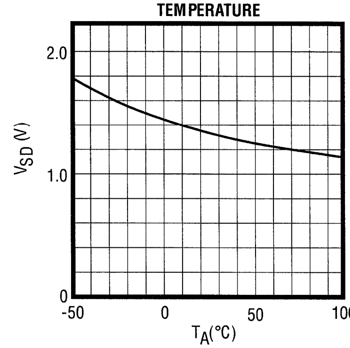
QUIESCENT CURRENT (OFF MODE) vs. TEMPERATURE



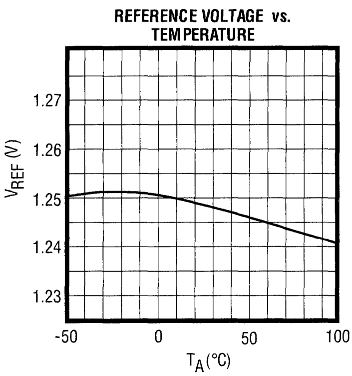
CONTROL PIN CURRENT vs. TEMPERATURE

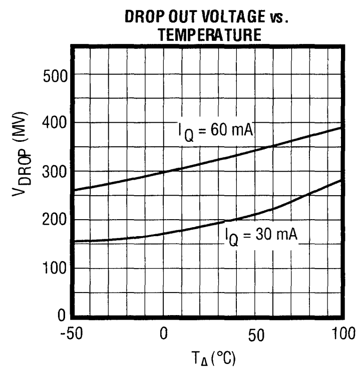


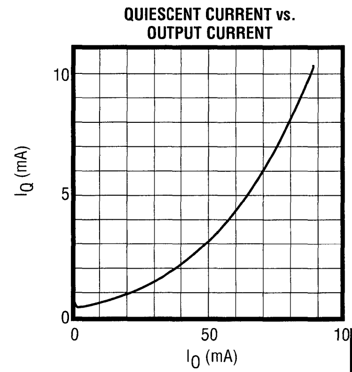
CONTROL PIN VOLTAGE vs. TEMPERATURE

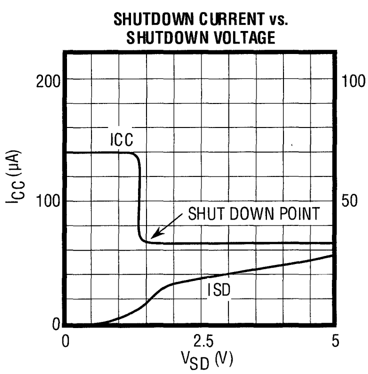


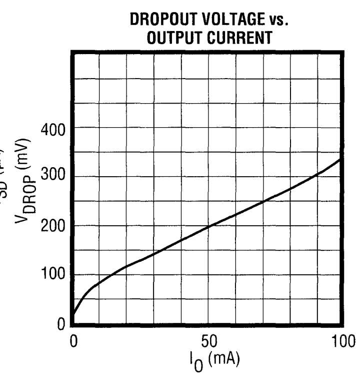
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

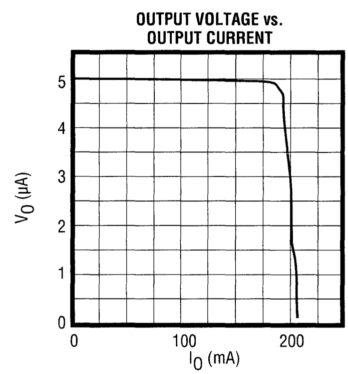


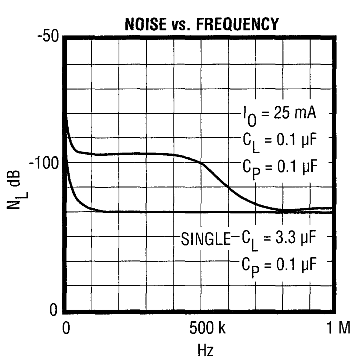


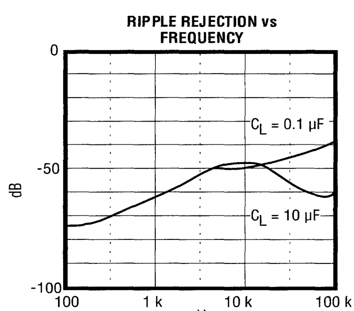


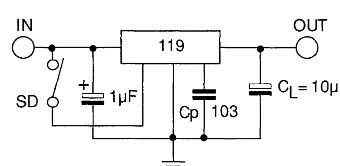








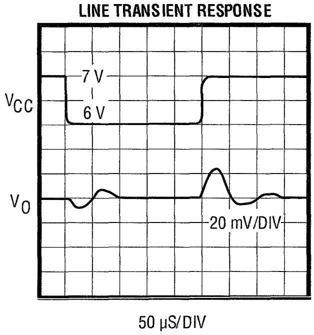




TK11900M TPC 17

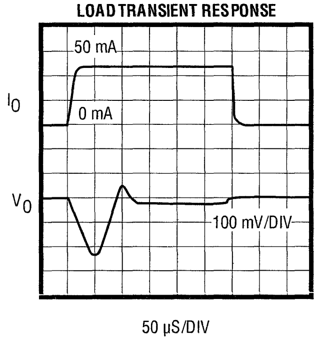
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

LINE TRANSIENT RESPONSE



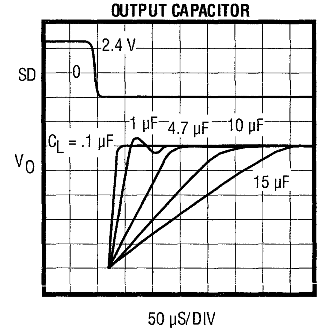
TK11900M TPC 18

LOAD TRANSIENT RESPONSE



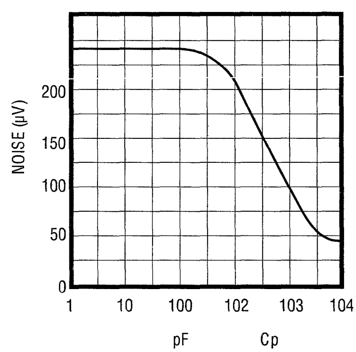
TK11900M TPC 19

TURN ON TIME vs. OUTPUT CAPACITOR



TK11900M TPC 20

NOISE vs. BYPASS CAPACITOR VALUE



TK11900M TPC 21

TOKO

VOLTAGE REGULATOR WITH RESET OUTPUT

FEATURES

- **Very Low Dropout Voltage**
- **Reset Output for Microprocessor**
- **Very Low Quiescent Current (No Load)**
- **Internal Thermal / Overload Shutdown**
- **Low Noise Voltage**
- **Input and Output Voltage Sense**
- **±2.5% Output Voltage Accuracy**
- **CMOS or TTL ON/OFF Control**
- **Very High Speed Transient Response (TYP 50 µS) (Off→On)**

APPLICATIONS

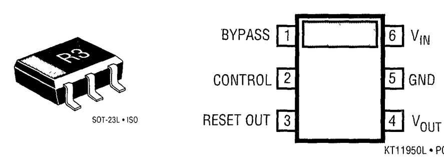
- **Battery Powered Systems**
- **Cellular Telephones**
- **Pagers**
- **Personal Communications Equipment**
- **Portable Instrumentation**
- **Portable Consumer Equipment**
- **Radio Control Systems**
- **Remote Control Transmitters**
- **Low Voltage Systems**

DESCRIPTION

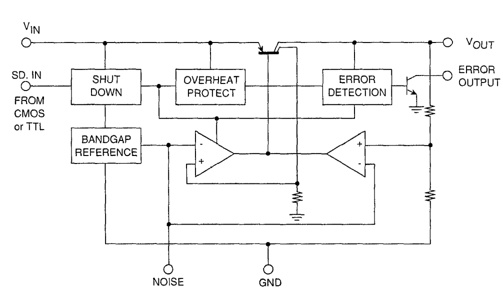
The TK11950 is a low power, linear regulator with on/off switch. Built-in voltage comparators provide a reset logic LOW level whenever the input or output voltage falls outside internally preset limits. The internal electronic switch can be controlled by CMOS or TLL levels. The device is in the OFF state when the control pin is biased HIGH.

An internal PNP pass-transistor is used in order to achieve low dropout voltage (typically 200 mV at 50 mA load current). The device has very low quiescent current (130 µA) in the ON mode with no load and 2 mA with 30 mA load. The quiescent current is typically 4 mA at 60 mA load. The current consumption in the OFF mode is 65 µA. An internal thermal shutdown circuit limits the junction temperature to below 150 °C. The load current is internally monitored and the device will shut down (no load current) in the presence of a short circuit at the output. The regulated output voltage is accurate to within ±2.5 %. The output noise is very low at 100 dB down from V_{OUT} when an external noise bypass capacitor is used.

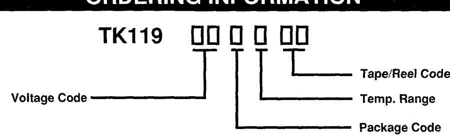
TK119XXM



BLOCK DIAGRAM



ORDERING INFORMATION



Voltage Code	Package Code	Temp. Range	Tape/Reel Code
48 = 4.8 V	M : Surface Mount	C : -20 to +70 °C	BX : Bulk/Bag
50 = 5.0 V		I : -40 to + 85 °C	TR : Tape Right
			TL : Tape Left

ABSOLUTE MAXIMUM RATINGS

Supply Voltage .... 17 V
Output Voltage .... V_{OUT}x1.15 V
Load Current .... 100 mA
Power Dissipation (Note1) .... 200 mW
Storage Temperature Range .... -50 to +150 °C
Operating Temperature Range (C version) -20 to +70 °C
Operating Temperature Range (I version) -40 to +85 °C
Lead Soldering Temp. (10 sec.) .... 240 °C
Junction Temperature .... 150 °C

ELECTRICAL CHARACTERISTICS

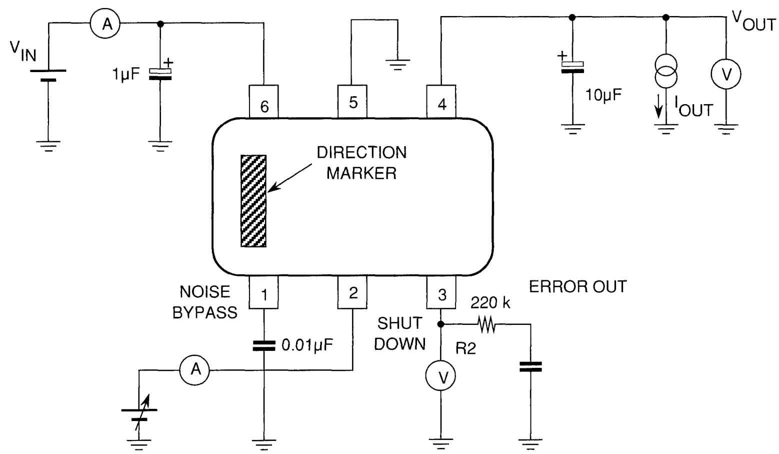
Test conditions: V_{IN} = (V_O + 1), (Note 2).

SYMBOL	PARAMETER	TEST CONDITION	-20 to +70 °C			-40 to +85 °C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IN}	Supply Voltage Range		1.8		16	1.8		16	V
I_{IN1}	Supply Current 1	$V_{IN} = V_O + 1$ V, $I_O = 0$ mA		140	300		140	300	µA
I_{IN2}	Supply Current 2	$V_{IN} = V_O - 1$ V, $I_O = 0$ mA		400	900		400	900	µA
I_Q	Quiescent Current	$V_{IN} = V_O + 1$ V, $I_O = 60$ mA		5	10		5	10	mA
V_O	Regulated Output Voltage	$V_{IN} = V_O + 1$, $I_O = 1$ mA, $T_A = 25$ °C	V_{OUT} ±2.5% or ±80						mV
V_O	Regulated Output Voltage	$V_{IN} = V_O + 1$V, $I_O = 1$ mA	±3.5% or ±110			±4% or ±120			mV
V_{DROP}	Dropout Voltage	$I_O = 30$ mA		160	350		160	350	mV
I_O	Output Current	$V_{IN} = V_O + 1$ V			100			100	mA
Line Reg	Line Regulation	$V_{IN} = (V_O + 1\ V) \sim (V_O + 10\ V)$, V_{IN} MAX		5	50		5	50	±mV
Loa Reg	Load Regulation	$I_O = 1 \sim 80$ mA, $V_{IN} = V_O + 1$ V		25	150		25	150	mV
RR	Ripple Rejection	$V_{IN} = V_O + 1.5$ V		68			68		dB
	Output Noise	$C_L = 10$ µF, $C_P = 0.01$ µF, 10 Hz < f < 100 kHz		50			50		µV(rms)
ΔV/ΔT	V_O Temperature Coefficient	$V_{IN} = V_O + 1$ V, $I_O = 10$ mA		±0.2			±0.2		mV/°C
V_{DET}	Low Voltage Detector		V_{OUT} x 0.95						V
E_R/F_L	Error V Det. Range		- 4	V_{DET}	+ 4	- 4	V_{DET}	+ 4	%
V_{SAT}	Saturation Voltage	$I_{FLAG} = 100$ µA		0.2	0.4		0.2	0.4	V
Shut Down									
I_{OFF}	Off Time Current			65	150		65	150	µA
I_{CONT1}	Control Pin Current 1	$V_{CONT} = 5$ V		25	100		25	100	µA
I_{CONT2}	Control Pin Current 2			45	150		45	150	µA
V_{CONT1}	Control Voltage 1	V_{OUT} ON			0.8		0.8		V
V_{CONT2}	Control Voltage 2	V_{OUT} OFF	2.4			2.4			V
	Transient	Off→On, $C_L = 0.1$ µF, $C_P = 0.1$ µF, $I_O = 30$mA		50			50		µS

Note 1: Power dissipation must be derated at the rate of 1.6 mW/°C for operation at T_A = 25 °C and above. When the device is mounted on a PC board, the power dissapation is increased to 400 mW if mounted as shown on page 3-113.

Note 2: Due to the common format used here, some specifications may not apply to all versions of output voltage. Detailed specifications are available for each version.

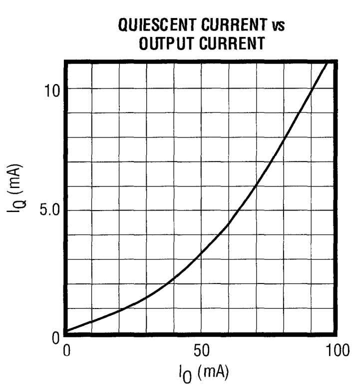
TEST CIRCUIT



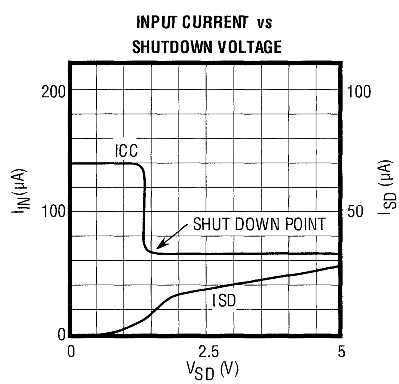
TK119XX FIG 01

TYPICAL PERFORMANCE CHARACTERISTICS

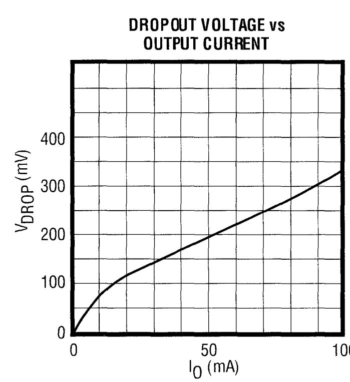
TK119xx



TK119XX TPC 01



TK119XX TPC 02

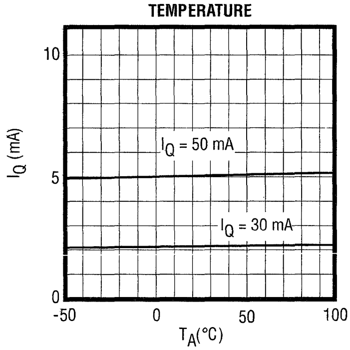


TK119XX TPC 03

TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

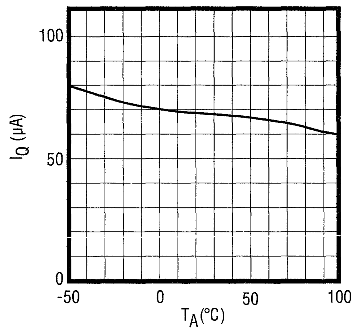
TK119xx

QUIESCENT CURRENT vs TEMPERATURE



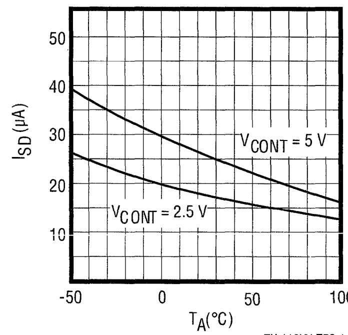
TK 119XXTPC 12

QUIESCENT CURRENT (OFF MODE) vs TEMPERATURE



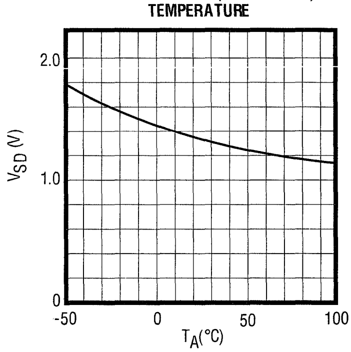
TK 119XX TPC 13

SHUTDOWN PIN INPUT CURRENT vs TEMPERATURE



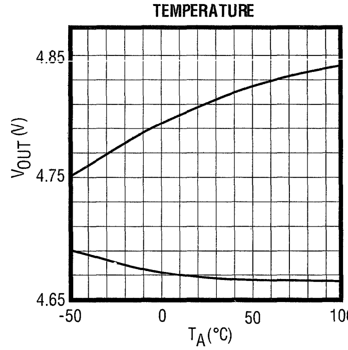
TK 119XX TPC 14

SHUTDOWN VOLTAGE (OUTPUT OFF) vs TEMPERATURE



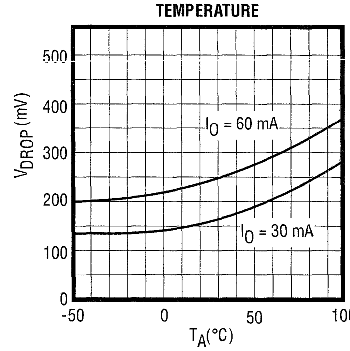
TK 119XX TPC 15

LOW VOLTAGE DETECT (HYSTERESIS) vs TEMPERATURE



TK 119XX TPC 16

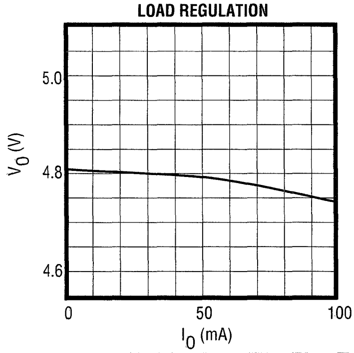
DROPOUT VOLTAGE vs TEMPERATURE



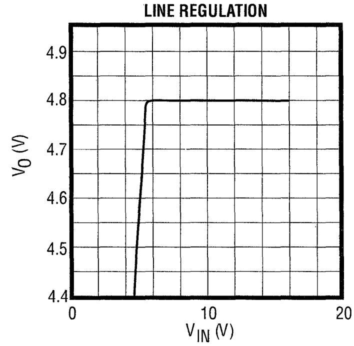
TK 119XX TPC 17

TK11948

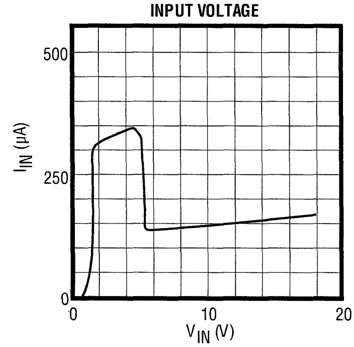
LOAD REGULATION



LINE REGULATION



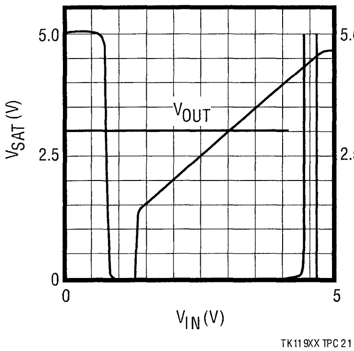
INPUT CURRENT (NO LOAD) vs INPUT VOLTAGE



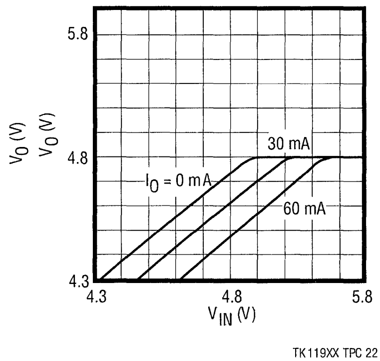
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11948

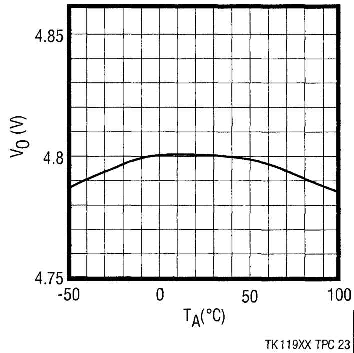
LOW VOLTAGE DETECTOR vs INPUT VOLTAGE



OUTPUT VOLTAGE vs. INPUT VOLTAGE



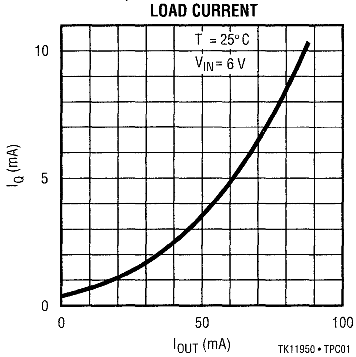
OUTPUT VOLTAGE vs TEMPERATURE



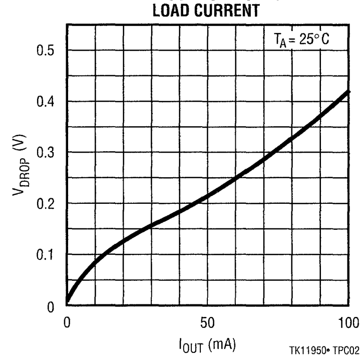
3

TK11950

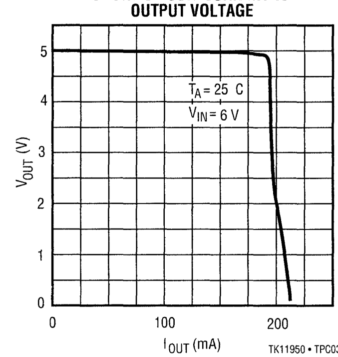
QUIESCENT CURRENT vs LOAD CURRENT



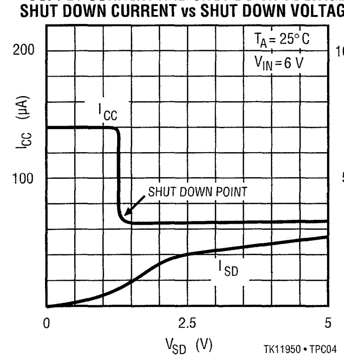
DROPOUT VOLTAGE vs LOAD CURRENT



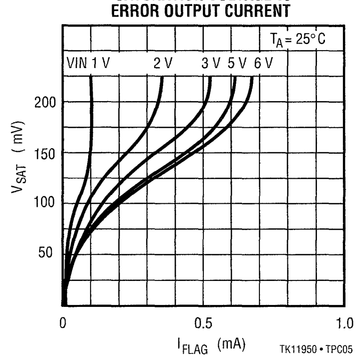
SHORT CIRCUIT CURRENT vs OUTPUT VOLTAGE



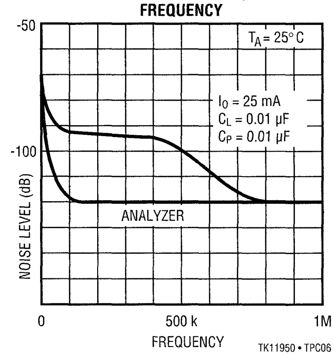
SUPPLY CURRENT AND SHUT DOWN VOLTAGE SHUT DOWN CURRENT vs SHUT DOWN VOLTAGE



SATURATION VOLTAGE vs ERROR OUTPUT CURRENT



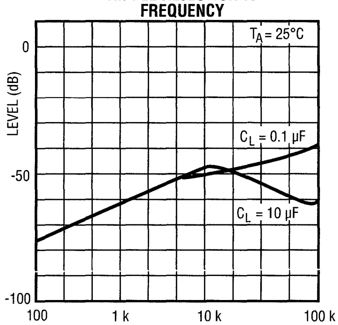
NOISE VOLTAGE vs FREQUENCY



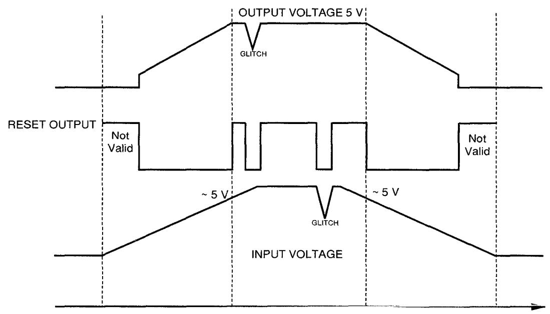
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11950

RIPPLE REJECTION vs FREQUENCY

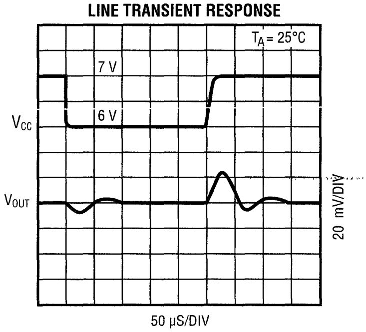


TK11950 • TPC07



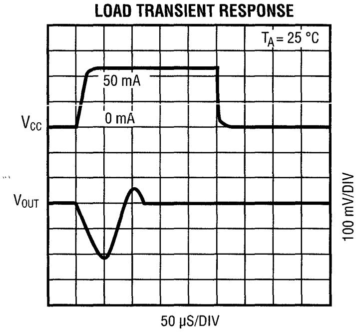
TIMING DIAGRAM
PRINCIPLE OF OPERATION

LINE TRANSIENT RESPONSE



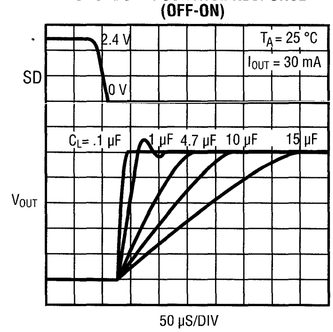
TK11950 • TPC08

LOAD TRANSIENT RESPONSE



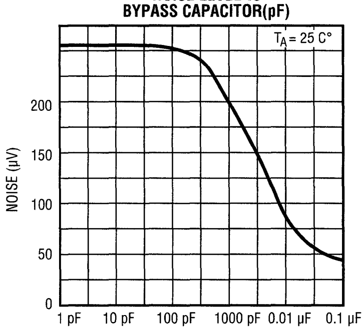
TK11950 • TPC10

SHUTDOWN CONTROL RESPONSE (OFF-ON)



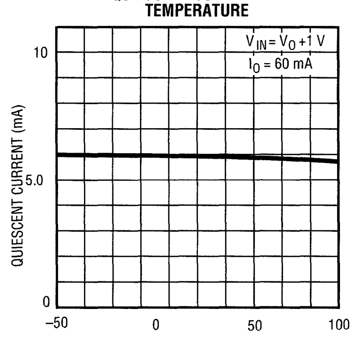
TK11950 • TPC09

NOISE LEVEL vs BYPASS CAPACITOR(pF)



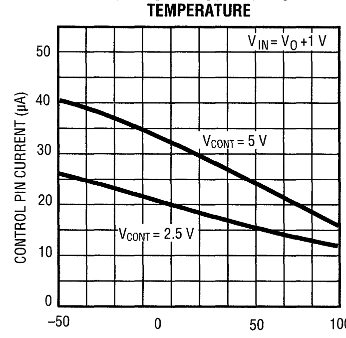
TK11950 • TPC11

QUIESCENT CURRENT vs TEMPERATURE



TK11950 • TPC12

CONTROL PIN CURRENT vs TEMPERATURE

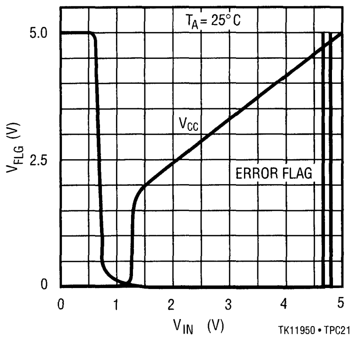


TK11950 • TPC13

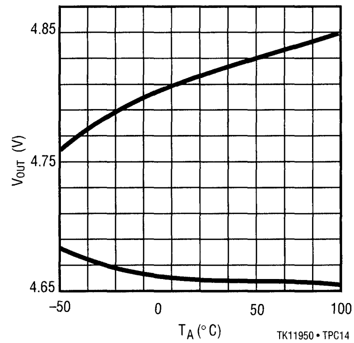
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK11950

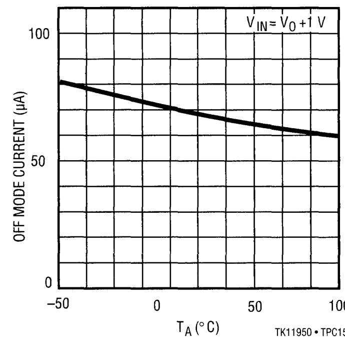
ERROR DETECT vs INPUT VOLTAGE



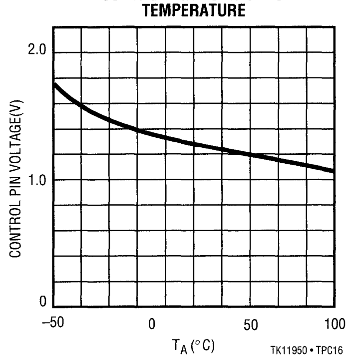
HYSTERESIS vs TEMPERATURE



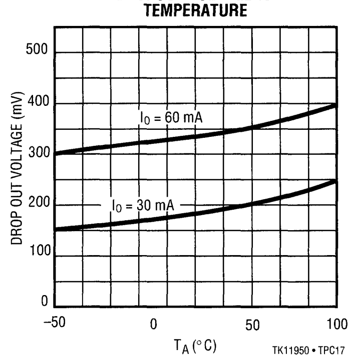
OFF MODE CURRENT vs TEMPERATURE



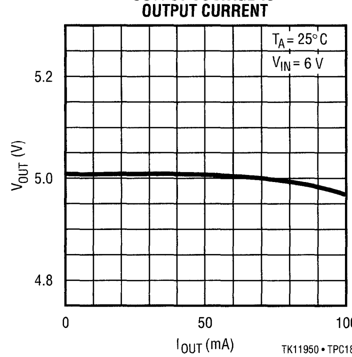
CONTROL PIN VOLTAGE vs TEMPERATURE



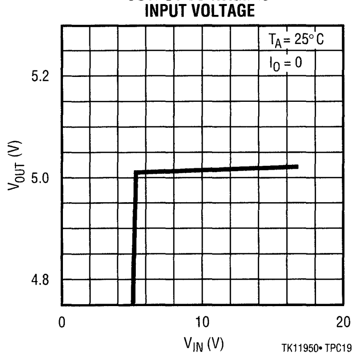
DROPOUT VOLTAGE vs TEMPERATURE



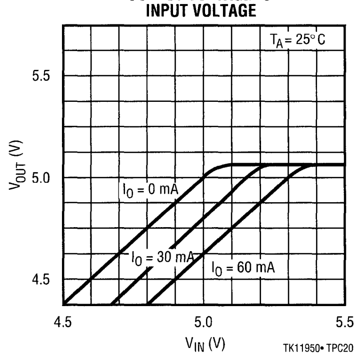
OUTPUT VOLTAGE vs OUTPUT CURRENT



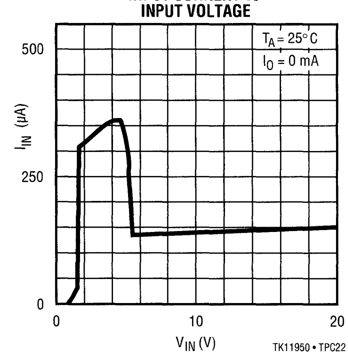
OUTPUT VOLTAGE vs INPUT VOLTAGE



OUTPUT VOLTAGE vs INPUT VOLTAGE



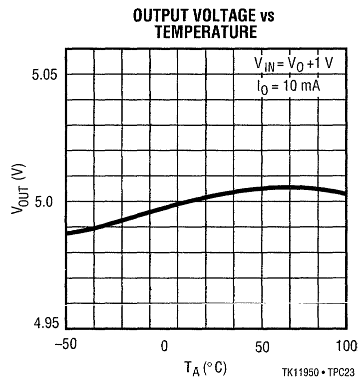
INPUT CURRENT vs INPUT VOLTAGE



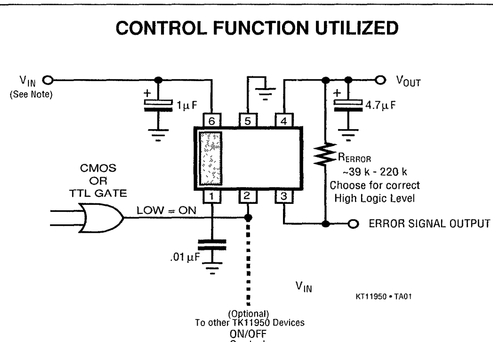
3

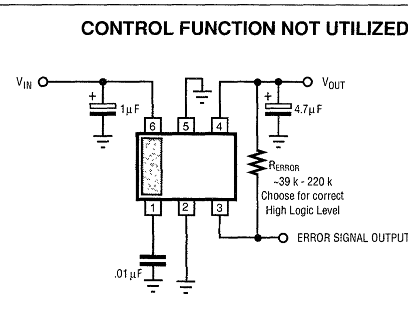
TK11950

TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)



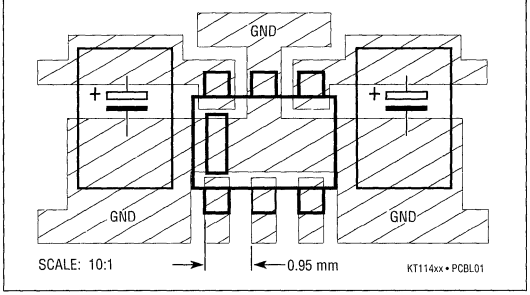
TYPICAL APPLICATIONS





Note: Parallel connection of control pins is allowed if all devices use identical input voltage.

TYPICAL APPLICATIONS (CONT.)



Application Hints

The power dissapation of the TK119xx can be increased to 400 mW when mounted to the PC board as shown at left.. Maximize copper foil area connecting to all IC pins for optimum performance. Place input and output bypass capacitors close to the GND pin. For best transient behavior and lowest output impedance, use as large a capacitor value as possible. The temperature coefficient of the capacitance and Equivalent Series Resistance (ESR) should be taken into account. These parameters can influence power supply noise and ripple rejection. In extreme cases, oscillation may occur. In order to maintain stability, the output bypass capacitor value should be minimum 0.1 µF for Tantalum electrolytic or .22 µF for Aluminum electrolytic.

Handling Molded Resin Packages

All plastic molded packages absorb some moisture from the air. If moisture absorption occurs prior to soldering the device into the printed circuit board, increased separation of the lead from the plastic molding may occur, degrading the moisture barrier characteristics of the device. This property of plastic molding compounds should not be overlooked, particularly in the case of very small packages, where the plastic is very thin.

In order to preserve the original moisture barrier properties of the package, devices are stored and shipped in moisture proof bags filled with dry air. The bags should not be opened or damaged prior to the actual use of the devices. If this is unavoidable, the devices should be stored in a low relative humidity environment (40 to 65%) or in an enclosed environment with desiccant.

3

NOTES

TOKO

TK711/712/713

LOW DROPOUT REGULATOR

FEATURES

- Low Dropout Voltage
- Low Quiescent Current
- Very Stable Output
- Extremely Small Package (SOT23)
- Built-in Output On/Off Control On 713xx
- Noise Reduction Available On 712xx

APPLICATIONS

- Switch Mode Power Supplies
- Power Factor Controllers
- DC-DC Converters
- Stepper Motor Drivers
- Solenoid Drivers
- Printer Hammer Drivers

DESCRIPTION

TK711xx/712xx/713xx series are low saturation, linear regulators used for the applications with large supply voltage change. Because a PNP power transistor is used, dropout voltage is very low, making it possible to maintain a stable output voltage even if the battery voltage decreases. This makes the battery last longer. The TK711xx series is connected in a basic three terminal configuration. The TK712xx series has a noise bypass pin available. The TK713xx series has a on/off control pin only (a low level turns the output on). Since the current at the High Level is extremely stable (TYP 10 μA at V_{IN} = 5 V), a smaller output capacitor is used.
The TK711xx/712xx/713xx is available in a very small SOT23 surface mount package.

ORDERING INFORMATION

TK711 □□ □ □ □□

Voltage Code — Package Code — Temp. Range — Tape/Reel Code

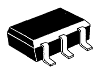
VOLTAGE CODE
15 = 1.5 V
27 = 2.75 V
30 = 3.0 V
40 = 4.0 V
47 = 4.75 V
50 = 5.0 V

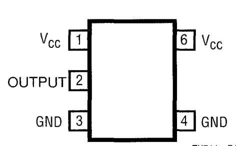
PACKAGE CODE
M : Surface Mount

TEMP. RANGE
C : -30 to +80 °C

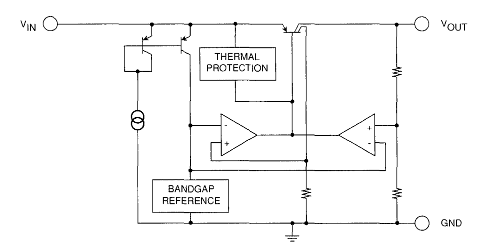
TAPE/REEL CODE
BX : Bulk/Bag
TX : Paper Tape
TL : Tape Left

TK711/712/713

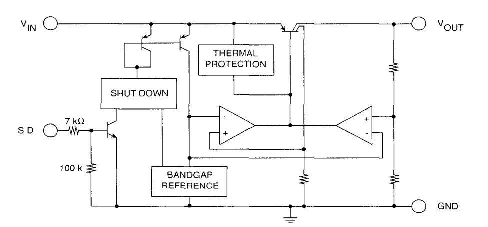




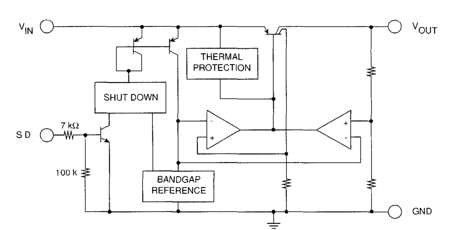
BLOCK DIAGRAM 711xx



BLOCK DIAGRAM 712xx



BLOCK DIAGRAM 713xx



ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 16 V
Power Dissipation .... 150 mW
Operating Voltage Range .... 1.4 to 14.5 V
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -30 to +80 °C
Lead Soldering Temp. (10 sec.) .... 240 °C

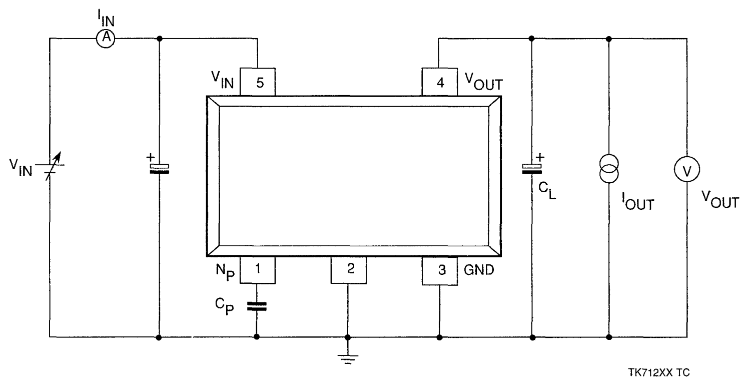
ELECTRICAL CHARACTERISTICS

Test Conditions: T_A = 25 °C, $V_{IN} = (V_O +1)$

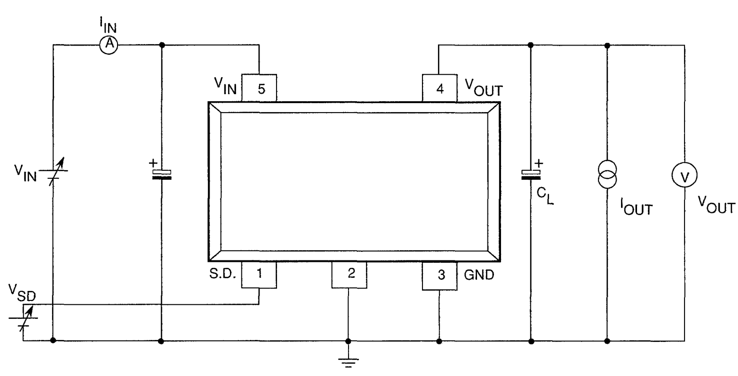
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{IN1}	Supply Current 1	$V_{IN} = (V_O +1)$ V, I_O = 0 mA		140	300	µA
I_{IN2}	Supply Current 2	$V_{IN} \le V_O$, I_O = 0 mA		1.4	3.0	mA
I_{IN3}	Supply Current 3	At Shutdown (V_{IN} = 10 V)		10	50	µA
V_O	Output Voltage			1.5	6	V
V_{OE}	Output Voltage Error		3.0	V_O	3.0	%
V_{OE}	Output Voltage Error		100	V_O	100	V
V_{DROP1}	In/Out Voltage Drop 1	I_O = 30 mA		120	200	mV
I_O	Output Current	V_O = 2 V max (Note 1)	80	120		mA
I_O	Output Current	V_O = 2 V max (Note 1)	50	90		mA
Lin Reg	Line Regulation	$V_{IN} = (V_O +1)$~ $(V_O +10) \le V_{OP}$ max		5.0	30	mV
Loa Reg	Load Regulation	I_O = 1 to 60 mA		15	65	mV
Loa Reg	Load Regulation	I_O = 1 to 30 mA		13	45	mV
$\Delta V/T_A$	Environmental Temperature of V_O Dependency					mV/C
RR	Ripple Rejection	C_L = 10 µF, 400 Hz		60		dB
Shutdown (711xx)						
C_{CONT1}	Shutdown Voltage 1	V_{OUT} = On	-0.5		0.4	V
C_{CONT2}	Shutdown Voltage 2	V_{OUT} = Off	1.0			V
I_{CONT}	Control Current	V_{CONT} - 1.0 V		50	150	µA

Note 1: I_O is the current within P_D curve.

TEST CIRCUIT 712xx



TEST CIRCUIT 713xx

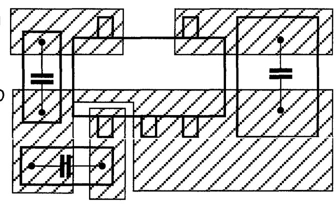


3

APPLICATION NOTES

1. OPTIMUM PERFORMANCE

Optimum performance can only be achieved when the IC is mounted on a PC board according to the diagram below. This is because of the extremely small package and limited power dissipation. Shape the metal portion of the PCB as shown in the following drawing.



Use a large bypass capacitor and connect it in a place near GND of the IC. Pay attention to temperature characteristics of the capacitor, especially the increase of ESR and decrease of capacitance in low temperatures. Oscillation, reduction of ripple rejection and increased noise may occur in some cases if the proper capacitor is not used. An output capacitor more than 1.0 µF is required to maintain stability. The standard test condition is 3.3 µF (T_A = 25 °C).

2. DROPOUT VOLTAGE

Dropout voltage is the voltage difference between the input voltage and the output voltage where the output voltage decreases to 100 mV below the nominal output voltage as the input voltage is decreased.

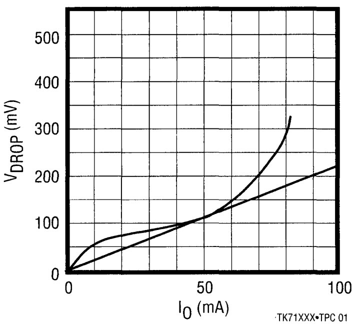
To measure dropout voltage, set the input voltage to the nominal output voltage +1 V and measure the output voltage. Reduce the input voltage to the point where the output is 100 mV below the prevoiusly measured value. The dropout voltage is the difference between the input and ouput voltage at this point. This voltage depends on the load current and ambient temperature.

3. OVERHEAT PROTECTION

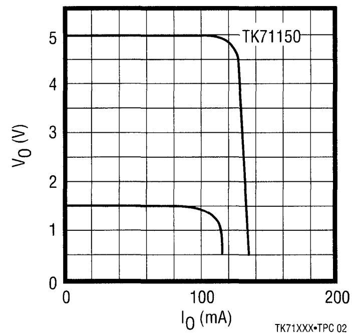
The circuit will be "OFF" when the chip temperature rises to (T_J = 150 °C). The circuit will return to "ON" as the device cools.

TYPICAL PERFORMANCE CHARACTERISTICS

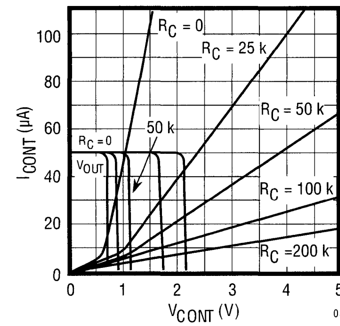
DROPOUT VOLTAGE vs. OUTPUT CURRENT



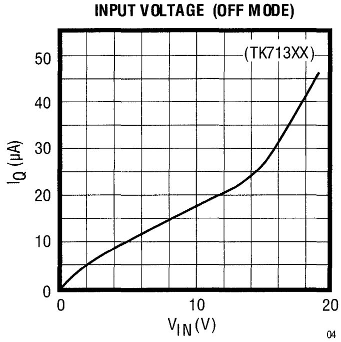
SHORT CIRCUIT PROTECTION



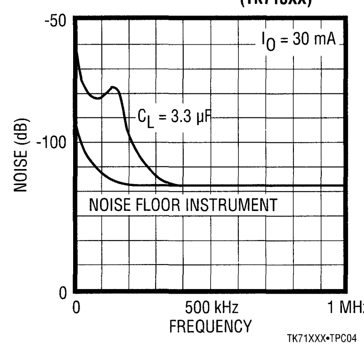
ON/OFF CONTROL PIN (TK713XX) CHARACTERISTICS



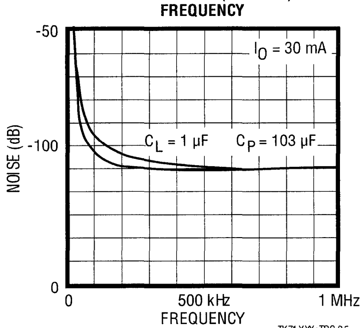
QUIESCENT CURRENT vs INPUT VOLTAGE (OFF MODE)



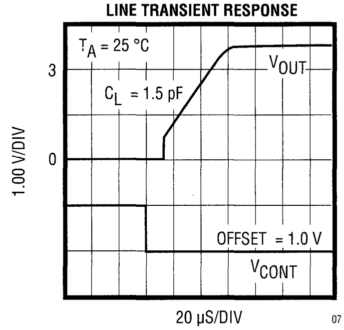
NOISE SPECTRUM (TK711XX) (TK713XX)



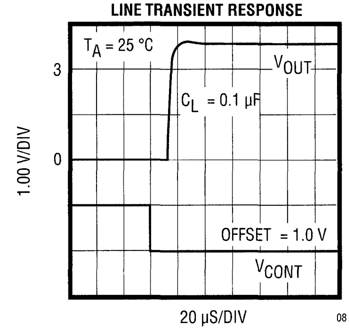
NOISE SPECTRUM (TK712XX) vs FREQUENCY



LINE TRANSIENT RESPONSE

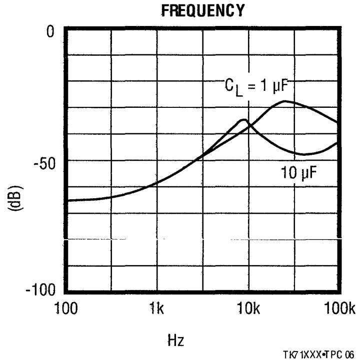


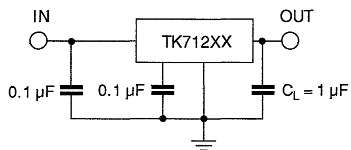
LINE TRANSIENT RESPONSE

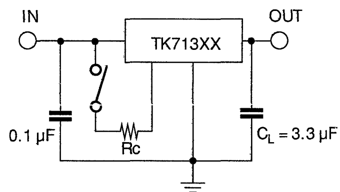


TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

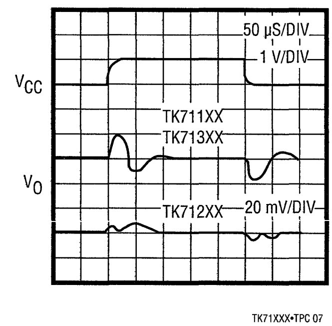
RIPPLE REJECTION vs FREQUENCY



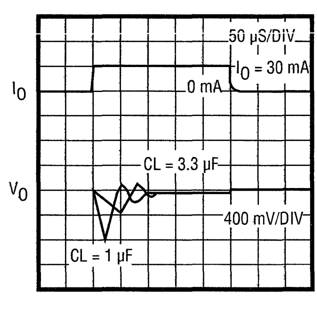




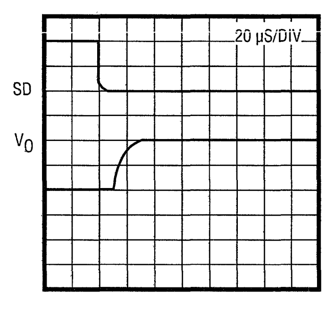
LINE TRANSIENT RESPONSE



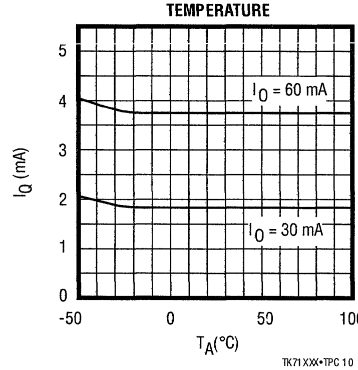
LOAD TRANSIENT RESPONSE



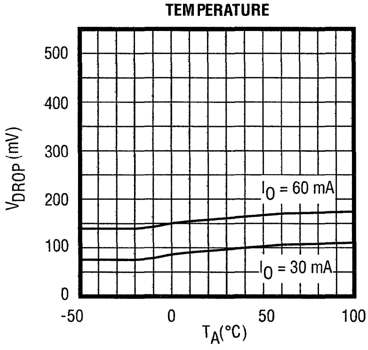
OUTPUT CONTROL RESPONSE (TK713XX)



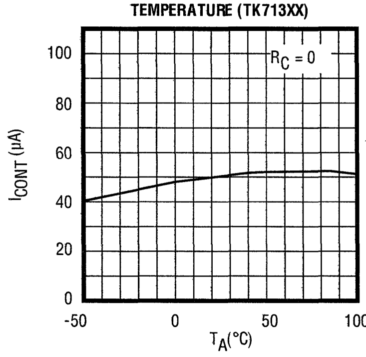
QUIESCENT CURRENT vs TEMPERATURE



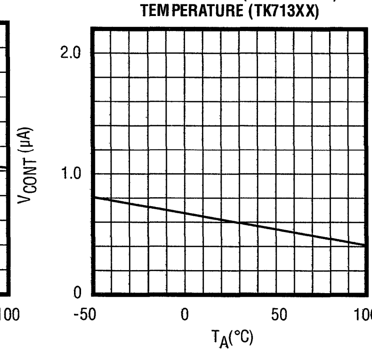
DROPOUT VOLTAGE vs TEMPERATURE



CONTROL CURRENT vs TEMPERATURE (TK713XX)



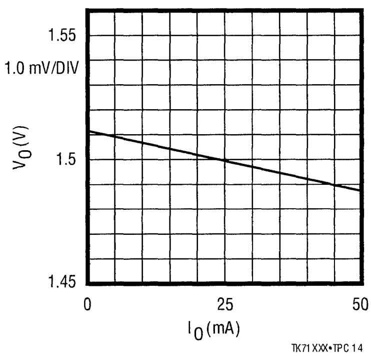
CONTROL VOLTAGE (OUTPUT OFF) vs TEMPERATURE (TK713XX)



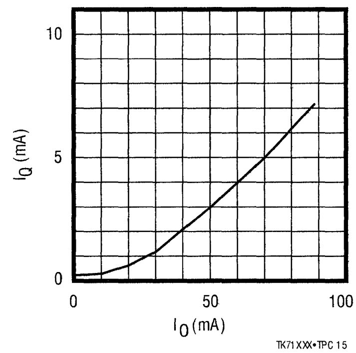
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK71115, TK71215, TK71315

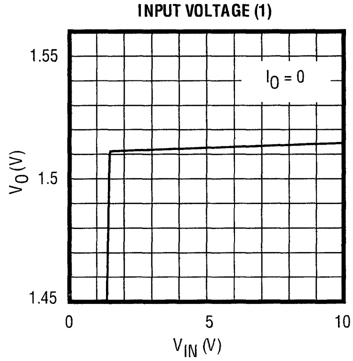
OUTPUT VOLTAGE vs OUTPUT CURRENT



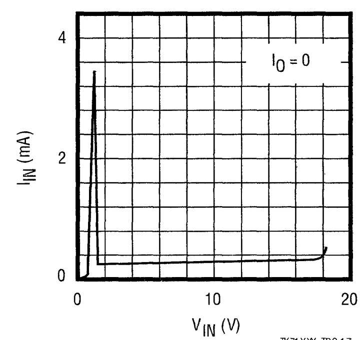
QUIESCENT CURRENT vs OUTPUT CURRENT



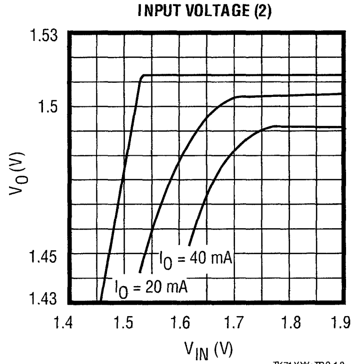
OUTPUT VOLTAGE vs INPUT VOLTAGE (1)



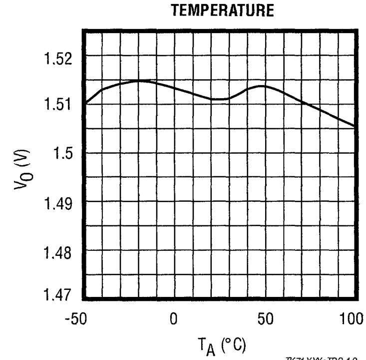
INPUT CURRENT vs INPUT VOLTAGE



OUTPUT VOLTAGE vs INPUT VOLTAGE (2)



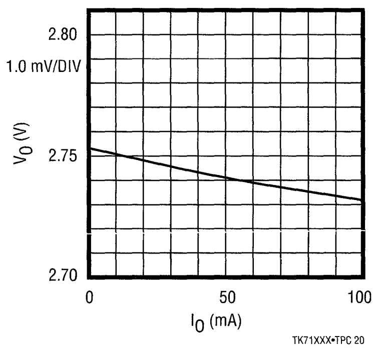
OUTPUT VOLTAGE vs TEMPERATURE



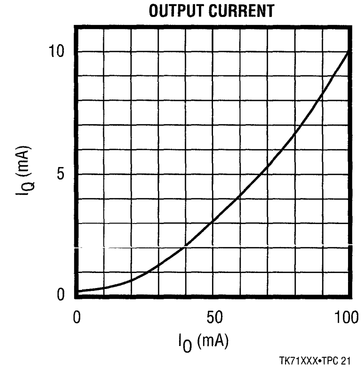
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK71127, TK71227, TK71327

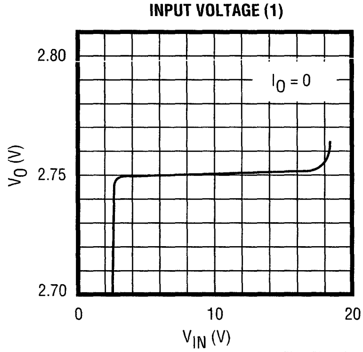
OUTPUT VOLTAGE vs OUTPUT CURRENT



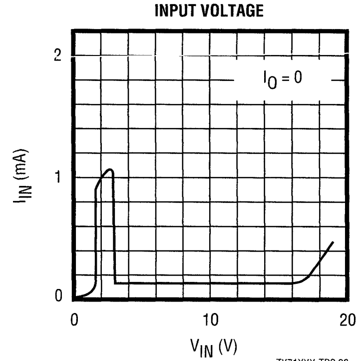
QUIESCENT CURRENT vs OUTPUT CURRENT



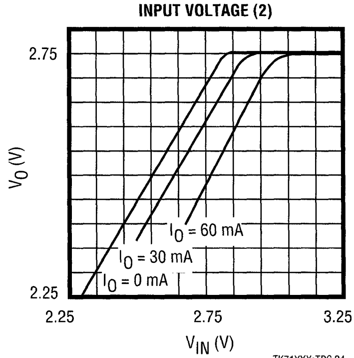
OUTPUT VOLTAGE vs INPUT VOLTAGE (1)



INPUT CURRENT vs. INPUT VOLTAGE



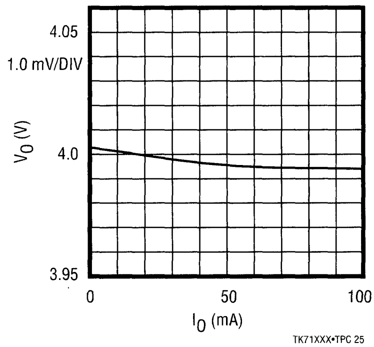
OUTPUT VOLTAGE vs INPUT VOLTAGE (2)



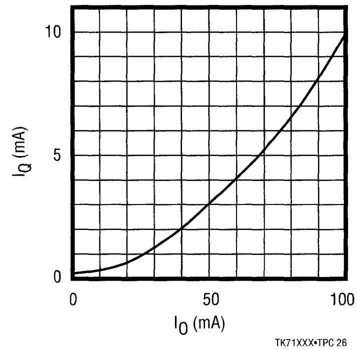
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK71140, TK71240, TK71340

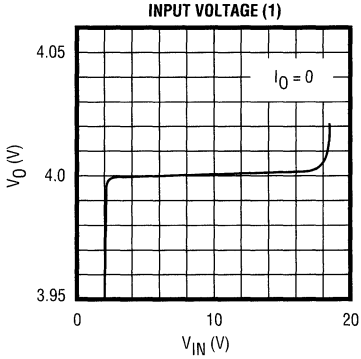
OUTPUT VOLTAGE vs. OUTPUT CURRENT



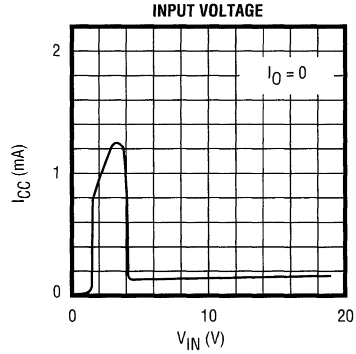
QUIESCENT CURRENT vs. OUTPUT CURRENT



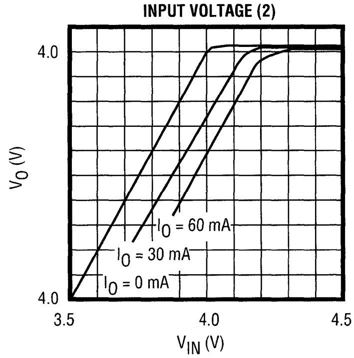
OUTPUT VOLTAGE vs. INPUT VOLTAGE (1)



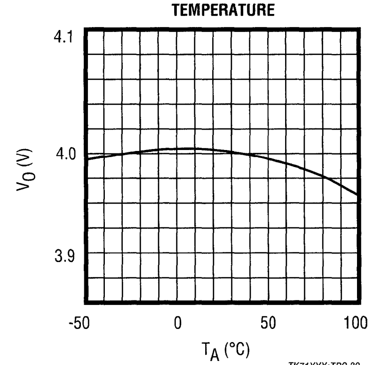
INPUT CURRENT vs. INPUT VOLTAGE



OUTPUT VOLTAGE vs. INPUT VOLTAGE (2)



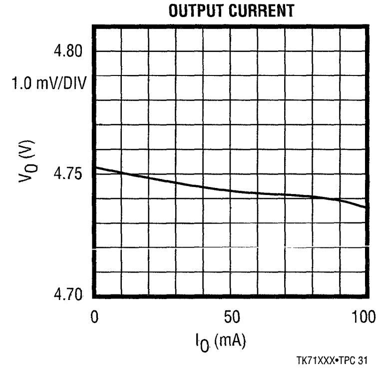
OUTPUT VOLTAGE vs TEMPERATURE



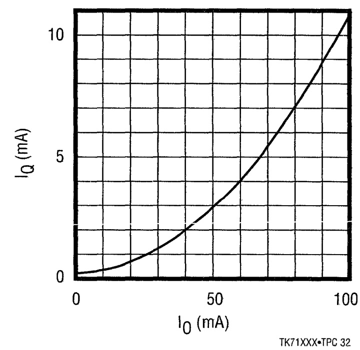
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK71147, TK71247, TK71347

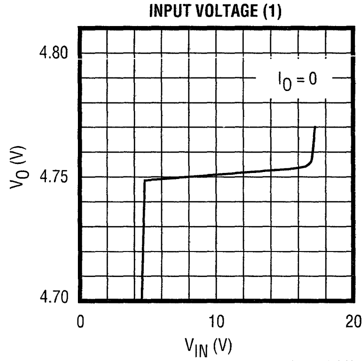
OUTPUT VOLTAGE vs. OUTPUT CURRENT



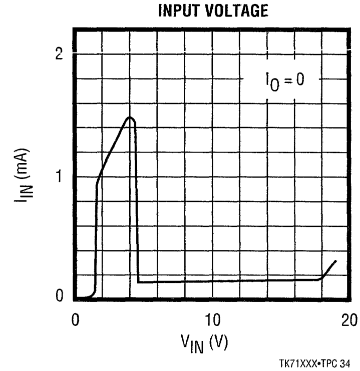
QUIESCENT CURRENT vs. OUTPUT CURRENT



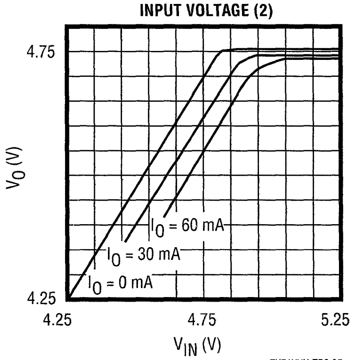
OUTPUT VOLTAGE vs. INPUT VOLTAGE (1)



INPUT CURRENT vs. INPUT VOLTAGE



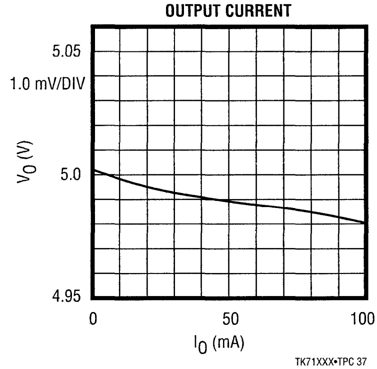
OUTPUT VOLTAGE vs. INPUT VOLTAGE (2)



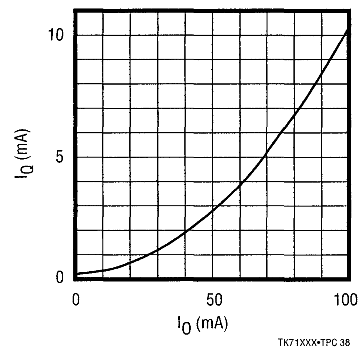
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

TK71150, TK71250, TK71350

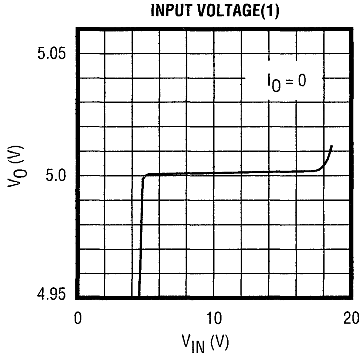
OUTPUT VOLTAGE vs. OUTPUT CURRENT



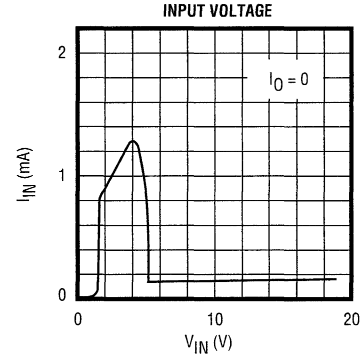
QUIESCENT CURRENT vs. OUTPUT CURRENT



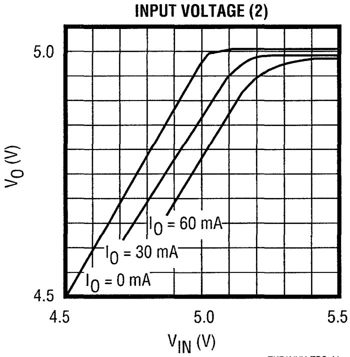
OUTPUT VOLTAGE vs. INPUT VOLTAGE(1)



INPUT CURRENT vs. INPUT VOLTAGE



INPUT VOLTAGE vs. INPUT VOLTAGE (2)



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NOTES

TOKO

DC-DC CONVERTER

FEATURES

- Very Small Size
- Few External Components
- Wide Input Supply Voltage Range (1.1 to 18 V)
- Six Selectable Output Voltages up to 32 V
- Single Battery Cell Operation

APPLICATIONS

- Variable Capacitance and PIN Photodiode Bias
- Portable Instrumentation
- Radio Control Systems
- Mobile Radios
- Cellular Telephones
- Cordless Telephones
- Fiberoptic Receivers
- Local Area Network (LAN) Receivers
- Battery Operated Equipment

DESCRIPTION

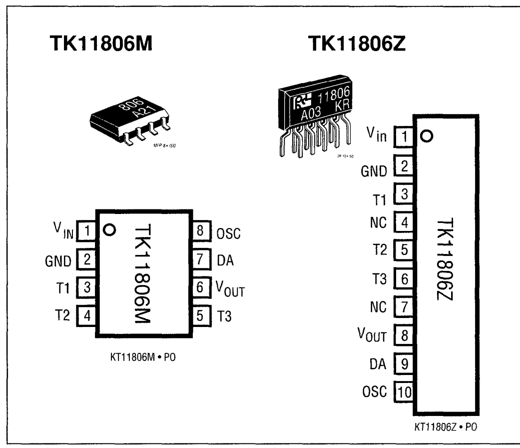
The TK11806 is a low power, low input voltage DC-DC converter.

The device has been optimized for variable capacitance diode and PIN diode bias applications. It generates DC output voltages ranging from 9.3 V to 32 V in six steps. The desired output voltage may be selected by simple wire connections between control pins. The input DC voltage can be as low as 1.1 V or as high as 18 V.

The device has a built-in relaxation oscillator. The frequency of oscillation is determined by external component values. The TK11806 has built-in voltage reference and an array of temperature compensated zener diodes in order to generate various output voltages with minimum external part count.

The device is available in an 8-lead plastic surface mount package (MFP-8) or a 10-lead plastic (ZP-10) package.

External inductive components are also available from TOKO.



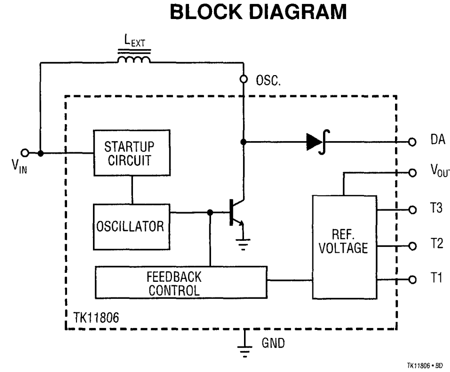
ORDERING INFORMATION

TK11806 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +75 °C	BX: Bulk/Bag TX: Paper Tape TR: Tape Right TL: Tape Left MG: Magazine

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Input Voltage, V_{IN}..20 V
Output Voltage, V_{OUT}..35 V
Power Dissipation TK11806M (Note 1)..................350 mW
Power Dissipation TK11806Z (Note 2)...................490 mW
Junction Temperature...150 °C
Storage Temperature Range.......................-55 to +150 °C
Operating Temperature Range....................-20 to +75 °C
Lead Soldering Temp. (10 sec.) M-Package............260 °C
Lead Soldering Temp. (10 sec.) Z-Package.............300 °C

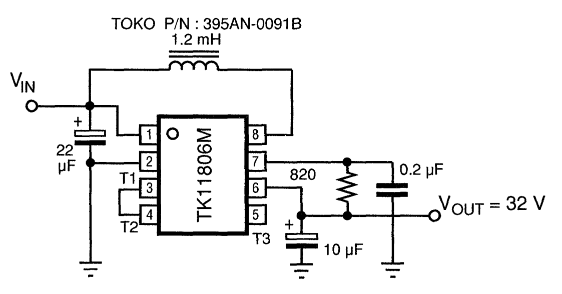
ELECTRICAL CHARACTERISTICS

Test conditions: V_{IN}= 5.0 V, V_{OUT}= 32.0 V unless otherwise specified. T_A= 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Supply Voltage Range		1.1		18	V
I_{IN}	Input Current	V_{OUT}=32 V, I_{OUT}=0.1 mA		4.7	9.0	mA
I_{IN}	Input Current	V_{OUT}=32 V, I_{OUT}=1.0 mA		12.1	19	mA
V_{OUT1}	Output Voltage	I_{OUT}=0 µA, 1.1 V≤V_{IN}≤18.0 V Note 3	30	32.0	34.0	V
V_{OUT2}	Output Voltage	I_{OUT}=0 µA, 1. 1V≤V_{IN}≤18. 0V Note 3	26	28	30	V
V_{OUT3}	Output Voltage	I_{OUT}=0 µA, 1.1 V≤V_{IN}≤18. 0V Note 3	22.0	24.0	26.0	V
V_{OUT4}	Output Voltage	I_{OUT}=0 µA, 1. 1V≤V_{IN}≤15. 0V Note 3	15.5	16.8	18.0	V
V_{OUT5}	Output Voltage	I_{OUT}=0 µA, 1.1 V≤V_{IN}≤11. 0V Note 3	11.0	12.8	14.5	V
V_{OUT6}	Output Voltage	I_{OUT}=0 µA, 1.1 V≤V_{IN}≤8. 0V Note 3	8.0	9.3	10.5	V
I_{OUT}	Output Current	V_{OUT}=32 V Note 4	1.8	2.4		mA
LD_{REG}	Load Regulation	0.0 mA≤I_{OUT}≤1.0 mA		0.24	0.5	%
$\Delta V_{OUT1}/\Delta T_A$	Temperature Coefficient	V_{OUT}=32 V, I_{OUT}=0.1 mA		0.25		mV/°C
V_{OSC}	Oscillator Start-up Voltage	I_{OUT}= 0 mA		0.9	1.1	V

Note 1: Power dissipation must be derated at the rate of 3 mW/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 4.5 mW/°C for operation at T_A = 25 °C and above.
Note 3: Connect T_1 through T_3 as specified.
Note 4: Use inductor as specified.

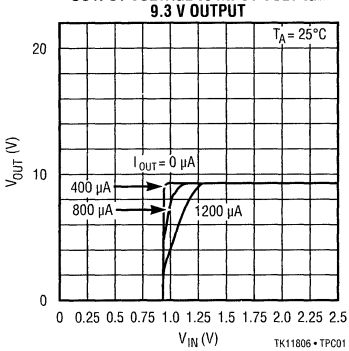
TEST CIRCUIT



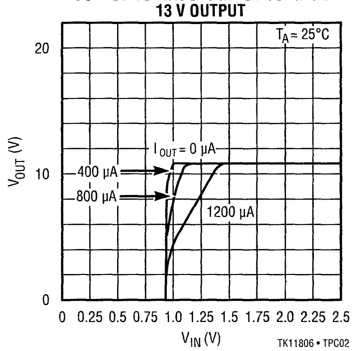
OUTPUT VOLTAGE (V)	CONNECTION
32	T_1-T_2
28	T_1-T_3
24	T_1-T_2-T_3
17	T_1-T_2 , T_3-V_{OUT}
13	T_1-V_{OUT}
9.3	T_1-T_2-V_{OUT}

TYPICAL PERFORMANCE CHARACTERISTICS

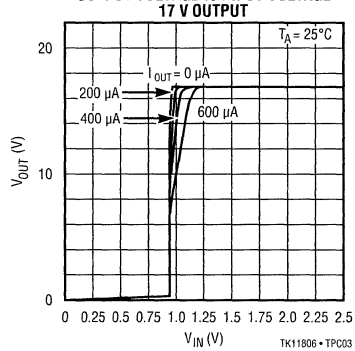
OUTPUT VOLTAGE vs INPUT VOLTAGE 9.3 V OUTPUT



OUTPUT VOLTAGE vs INPUT VOLTAGE 13 V OUTPUT

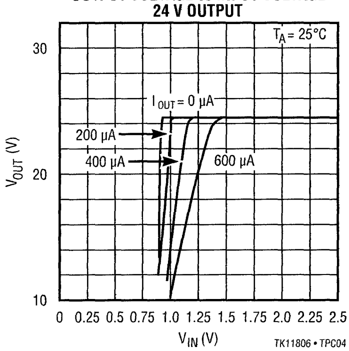


OUTPUT VOLTAGE vs INPUT VOLTAGE 17 V OUTPUT

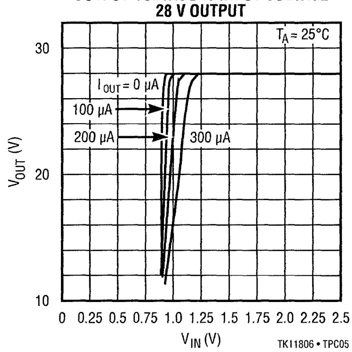


3

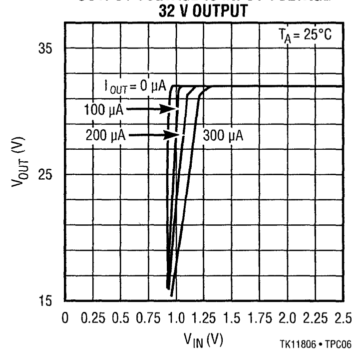
OUTPUT VOLTAGE vs INPUT VOLTAGE 24 V OUTPUT



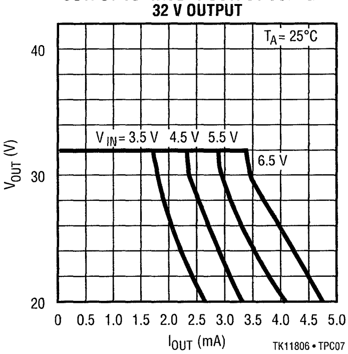
OUTPUT VOLTAGE vs INPUT VOLTAGE 28 V OUTPUT



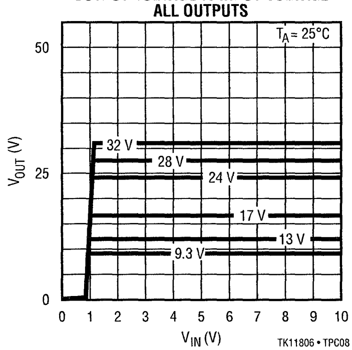
OUTPUT VOLTAGE vs INPUT VOLTAGE 32 V OUTPUT



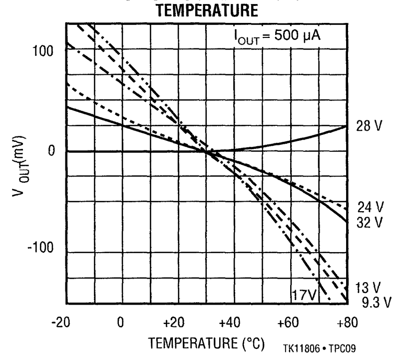
OUTPUT VOLTAGE vs OUTPUT CURRENT 32 V OUTPUT



OUTPUT VOLTAGE vs INPUT VOLTAGE ALL OUTPUTS

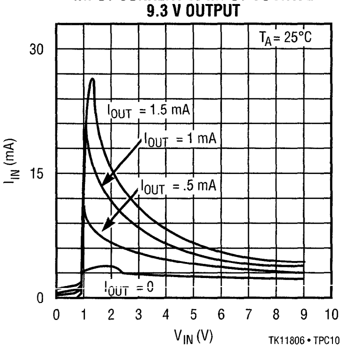


OUTPUT VOLTAGE DRIFT vs TEMPERATURE

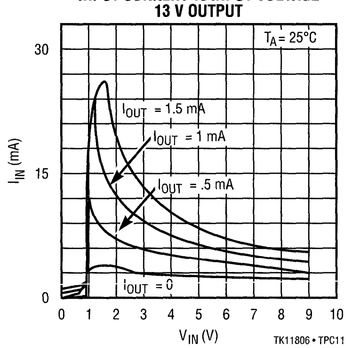


TYPICAL PERFORMANCE CHARACTERISTICS

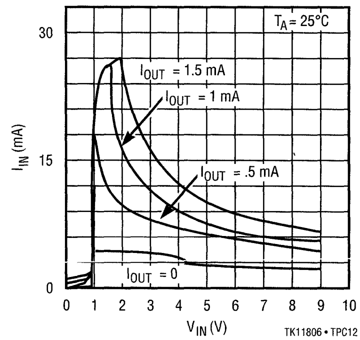
INPUT CURRENT vs INPUT VOLTAGE
9.3 V OUTPUT



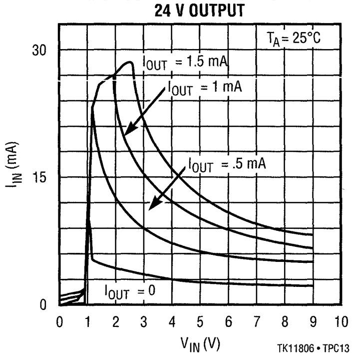
INPUT CURRENT vs INPUT VOLTAGE
13 V OUTPUT



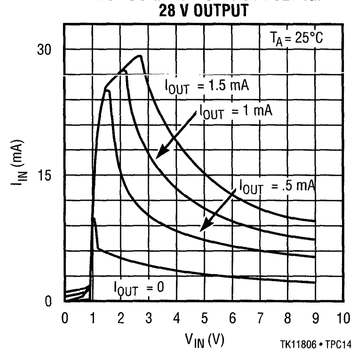
INPUT CURRENT vs INPUT VOLTAGE
17 V OUTPUT



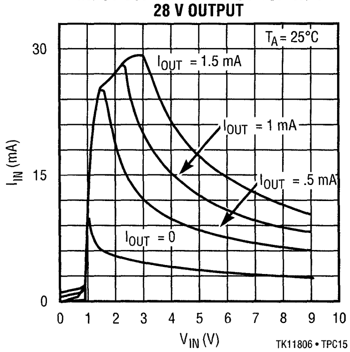
INPUT CURRENT vs INPUT VOLTAGE
24 V OUTPUT



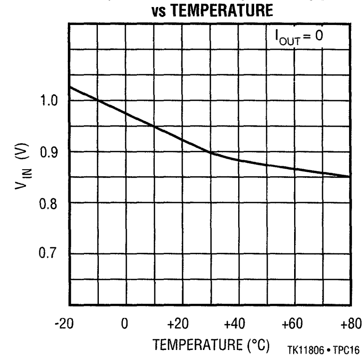
INPUT CURRENT vs INPUT VOLTAGE
28 V OUTPUT



INPUT CURRENT vs INPUT VOLTAGE
28 V OUTPUT

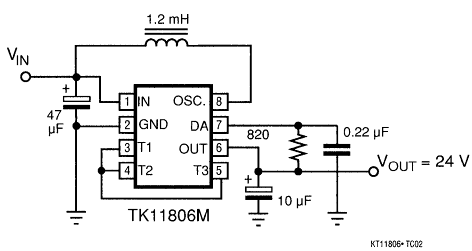


OSCILLATOR START-UP VOLTAGE
vs TEMPERATURE

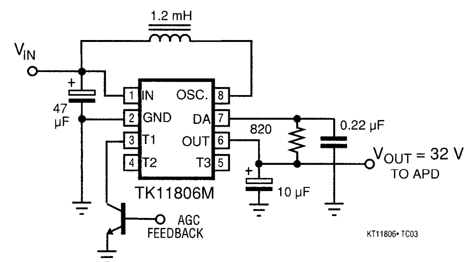


TYPICAL APPLICATIONS

VARIABLE CAPACITANCE DIODE BIAS CIRCUIT

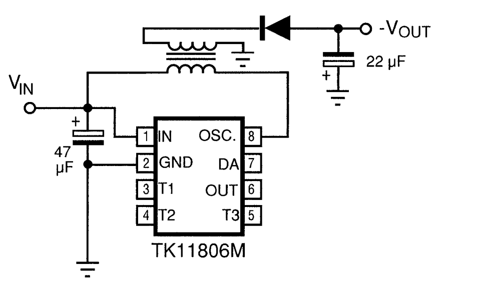


AVALANCHE PHOTODIODE BIAS WITH AGC

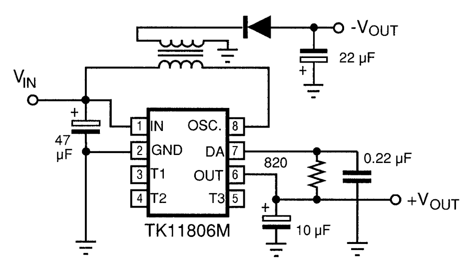


3

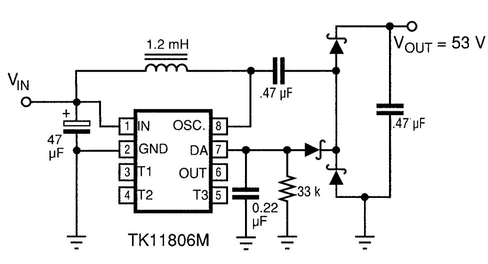
NEGATIVE OUTPUT



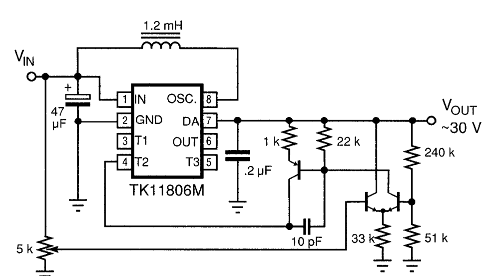
POSITIVE AND NEGATIVE OUTPUTS



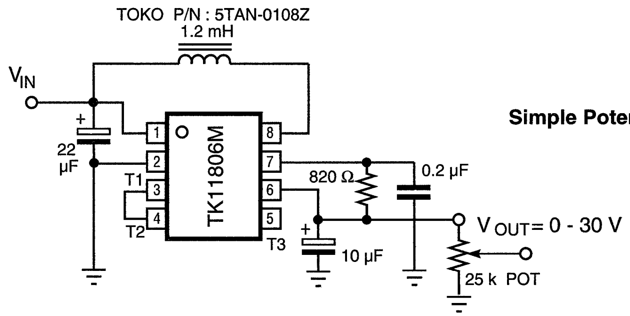
VOLTAGE BOOST CIRCUIT



VARIABLE BIAS SOURCE

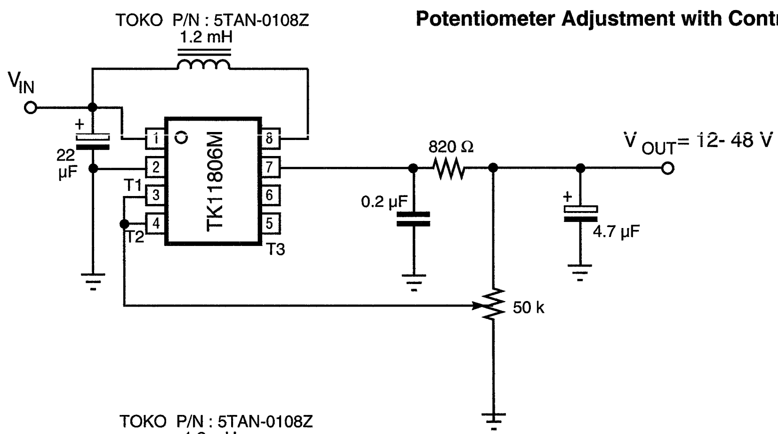


METHODS FOR VARIABLE OUTPUT CONTROL

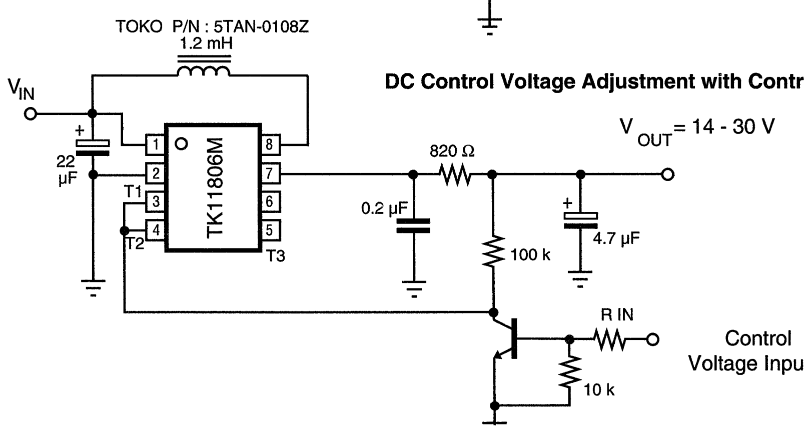


Simple Potentiometer Adjustment

Potentiometer Adjustment with Control Loop



DC Control Voltage Adjustment with Control Loop



FEATURES

- Very Low Noise
- Very Small Size
- Few External Components
- Wide Supply Voltage Range (0.9 to 10 V)
- Sinewave Oscillator
- Selectable Output Voltages

APPLICATIONS

- Variable Capacitance and PIN Photodiode Bias
- Portable Instrumentation
- Radio Control Systems
- Mobile Radios
- Cellular Telephones
- Cordless Telephones
- Fiberoptic Receivers
- Local Area Network (LAN) Receivers
- Battery Operated Equipment

DESCRIPTION

The TK11821 is a low power, low input voltage DC-DC converter. The device has been optimized for variable capacitance diode and PIN photodiode bias applications. It generates 10 Vdc and 24 Vdc output voltages from an input voltage as low as 0.9 V.

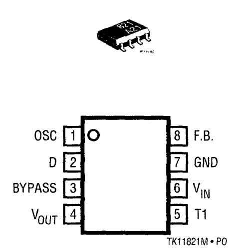
Since the built-in high frequency oscillator generates sinewaves, the TK11821 produces very low RF interference noise. The internal oscillator is capable of operation at frequencies as high as 6-8 MHz, therefore, interference filtering is simple and effective. This unique feature makes the TK11821 ideally suitable for RF and fiber optic receiver applications.

The device is capable of operation in the 0.9 to 10 V power supply voltage range.

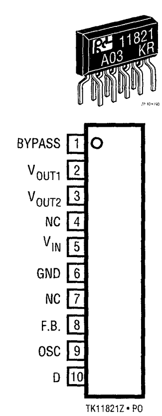
Output 1 provides 24 V output, while T1 is at 10 V. When Output and T1 are shorted, 10 V is available.

The TK11821 is available in 8-pin plastic surface mount (MFP-8) and 10-pin plastic (ZP-10) packages.

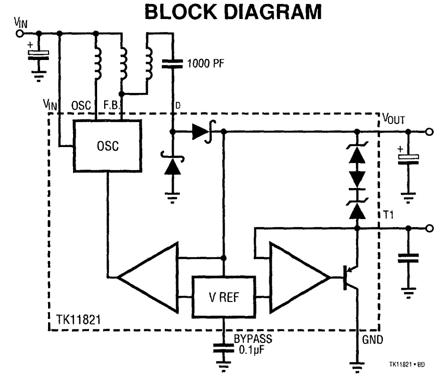
TK11821M



TK11821Z



BLOCK DIAGRAM



ORDERING INFORMATION

TK11821 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -20 to +70 °C	BX: Bulk/Bag
Z : ZIP		TX: Paper Tape
		TR: Tape Right
		TL: Tape Left
		MG: Magazine

ABSOLUTE MAXIMUM RATINGS

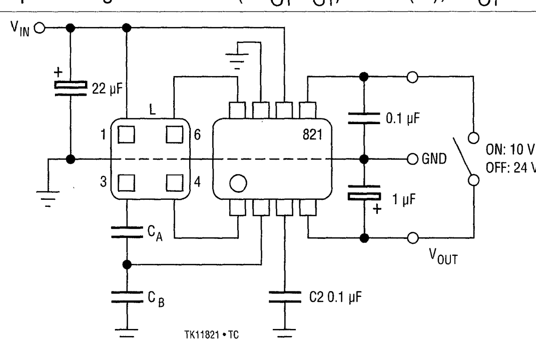
Input Voltage .... 10 V
Output Voltage .... 26 V
Output Current .... 0.5 mA
Operating Voltage Range .... 0.9 to 10 V
Power Dissipation TK11821M (Note 1) .... 350 mW
Power Dissipation TK11821Z (Note 2) .... 490 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -20 to +70 °C
Lead Soldering Temp. (10 sec.) M-Package .... 260 °C
Lead Soldering Temp. (10 sec.) Z-Package .... 300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{IN}=1.1 V, T_A=25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC1}	Input Current 1	I_O = 0 , V_O = 10 V		3.5	7.0	mA
I_{CC2}	Input Current 2	I_O = 50 µA, V_O = 10 V		5.5	9.0	mA
V_{O1}	Output Voltage	I_O = 50 µA	22.5	24.0	25.5	V
V_{O2}	Output Voltage	V_O - T1 shorted, I_O = 50 µA	9.6	10.0	10.4	V
I_O	Output Current	V_O - T1 shorted	90	100		µA
Loa Reg	Load Regulation	Note 4		0.1	0.35	%
$\Delta V_O / T_{A1}$	Output Voltage vs. Temp 1	V_O = 24 V, I_O = 50 µA		+2.3		mV/°C
$\Delta V_O / T_{A2}$	Output Voltage vs. Temp 2	V_O = 10 V, I_O = 50 µA		-1.5		mV/°C
V_{OSC-S}	Oscillation Starting Voltage	I_O = 0 µA (M Pkg)	0.75			V
V_{OSC-S}	Oscillation Starting Voltage	I_O = 0 µA (Z Pkg)	1.5			V
f_{OSC}	Oscillation Frequency	I_O = 0 µA, Note 3 (M Pkg)		4		MHz
f_{OSC}	Oscillation Frequency	I_O = 0 µA, Note 3 (Z Pkg)		3.5		MHz

Note 1: Power dissipation must be derated at the rate of 3 mW/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 4 mW/°C for operation at T_A = 25 °C and above.
Note 3: Use the same value for L that was used in the measurement circuit.
Note 4: Output Voltage Variation = $(\Delta V_{O1}/V_{O1})$ X 100 (%), $\Delta V_{O1} = V_{O1}$ (no load) - V_{O1} (I_O - 50 µA).

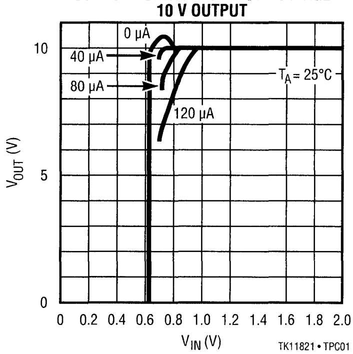


TEST CIRCUIT

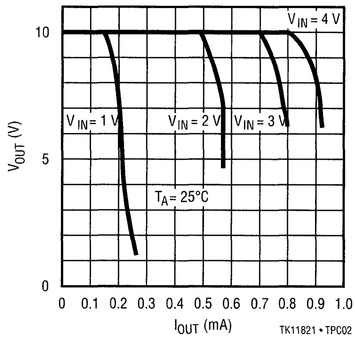
INPUT VOLTAGE	C_A	C_B	TOKO COIL PART NUMBER
0.9 V to 2 V	33 pF	10 pF	PS5CDLN-1250
1.8 V to 10 V	820 pF	33 pF	PS5CDLN-1303

TYPICAL PERFORMANCE CHARACTERISTICS

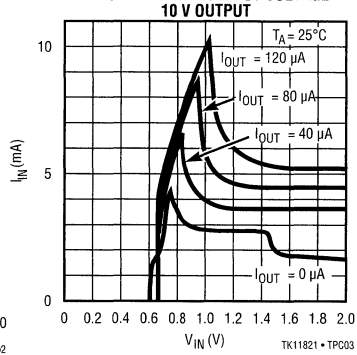
OUTPUT VOLTAGE vs INPUT VOLTAGE 10 V OUTPUT



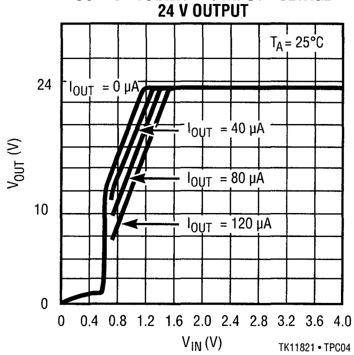
OUTPUT VOLTAGE vs OUTPUT CURRENT 10 V OUTPUT



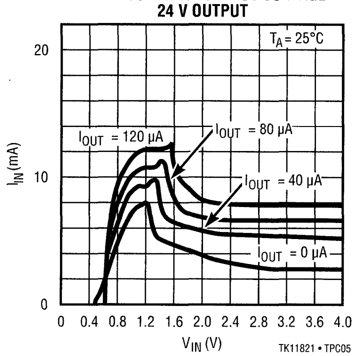
INPUT CURRENT vs INPUT VOLTAGE 10 V OUTPUT



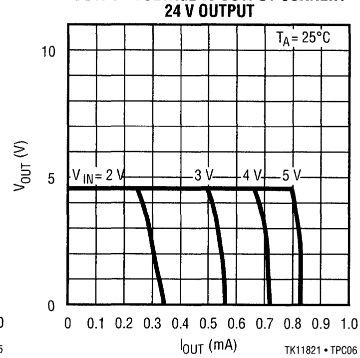
OUTPUT VOLTAGE vs INPUT VOLTAGE 24 V OUTPUT



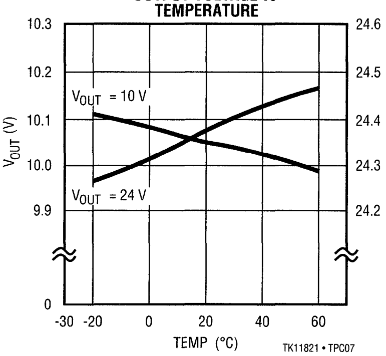
INPUT CURRENT vs INPUT VOLTAGE 24 V OUTPUT



OUTPUT VOLTAGE vs OUTPUT CURRENT 24 V OUTPUT



OUTPUT VOLTAGE vs TEMPERATURE



NOTES

ADVANCE INFORMATION

PRIMARY SIDE CONTROLLER

FEATURES

- Optimized for Offline Operation
- Toggle Option for 45% (75001)
- 90% Duty Cycle Limit (75003)
- Over-Current Protection via Frequency Reduction
- Low Standby Current for Current-Fed Startup
- Current-Mode or Voltage-Mode Control
- Built-In User-Adjustable Slope Compensation
- Functionally Integrated & Simplified 5-pin Design
- Surface Mount U-PAK-5 (1 Watt) Package

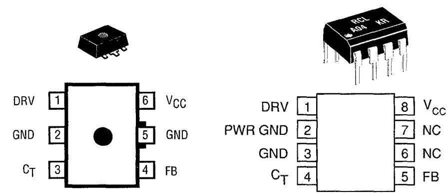
APPLICATIONS

- Off-Line Primary Side Control Power Supplies
- Off-Line Consumer Power Supplies
- Industrial Power Supplies
- Off-Line Battery Chargers

DESCRIPTION

The TK75001/75003 is a primary side controller for switching mode power supplies. It is suitable for both voltage-mode and current-mode control and has advanced features not available in controllers with an even higher pin count. The key to full functionality in a 5-pin package is that the current signal and the error signal are added together and fed into the feedback pin. A sawtooth current flowing out of the feedback pin provides slope compensation, in proportion to the resistance terminating that pin. If the sum of the current signal and the error signal exceeds the Over Current Detector threshold, indicating that the Current Control Detector loses control of the switch current, the charging current of the timing capacitor will be reduced to 25% for the remainder of the period. The reduced charge current leads up to a four-fold reduction in switching frequency, effectively preventing short-circuit current runaway.

TK75001/75003



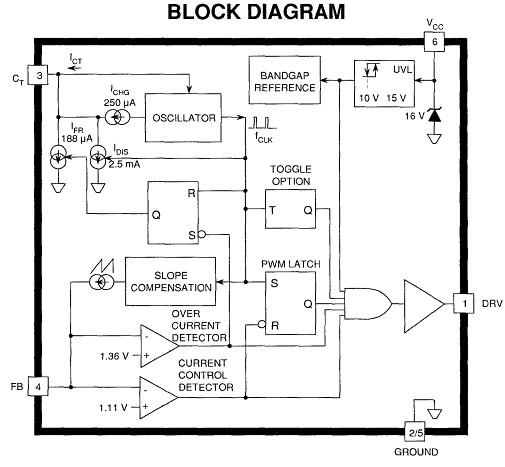
ORDERING INFORMATION

TK75001 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
U : U-pack	C : 0 to + 70 °C	BX : Bulk/Bag
D : Plastic DIP	I : -40 to + 85 °C	TX : Paper Tape
J : Ceramic DIP	M : -55 to + 125 °C	TR : Tape Right
		TL : Tape Left
		MG: Magazine

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 17 V
Power Dissipation
75001/75003U& D (Note 1) .... 1000 mW
75001/75003J (Note 2) .... 825 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Lead Soldering Temp. (10 sec.) .... 300 °C
Operating Temperature Range
(Commercial) .... 0 to +70 °C
(Industrial) .... -40 to +85 °C
(Military) .... -55 to +125 °C

ELECTRICAL CHARACTERISTICS V_{CC} = 12.0 V, C_T = 800 pF, T_A = Operating Temperature Range.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
$I_{CC(off)}$	Stand-by Current	V_{CC} at edge of $V_{CC(on)}$		900	TBD	µA
$I_{CC(on)}$	Supply Current			14	TBD	mA
$V_{CC(on)}$	On Voltage			14	TBD	V
$V_{CC(off)}$	Off Voltage		TBD	10		V
ΔV_{CC}	Hysteresis		TBD	4.0		V
V_Z	Internal Clamp	@ 20 mA		16.0	TBD	V
Oscillator						
f_{CLK}	Clock Frequency		(-5.0%)	100	(+5.0%)	kHz
f_{VPEAK}	Peak Voltage		TBD	3.5	TBD	V
Reference						
V_{CCD}	Current Ctrl. Reference	T_A = 25 °C	(-1.0%)	1.11	(+1.0%)	V
			(-2.0%)	1.11	(+2.0%)	V
V_{OCD}	Over Current Reference		(-2.0%)	1.36	(+2.0%)	V
Feedback (Current Sense and Error Signal)						
t_{PD}	Propagation Delay to Output			75	TBD	ns
$i_{SC(pk)}$	Slope Compensation Peak Current		TBD	100	TBD	µA
Output						
$D_{(max)}$	Maximum Duty Cycle	Without toggle option	TBD	90	TBD	%
		With toggle option	TBD	45	TBD	%
t_R & t_F	Rise Time/Fall Time	1000 pF load		75	TBD	nS
V_{OL}	Output Low Voltage	Sinking 100 mA		0.7	TBD	V
V_{CC}-V_{OH}	Output High Voltage Drop	Sourcing 100 mA		0.7	TBD	V
Frequency Reducer (Over Current Protection Timing)						
i_{CT} / i_{CHG}	Charging Reduction Ratio	TK75003	TBD	25	TBD	%
i_{CT} / i_{CHG}	Charging Reduction Ratio	TK75001	TBD	14	TBD	%

Note 1: Power dissipation must be derated at the rate of 8 mW/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 6.6 mW/°C for operation at T_A = 25 °C and above.

ERROR SIGNAL ISOLATOR

FEATURES

- Eliminates Opto-Coupler in Feedback Design
- Replaces TL431 and Eliminates Parasitic Zero
- Pulse Transformer Driver
- Same Transformer for Any Output Voltage
- Peak Current Controlled
- Automatic Volt-Second Balancing
- Self-Running Oscillator
- Hi-Performance Opamp & Bandgap Reference
- Functionally Integrated & Simplified 5-pin Design
- Surface Mount U-PAK-5 (1 Watt) Package

APPLICATIONS

- Power Supplies with Primary-Side Controller
- Replacement for Opto-coupler
- Instrumentation
- Industrial Process Control
- Test Equipment
- Data Acquisition

DESCRIPTION

The TK75002 is designed to monitor the output voltage of a power supply, generate an error signal, and transmit the error signal through an isolation barrier using a small pulse transformer. In conjunction with the pulse transformer, it replaces the TL431/optocoupler combination and eliminates the undesirable zero created by that combination. The transformer is driven with pulse amplitude modulation in a free-running oscillator configuration. The period of oscillation is proportional to the pulse transformer inductance. The voltage pulse magnitude is internally limited so that the pulse transformer design need not be changed for various output voltages.

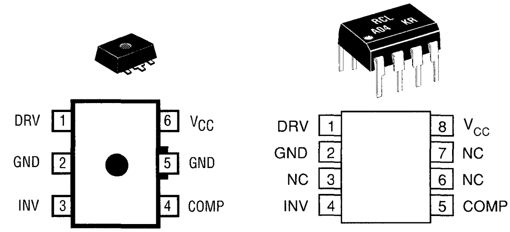
ORDERING INFORMATION

TK75002 □ □ □□

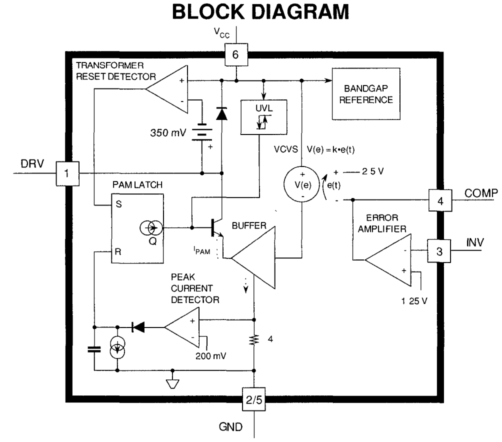
- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
U : U-pack	C : 0 to + 70 °C	BX : Bulk/Bag
D : Plastic DIP	I : -40 to + 85 °C	TX : Paper Tape
J : Ceramic DIP	M : -55 to + 125 °C	TR : Tape Right
		TL : Tape Left
		MG: Magazine

TK75002



BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 17 V
Power Dissipation (Note 1) .... 1 W
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

Operating Temperature Range
(Commercial) .... 0 to +70 °C
(Industrial) .... -40 to +85 °C
(Military) .... -55 to +125 °C

ELECTRICAL CHARACTERISTICS V_{CC} = 5.0 V, T_A = Operating Temperature Range

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Reference						
V_{REF}	Error Amp Reference	T_J = 25 °C	(-1.0%)	1.25	(+1.0%)	V
V_{REF}	Error Amp Reference		(-2.0%)	1.25	(+2.0%)	V
Error Amplifier						
A_V	Open Loop Gain		60	95		dB
GBW	Gain Bandwidth Product		TBD	3		MHz
$I_{E/A}$	Source Current	V_{PIN4} > 2.5 V	-0.5	-2		mA
$I_{E/A}$	Sink Current	V_{PIN4} <1 V	TBD	11		mA
I_{IB}	Input Bias Current			0.2	2.5	µA
Pulse Amplitude Modulator						
V_F	Diode Clamp Voltage	I_F = 50 mA, T_J = 25 °C	TBD	0.8	TBD	V
f_{PAM}	PAM Freq. (Recommended)				1.5	MHz
V_{CC} - $V_{PAM(MIN)}$	PAM Driving Voltage	I_{PAM} = $I_{PAM\ (PK)}$, $V_{CC} \geq 5$ V	3.0	4.0	TBD	V
k	VCVS Level Shift Gain		TBD	1.3	TBD	V/V
Peak Current Detector						
$I_{PAM(PK)}$	Peak PAM Current Threshold		TBD	50	TBD	mA
$t_{D(off)}$	Turn Off Delay			75	TBD	ns
Transformer Reset Detector						
V_{BIAS}	Bias Voltage			.35		V
Supply Voltage and Current						
I_{CC}	Supply Current	I_{PAM} = I_F = 0, V_{CC} 5 to 15 V		8	TBD	mA
Under Voltage Lockout						
$V_{UVL(on)}$	Turn On Threshold of V_{CC}		TBD	4.2	TBD	V
ΔV_{UVL}	UVL Hysteresis		TBD	0.2		V

Note 1: Power dissipation must be derated at the rate of 8 mW/°C for operation at T_A = 25 °C and above.

TOKO

TK75018

ADVANCE INFORMATION

SWITCHED CAPACITOR VOLTAGE CONVERTER WITH REGULATOR

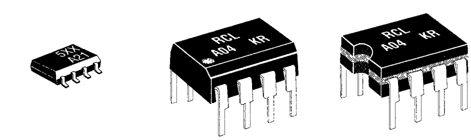
FEATURES

- 25 mA Output Current
- Operating Range 3.5 V to 15 V
- Reference and Error Amplifier for Regulation
- External Shutdown
- External Oscillator Sync
- Can be Paralleled

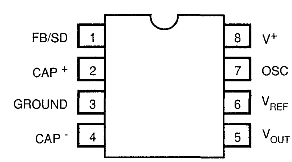
APPLICATIONS

- Voltage Inverter
- Negative Voltage Doubler
- Voltage Regulator
- Positive Voltage Doubler

TK75018M **TK75018D** **TK75018J** **TK75018J**



TK75018
Ceramic Dip, Plastic Dip, MFP



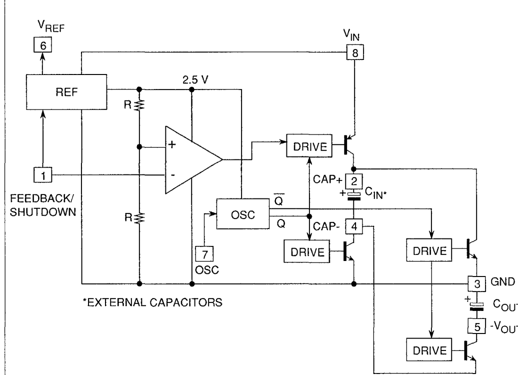
DESCRIPTION

The TK75018 is a monolithic switched capacitor converter with feedback control. With just two capacitors, the TK75018 can create a negative voltage supply which tracks a positive supply. As an alternative, the feedback pin can be used to establish regulation at a desired voltage and it can also be used as a shutdown signal input. A single TK75018 can also be configured as a non-inverting step-up converter or dual output voltage doubler. Output voltages from –5 V to +30 V can be obtained.

With no external timing elements, the converter will self-oscillate at 25 kHz, nominally. This frequency can be user adjusted with a small capacitor or synchronized to another oscillator.

Quiescent current is typically 2.5 mA. Standby current is guaranteed less than 150 µA over the full operating temperature and input voltage ranges.

BLOCK DIAGRAM



ORDERING INFORMATION

TK75018 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
D : Plastic DIP	C : -0 to + 70 °C	BX : Bulk/Bag
J : Ceramic DIP	I : -40 to + 85 °C	MG: Magazine
M: Surface Mount	M : -55 to + 125 °C	

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{IN} For Doubler Conf. .... 16 V
Negative Voltage .... -6.5 V
Lead Soldering Temp. (10 sec.) .... 300 °C
Storage Temperature Range .... -55 to +150 °C
Power Dissipation
TK75018M (Note 1) .... 600 mW
TK75018D (Note 2) .... 1000 mW
TK75018J (Note 3) .... 825 mW

Junction Temperature (Note 4)
TK75018 .... 125 °C
TK75018M .... 150 °C
Operating Temperature Range
TK75018C .... 0 to +70 °C
TK75018I .... -40 to +85 °C
TK75018M .... -55 to +125 °C

ELECTRICAL CHARACTERISTICS Test conditions: V_{IN} = 5.0 V, T_A = Operating Temperature Range

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	I_{LOAD} = 0 mA, V_{IN} = 3.5 V		2.5	3.5	mA
V_{CC}	Supply Voltage Range		3.5		35	V
V_{LOSS}	Voltage Loss (V_{IN}- | V_{OUT} |)	C_{IN} = C_{OUT} = 100 µF Tantalum (Note 5), I_{OUT} = 10 mA		0.35	0.55	V
V_{LOSS}	Voltage Loss (V_{IN}- | V_{OUT} |)	C_{IN} = C_{OUT} = 100 µF Tantalum (Note 5), I_{OUT} = 25 mA		.6	1.0	V
R_{OOUT}	Output Resistance	ΔI_{OUT} = 1 mA to 25 mA (Note 6)		10	15	Ω
f_O	Oscillator Frequency	3.5 V ≤ V_{IN} ≤ 15 V	15	25	35	kHz
V_{REF}	Reference Voltage	I_{REF} = 60 µA, T_j = 25 °C	2.35 2.25	2.50	2.65 2.75	V V
V_O	Regulated Voltage	V_{IN} = 7 V, T_j = 25 °C, R_L = 5000 (Note 7)	-4.7	-5.0	-5.2	V
ΔV_{OLINE}	Line Regulation	7 V ≤ V_{IN} ≤ 12 V, R_L = 5000 (Note 7)		5	80	mV
ΔV_{OLOAD}	Load Regulation	V_{IN} = 7 V, 200 Ω ≤ R_L ≤ 5 kΩ (Note 7)		10	50	mV
I_{SWPEAK}	Maximum Switch Current			300		mA
I_{CCOFF}	Supply Current in Shutdown	V_{PIN1} = 0 V		100	150	µA
R_{OREF}	Ref. Output Resistance	I_{REF} ≤ 80 µA		670		Ω

Note 1: Power dissipation must be derated at the rate of 4.8 mW/°C for operation at T_A = 25 °C and above
Note 2: Power dissipation must be derated at the rate of 8 mW/°C for operation at T_A = 25 °C and above.
Note 3: Power dissipation must be derated at the rate of 6.6 mW/°C for operation at T_A = 25 °C and above.
Note 4: Functionality is guaranteed up to the absolute maximum junction temperature.
Note 5: For voltage loss tests, the device is connected as an inverter, with pins 1, 6, and 7 unconnected. The voltage loss may be higher in other configurations.
Note 6: Output resistance means the slope of the , ΔV_{OUT} vs ΔI_{OUT} curve, for output currents of 1 to 25 mA. This represents a linear approximation of the curve.
Note 7: Device is connected as a positive to negative converter/regulator with R1 = 20 k, R2 = 102.5 k, C1 = 0.002 µF, C_{IN} = 10 µF tantalum, C_{OUT} = 100 µF tantalum.

TOKO

ADVANCE INFORMATION

SMART MOSFET DRIVER

FEATURES

- **30 ns Rise and Fall into 1000 pF**
- **300 μA Stand-by Current Consumption**
- **Under Voltage Lockout Combined with First Pulse Wake-Up Feature***
- **Cycle by Cycle Current Limiting**
- **Virtually Eliminated Switching Spike When Used With Gate Charge Recovery Circuit****
- **Thermal Overload Protection**
- **5-pin Surface Mount Package with 1 W Maximum Internal Power Dissipation Limit**

DESCRIPTION

The TK75050 is a novel device to drive high power insulated gate transistors (e.g. MOSFETs and IGBTs). The IC can source or sink 1A and features built-in cycle-by-cycle current limiting, undervoltage lockout (UVLO) circuit combined with first pulse wake-up and thermal overload protection. Using the IC in the proprietary Gate Charge Recovery application, the switching spike developing across the current sense resistor practically becomes negligible. Due to its low stand-by current and first-pulse wake-up feature, the device can be used in self-biased power supplies. The IC's high-speed cycle-by-cycle current limiting capability eliminates the short circuit runaway problem, characteristic to most current controlled converters. The IC is well suited to provide supplementary overload protection in voltage-mode controlled converters, too. Besides the surface mount UPAK-5, the device is also available in the widely used DIP-8 package.

* The First Pulse Wake-Up is a built-in proprietary feature of the IC. When the IC is powered on, and the supply voltage exceeds the upper threshold of the UVLO circuit, the start-up circuit is enabled but the device remains in low quiescent current stand-by state. The IC wakes up from stand-by and begins the normal operation when the first drive pulse arrives at the input. The normal operation ceases and the IC returns to stand-by when the supply voltage drops below the lower threshold of the UVLO circuit.

ORDERING INFORMATION

TK75050 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
U : UPAK	C : 0 to + 70 °C	BX : Bulk/Bag
D : Plastic Dip	I : -40 to + 85 °C	TX : Paper Tape
	M : -55 to + 125 °C	TR : Tape Right
		TL : Tape Left
		MG: Magazine

APPLICATIONS

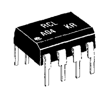
- **Power MOSFETs and IGBTs**
- **Switch Mode Power Supplies**
- **Power Factor Controllers**
- **DC-DC Converters**
- **Step Motor Drivers**
- **Solenoid Drivers**

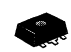
** The Gate Charge Recovery Circuit is an application developed by TOKO Inc., to virtually eliminate the leading edge spikes generated across the current sense resistor by capacitive feedthrough of the MOSFET's gate drive signal.

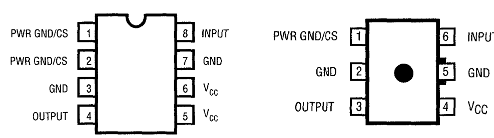
3

TK75050

DIP-8 **UPAK-5**







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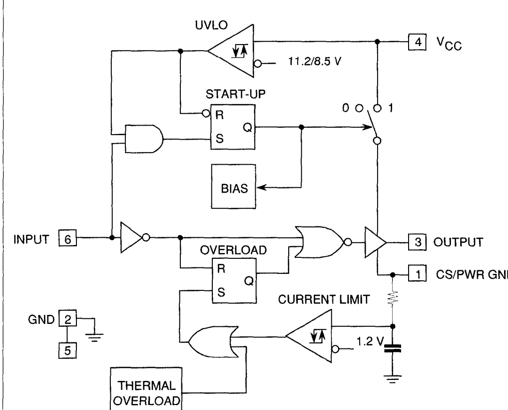


ABSOLUTE MAXIMUM RATINGS

Input Voltage $V_{CC,MAX}$ .... 18 V
Power Dissipation (Note 1) UPAK .... 1000 mW
Power Dissipation (Note 2) DIP .... 825 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Lead Soldering Temp. (10 sec.) .... 240 °C
Operating Temperature Range
(Commercial) .... 0 to +70 °C
(Industrial) .... -40 to +85 °C
(Military) .... -55 to +125 °C

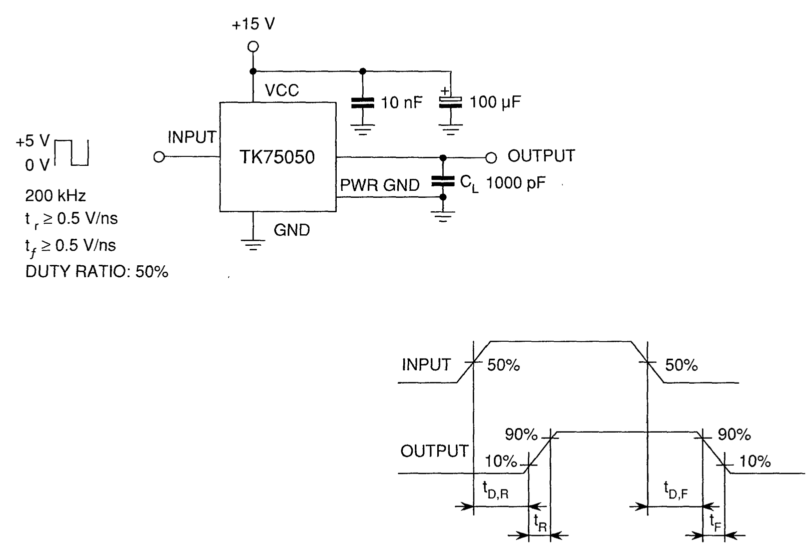
ELECTRICAL CHARACTERISTICS

Test Conditions: T_A = 25 °C, V_C = 15 V, C_L = 1000 pF

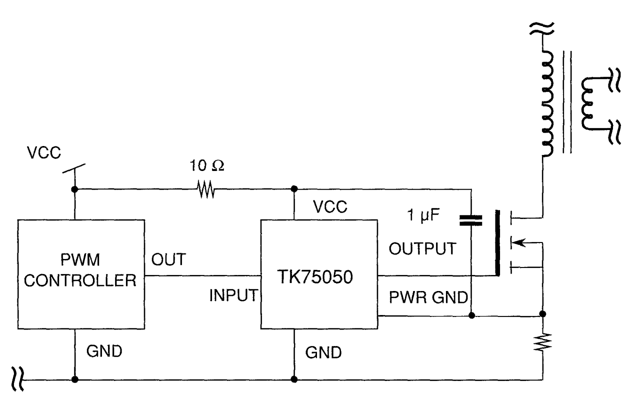
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	Output Low		20		mA
		Output High		18		mA
		Stand-by (Note 3)		300		µA
$V_{CC, ON}$	UVLO Upper Threshold	V_{CC} Low to High		11.2		V
$V_{CC, OFF}$	UVLO Lower Threshold	V_{CC} High to Low		8.5		V
$V_{IN, L}$	Input Logic Level, Low		0	0.4	0.8	V
$V_{IN, H}$	Input Logic Level, High		2.0	2.4	15	V
$I_{IN, L}$	Input Current, Low			-100		µA
$I_{IN, H}$	Input Current, High			10		nA
$V_{OUT,L}$	Output Voltage, High			13.6		V
$V_{OUT,H}$	Output Voltage, Low			0.6		V
T_{OFF}	Thermal Overload Threshold, High	Temp Low to High	–	150	–	°C
T_{ON}	Thermal Overload Threshold, Low	Temp High to Low	–	100	–	°C
V_{CL}	Current Limit Threshold		1.1	1.2	1.3	V
$V_{CL,H}$	Current Limit Hysteresis		–	200	–	mV
t_{DR}	Time Delay, Rise	0 - 10%		30	50	ns
t_R	Rise Time	10 - 90%		30	50	ns
t_{DF}	Time Delay, Fall	100 - 90%		30	50	ns
t_F	Fall Time	90 - 10%		25	50	ns
$t_{D,CS-OUT}$	Time Delay, Current Sense to Output	100 - 90%		70		ns

Note 1: Power dissipation must be derated at the rate of 8 mW/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 6.6 mW/°C for operation at T_A = 25 °C and above.
Note 3: Before wake-up, at any V_{CC} below $V_{CC,MAX}$ or after wake-up, if V_{CC} drops below $V_{CC,OFF}$.
Condition for wake-up: V_{CC} passes $V_{CC,ON}$ and stays above $V_{CC,OFF}$ when the wake-up pulse arrives.

TEST CIRCUIT



GATE CHARGE RECOVERY CIRCUIT



NOTES

ADVANCE INFORMATION

SWITCHED CAPACITOR VOLTAGE CONVERTER WITH REGULATOR

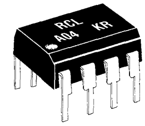
FEATURES

- 100 mA Output Current
- Operating Range 3.5 V to 35 V
- Reference and Error Amplifier for Regulation
- External Shutdown
- External Oscillator Sync
- Can be Paralleled

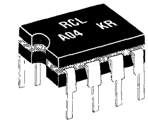
APPLICATIONS

- Voltage Inverter
- Negative Voltage Doubler
- Voltage Regulator
- Positive Voltage Doubler

TK81054D



TK81054J
TK81054J



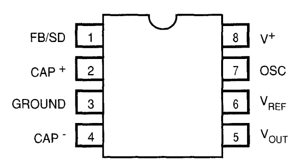
DESCRIPTION

The TK81054 is a monolithic switched capacitor converter with feedback control. With just two capacitors, the TK81054 can create a negative voltage supply which tracks a positive supply. As an alternative, the feedback pin can be used to establish regulation at a desired voltage and it can also be used as a shutdown signal input. A single TK81054 can also be configured as a non-inverting step-up converter or dual output voltage doubler. Output voltages from –5 V to +70 V can be obtained.

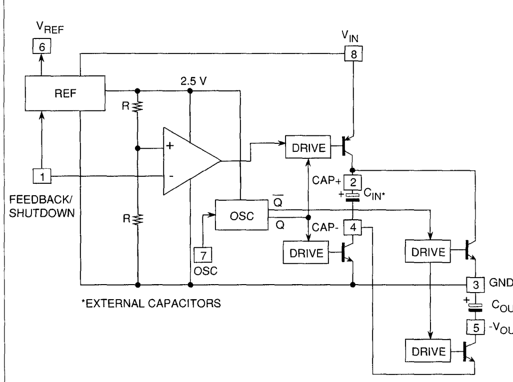
With no external timing elements, the converter will self-oscillate at 25 kHz, nominally. This frequency can be user adjusted with a small capacitor or synchronized to another oscillator.

Quiescent current is typically 2.5 mA. Standby current is guaranteed less than 150 µA over the full operating temperature and input voltage ranges. The supply voltage range covers an order of magnitude from 3.5 V to 35 V. However, for negative output configuration, $V_{IN} + |V_{OUT}|$ must not exceed the maximum supply ratings.

TK81054
Ceramic Dip, Plastic Dip



BLOCK DIAGRAM



ORDERING INFORMATION

TK81054 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
D : Plastic DIP	C : -0 to + 70 °C	BX : Bulk/Bag
J : Ceramic DIP	I : -40 to + 85 °C	MG: Magazine
	M : -55 to + 125 °C	

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{IN} For Doubler Conf. ....35 V
Negative Voltage ....-6.5 V
Lead Soldering Temp. (10 sec.) ....300 °C
Storage Temperature Range....................-55 to +150 °C
Power Dissipation
TK81054D (Note 1) ....1000 mW
TK81054J (Note 2) ....825 mW

Junction Temperature (Note 4)
TK81054 ....125 °C
TK81054M ....150 °C
Operating Temperature Range
TK81054C ....0 to +70 °C
TK81054I ....-40 to +85 °C
TK81054M ....-55 to +125 °C

ELECTRICAL CHARACTERISTICS Test conditions: V_{IN} = 5.0 V, T_A = Operating Temperature Range

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	I_{LOAD} = 0 mA, V_{IN} = 3.5 V		2.5	3.5	mA
V_{CC}	Supply Voltage Range		3.5		35	V
V_{LOSS}	Voltage Loss (V_{IN}- | V_{OUT} |)	C_{IN} = C_{OUT} = 100 µF Tantalum (Note 3), I_{OUT} = 10 mA		0.35	0.55	V
V_{LOSS}	Voltage Loss (V_{IN}- | V_{OUT} |)	C_{IN} = C_{OUT} = 100 µF Tantalum (Note 4), I_{OUT} = 100 mA		1.1	1.6	V
R_{OOUT}	Output Resistance	ΔI_{OUT} = 10 mA to 100 mA (Note 5)		10	15	Ω
f_O	Oscillator Frequency	3.5 V ≤ V_{IN} ≤ 35 V	15	25	35	kHz
V_{REF}	Reference Voltage	I_{REF} = 60 µA, T_j = 25 °C	2.35 2.25	2.50	2.65 2.75	V V
V_O	Regulated Voltage	V_{IN} = 7 V, T_j = 25 °C, R_L = 5000 (Note 6)	-4.7	-5.0	-5.2	V
ΔV_{OLINE}	Line Regulation	7 V ≤ V_{IN} ≤ 12 V, R_L = 5000 (Note 6)		5	35	mV
ΔV_{OLOAD}	Load Regulation	V_{IN} = 7 V, 100 Ω ≤ R_L ≤ 500 Ω (Note 6)		10	50	mV
I_{SWPEAK}	Maximum Switch Current			300		mA
I_{CCOFF}	Supply Current in Shutdown	V_{PIN1} = 0 V		100	150	µA
R_{OREF}	Ref. Output Resistance	I_{REF} ≤ 80 µA		670		Ω

Note 1: Power dissipation must be derated at the rate of 8 mW/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 6.6 mW/°C for operation at T_A = 25 °C and above.
Note 3: Functionality is guaranteed up to the absolute maximum junction temperature.
Note 4: For voltage loss tests, the device is connected as an inverter, with pins 1, 6, and 7 unconnected. The voltage loss may be higher in other configurations.
Note 5: Output resistance means the slope of the, ΔV_{OUT} vs ΔI_{OUT} curve, for output currents of 10 to 100 mA. This represents a linear approximation of the curve.
Note 6: Device is connected as a positive to negative converter/regulator with R1 = 20 k, R2 = 102.5 k, C1 = 0.002 µF, C_{IN} = 10 µF tantalum, C_{OUT} = 100 µF tantalum.

TOKO

TK81073

ADVANCE INFORMATION

MICROPOWER DC-DC CONVERTER ADJUSTABLE AND FIXED 5 V, 12 V

FEATURES

- Operates at Supply Voltages From 1.0 V to 15 V
- Consumes only 95 µA Supply Current
- Works in Step-up or Step-Down Mode
- Only Three External Components Required
- Low-Battery Detector Amplifier On-Chip
- User-Adjustable Current Limit
- Internal 1A Power Switch
- Fixed or Adjustable Output Voltage Versions
- Surface Mount MFP-8 or Dip-8 Plastic Package

APPLICATIONS

- Pagers
- Cameras
- Single-Cell to 5 V Converters
- Battery Backup Supplies
- Laptop and Palmtop Computers
- Cellular Telephones
- Portable Instruments
- 4 mA-20 mA Loop Powered Instruments

3

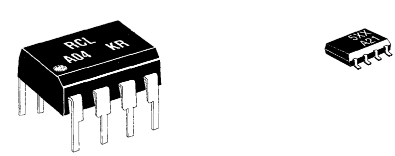
DESCRIPTION

The TK81073 is a gated-oscillator or burst-mode DC to DC converter. It uses very low supply current and can operate with an input voltage as low as 1.0 Volt. This makes the TK81073 the ideal choice for applications which use a single cell as the power source.

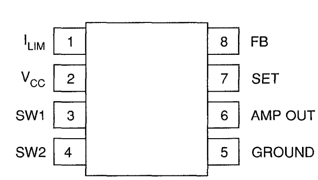
The TK81073 can be used as either a step up (Boost) or step down (Buck) converter. In the standard boost mode configuration the TK81073-5 uses only 135 µA unloaded and is capable of providing 5 V at 40 mA to the load with an input supply as low as 1.25 V. The TK81073 also has an internal switch current limit which can be adjusted by the user with 1 external resistor.

The TK81073 is available in three versions; the TK81073-5 and the TK81073-12 have fixed outputs of 5 and 12 volts respectively while the TK81073 is user adjustable. The fixed voltage versions require only three external components while the adjustable version needs two additional external resistors to set the output voltage. All versions also include an amplifier on the chip which may be used to detect low input battery voltage or as part of a linear post-regulator.

TK81073D **TK81073M**



TK81073
Plastic Dip
Plastic MFP-8



ORDERING INFORMATION

TK81073 □ □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code
- Voltage Code

VOLTAGE CODE
73 = Adjustable
73-5 = 5 V
73-12 = 12 V

PACKAGE CODE
M : Surface Mount
D : Plastic DIP

TEMP. RANGE
C : -20 to + 70 °C
I : -40 to + 85 °C

TAPE/REEL CODE
BX : Bulk/Bag
TX : Paper Tape
TR : Tape Right
TL : Tape Left
MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 15 V
Power Dissipation (MFP8) Note 1 .... 500 mW
Power Dissipation (DIP8) Note 2 .... 1000 mW
Lead Soldering Temp. (10 sec.) .... 300 °C

Junction Temperature .... 150 °C
Storage Temperature Range .... -65 to +150 °C
Operating Temperature Range
(Commercial) .... 0 to +70 °C
(Industrial) .... -40 to +85 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{IN} = 1.5 V, unless otherwise specified. T_A = 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_Q	Quiescent Current	Switch Off		95	130	µA
i_Q	Quiescent Current, Step-Up Mode Configuration	No Load TK81074 TK81075		135 250		µA
V_{IN}	Input Voltage	Step-Up Mode	1.15 1.0		12.6 12.6	V
		Step-Down Mode			15	V
	Comparator Trip Point Voltage	TK81073 (Note 3)	202	212	222	mV
V_{OUT}	Output Sense Voltage	TK81073-5 (Note 4) TK81073-12 (Note 4)	4.75 11.4	5 12	5.25 12.6	V V
	Comparator Hysteresis	TK81073		5	10	mV
	Output Hysteresis	TK81073-5 TK81073-12		125 300	250 600	mV mV
F_{OSC}	Oscillator Frequency		15	19	23	kHz
DC	Duty Cycle	Full Load ($V_{FB} < V_{REF}$)	65	72	80	%
t_{ON}	Switch ON Time		30	38	50	µs
I_{FB}	Feedback Pin Bias Current	TK81073, V_{FB} = 0 V		10	50	nA
I_{SET}	Set Pin Bias Current	$V_{SET} = V_{REF}$		60	120	nA
V_{AO}	AO Output Low	1_{AO} = -100 µA		0.15	0.4	V
	Reference Line Regulation	1.0 V ≤ V_{IN} ≤ 1.5 V 1.5 V ≤ V_{IN} ≤ 12 V	 0.05	0.35 0.1	1.0	%/V
V_{CESAT}	Switch Saturation Voltage Step-Up Mode	V_{IN} = 1.5 V, I_{SW} = 400 mA		300	400	mV
		V_{IN} = 1.5 V, I_{SW} = 500 mA		400	550	mV
		V_{IN} = 5 V, I_{SW} = 1 A		700	1000	mV
A_V	A2 Error Amp Gain	R_L = 100 kΩ (Note 5)		400	1000	V/V

ELECTRICAL CHARACTERISTICS (CONT.)

Test conditions: V_{IN} = 1.5 V, T_A = 25 °C, unless otherwise specified.

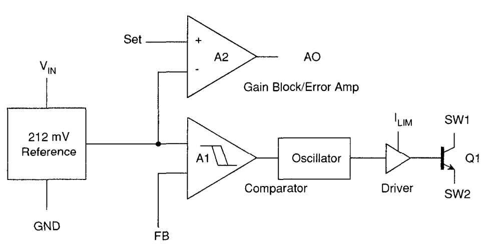
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{REV}	Reverse Battery Current	(Note 6)		750		mA
I_{LIM}	Current Limit	220 Ω Between I_{LIM} and V_{IN}		400		mA
	Current Limit Temperature Coefficient			-0.3		%/°C
I_{LEAK}	Switch OFF Leakage Current	Measured at SW1 Pin		1	10	µA
V_{SW2}	Maximum Excursion Below GND	I_{SW1} < 10 µA, Switch Off		-400	-350	mV

Note 1: Power dissipation must be derated at the rate of 4.8 mW/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 8 mW/°C for operation at T_A = 25 °C and above.
Note 3: Both high and low trip points fall within these limits.
Note 4: The output voltage of the fixed versions always falls within this range. The waveform at the sense pin has a sawtooth shape due to comparator hysteresis.
Note 5: 100 kΩ resistor between 5 V and the pin 6.
Note 6: Guaranteed to withstand continuous application of +1.6 V, applied to pin 5 and pin 4 while pins 1, 2, and 3 are grounded.

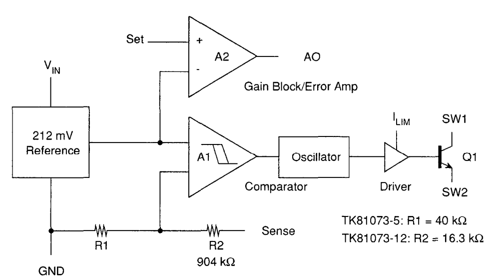
3

BLOCK DIAGRAMS

TK81073



TK81073-5
TK81073-12



NOTES

PRELIMINARY INFORMATION

HIGH POWER FACTOR PREREGULATOR

FEATURES

- **Control Boost PWM to 0.99 Power Factor**
- **Limit Line Current Distortion to <5%**
- **World-Wide Operation Without Switches**
- **Feed-Forward Line Regulation**
- **Low Noise Sensitivity**
- **Pin Compatible With UC1854**
- **Low Start-up Supply Current**
- **Fixed-Frequency PWM Drive**
- **Low-offset Analog Multiplier/Divider**
- **1 Amp Totem-Pole Gate Driver**
- **Precision Voltage Reference**

DESCRIPTION

The TK81854 family of integrated circuits provide active power factor correction for power systems that otherwise would draw non-sinusoidal current from sinusoidal power lines. These parts implement all the control functions necessary to build a power supply preregulator capable of optimally using available power-line current while minimizing line-current distortion. To do this, the TK81854 contains a voltage amplifier, a precision analog multiplier/divider, a current amplifier, and a fixed-frequency PWM. In addition, the TK81854 contains a power MOSFET gate driver, 7.5 V reference, line anticipator, load-enable comparator, low supply detector, and over current comparator.

The TK81854 family uses average current mode control to accomplish fixed-frequency current control with stability and low distortion. Unlike peak current mode control, average current control accurately maintains sinusoidal line current without slope compensation.

The TK81854's high reference voltage and high oscillator amplitude minimize noise sensitivity while fast PWM elements permit chopping frequencies above 200 kHz. The TK81854 can be used in systems with line voltages that vary from 75 to 275 volts and with line frequencies across the 50 Hz to 400 Hz range. To reduce the burden on the circuitry that supplies power to this device, the TK81854 family features low start-up supply current.

These devices are available in 16-pin plastic and ceramic DIP packages as well as a 20-pin PLCC, LCC and MFP packages.

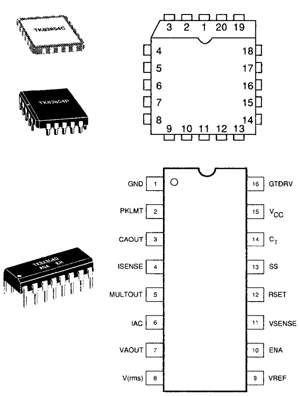
ORDERING INFORMATION

TK8[1]854[ ] [ ][ ]

- Tape/Reel Code
- Package Code
- Temp. Range

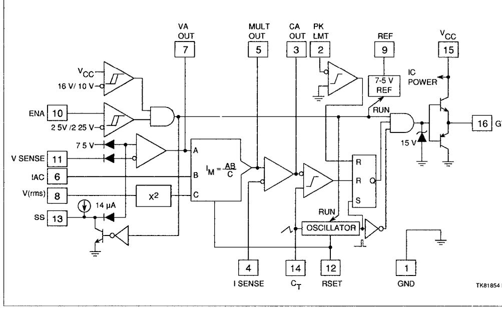
TEMP. RANGE	PACKAGE CODE	TAPE/REEL CODE
1 : -55 to +125 °C	D: Plastic	BX: Bulk/Bag
2 : -40 to +85 °C	J : Ceramic	MG: Magazine
3 : -20 to +70 °C	P : PLCC	
	C : LCC	
	M: Surface Mount	

TK81854



PACKAGE PIN FUNCTION	
FUNCTION	**PIN**
N/C	1
GND	2
PKLMT	3
CA Out	4
I_{SENSE}	5
N/C	6
Mult Out	7
I_{AC}	8
VA Out	9
V(rms)	10
N/C	11
V_{REF}	12
ENA	13
V_{SENSE}	14
R_{SET}	15
N/C	16
SS	17
C_T	18
V_{CC}	19
GT Drv	20

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC} .... 35 V
GTDRV Current, Continuous .... 0.5 A
GTDRV Current, 50% Duty Cycle .... 1.5 A
Input Voltage, VSENSE, V(rms) .... 11 V
Input Voltage, ENA, ISENSE, MULTOUT .... 11 V
Input Voltage, PKLMT .... 5 V
Input Current, RSET, IAC, PKLMT .... 10 mA
Power Dissipation (Plastic DIP) Note 1 .... 1 W
Power Dissipation (Ceramic DIP) Note 2 .... 825 mW
Power Dissipation (PLCC) Note 3 .... 1200 mW
Power Dissipation (MFP) Note 4 .... 410 mW
Operating Temperature Range
(Commercial) .... -20 to +70 °C
(Industrial) .... -40 to +85 °C
(Military) .... -55 to +125 °C
Storage Temperature Range .... -65 to +150 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 18 V, R_{SET} = 15 k to ground, C_T = 1.5 nF to ground, PKLMT = 1 V, ENA = 7.5 V, V(rms) = 1.5 V, IAC = 100 µA, ISENSE = 0 V, CAOUT = 3.5 V, VAOUT = 5 V, VSENSE = 7.5 V, no load on any output. T_A = Operating Temperature Range

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
$I_{CC(OFF)}$	Supply Current, Off	ENA = 0 V		1.5	2.0	mA
$I_{CC(ON)}$	Supply Current, On			10	16	mA
$ULVO_{(ON)}$	V_{CC} Turn-On Threshold		14.5	16	17.5	V
$ULVO_{(OFF)}$	V_{CC} Turn-Off Threshold		9	10	11	V
V_{ENA}	Enable Threshold, Rising		2.4	2.55	2.7	V
$V_{ENE(HYST)}$	Enable Threshold Hysteresis		0.2	0.25	0.3	V
I_{ENA}	Enable Input Current	ENA = 0 V	–5.0	–0.2	5.0	µA
$I_{V(rms)}$	V(rms) Input Current	V(rms) = 5 V	-1.0	-0.01	1.0	mA
Voltage Amplifier						
$V_{OS(AMP)}$	Voltage Amp Offset Voltage	VAOUT = 3.5 V	–8		8	mV
$I_{B(SENSE)}$	VSENSE Bias Current	VSENSE = 0 V	–500	–25	500	nA
A_{OL}	Voltage Amp Gain		70	100		dB
V_{OUT}	Voltage Amp Output Swing			0.5 to 5.8		V
I_{SC}	Voltage Amp Short Circuit Current	VAOUT = 0 V	-30	-12	-5	mA
I_{SS}	SS Off Start Current	SS = 2.5 V	-20	-14	-6	µA
Current Amplifier						
V_{OS}	Current Amp Offset Voltage		–4		4	mV
$I_{B(SENSE)}$	ISENSE Bias Current		–500	–120	500	nA
A_I	Current Amp Gain		80	110		dB
$V_{I(OUT)}$	Current Amp Output Swing			0.5 to 16		V

Note 1: Power dissipation must be derated at the rate of 8 mW/°C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 6.6 mW/°C for operation at T_A = 25 °C and above.
Note 3: Power dissipation must be derated at the rate of 9.6 mW/°C for operation at T_A = 25 °C and above.
Note 4: Power dissipation must be derated at the rate of 3.3 mW/°C for operation at T_A = 25 °C and above.
Note 5: All voltages with respect to GND (Pin 1).
Note 6: All currents are positive into the specified terminal.

ELECTRICAL CHARACTERISTICS (CONT.)

Test conditions: V_{CC} = 18 V, R_{SET} = 15 k to ground, C_T = 1.5 nF to ground, PKLMT = 1 V, ENA = 7.5 V, V(rms) = 1.5 V, IAC = 100 μA, ISENSE = 0 V, CAOUT = 3.5 V, VAOUT = 5 V, VSENSE = 7.5 V, no load on any output. T_A = Operating Temperature Range

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Current Amplifier						
I_{SCC}	Current Amp Short Circuit Current	CAOUT = 0 V	-30	-12	-5	mA
$V_{(ISENSE)}$	Input Range, ISENSE, MULTOUT			-.3 to 2.5		V
GBWP	Current Amp Gain-BW Product	T_A = 25 °C	400	800		kHz
Reference						
N_{RO}	Reference Output Voltage	I_{REF} = 0 mA, T_A = 25 °C	7.4	7.5	7.6	V
		I_{REF} = 0 mA, Over Temp	7.35	7.5	7.65	V
$V_{R(LOAD)}$	V_{REF} Load Regulation	$-10\ mA<I_{REF}<0\ mA$	–15	5	15	mV
$V_{R(LINE)}$	V_{REF} Line Regulation	$15\ V<V_{CC}<35\ V$	–10	2	10	mV
I_{SVR}	V_{REF} Short Circuit Current	REF = 0 V	-50	-28	-12	mA
Current Limit						
V_{POS}	PKLMT Offset Voltage		–10		10	mV
I_P	PKLMT Input Current	PKLMT = –0.1 V	–200	–100		μA
t_{PKLMT}	PKLMT to GTDRV Prop. Delay	PKLMT falling from 50 mV to –50 mV		175		ns
Gate Driver						
V_{GMAX}	Maximum GTDRV Output Voltage	0 mA load on GTDRV, $18\ V<V_{CC}<35\ V$	13	14.5	18	V
V_{GH}	GTDRV Output Voltage High	–200 mA load on GTDRV, V_{CC} = 15 V	12	12.8		V
V_{GL1}	GTDRV Output Voltage Low, OFF	V_{CC} = 0 V, 50 mA load on GTDRV		0.9	1.5	V
V_{GL2}	GTDRV Output Voltage Low	200 mA load on GTDRV		1.0	2.2	V
I_G	Peak GTDRV Current	10 nF from GTDRV to GND		1		A
G_{TR}/G_{TF}	GTDRV Rise/Fall Time	1 nF from GTDRV to GND		35		ns
G_{DC}	GTDRV Maximum Duty Cycle			95		%

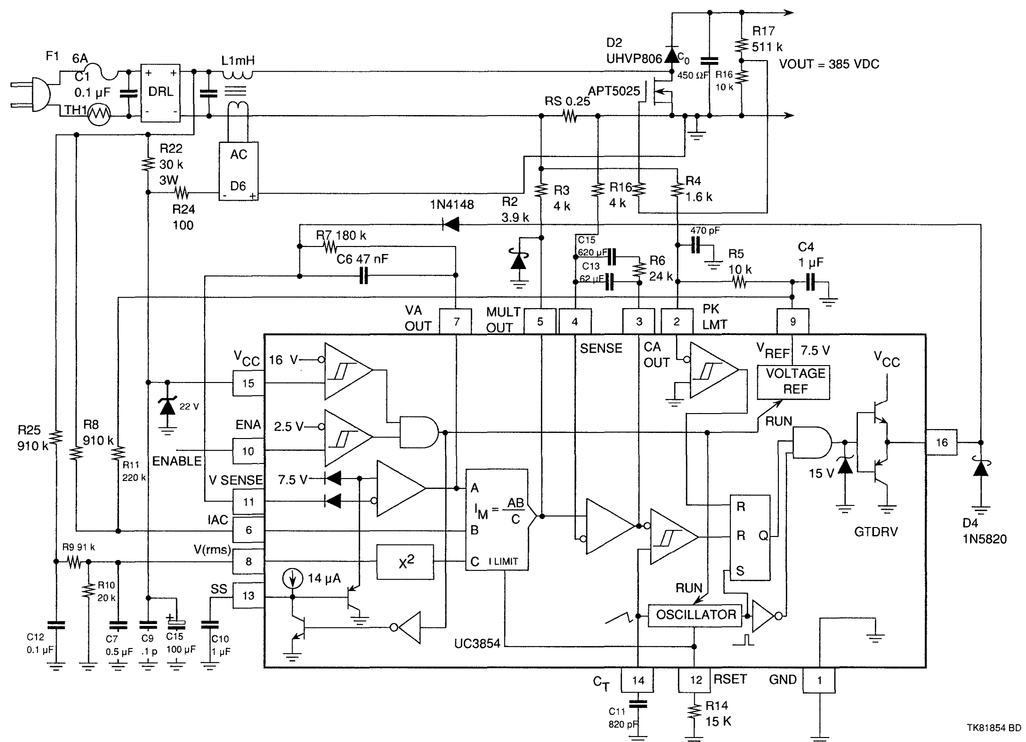
ELECTRICAL CHARACTERISTICS (CONT.)

Test conditions: V_{CC} = 18 V, R_{SET} = 15 k to ground, C_T = 1.5 nF to ground, PKLMT = 1 V, ENA = 7.5 V, V(rms) = 1.5 V, IAC = 100 μA, ISENSE = 0 V, CAOUT = 3.5 V, VAOUT = 5 V, VSENSE = 7.5 V, no load on any output. T_A = Operating Temperature Range

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Multiplier						
I_{CMF}	Multiplier Output Current Full Scale	IAC = 100 μA, R_{SET} = 10 k	–220	–200	–180	μA
I_{OM0}	Multiplier Output Current Zero	IAC = 0 μA, R_{SET} = 15 k	–2.0	–0.2	–2.0	μA
$I_{OM(MAX)}$	Multiplier Maximum Output Current	IAC = 450 μA, R_{SET} = 15 k	–280	–255	–220	μA
I_{OM1}	Multiplier Output Current	IAC = 50 μA, V(rms) = 1.5 V,VA = 4 V	–100	–80	–60	μA
I_{OM2}	Multiplier Output Current	IAC = 100 μA, V(rms) = 1.5 V, VA = 2 V	–65	–47	–30	μA
I_{OM3}	Multiplier Output Current	IAC = 200 μA, V(rms) = 1.5 V, VA = 4 V	–285	–255	–215	μA
I_{OM4}	Multiplier Output Current	IAC = 300 μA, V(rms) = 5 V, VA = 2 V	–27	–21	–15	μA
I_{OM5}	Multiplier Output Current	IAC = 100 μA, V(rms) = 5 V, VA = 4 V	–110	–92	–74	μA
A_M	Multiplier Gain Constant	See Note 6		–1.0		V
Oscillator						
f_{OSC}	Oscillator Frequency		46	55	62	kHz
V_{RP}	C_T Ramp Peak-to-Peak Amplitude		4.8	5.2	5.6	V
V_{RV}	C_T Ramp Valley Voltage		0.8	1.1	1.3	V

Note 6: Multiplier Gain Constant (K) is defined by the following equation: $I\ MULTOUT = \frac{K * IAC * (VAOUT - 1)}{V(rms)^2}$

TYPICAL APPLICATION



PIN DESCRIPTIONS

GND (Pin 1) (Ground): All voltages are measured with respect to GND. VCC and REF should be bypassed directly to GND with a 0.1 µF or larger ceramic capacitor. The timing capacitor discharge current also returns to this pin, so the lead from the oscillator timing capacitor to GND should also be as short and as direct as possible.

PKLMT (Pin 2) (Peak Limit): The threshold for PKLMT in GND. Connect this input to the negative voltage on the current sense resistor as shown in Figure 1. Use a resistor to REF to offset the negative current sense signal up to GND.

CAOUT (Pin 3) (Current Amplifier Output): This is the output of a wide-bandwidth opamp that senses line current and commands the pulse width modulator (PWM) to force the correct current. This output can swing close to GND, allowing the PWM to force zero duty cycle when necessary. The current amplifier will remain active even if the IC is disabled.

ISENSE (Pin 4) (Current Sense Minus): This is the inverting input to the current amplifier. This input and the non-inverting input MULTOUT remain functional down to and below GND. Care should be taken to avoid taking these inputs below –0.5 V, because they are protected with diodes to GND.

PIN DESCRIPTIONS (CONT.)

MULTOUT (Pin 5) (Multiplier Output and Current Sense Plus): The output of the analog multiplier and the non-inverting input of the current amplifier are connected together at MULTOUT. The cautions about taking ISENSE below –0.5 V also apply to MULTOUT. As the multiplier output is a current, this is a high impedance input similar to ISENSE, so the current amplifier can be configured as a differential amplifier to reject GND noise. The test circuit shows an example of using the current amplifier differentially.

IAC (Pin 6) (Input AC Current): This input to the analog multiplier is a current. The multiplier is tailored for very low distortion from this current input (IAC) to MULTOUT), so this is the only multiplier input that should be used for sensing instantaneous line voltage. The nominal voltage on IAC is 6 V, so in addition to a resistor from IAC to rectified 60 Hz, connect a resistor from IAC to REF. If the resistor to REF is one fourth of the value of the resistor to the rectifier, then the 6 V offset will be cancelled, and the line current will have minimal cross-over distortion.

VAOUT (Pin 7) (Voltage Amplifier Output): This is the output of the opamp that regulates output voltage. Like the current amplifier, the voltage amplifier will also stay active even if the IC is disabled with either ENA or V_{CC}. This means that large feedback capacitors across the amplifier will stay charged through momentary disable cycles. Voltage amplifier output levels below 1 V will inhibit multiplier output.

V(rms) (Pin 8) (RMS Line Voltage): The output of a boost PWM is proportional to the input voltage, so when the line voltage into a low-bandwidth boost PWM voltage regulator changes, the output will change immediately and slowly recover to the regulated level. For these devices, the V(rms) input compensates for line voltage changes if it is connected to a voltage proportional to the RMS input line voltage. For best control, the V(rms) voltage should stay between 1 V and 5 V.

REF (Pin 9) (Voltage Reference Output): REF is the output of an accurate 7.5 V voltage reference. This output is capable of delivering 10 mA to peripheral circuitry and is internally short circuit current limited. REF is disabled and will remain at 0 V when V_{CC} is low or when ENA is low. Bypass REF to GND with an 0.1 mF or larger ceramic capacitor for best stability.

ENA (Pin 10) (Enable): ENA is a logic input that will enable the PWM output, voltage reference, and oscillator. ENA also will release the soft start clamp, allowing SS to rise. When unused, connect ENA to a +5 V supply or pull ENA high with a 22 k resistor.

VSENSE (Pin 11) (Voltage Amplifier Inverting Input): This is normally connected to a feedback network and to the boost converter output through a divider network.

RSET (Pin 12) (Oscillator Charging Current and Multiplier Limit Set): A resistor from RSET to ground will program oscillator charging current and maximum multiplier output. Multiplier output current will not exceed 3.75 V divided by the resistor from RSET to ground.

SS (Pin 13) (Soft Start): SS will remain at GND as long as the IC is disabled or V_{CC} is too low. SS will pull up to over 8 V by an internal 14 μA current source when both V_{CC} becomes valid and the IC is enabled. SS will act as the reference input to the voltage amplifier if SS is below REF. With a large capacitor from SS to GND, the reference to the voltage regulating amplifier will rise slowly, and increase the PWM duty cycle slowly. In the event of a disable command or a supply dropout, SS will quickly discharge to ground and disable the PWM.

C_T (Pin 14) (Oscillator Timing Capacitor): A capacitor from C_T to GND will set the PWM oscillator frequency according to this relationship:

$$F = \frac{1.25}{RSET\ C_T}$$

V_{CC} (Pin 15) (Positive Supply Voltage): Connect V_{CC} to a stable source of at least 20 mA above 17 V for normal operation. Also bypass V_{CC} directly to GND to absorb supply current spikes required to charge external MOSFET gate capacitances. To prevent inadequate GTDRV signals, these devices will be inhibited unless V_{CC} exceeds the upper under-voltage lockout threshold and remains above the lower threshold.

GTDRV (Pin 16) (Gate Driver): The output of the PWM is a totem pole MOSFET gate driver on GTDRV. This output is internally clamped to 15 V so that the IC can be operated with V_{CC} as high as 35 V. Use a series gate resistor of at least 5 Ωs to prevent interaction between the gate impedance and the GTDRV output driver that might cause the GTDRV output to overshoot excessively. Some overshoot of the GTDRV output is always expected when driving a capacitive load.

TYPICAL APPLICATIONS

A 250 W PREREGULATOR

The test circuit shows a typical application of the TK83854 as a preregulator with high power factor and efficiency. The assembly consists of two distinct parts, the control circuit centering on the TK83854 and the power section.

The power section is a "boost" converter, with the inductor operating in the continuous mode. In this mode, the duty cycle is dependent on the ratio between input and output voltages, also, the input current has low switching frequency ripple, which means that the line noise is low. Furthermore, the output voltage must be higher than the peak value of the highest expected AC line voltage, and all components must be rated accordingly.

In the control section, the TK83854 provides PWM pulses (GTDRV, Pin 16) to the power MOSFET gate. The duty cycle of this output is simultaneously controlled by four separate inputs to the chip:

INPUT	PIN #	FUNCTION
VSENSE	11	Output DC Voltage
IAC	6	Line Voltage Waveform
ISENSE/MULTOUT	4/5	Line Current
V(rms)	8	RMS Line Voltage

Additional controls of an auxiliary nature are provided. They are intended to protect the switching power MOSFETS from certain transient conditions, as follows:

INPUT	PIN #	FUNCTION
ENA	10	Start-Up Delay
SS	13	Soft Start
PKLMT	2	Maximum Current Limit

PROTECTION INPUTS

ENA (Enable)

The ENA input must reach 2.5 volts before the REF and GTDRV outputs are enabled. This provides a means to shut down the gate in case of trouble, or to add a time delay at power up. A hysteresis gap of 200 mV is provided at this terminal to prevent erratic operation. Undervoltage protection is provided directly at pin 15, where the on/off thresholds are 16 V and 10 V.

SS (Soft Start)

The voltage at pin 13 (SS) can reduce the reference voltage used by the error amplifier to regulate the output DC voltage. With pin 13 open, the reference voltage is typically 7.5 V. An internal current source delivers approximately −14 μA from pin 13. Thus a capacitor connected between that pin and ground will charge linearly from zero to 7.5 V in 0.54C seconds, with C expressed in microfarads.

PKLMT (Peak Current Limit)

Use pin 2 to establish the highest value of current to be controlled by the power MOSFET. With the resistor divider values shown in the test circuit, the 0.0 V threshold at pin 2 is reached when the voltage drop across the 0.25 Ω current sense resistor is 7.5 V ∗ 2 k/10 k = 1.5 V, corresponding to 6A. A bypass capacitor from pin 2 to ground is recommended to filter out very high frequency noise.

3

CONTROL INPUTS

VSENSE (Output DC Voltage Sense)

The threshold voltage for the VSENSE input is 7.5 V and the input bias current is typically 50 nA. The values shown in the test circuit are for an output voltage of 400 VDC. In this circuit, the voltage amplifier operates with a constant low frequency gain for minimum output excursions. The 47 nF feedback capacitor places a 15 Hz pole in the voltage loop that prevents 120 Hz ripple from propagating to the output current.

IAC (Line Waveform)

In order to force the line current waveshape to follow the line voltage, a sample of the power line voltage is introduced at pin 6. This signal is multiplied by the output of the voltage amplifier in the internal multiplier by the output of the voltage amplifier in the internal multiplier to generate a reference signal for the current control loop.

This input is not a voltage, but a current (hence IAC). It is set up by the 150 k and 620 k resistive divider (see test circuit). The voltage at pin 6 is internally held at 6 V, and the two resistors are chosen so that the current flowing into pin 6 varies from zero (at each zero crossing) to about 400 μA at

TYPICAL APPLICATIONS (CONT.)

the peak of the waveshape. The following formulas were used to calculate these resistors:

$$R_{AC} = (Vpk + 6) / 400\ \mu A = 620\ k$$

$$R_{REF} = R_{IAC} / 4 = 150\ k$$

(where Vpk is the peak line voltage)

ISENSE/MULTOUT (Line Current)

The voltage drop across the 0.25 Ω current-sense resistor is applied to pins 4 and 5 as shown. The current-sense amplifier also operates with high low-frequency gain, but unlike the voltage amplifier, it is set up to give the current-control loop a very wide bandwidth. This enables the line current to follow the line voltage as closely as possible. In the present example, this amplifier has a zero at about 500 Hz, and a gain of about 18 dB thereafter.

V(rms) (RMS Line Voltage)

An important feature of the TK83854 preregulator is that it can operate with a three-to-one range of input line voltages, covering everything from low line in the U.S. (85 VAC) to high line in Europe (255 VAC). This is done using line feedforward, which keeps the input power constant with varying input voltage (assuming constant load power). To do this, the multiplier divides the line current by the square of the rms value of the line voltage. The voltage applied to pin 8, proportional to the average of the rectified line voltage (and proportional to the rms value), is squared in the TK83854, and then used as a divisor by the multiplier block. The multiplier output, at pin 5, is a current that increases with the current at pin 6 and the voltage at pin 7, and decreases with the square of the voltage at pin 8.

PWM FREQUENCY

The PWM oscillator frequency in the test circuit is 100 kHz. This value is determined by C_T at pin 14 and RSET at pin 12. RSET should be chosen first because it affects the maximum value of IMULT according to the equation:

$$IMULT_{MAX} = \frac{-3.75}{RSET}$$

This effectively sets a maximum PWM-controlled current. With RSET = 15 k,

$$IMULT_{MAX} = \frac{-3.75\ V}{15\ k} = -250\ \mu A$$

It is also important to note that the multiplier output current will never exceed twice IAC.

With the 4 k resistor from MULTOUT to the 0.25 Ω current sense resistor, the maximum current in the current sense resistor will be

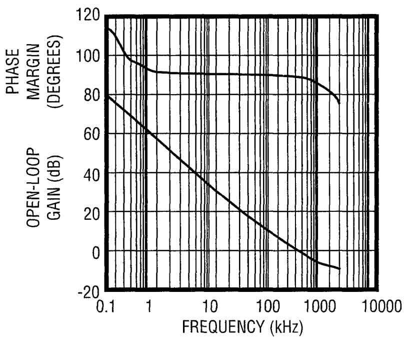
$$I_{MAX} = \frac{-IMULT_{MAX} * 4\ k}{0.25\ \Omega} = 4\ Amp$$

Having thus selected RSET, the current sense resistor, and the resistor from MULTOUT to the current sense resistor, calculate C_T for the desired PWM oscillator frequency from the equation

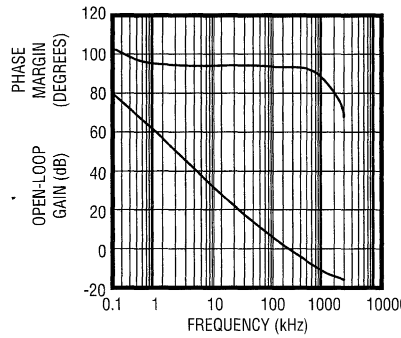
$$C_T = \frac{1.25}{F * RSET}$$

TYPICAL PERFORMANCE CHARACTERISTICS

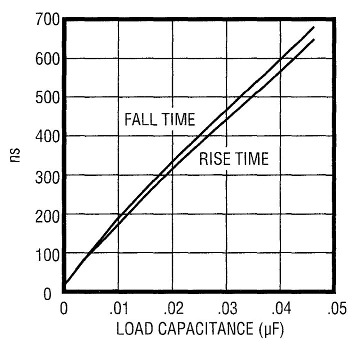
CURRENT AMPLIFIER GAIN AND PHASE vs FREQUENCY



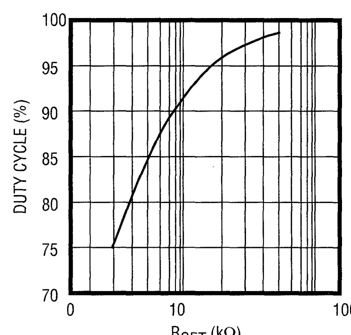
VOLTAGE AMPLIFIER GAIN AND PHASE vs FREQUENCY



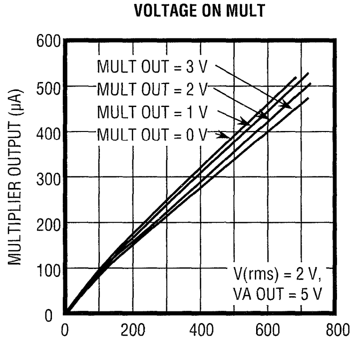
GATE DRIVE RISE AND FALL TIME vs LOAD CAPACITANCE



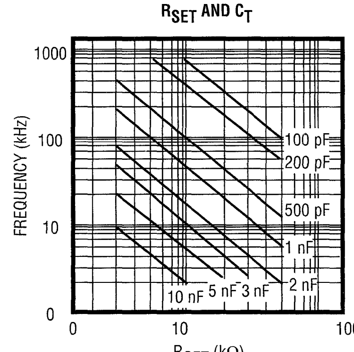
GATE DRIVE MAXIMUM DUTY CYCLE vs OSCILLATOR RESET



MULTIPLIER OUTPUT vs VOLTAGE ON MULT

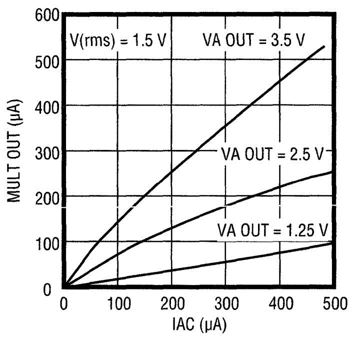


OSCILLATOR FREQUENCY vs R_{SET} AND C_T



TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

Multiplier Output vs Multiplier Inputs with Mult Out = 0 V



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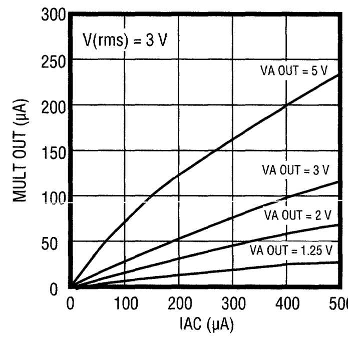

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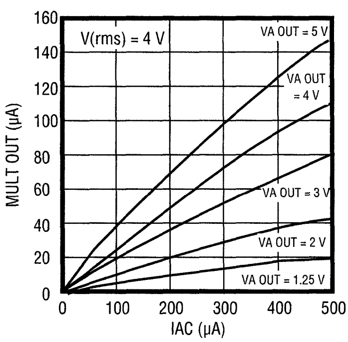

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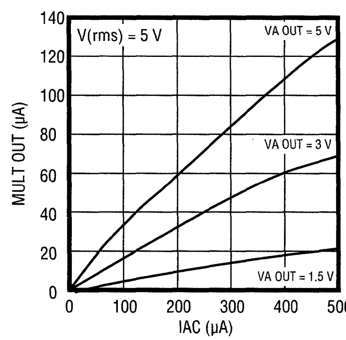


10

POWER FACTOR CONTROLLER

FEATURES

- Boost Mode Power Factor Control
- Peak Current Sensing PFC Control
- Typical Power Factor > .996
- Over Voltage Protection
- Programmable Ramp Compensation
- Electrostatic Discharge Protection
- Pin Compatible with the ML4812

APPLICATIONS

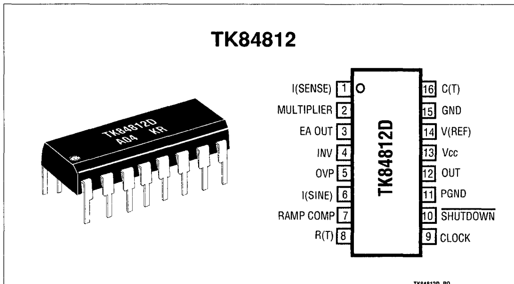
- Switching Power Supplies with PFC
- Computers
- Work Stations
- Telecommunications Equipment
- Office Equipment
- Medical Electronics
- IEC-555 Power Supplies

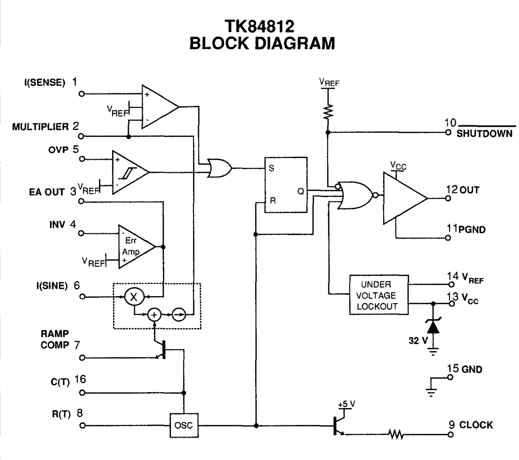
DESCRIPTION

The TK84812 is a boost mode Power Factor Control (PFC) circuit. The low external parts count makes this IC economical to include active power factor control in power supplies of 50 watts and above.

The outputs of the controller provide high current (>1 A peak) and high slew rate for excellent control of MOSFET gates. The TK84812 utilizes peak current sensing control circuitry, with a current sense transformer or a SENSE FET device as a sense element. This method of current sensing improves overall efficiency. Special care has been taken to provide high system noise immunity. The device has under voltage lockout circuitry with 6 V hysteresis, wide common mode range current sense comparator. Ramp compensation is programmable by an external resistor, to provide stability at duty cycles greater than 50%. Over voltage protection eliminates output "runaway" when there is no or small output load.

The TK84812 is temperature compensated and is offered in the commercial, industrial, and military temperature ranges. Both 16 pin plastic and ceramic dip packages are available.





ORDERING INFORMATION

TK84812 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
D : Plastic	C : 0 to +70 °C	BX : Bulk/Bag
J : Ceramic	I : -40 to +85 °C	MG: Magazine
	M : -55 to +125 °C	

ABSOLUTE MAXIMUM RATINGS

Supply Voltage ....36 V
Supply Current ....33 mA
Output Current, Source or Sink (Pin 12) DC ....1.0 A
Output Energy (Capacitive Load Per Cycle).............5 µj
Multiplier I(SINE) Input (Pin 6) ....1.2 mA
Error Amp Sink Current (Pin 3) ....10 mA
Oscillator Charge Current ....2 mA
Analog Inputs ....-0.3 V to 5.5 V

Storage Temperature Range ....-65 to +150 °C
Operating Temperature Range
(Commercial) ....0 to +70 °C
(Industrial) ....-40 to +85 °C
(Military) ....-55 to +125 °C
Lead Soldering Temp. (10 sec.) ....260 °C
Junction Temperature ....150 °C
Thermal Resistance, Plastic Dip ....65 °C/W

ELECTRICAL CHARACTERISTICS

R_T = 14 kΩ, C_T = 1000 pF, T_A= Operating Temperature Range. V_{CC} = 15 V (Note 2)

SYMBOL	PARAMETER	TEST CONDITION	TK84812C			TK84812I			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Oscillator									
$f_{INTL(OSC)}$	Initial Accuracy	T_J = 25 °C	91	98	105	91	98	105	kHz
$\Delta f_{V(OSC)}$	Voltage Stability	12 V< V_{CC} < 18 V		3.0			3.0		%
$\Delta f_{T(OSC)}$	Temperature Stability			6			6		%
$\Delta f_{(OSC)}$	Total Variation	Line, Temp	90		108	88		112	kHz
$V_{RVP (OSC)}$	Ramp Valley to Peak			3.3			3.3		V
$V_{RT(OSC)}$	R(T) Pin Voltage		4.8	5.0	5.2	4.8	5.0	5.2	V
$I_{D(OSC)}$	Discharge Current	T_J = 25 °C, $V_{PIN\ 16}$ = 2 V	7.5	8.4	9.3	7.5	8.4	9.3	mA
	(Pin 8 open)	$V_{PIN\ 16}$ = 2 V	7.2	8.4	9.5	7.2	8.4	9.5	mA
Reference Section									
$V_{(REF)}$	Output Voltage	I_O = 1 mA, T_J = 25 °C	4.95	5.00	5.05	4.95	5.00	5.05	V
$LI_{REG(REF)}$	Line Regulation	12 V < V_{CC} < 25 V		20	35		20	35	mV
$LD_{REG(REF)}$	Load Regulation	1 mA < I_O < 20 mA		6	20		6	20	mV
$\Delta V_{T(REF)}$	Temperature Stability			0.4			0.4		%
$\Delta V_{TOT(REF)}$	Total Variation	Line, Load, Temp	4.9		5.1	4.85		5.15	V
$V_{N(REF)}$	Output Noise Voltage	10 Hz to 10 kHz		50			50		µV
$V_{LT(REF)}$	Long Term Stability	T_J = 125 °C, 1000 hrs. (Note 1)		5	25		5	25	mV
$I_{SC(REF)}$	Short Circuit Current	V_{REF} = 0 V	-30	-85	-180	-30	-85	-180	mA
Error Amp Section									
$V_{OS(EA)}$	Input Offset Voltage		-15		+15	-15		+15	mV
$I_{B(EA)}$	Input Bias Current	$V_{PIN\ 4}$ = V_{REF} + 25 mV		-0.1	-1.0		-0.1	-1.0	µA
$A_{V(OL,EA)}$	Open Loop Gain	1 V < $V_{PIN\ 4}$ < 5 V	60	75		60	75		dB
$PSRR_{(EA)}$	PSRR	12 V < V_{CC} < 25 V	60	75		60	75		dB
$I_{SINK(EA)}$	Output Sink Current	$V_{PIN\ 3}$ = 1.1 V, $V_{PIN\ 4}$ = 6.2 V	2	12		2	12		mA
$I_{SOURCE(EA)}$	Output Source Current	$V_{PIN\ 3}$ = 5.0 V, $V_{PIN\ 4}$ = 4.8 V	-0.5	-1.0		-0.5	-1.0		mA
$V_{OH(EA)}$	Output High Voltage	I_{PIN3} = -0.5 mA, $V_{PIN\ 4}$ = 4.8 V	5.3	5.5		5.3	5.5		V
$V_{OL(EA)}$	Output Low Voltage	$I_{PIN\ 3}$ = 1 mA, $V_{PIN\ 4}$ = 6.2 V		0.5	1.0		0.5	1.1	V
$BW_{(EA)}$	Unity Gain Bandwidth			1.0			1.0		MHz

ELECTRICAL CHARACTERISTICS (CONT.)

R_T = 14 kΩ, C_T = 1000 pF, T_A= Operating Temperature Range. V_{CC} = 15 V (Note 2)

SYMBOL	PARAMETER	TEST CONDITION	TK84812C			TK84812I			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Multiplier									
$V_{ISINE(M)}$	I(SINE) Input Voltage	I(SINE) = 500 µA	0.4	.7	0.9	0.4	0.7	0.9	V
$I_{OUT(M)}$	Output Current (Pin 2)	I(SINE) = 500 µA, Pin 4 = V_{REF} -20 mV	460	480	510	460	480	510	µA
		I(SINE) = 500 µA, Pin 4 = V_{REF} +20 mV		3	10		3	10	µA
		I(SINE) = 1 mA, Pin 4 = V_{REF} -20 mV	900	950	1020	900	950	1020	µA
	$V_{PIN\ 7}$ = 50 µA	I(SINE) = 500 µA, Pin 4 = V_{REF} -20 mV		455			455		µA
BW(M)	Bandwidth			200			200		kHz
$PSRR_{(EA)}$	PSRR	12 V < V_{CC} < 25 V		70			70		dB
OVP Comparator									
$V_{OS(OVP)}$	Input Offset Voltage	Output Off	-15		+15	-15		+15	mV
$V_{H(OVP)}$	Hysteresis		80	105	130	80	105	130	mV
$I_{B(OVP)}$	Input Bias Current			-0.3	-3.0		-0.3	-3.0	µA
$\Delta t_{(OVP)}$	Propagation Delay			150			150		ns
I(SENSE) Comparator									
$V_{CMR(SENSE)}$	Input CMR		-0.2		5.5	-0.2		5.5	V
$V_{OS(SENSE)}$	Input Offset Voltage		-15		+15	-15		+15	mV
$I_{B(SENSE)}$	Input Bias Current			-2	-10		-2	-10	µA
$I_{OS(SENSE)}$	Input Offset Current		-1		+1	+1		-1	µA
$\Delta t_{(SENSE)}$	Propagation Delay			150			150		ns
$I_{LIM(SENSE)}$	I(limit) Trip Point	$V_{PIN\ 2}$ = 5.5 V	4.8	5	5.2	4.8	5	5.2	V
Output Section									
$V_{OL(O)}$	Output Voltage Low	I_{OUT} = -20 mA		0.1	0.4		0.1	0.4	V
		I_{OUT} = -200 mA		1.6	2.2		1.6	2.2	V
$V_{OH(O)}$	Output Voltage High	I_{OUT} = 20 mA	13	13.5		13	13.5		V
		I_{OUT} = 200 mA	12	13.4		12	13.4		V
$V_{ULVO(O)}$	V_{OUT} Low in UVLO	I_{OUT} = -5 mA V_{CC} = 8 V		.1	0.8		.1	0.8	V
$t_{R(O)}$; $t_{F(O)}$	Output Rise/Fall Time	C_L = 1000 pF		50			50		ns

Note 1: This parameter not 100% tested in production but guaranteed by design.
Note 2: V_{CC} is raised above the startup threshold first to activate the IC, then returned to 15 V.

ELECTRICAL CHARACTERISTICS (CONT.)

R_T = 14 KΩ, C_T = 1000 pF, T_A= Operating Temperature Range. V_{CC} = 15 V (Note 2)

SYMBOL	PARAMETER	TEST CONDITION	TK84812C			TK84812I			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Under Voltage Lockout									
$V_{ST(UVLO)}$	Start-Up Threshold		15	16	17	15	16	17	V
$V_{SD(UVLO)}$	Shut-Down Threshold		9	10	11	9	10	11	V
V_{REFG}	V_{REF} Good Threshold			4.4			4.4		V
V_{IH}	Shutdown Input		2.0			2.0			V
V_{IL}	Shutdown Input				0.8			0.8	V
I_{IL}	Shutdown Input	$V_{PIN\ 10}$ = 0 V			1.5			-1.5	mA
I_{IH}	Shutdown Input	$V_{PIN\ 10}$ = 5 V			10			10	µA
C_{VL}	Clock Voltage High	R_L = 16 k	3.0	3.5		3.0	3.5		V
C_{VH}	Clock Voltage Low	R_L = 16 k		0.2	0.5		0.2	0.5	V
Total Device									
I_{TOT}	Supply Current	Start-Up, V_{CC} = 14 V		0.8	1.2		0.8	1.2	mA
		Operating T_J = 25 °C		20	25		20	25	mA
				20	30		20	33	mA
V_Z	Internal Zener Voltage	ICC = 33 mA	25	30	34	25	30	34	V

Note 1: This parameter not 100% tested in production but guaranteed by design.
Note 2: V_{CC} is raised above the startup threshold first to activate the IC, then returned to 15 V.

PIN DESCRIPTION

PIN #	NAME	FUNCTION
1	I(SENSE)	Input from the Current Sense Transformer to the PWM comparator (+). Current Limit occurs when this point reaches 5 V.
2	MULTIPLIER	Output of the current multiplier. A resistor to ground on this pin converts the current to a voltage.
3	EA OUT	Output error amplifier
4	INV	Inverting input to error amplifier.
5	OVP	Input to the over voltage comparator.
6	I(SINE)	Current multiplier input

PIN #	NAME	FUNCTION
7	RAMP COMP	Buffered output from the oscillator ramp (C(T)). A resistor to ground sets a current, which is subtracted from the multiplier output.
8	R(T)	Oscillator timing resistor pin. A 5 V source across this resistor sets the charging current for C(T)
9	CLOCK	Digital Clock Output
10	$\overline{\text{SHUTDOWN}}$	A TTL compatible low level on this pin turns off the output.
11	PGND	Return for the high current output
12	OUT	High current output.

PIN DESCRIPTION (CONT.)

PIN #	NAME	FUNCTION
13	Vcc	Positive Supply of the IC.
14	V_{REF}	Buffered 5 V reference output.
15	GND	Analog signal ground
16	C(T)	Timing capacitor for the oscillator.

FUNCTIONAL DESCRIPTION

OSCILLATOR

The TK84812 oscillator charges the external capacitor (C_T) with a current (I_{SET}) equal to $5/R_{SET}$. When the capacitor voltage reaches the upper threshold, the comparator changes state and the capacitor discharges to the lower threshold through Q1. While the capacitor is discharging, the clock pulse is high.

The Oscillator period can be described by the following relationship: $T_{OSC} = T_{RAMP} + T_{DEADTIME}$

where: $T_{RAMP} \frac{C_V \times V}{I_{SET}}$

and: $T_{DEADTIME} \frac{C_V \times V}{(8.4\ \text{mA} - I_{SET})}$

FUNCTIONAL DESCRIPTION (CONT.)

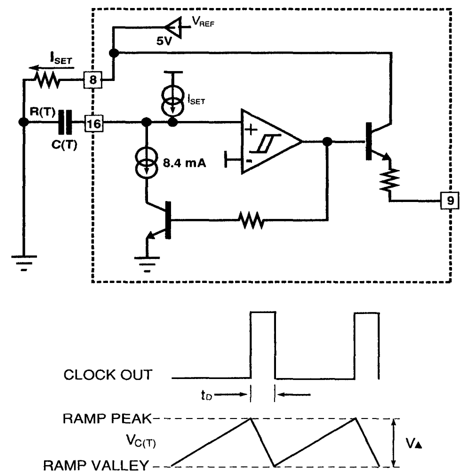


Figure 1. Oscillator Block Diagram

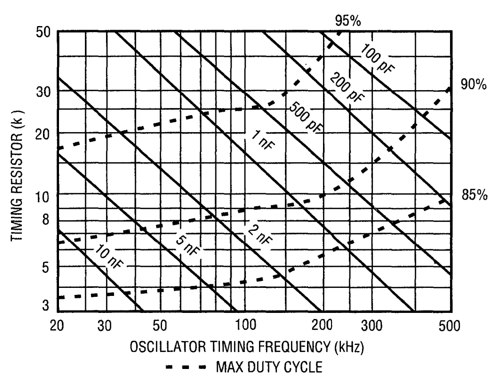


Figure 2. Oscillator Timing Resistance vs. Frequency

FUNCTIONAL DESCRIPTION (CONT.)

OUTPUT DRIVER

The TK84812 output driver is a 1 amp peak output high speed totem pole circuit specially designed to drive capacitive loads, such as MOSFET gates.

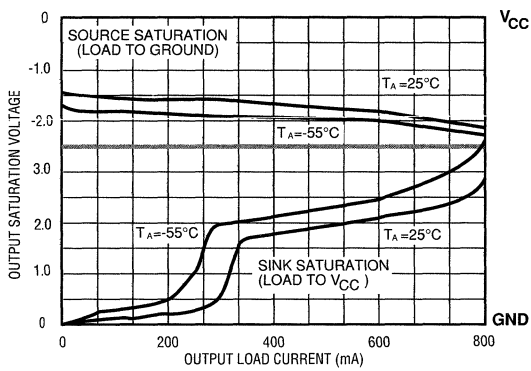


Figure 3. Output Saturation Voltage vs. Output Current

ERROR AMPLIFIER

The TK84812 error amplifier is a high open loop gain, wide bandwidth amplifier.

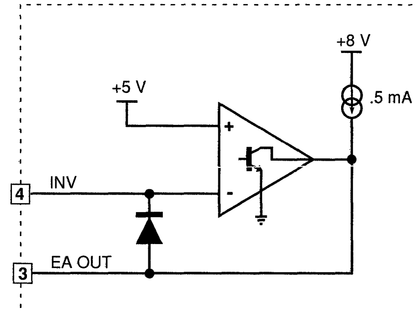


Figure 4. Error Amplifier

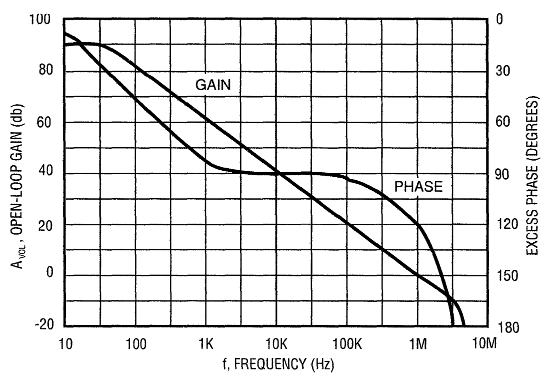


Figure 5. Error Amp Open-Loop Gain and Phase vs. Frequency

FUNCTIONAL DESCRIPTION (CONT.)

MULTIPLIER

The TK84812 multiplier receives the rectified line input sine wave through the multiplier input on pin 6.

The output of the multiplier is a current proportional to:

$$I_{OUT} \propto I(SINE) \times I(EA)$$

Where: I(SINE) is the current into pin 6, and I(EA) is a factor which varies from 0 to 1 proportional to the output of the error amplifier. When the error amplifier is saturated high, the output of the multiplier is approximately equal to the I(SINE) input current.

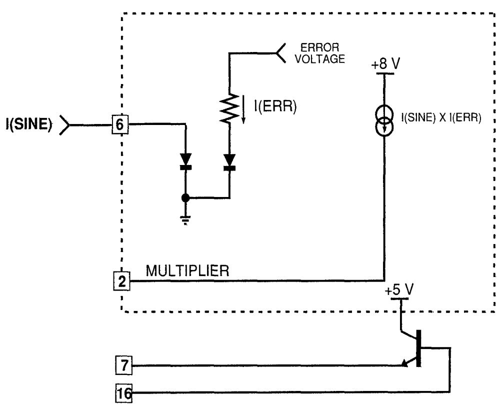


Figure 6. Multiplier Block Diagram

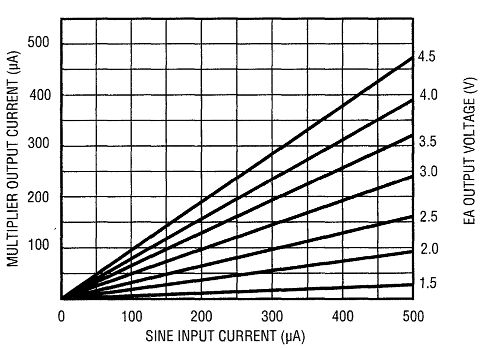


Figure 7. Multiplier Linearity

UNDER VOLTAGE LOCKOUT

On power up the TK84812 remains in the UVLO condition; output low and quiescent current low. The IC becomes operational when V_{CC} reaches 16 V. When V_{CC} drops below 10 V, the UVLO condition is imposed. During the UVLO condition, the 5 V V_{REF} pin is "off", making it usable as a "flag".

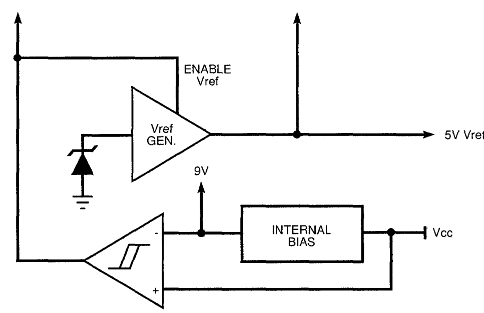


Figure 8. Under Voltage Lockout

TYPICAL APPLICATIONS

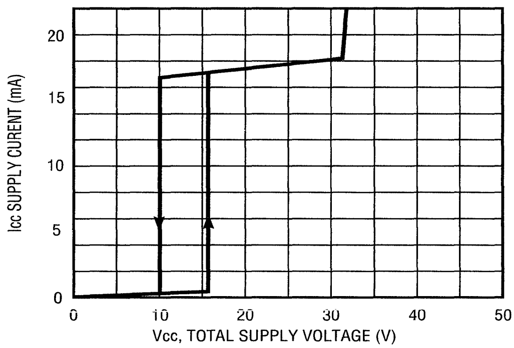


Figure 9. Total Supply Current vs. Supply Voltage

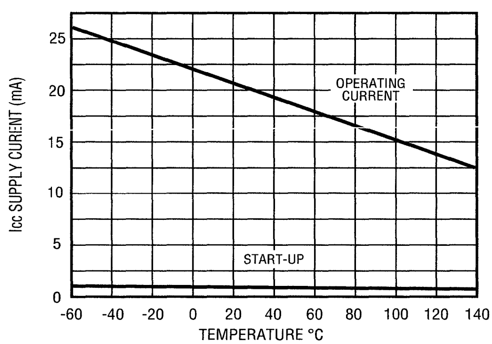


Figure 10. Total Supply Current vs. Temperature

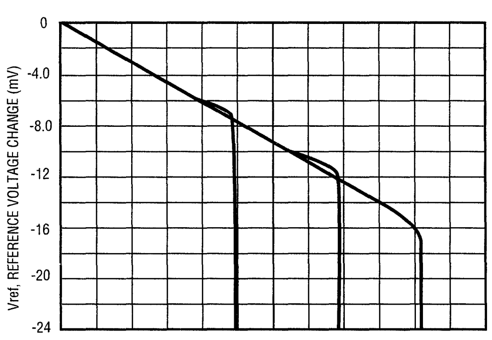


Figure 11. Reference Load Regulation

GENERAL

The power factor controller is a boost mode pre-regulator that provides approximately 380 volts DC for a PWM power supply. It utilizes peak current sensing to give a typical corrected power factor of .996 over all load conditions. The calculations in the following sections refer to the applications circuit.

INPUT INDUCTOR (L1) SELECTION

The central component in the regulator is the input boost inductor. The value of this inductor controls various critical operational aspects of the regulator. If the value is too low, the input current distortion will be high and will result in low power factor and increased noise at the input. This will require more input filtering. In addition, when the value of the inductor is low the inductor dries out (runs out of current) at low currents. Thus the power factor will decrease at lower power levels and/or higher line voltages. If the inductor value is too high, for a given operating current, the required size of the inductor core will be large and/or the required number of turns will be high. So a balance must be reached between distortion and core size. One more condition where the inductor can dry out is analyzed below, where it is shown to be maximum duty cycle dependent.

For the boost converter at steady state:

$$V_{OUT} = \frac{V_{IN}}{1 - D_{ON}}$$

Where D_{ON} is the duty cycle $(T_{ON}/(T_{ON} + T_{OFF})$. The input boost inductor will dry out when the following condition is satisfied:

$$V_{IN}(t) < V_{OUT} \times (1 - D_{ON})$$

$$V_{INDRY} = (1 - D_{ON\,(max)}) \times V_{OUT}$$

V_{INDRY} : Voltage where the inductor dries out

V_{OUT} : Output DC Voltage

The previous relationship shows that the resetting volt-seconds are more than setting volts-seconds. In energy transfer terms, this means that less energy is stored in the inductor during the ON time than it is asked to deliver during the OFF time. The net result is that the inductor dries out.

TYPICAL APPLICATIONS (CONT.)

The recommended maximum duty cycle is 95% at 100 kHz to allow time for the input inductor to dump its energy to the output capacitors.

For example:

if: $V_{OUT} = 380$ V and
$D_{ON\,(max)} = 0.95$

then substituting in (3) yields $V_{INDRY} = 20$ V . The effect of drying out is an increase in distortion at low voltages.

For a given output power, the instantaneous value of the input current is a function of the input sinusoidal voltage waveform, i.e. as the input voltage sweeps from zero volts to a maximum value equal to its peak so does the current.

The load of the power factor regulator is usually a switching power supply which is essentially a constant power load. As a result, an increase in the input voltage will be offset by a decrease in the input current.

By combining the ideas set forth above, some ground rules can be obtained for the selection and design of the input inductor:

Step 1: Find minimum operating current.

$$I_{IN(min)PEAK} = \frac{1.414 X P_{IN(min)}}{V_{IN(max)}}$$

$V_{IN(max)} = 260$ V

$P_{IN(min)} = 50$ W

then: $I_{IN(min)} = 0.272$A

Step 2: Choose a minimum current at which point the inductor current will be on the verge of drying out. For this example 40% of the peak current found in step 1 was chosen.
then:
$I_{LDRY} = 100$ mA

Step 3: The value of the inductance can now be found using previously calculated data.

$$L1 = \frac{V_{INDRY} X D_{ON(max)}}{L_{INDRY} X f_{OSC}}$$

$$= \frac{20 \text{ V X } 0.95}{100 \text{ mA X } 100 \text{ kHz}} = 2 \text{ mH}$$

The inductor can be allowed to decrease in value when the current sweeps from minimum to maximum value. This allows the use of smaller core sizes. The only requirement is that the ramp compensation must be adequate for the lower inductance value of the core so that there is adequate compensation at high current.

3

Step 4: The presence of the ramp compensation will change the dry out point, but the value found above can be considered a good starting point. Based on the amount of power factor correction the above value of L1 can be optimized after a few iterations.

Gapped Ferrites, Molypermalloy, and Powered Iron cores are typical choices for core material. The core material selected should have a high saturation point and acceptable losses at the operating frequency.

One ferrite core that is suitable at around 200 W is the T157-18 made by Micrometals. Two of these toroids are stacked with 140 turns of AWG #20 to provide 2 millihenries at 2 amps DC.

OSCILLATOR COMPONENT SELECTION

The oscillator timing components can be calculated by using the following expression:

$$f_{OSC} = \frac{1.36.}{R_T\ C_T}$$

For example:

Step 1: At 100 KHz with 95% duty cycle $T_{OFF} = 500$ ns calculate C_T using the following formula:

$$C_T = \frac{T_{OFF} X I_{DIS}}{V_{OSC}} = 1000 \text{ pf}$$

TYPICAL APPLICATIONS (CONT.)

Step 2: Calculate the required value of the timing resistor.

$$R_T = \frac{1.36}{f_{OSC} X C_T} = \frac{1.36}{100\ kHz\ X\ 1000\ pF} = 13.6\ k$$

Choose R_T = 14 k

CURRENT SENSE AND SLOPE (RAMP) COMPENSATION COMPONENT SELECTION

Slope compensation in the TK84812 is provided internally. The amount of slope compensation should be at least 50% of the downslope of the inductor current during the off time as reflected on pin 1. Note that slope compensation is a requirement only if the inductor current is continuous and the duty cycle is more than 50%. The highest inductor downslope is found at the point of inductor discontinuity:

$$\frac{d_{IL}}{dt} = \frac{V_b - V_{INDRY}}{L} = \frac{380\ V - 20\ V}{2\ mH}$$

The downslope as reflected to the input of the PWM comparator is given by:

$$S_{PWM} = \frac{V_b - V_{INDRY}}{L1}\ X\ R11/Nc$$

Where NC is the turns ratio of the current transformer (T1) used. In general, current transformers simplify the sensing of switch currents especially at high power levels where the use of sense resistors is complicated by the amount of power they have to dissipate. Normally the primary side of the transformer consists of a single turn and the secondary consists of several turns of either enameled magnet wire or insulated wire. We have used a standard Beckman Industrial HM31-20100 current sense transformer. The rectifying diode at the output of the current transformer can be a 1N4148 for secondary currents up to 75 mA average. Sense FETs or resistive sensing can also be used to sense the switch current, the sensed signal has to be amplified to the proper level before it is applied to the IC.

The value of ramp compensation (SC_{PWM}) as seen at pin 1 is:

$$SC_{PWM} = \frac{2.5\ X\ R9}{R16\ X\ C6\ X\ R18}$$

The required value for R18 can be found by:

$$SC_{PWM} = A_{SC}\ X\ S_{PWM}$$

where A_{SC} is the amount of slope compensation and solving for Rsc.

The value of R_M (pin 2) depends on the selection of Rp (pin 6)

$$R_M = \frac{V_{IN(max)\ PEAK}}{I_{sine(PEAK)}} = \frac{260\ X\ 1.414}{0.72\ mA} = 510\ k$$

$$R_P > \frac{V_{CLAMP}\ X\ R2}{V_{IN(min)}} = \frac{4.8\ X\ 510\ k}{80\ X\ 1.414} \approx 22\ k$$

Choose R_M = 27 k

The peak inductor current can be found approximately by:

$$Ilpeak = \frac{1.414\ X\ P_{OUT}}{V_{IN(min)RMS}} = \frac{1.414\ X\ 200}{90} = 3.14\ A$$

The selection of Nc which depends on the maximum switch current, assume 4A for this example is 80 turns,

$$R_{S1} = \frac{V_{CLAMP}\ X\ Nc}{I_{PEAK}} = \frac{4.8\ X\ 80}{4} \approx 100\ \Omega$$

Where R_S is the sense resistor, and Vclamp is the current clamp at the inverting input of the PWM comparator. The clamp is internally set to 5 V. In actual application it is a good idea to assume a value less than 5 V to avoid unwanted current limiting action due to component tolerances. In the application Vclamp was chosen as 4.8 V.

Having calculated Rs the value S_{PWM} and of Rsc can now be calculated:

$$S_{PWM} = \frac{380\ V - 20}{2\ mH}\ X\ \frac{100}{80} = 0.225\ V/\mu s$$

$$R_{SC} = \frac{2.5\ X\ R_M}{A_{SC}\ X\ S_{PWM}\ X\ R_T\ X\ C_T}$$

TYPICAL APPLICATIONS (CONT.)

$$R_{SC} = \frac{2.5 \text{ X } 27\text{ k}}{0.7 \text{ X } (.225 \text{ X } 10^6) \text{ X } 14 \text{ k X } 1 \text{ nf}} \approx 30 \text{ k}$$

Choose R_{SC} = 33 k

The following values were used for calculation:

R_M = 27 k
Asc = 0.7
Rt = 14 k
Ct = 1 nF

Voltage Regulation Components

The value of the voltage regulation loop components are calculated based on the operating output voltage. Note that safety regulations require the use of sense resistors that have adequate voltage rating. The input bias current of the error amplifier is approximately 0.5 µA, therefore the current available from the voltage sense resistors should be significantly higher than this value. the total power rating is 1/2 W. The operating power is set to be 0.4 W, then with 380 V output voltage, the value can be calculated as follows:

R9 = $(380\text{ V})^2/0.4$ W = 361 k

Therefore choose a 357 k 1/2 W 1% resistor.Then R10 can be calculated as below:

$$R10 = \frac{V_{REF} \text{ X } R5}{V_B - V_{REF}} = \frac{5 \text{ V X } 357 \text{ k}}{380 \text{ V} - 5 \text{ V}} = 4.747 \text{ k}$$

Choose 4.53 k in series with a 500 ohm adjustment pot.

One more critical component in the voltage regulation loop is the feedback capacitor for the error amplifier. The voltage loop bandwidth should be set such that it rejects the 120 Hz ripple which is present at the output. If this ripple is not adequately attenuated, it will cause distortion of the input current waveform. Typical bandwidths range anywhere from a few Hz to 15 Hz. The main compromise is between transient response and distortion. The feedback capacitor can be calculated using the following formula:

$$C8 = \frac{1}{3.142 \text{ X } R5 \text{ X } BW} =$$

$$C8 = \frac{1}{3.162 \text{ X } 357 \text{ k X } 2 \text{ Hz}} = 0.44 \text{ µF}$$

OVERVOLTAGE PROTECTION (OVP)

The OVP loop should be set so that there is no interaction with the voltage control loop. Typically it should be set to a level where the power components are safe to operate. Ten to fifteen volts above Vout seems to be adequate. This sets the maximum transient output voltage to about 395 V.

By choosing the high voltage side resistor of the OVP circuit the same way as above, (R7 = 356 k) then R8 can be calculated as:

$$R8 = \frac{V_{REF} \text{ X } R7}{V_{OVP} - V_{REF}} = \frac{5 \text{ V X } 357 \text{ k}}{395 \text{ V} - 5 \text{ V}} = 4.576 \text{ k}$$

Choose 4.53 k 1%

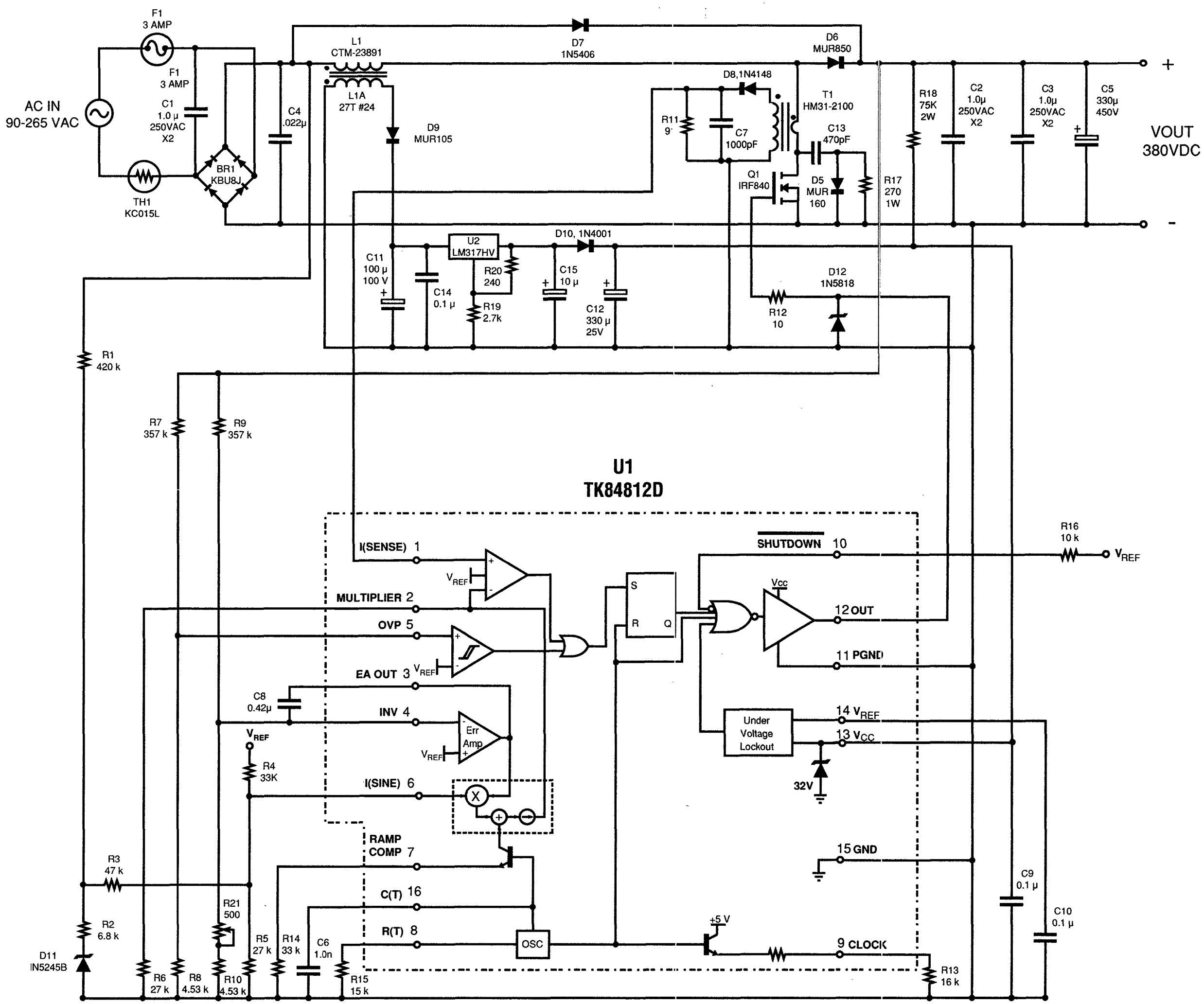
Note that R7, R8, R9, and R10 should be 1% or better tolerance.

Controller Shutdown

The TK84812 provides a shutdown pin which can be used to disable the IC. Caution should be taken because when this pin is used power supply sequencing problems could arise if the 380 V bus supplies power to a regulator that has a bootstapped housekeeping circuit. A circuit could be devised using V_{REF} as a flag to inhibit the PWM section of the supply as an example.

Power Factor Enhancement Circuit

Predistortion is added to rectified AC input waveform before it is applied to the $I_{(SINE)}$ input (pin 6) by a soft clamping technique. Tests have shown that the power factor can be improved by the inclusion of this circuit as implemented in the application schematic.



TK84812 APPLICATIONS CIRCUIT

TK84812 APPLICATIONS BOARD PARTS LIST

ITEM	PART NUMBER	MANUFACTURER	DISTRIBUTOR
U1	TK84812	TOKO	
U2	LM317HVH	National	(Digi-Key)
Q1	IRF840	Internat. Rect.	(Digi-Key)
BR1	KBU8J Bridge Rectifier	Gen. Inst.	(Newark)
D5	MUR160	Motorola	(Newark)
D6	MUR850	Motorola	(Newark)
D7	1N5406	Gen. Inst.	(Digi-Key)
D8	1N4148	Diodes Inc.	(Digi-Key)
D9	MUR105	Motorola	(Newark)
D10	1N4001	Diodes Inc.	(Digi-Key)
D11	1N5254B	Diodes Inc.	(Digi-Key)
D12	1N5818	Diodes Inc.	(Digi-Key)
C1	1 µF 250VAC X P4616		(Digi-Key)
C2	1 µF 250VAC X P4616		(Digi-Key)
C3	1 µF 250VAC X P4616		(Digi-Key)
C4	2200 pF 1 kV P4113		(Digi-Key)
C5	330 µF 450 V P6443		(Digi-Key)
C6	1000 pF 50 V ± 5% NPO 87F4866		(Newark)
C7	1000 pF 50 V P4812		(Digi-Key)
C8	0.47 µF 50 V 87F4755		(Newark)
C9	0.1 µF 50 V P4887		(Digi-Key)
C10	0.1 µF 50 V P4887		(Digi-Key)
C11	100 µF 100 V P530		(Digi-Key)
C12	330 µF 450 V P5278		(Digi-Key)
C13	470 pF 1 kV P4124		(Digi-Key)
C14	1 µF 100 V P4910		(Digi-Key)
C15	10 µF 100 V P5297		(Digi-Key)
R1	420 k 1/4 W 5%		(Digi-Key)

3

TK84812 APPLICATIONS BOARD PARTS LIST (CONT.)

ITEM	PART NUMBER	MANUFACTURER	DISTRIBUTOR
R2	6.8 k 1/8 W 5%		(Digi-Key)
R3	47 k 1/8 W 5%		(Digi-Key)
R4	33 k 1/8 W 5%		(Digi-Key)
R5	27 k 1/8 W 5%		(Digi-Key)
R6	27 k 1/8 W 5%		(Digi-Key)
R7	357 k 1/4 W 1%		(Digi-Key)
R8	4.53 k 1/4 W 1%		(Digi-Key)
R9	357 k 1/4 W 1%		(Digi-Key)
R10	4.53 k 1/4 W 1%		(Digi-Key)
R11	91 1/8 W 5%		(Digi-Key)
R12	10 1/4 W 5%		(Digi-Key)
R13	16 k 1/8 W 5%		(Digi-Key)
R14	33 k 1/8 W 5%		(Digi-Key)
R15	15 k 1/8 W 5%		(Digi-Key)
R16	10 k 1/8 W 5%		(Digi-Key)
R17	270 1 W 5%		(Digi-Key)
R18	75 k 2 W 5%		(Digi-Key)
R19	2.7 k 1/4 W 5%		(Digi-Key)
R20	240 1/4 W 5%		(Digi-Key)
TH1	KC015L (Thermistor)	Keystone Carbon	(Digi-Key)
F1	3A 250 V		(Digi-Key)
L1	CTM28992	CTM Magnetics (602) 967-9447	
T1	HM3210100	Beckman Industrial (714) 447-2345	

TOKO

TK84819

POWER FACTOR CONTROLLER
PWM COMBO

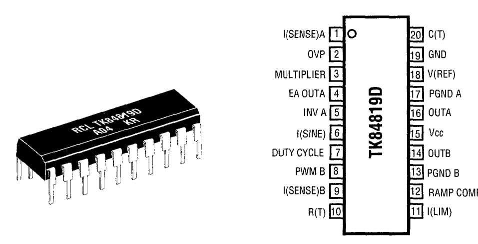
FEATURES

- Reduced Overall Current Consumption
- Reduced Start-Up Current
- Slow Start Following Current Limit Shutdown
- Boost Mode Power Factor Control
- Current or Voltage Mode PWM
- Peak Current Sensing PFC Control
- Typical Power Factor > .996
- Current Limit and Over Voltage Protection
- Programmable Ramp Compensation
- Electrostatic Discharge Protection
- Pin Compatible with the ML4819

APPLICATIONS

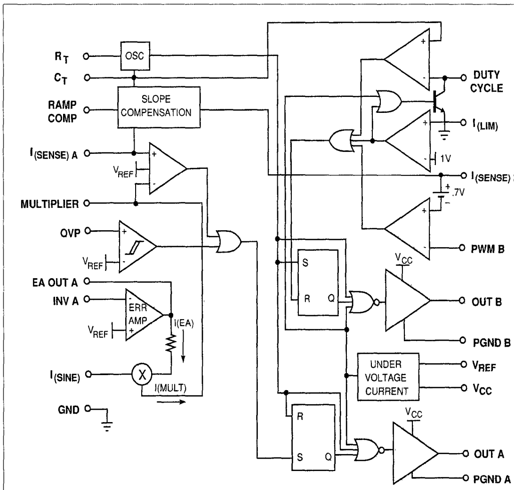
- Switching Power Supplies with PFC
- Computers
- Work Stations
- Telecommunications Equipment
- Office Equipment
- Medical Electronics
- IEC-555 Power Supplies

TK84819



DESCRIPTION

The TK84819 is a complete boost mode Power Factor Control (PFC) circuit which also includes a PWM controller. The PFC circuit and PWM controller share the same oscillator and are synchronized. The outputs of the controller provide high current (>1 A peak) and high slew rate for excellent control of MOSFET gates. The PFC section utilizes peak current sensing control circuitry, with a current sense transformer or a SENSE FET device as a sense element. This non-dissapative method of current sensing improves overall efficiency. The PWM section includes cycle by cycle current limiting, precise duty cycle limiting for single ended converters, and slope compensation. Special care has been taken to provide high system noise immunity. The device has under voltage lockout circuitry with 6 V hysteresis, wide common mode range current sense comparators and precision duty cycle limiting circuit for the PWM section.



ORDERING INFORMATION

TK84819 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
D : Plastic	C : 0 to +70 °C	BX : Bulk/Bag
J : Ceramic	I : -40 to +85 °C	MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Supply Voltage ....35 V
Output Current, Source or Sink (Pin 14,16) DC ....1.0 A
Output Energy (Capacitive Load Per Cycle) ....5 µj
Multiplier I(SINE) Input Pin 6 ....1.2 mA
Analog Inputs ....-0.3 V to 5.5 V
Storage Temperature Range ....-65 to +150 °C

Operating Temperature Range
(Commercial) ....0 to +70 °C
(Industrial) ....-40 to +85 °C
Lead Soldering Temp. (10 sec.) ....260 °C
Junction Temperature ....150 °C
Thermal Resistance, Plastic Dip...........................65 °C/W

ELECTRICAL CHARACTERISTICS

Test Conditions: V_{CC} = 15 V (Note 2), R_T = 14 kΩ, C_T = 1000 pF, T_A= Operating Temperature Range.
Note 1: This parameter not 100% tested in production but guaranteed by design.
Note 2: V_{CC} is raised above the startup threshold first to activate the IC, then returned to 15 V.

SYMBOL	PARAMETER	TEST CONDITION	TK84819C MIN	TK84819C TYP	TK84819C MAX	TK84819I MIN	TK84819I TYP	TK84819I MAX	UNITS
Oscillator									
$f_{INTL(OSC)}$	Initial Accuracy	T_J = 25 °C	90	97	104	90	97	104	kHz
$\Delta f_{V(OSC)}$	Voltage Stability	12 V< V_{CC} < 25 V		3.0			3.0		%
$\Delta f_{T(OSC)}$	Temperature Stability			6			6		%
$\Delta f_{(OSC)}$	Total Variation	Temp	88		106	84		110	kHz
$V_{RV\ (OSC)}$	Ramp Valley			.9			.9		V
$V_{RP(OSC)}$	Ramp Peak			4.3			4.3		V
$V_{RT(OSC)}$	R(T) Pin Voltage		4.8	5.0	5.2	4.8	5.0	5.3	V
$I_{D(OSC)}$	Discharge Current	T_J = 25 °C, $V_{PIN\ 20}$ = 2 V	7.5	8.4	9.3	7.5	8.4	9.3	mA
	(Pin 10 open)	$V_{PIN\ 20}$ = 2 V	7.2	8.4	9.5	7.0	8.4	10.0	mA
Duty Cycle Comp.									
$V_{OS(DCC)}$	Input Offset Voltage		-15		+15				mV
$I_{B(DCC)}$	Input Bias Current			-0.7	-10		-0.7	-10	µA
$\partial_{(DCC)}$	Duty Cycle	$V_{PIN\ 7} = V_{REF}/2$	42	45	49	40	45	49.7	%
Reference Section									
$V_{(REF)}$	Output Voltage	I_O = 1 mA, T_J = 25 °C	4.95	5.00	5.05	4.95	5.00	5.05	V
$LI_{REG(REF)}$	Line Regulation	12 V < V_{CC} < 25 V		2	35		2	65	mV
$LD_{REG(REF)}$	Load Regulation	1 mA < I_O < 20 mA		8	25		8	30	mV
$\Delta V_{T(REF)}$	Temperature Stability			0.4			0.4		%
$\Delta V_{TOT(REF)}$	Total Variation	Line, Load, Temp	4.9		5.1	4.75		5.25	V
$V_{N(REF)}$	Output Noise Voltage	10 Hz to 10 kHz		50			50		µV
$V_{LT(REF)}$	Long Term Stability	T_J = 125 °C, 1000 hrs. (Note 1)		5	25		5		mV
$I_{SC(REF)}$	Short Circuit Current	V_{REF} = 0 V	-30	-85	-180	-25	-85	-185	mA
Error Amp Section									
$V_{OS(EA)}$	Input Offset Voltage		-15		+15	-15		+15	mV
$I_{B(EA)}$	Input Bias Current	$V_{PIN\ 4} = V_{REF}$ = 25 mV		-0.1	-1.0		-0.1	-1.0	µA
$A_{V(OL,EA)}$	Open Loop Gain	1 V < $V_{PIN\ 4}$ < 5 V	60	90		55	90		dB
$PSRR_{(EA)}$	PSRR	12 V < V_{CC} < 25 V	60	75		60	75		dB

ELECTRICAL CHARACTERISTICS (CONT.)

Test Conditions: V_{CC} = 15 V (Note 2), R_T = 14 kΩ, C_T = 1000 pF, T_A= Operating Temperature Range.

SYMBOL	PARAMETER	TEST CONDITION	TK84819C			TK84819I			
			MIN	TYP	MAX	MIN	TYP	MAX	UNITS
Error Amp Section (Cont.)									
$I_{SINK(EA)}$	Output Sink Current	$V_{PIN\ 4}$ = 1.1 V, $V_{PIN\ 5}$= 5.2 V	2	12		1.5	12		mA
$I_{SOURCE(EA)}$	Output Source Current	$V_{PIN\ 4}$ = 5.0 V, $V_{PIN\ 5}$ = 4.8 V	-0.5	-1.0		-0.35	-1.0		mA
$V_{OH(EA)}$	Output High Voltage	I_{PIN4} = -0.5 mA, $V_{PIN\ 5}$ = 4.8 V	6.5	7.0		6.3	7.0		V
$V_{OL(EA)}$	Output Low Voltage	$I_{PIN\ 4}$ = 1 mA, V_{PIN5} = 5.2 V		0.7	1.0		0.7	1.2	V
$BW_{(EA)}$	Unity Gain Bandwidth			1.0			1.0		MHz
Multiplier									
$V_{ISINE(M)}$	I(SINE) Input Voltage	I(SINE) = 500 µA	0.4	.7	0.9	0.35	0.7	1.1	V
$I_{OUT(M)}$	Output Current (Pin 3)	I(SINE) = 500 µA, Pin 5 = V_{REF} -20 mV	460	495	505	450	495	520	µA
		I(SINE) = 500 µA, Pin 5 = V_{REF} +20 mV		0	10		0	40	µA
		I(SINE) = 1 mA, Pin 5 = V_{REF} -20 mV	900	990	1005	920	990	1035	µA
BW(M)	Bandwidth			200			200		kHz
$PSRR_{(EA)}$	PSRR	12 V < V_{CC} < 25 V		70			70		dB
Slope Compensator									
$V_{R(SC)}$	RAMP COMP VPin 12			V_{PIN20}-1			V_{PIN20}-1		V
$I_{R(SC)}$	Iout Pin 1 or Pin 9	IPIN 12 = 100 µA (Note 3)	45	48	51	40	48	55	µA
OVP Comparator									
$V_{OS(OVP)}$	Input Offset Voltage	Output Off	-15		+15	-15		+15	mV
$V_{H(OVP)}$	Hysteresis		100	120	140	85	120	150	mV
$I_{B(OVP)}$	Input Bias Current			-0.3	-3.0		-0.3	-3.0	µA
$\Delta t_{(OVP)}$	Propagation Delay			150			150		ns
I(SENSE) Comparator									
$V_{CMR(SENSE)}$	Input CMR	$V_{PIN\ 5}$ = V_{REF} - 20 mV	-0.2		5.5	-0.2		5.5	V
$V_{OS(SENSE)}$	Input Offset Voltage	I(SENSE) A	-15		+15	-15		+15	mV
		I(SENSE) B	0.4	0.7	0.9	0.38	0.7	0.92	V
$I_{B(SENSE)}$	Input Bias Current			-0.7	-10		-0.7	-10	µA
$I_{OS(SENSE)}$	Input Offset Current		-1		+1				µA
$\Delta t_{(SENSE)}$	Propagation Delay			150			150		ns
$I_{LIM(SENSE)}$	I(limit A) Trip Point	$V_{PIN\ 3}$ = 5.5 V	4.8	5	5.2	4.75	5	5.25	V
I(LIM) Comparator									
$V_{TRIP(LIM)}$	I(limit) Trip Point		.95	1	1.05	.9	1	1.1	V
$I_{B(LIM)}$	Input Bias Current			-0.7	-10		-0.7	-10	µA
$\Delta t_{(LIM)}$	Propagation Delay			150			150		ns

ELECTRICAL CHARACTERISTICS (CONT.)

R_T = 14 kΩ, C_T = 1000 pF, T_A= Operating Temperature Range. V_{CC} = 15 V (Note 2)

SYMBOL	PARAMETER	TEST CONDITION	TK84812C			TK84812I			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Output Section A, B									
$V_{OL(O)}$	Output Voltage Low	I_{OUT} = -20 mA		0.1	0.4		0.1	0.5	V
		I_{OUT} = -200 mA		1.6	2.2		1.6	2.3	V
$V_{OH(O)}$	Output Voltage High	I_{OUT} = 20 mA	13	13.5		12.5	13.5		V
		I_{OUT} = 200 mA	12	13.4		11.5	13.4		V
$V_{ULVO(O)}$	V_{OUT} Low in UVLO	I_{OUT} = -5 mA, V_{CC} = 8 V		0.65	0.8		0.65	1.0	V
$t_{R(O)}$; $t_{F(O)}$	Output Rise/Fall Time	C_L = 1000 pF		50			50		ns
Under Voltage Lockout									
$V_{ST(UVLO)}$	Start-Up Threshold		15	16	17	14.5	16	17.5	V
$V_{SD(UVLO)}$	Shut-Down Threshold		9	10	11	8.5	10	11.5	V
V_{REFG}	V_{REF} Good Threshold			4.4			4.4		V
Total Device									
I_{TOT}	Supply Current	Start-Up, V_{CC} = 14 V		0.27	0.5		0.27	0.6	mA
		Operating T_J = 25 °C		25	35		25	35	mA
		Op Temp		25	38		25	48	mA

Note 1: This parameter not 100% tested in production but guaranteed by design.
Note 2: V_{CC} is raised above the startup threshold first to activate the IC, then returned to 15V.
Note 3: PWM comparator bias currents are subtracted from this reading.

PIN DESCRIPTION

PIN #	NAME	FUNCTION
1	I(SENSE)A	Input from the Current Sense Transformer to the PWM comparator (+). Current Limit occurs when this point reaches 5 V.
2	OVP	Input to the over voltage comparator.
3	MULTIPLIER	Output of the current multiplier. A resistor to ground on this pin converts the current to a voltage.
4	EA OUT A	Output error amplifier
5	INV A	Inverting input to error amplifier.
6	I(SINE)	Current multiplier input

PIN #	NAME	FUNCTION
7	DUTY CYCLE SOFT START	PWM controller duty cycle is limited by setting this pin to a fixed voltage. A capacitor to ground sets the soft start time constant.
8	PWM B	Error voltage feedback input.
9	I(SENSE) B	Input for current sense resistor for current mode operation or for oscillator ramp for voltage mode operation.
10	R(T)	Oscillator timing resistor pin. A 5 V source across this resistor sets the charging current for C(T)
11	I(LIM)	Cycle by cycle PWM current limit. Exeeding the 1 V threshold on this pin terminates the PWM cycle.

PIN DESCRIPTION (CONT.)

PIN #	NAME	FUNCTION
12	RAMP COMP	Buffered output from the Oscillator ramp (C(T)). A resistor to ground sets a current 1/2 of which is sourced on pins 9 and 1.
13	GND B	Return for the high current totem pole output of the PWM controller.
14	OUT B	PWM Controller totem pole output.
15	V_{CC}	Positive supply for the IC.
16	OUT A	PFC controller totem pole output.
17	GND A	Return for the high current totem pole output of the PFC controller.
18	V_{REF}	Buffered output for the 5V voltage reference.
19	GND	Analog Signal Ground.
20	C(T)	Timing capacitor for the oscillator.

3

FUNCTIONAL DESCRIPTION

OSCILLATOR

The TK84819 oscillator charges the external capacitor (C_T) with a current (I_{SET}) equal to $5/R_{SET}$. When the capacitor voltage reaches the upper threshold, the comparator changes state and the capacitor discharges to the lower threshold through Q1. While the capacitor is discharging, the clock pulse is high.

The Oscillator period can be described by the following relationship: $T_{OSC} = T_{RAMP} + T_{DEADTIME}$

where: $$T_{RAMP} = \frac{C_V \times V_\Delta}{I_{SET}}$$

and: $$T_{DEADTIME} = \frac{C_V \times V_\Delta}{(8.4\,mA - I_{SET})}$$

The maximum duty cycle of the PWM section can be limited by setting a threshold on pin 7. When the (C_T) ramp is above the threshold at pin 7, the PWM output is held off and the PWM flip-flop is set:

$$D_{LIMIT} = \frac{D_{OSC}\ X\ (Y_{PIN7} - 0.9)}{3.4}$$

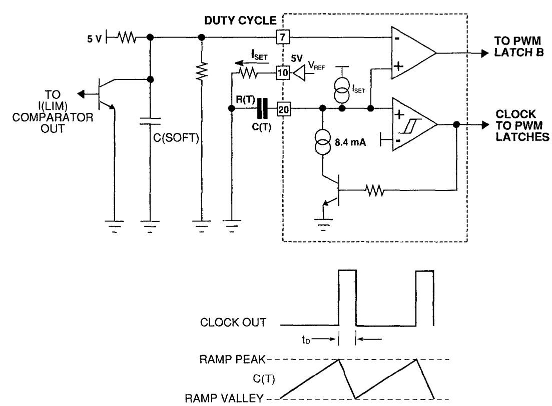


Figure 1. Oscillator Block Diagram

FUNCTIONAL DESCRIPTION (CONT.)

Where:

D_{LIMIT} = Desired duty cycle

D_{OSC} = Oscillator duty cycle

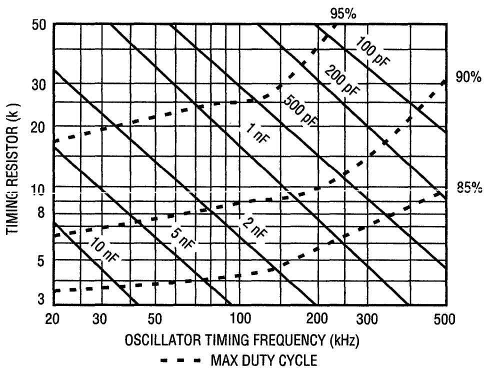


Figure 2. Oscillator Timing Resistance vs. Frequency

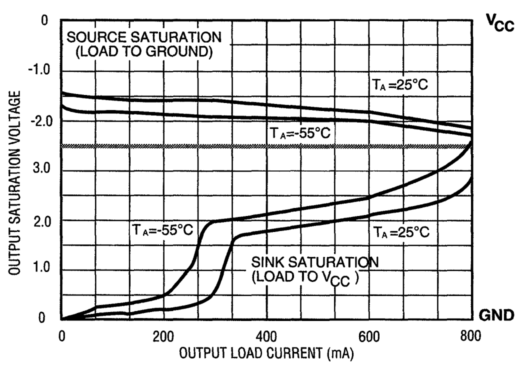


Figure 3. Output Saturation Voltage vs. Output Current

A capacitor from pin 7 to ground can be used for soft start when the current limit threshold (pin 11) is exceeded.

ERROR AMPLIFIER

The TK84819 error amplifier is a high open loop gain, wide bandwidth amplifier.

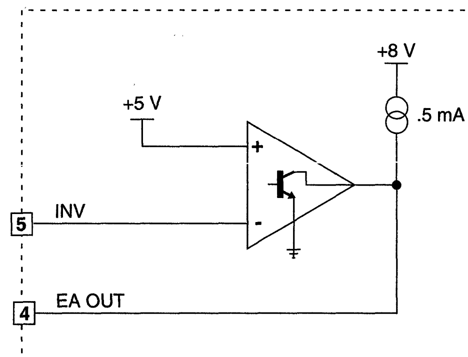


Figure 4. Error Amplifier

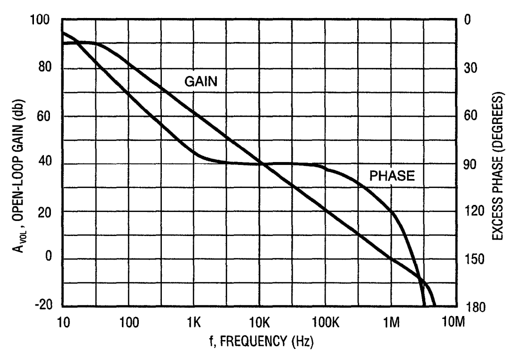


Figure 5. Error Amp Open-Loop Gain and Phase vs. Frequency

MULTIPLIER

The TK84819 multiplier is a linear current input multiplier to provide high immunity to the disturbances caused by high power switching. The rectified line input sine wave is converted to a current via a dropping resistor. In this way, small amounts of ground noise produce an insignificant effect on the reference to the PWM comparator.

FUNCTIONAL DESCRIPTION (CONT.)

The output of the multiplier is a current proportional to :

$$I_{OUT} \propto I\,(SINE) \times I\,(EA)$$

Where: I(SINE) is the current in the dropping resistor, and I(EA) is a factor which varies from 0 to 1 proportional to the output of the error amplifier. When the error amplifier is saturated high, the output of the multiplier is approximately equal to the I(SINE) input current.

The multiplier output current is converted into the reference voltage for the PWM comparator through a resistor to ground on the multiplier output (pin 3).

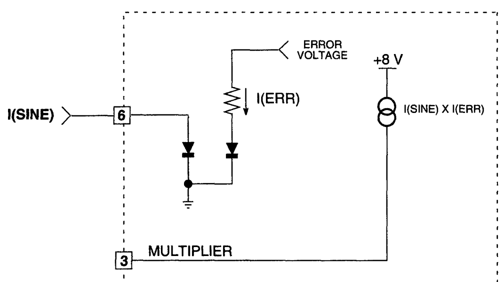


Figure 6. Multiplier Block Diagram

SLOPE COMPENSATION

Slope compensation is accomplished by adding 1/2 of the current flowing out of pin 12 to pin 1 (for the PFC section). The amount of slope compensation is equal to:

$$(I_{PIN12}/2) \times R_L$$

Where: R_L is the impedance to ground on pin 1 or pin 9. Since most of the PWM applications will be limited to 50% duty cycle, slope compensation should not be needed for the PWM section. This can be defeated by using a low impedance load to the current sense on pin 9.

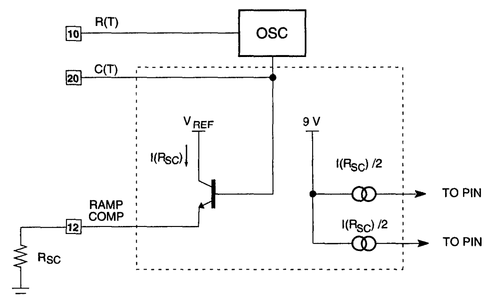


Figure 7. Slope Compensation

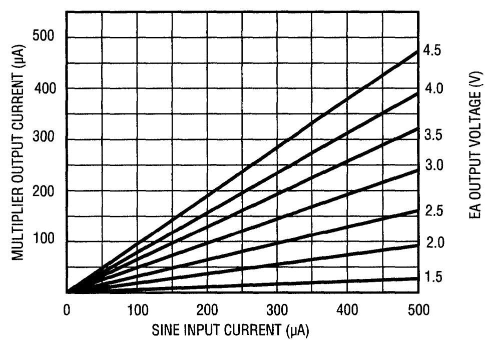


Figure 8. Multiplier Linearity

UNDER VOLTAGE LOCKOUT

On power up the TK84819 remains in the UVLO condition; output low and quiescent current low. The IC becomes operational when V_{CC} reaches 16 V. When V_{CC} drops below 10 V, the UVLO condition is imposed. During the UVLO condition, the 5 V V_{REF} pin is "off", making it usable as a "flag".

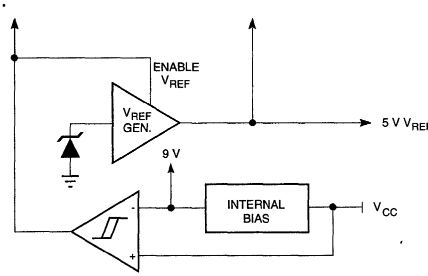


Figure 9. Under Voltage Lockout

3

TYPICAL APPLICATIONS

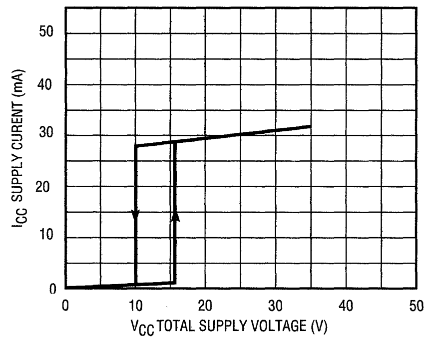


Figure 10. Total Supply Current vs. Supply Voltage

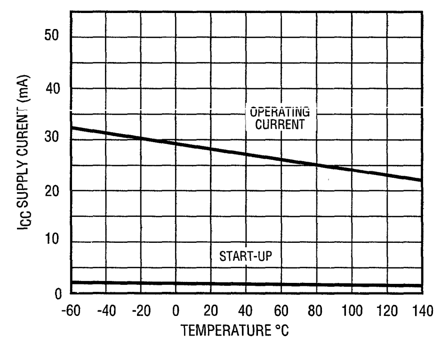


Figure 11. Total Supply Current vs. Temperature

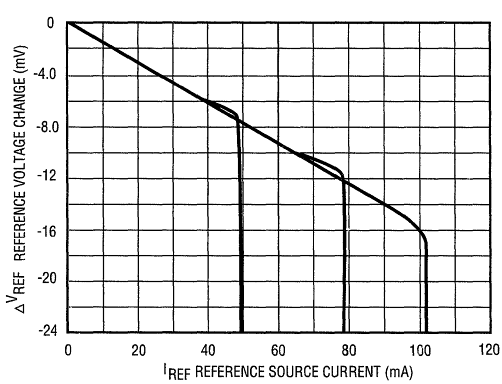


Figure 12. Reference Load Regulation

POWER FACTOR SECTION

The power factor section is a boost mode pre-regulator that provides approxamately 380 volts DC for the PWM section. It utilizes peak current sensing to give a typical corrected power factor of .996 over all load conditions. The following calculations refer to the applications circuit. (The component designators in the equations below refer to components in the application circuit.)

$$R_T = R15,\ C_T = C6$$

INPUT INDUCTOR (L1) SELECTION

The central component in the regulator is the input boost inductor. The value of this inductor controls various critical operational aspects of the regulator. If the value is too low, the input current distortion will be high and will result in low power factor and increased noise at the input. This will require more input filtering. In addition, when the value of the inductor is low the inductor dries out (runs out of current) at low currents. Thus the power factor will decrease at lower power levels and/or higher line voltages. If the inductor value is too high, for a given operating current, the required size of the inductor core will be large and/or the required number of turns will be high. So a balance must be reached between distortion and core size. One more condition where the inductor can dry out is analyzed below, where it is shown to be maximum duty cycle dependent.

For the boost converter at steady state:

$$V_{OUT} = \frac{V_{IN}}{1 - D_{ON}}$$

Where D_{ON} is the duty cycle $(T_{ON}/(T_{ON} + T_{OFF})$. The input boost inductor will dry out when the following condition is satisfied:

$$V_{IN}(t) < V_{OUT} \times (1 - D_{ON})$$

$$V_{INDRY} = (1 - D_{ON\,(max)}) \times V_{OUT}$$

V_{INDRY}: Voltage where the inductor dries out

V_{OUT}: Output DC Voltage

TYPICAL APPLICATIONS (CONT.)

The previous relationship shows that the resetting volt-seconds are more than setting volts-seconds. In energy transfer terms, this means that less energy is stored in the inductor during the ON time than it is asked to deliver during the OFF time. The net result is that the inductor dries out. The recommended maximum duty cycle is 95% at 100 kHz to allow time for the input inductor to dump its energy to the output capacitors.

For example:

if: $V_{OUT} = 380$ V and

$D_{ON\ (max)} = 0.95$

then substituting in (3) yields $V_{INDRY} = 20$ V. The effect of drying out is an increase in distortion at low voltages.

For a given output power, the instantaneous value of the input current is a function of the input sinusoidal voltage waveform, i.e. as the input voltage sweeps from zero volts to a maximum value equal to its peak so does the current.

The load of the power factor regulator is usually a switching power supply which is essentially a constant power load. As a result, an increase in the input voltage will be offset by a decrease in the input current.

By combining the ideas set forth above, some ground rules can be obtained for the selection and design of the input inductor:

Step 1: Find minimum operating current.

$$I_{IN(min)\ PEAK} = \frac{1.414 \text{ X } P_{IN(min)}}{V_{IN(max)}}$$

$V_{IN(max)} = 260$ V

$P_{IN(min)} = 50$ W

then: $I_{IN(min)} = 0.272$A

Step 2: Choose a minimum current at which point the inductor current will be on the verge of drying out. For this example 40% of the peak current found in Step 1 was chosen.

then:

$I_{LDRY} = 100$ mA

Step 3: The value of the inductance can now be found using previously calculated data.

$$L1 = \frac{V_{INDRY} \text{ X } D_{ON(max)}}{L_{INDRY} \text{ X } f_{OSC}}$$

$$= \frac{20 \text{ V X } 0.95}{100 \text{ mA X } 100 \text{ kHz}} = 2 \text{ mH}$$

The inductor can be allowed to decrease in value when the current sweeps from minimum to maximum value. This allows the use of smaller core sizes. The only requirement is that the ramp compensation must be adequate for the lower inductance value of the core so that there is adequate compensation at high current.

Step 4: The presence of the ramp compensation will change the dry out point, but the value found above can be considered a good starting point. Based on the amount of power factor correction the above value of L1 can be optimized after a few iterations.

Gapped Ferrites, Molypermalloy, and Powered Iron cores are typical choices for core material. The core material selected should have a high saturation point and acceptable losses at the operating frequency.

One ferrite core that is suitable at around 200 W is the T157-18 made by Micrometals. Two of these toroids are stacked with 140 turns of AWG #20 to provide 2 millihenries at 2 amps DC.

OSCILLATOR COMPONENT SELECTION

The oscillator timing components can be calculated by using the following expression:

$$f_{OSC} = \frac{1.36.}{R_T\ C_T}$$

TYPICAL APPLICATIONS (CONT.)

For example:

Step 1: At 100 kHz with 95% duty cycle T_{OFF} = 500 ns calculate C_T using the following formula:

$$C_T = \frac{T_{OFF} X I_{DIS}}{V_{OSC}} = 1000 \text{ pf}$$

Step 2: Calculate the required value of the timing resistor.

$$R_T = \frac{1.36}{f_{OSC} X C_T} = \frac{1.36}{100 \text{ kHz} X 1000 \text{ pF}} = 13.6 \text{ k}$$

Choose R_T = 14 k

CURRENT SENSE AND SLOPE (RAMP) COMPENSATION COMPONENT SELECTION

Slope compensation in the TK84819 is provided internally. A current equal to $V_{C(T)}/2(R18)$ is added to I(SENSE) A (pin 1). This is converted to a voltage by R10, adding slope to the sensed current through T1. The amount of slope compensation should be at least 50% of the downslope of the inductor current during the off time as reflected on pin 1. Note that slope compensation is a requirement only if the inductor current is continuous and the duty cycle is more than 50%. The highest inductor downslope is found at the point of inductor discontinuity:

$$\frac{d_{IL}}{dt} = \frac{V_b - V_{INDRY}}{L} = \frac{380 \text{ V} - 20 \text{ V}}{2 \text{ mH}}$$

The downslope as reflected to the input of the PWM comparator is given by:

$$S_{PWM} = \frac{V_b - V_{INDRY}}{L1} X \text{ R11/Nc}$$

Where NC is the turns ratio of the current transformer (T1) used. In general, current transformers simplify the sensing of switch currents especially at high power levels where the use of sense resistors is complicated by the amount of power they have to dissipate. Normally the primary side of the transformer consists of a single turn and the secondary consists of several turns of either enameled magnet wire or insulated wire. We have used a standard Beckman Industrial HM31-20100 current sense transformer. The rectifying diode at the output of the current transformer can be a 1N4148 for secondary currents up to 75 mA average. Sense FETs or resistive sensing can also be used to sense the switch current, the sensed signal has to be amplified to the proper level before it is applied to the IC.

The value of ramp compensation (SC_{PWM}) as seen at pin1 is:

$$SC_{PWM} = \frac{2.5 X R9}{R15 x C6 X R18}$$

The required value for R18 can be found by:

$$SC_{PWM} = A_{SC} X S_{PWM}$$

where A_{SC} is the amount of slope compensation and solving for R18

The value of R9 (pin 2) depends on the selection of R2 (pin 6)

$$R2 = \frac{V_{IN(max) PEAK}}{I_{sine(PEAK)}} = \frac{260 X 1.414}{0.72 \text{ mA}} = 510 \text{ k}$$

$$R9 > \frac{V_{CLAMP} X R2}{V_{IN(min)}} = \frac{4.8 X 510 \text{ k}}{80 X 1.414} \approx 22 \text{ k}$$

Choose R9 = 27K

The peak inductor current can be found approximately by:

$$Ilpeak = \frac{1.414 X P_{OUT}}{V_{IN(min)RMS}} = \frac{1.414 X 200}{90} = 3.14 \text{ A}$$

The selection of Nc which depends on the maximum switch current, assume 4A for this example is 80 turns,

$$R11 = \frac{V_{CLAMP} X Nc}{I_{PEAK}} = \frac{4.8 X 80}{4} \approx 100 \text{ Ohms}$$

TYPICAL APPLICATIONS (CONT.)

Where R11 is the sense resistor, and V_{CLAMP} is the current clamp at the inverting input of the PWM comparator. The clamp is internally set to 5 V. In actual application it is a good idea to assume a value less than 5 V to avoid unwanted current limiting action due to component tolerances. In the application V_{CLAMP} was chosen as 4.8 V.

Having calculated R11 the value S_{PWM} and of R18 can now be calculated:

$$S_{PWM} = \frac{380\text{ V} - 20}{2\text{ mH}} \times \frac{100}{80} = 0.225\text{ V/}\mu\text{s}$$

$$R18 = \frac{2.5 \times R9}{A_{SC} \times S_{PWM} \times R_T \times C_T}$$

$$R18 = \frac{2.5 \times 27\text{k}}{0.7 \times (.225 \times 10^6) \times 14\text{ k} \times 1\text{ nf}} \approx 30\text{ k}$$

Choose R18 = 33 k

The following values were used for calculation:

R9 = 27 k
Asc = 0.7
Rt = 14 k
Ct = 1 nF

VOLTAGE REGULATION COMPONENTS

The value of the regulation loop components are calculated based on the operating output voltage. Note that safety regulations require the use of sense resistors that have adequate voltage rating. As a rule, if 1/4 watt resistors are available, two should be used in series. The input bias current of the error amplifier is approximately 0.5 µA, therefore the current available from the voltage sense resistors should be significantly higher than this value. Since two 1/4 watt resistors have to be used, the total power rating is 1/2 W. The operating power is set to be 0.4 W, then with 380 V output voltage, the value can be calculated as follows:

$$R5 = (380\text{V})^2/0.4\text{ W} = 360\text{ k}$$

Therefore choose two 178 k 1/4 W 1% resistors connected in series. Then R6 can be calculated as follows:

$$R6 = \frac{V_{REF} \times R5}{V_B - V_{REF}} = \frac{5\text{ V} \times 357\text{ k}}{380\text{ V} - 5\text{ V}} = 4.76\text{ k}$$

Choose 4.75 k 1%

One more critical component in the voltage regulation loop is the feedback capacitor for the error amplifier. The voltage loop bandwidth should be set such that it rejects the 120 Hz ripple which is present at the output. If this ripple is not adequately attenuated, it will cause distortion of the input current waveform. Typical bandwidths range anywhere from a few Hz to 15 Hz. The main compromise is between transient response and distortion. The feedback capacitor can be calculated using the following formula:

$$C8 = \frac{1}{3.142 \times R5 \times BW} =$$

$$C8 = \frac{1}{3.162 \times 357\text{ k} \times 2\text{ Hz}} = 0.45\text{ }\mu\text{F}$$

OVERVOLTAGE PROTECTION (OVP)

The OVP loop should be set so that there is no interaction with the voltage control loop. Typically it should be set to a level where the power components are safe to operate. Ten to fifteen volts above V_{OUT} seems to be adequate. This sets the maximum transient output voltage to about 395 V.

By choosing the high voltage side resistor of the OVP circuit the same way as above, (R7 = 356 k) then R8 can be calculated as:

$$R8 = \frac{V_{REF} \times R7}{V_{OVP} - V_{REF}} = \frac{5\text{ V} \times 357\text{ k}}{395\text{ V} - 5\text{ V}} = 4.576\text{ k}$$

Choose 4.53 k 1%

Note that R5, R6, R7, and R8 should be 1% or better tolerance.

3

TYPICAL APPLICATIONS (CONT.)

OFF- LINE START-UP AND BIAS SUPPLY GENERATION

The start-up circuit can either be a "bleed resistor" type (39 k,2 W) or the circuit shown at right. The bleed resistor method offers the advantage of simplicity and lowest cost, but may cause excessive turn-on time at low line voltage.

When the voltage on V_{CC} (pin 15) exceeds 16 V, the IC starts up. The energy stored on C10 supplies the IC with running power until the supplemental winding on the output transformer can provide power to sustain operation.

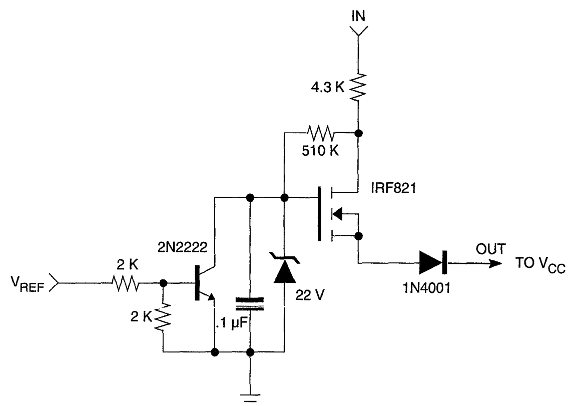


Figure 13. Start-Up Circuit

PWM SECTION

The PWM section uses current mode control. Current is sensed through R24 and filtered for high frequency noise and leading edge transients by R23 and C14. The main regulation loop is through PWM B. The TL431 in the secondary serves as both a voltage reference and error amplifier, with isolation provided by an opto-coupler which give a current command signal on pin 8. Loop compensation is provided by R29 and C20. The output voltage is set by:

$$V_{OUT} = 2.5 \times \left(1 + \frac{R29}{R28}\right)$$

The control loop is compensated using standard techniques.

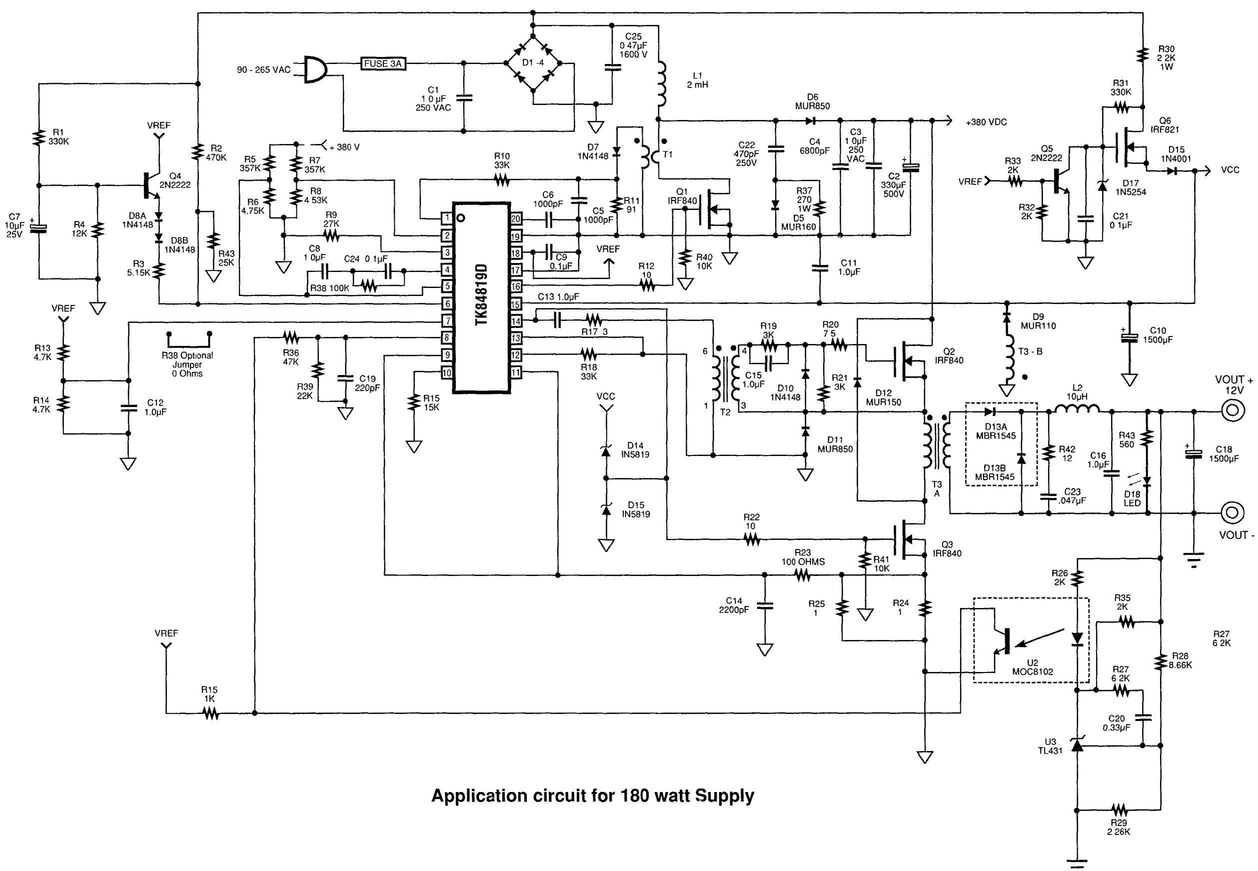
Current is limited to a threshold of 2A(1 V on R24). The duty cycle is limited in this circuit to below 50% to prevent output transformer core saturation. The maximum duty cycle limit of 45% is set using a threshold of $V_{REF}/2$ on pin 7.

The circuit can be modified for voltage mode operation by using the slope current that appears on pin 9.

The ramp amplitude appearing on pin 9 can be shown as:

$$V_R = \frac{I(R18)}{2} \text{ X } R(V)$$

where R18 is the slope compensation resistor. Since this circuit operates with a constant input voltage, (as provided by the PFC section), voltage feed-foward is unnecessary.



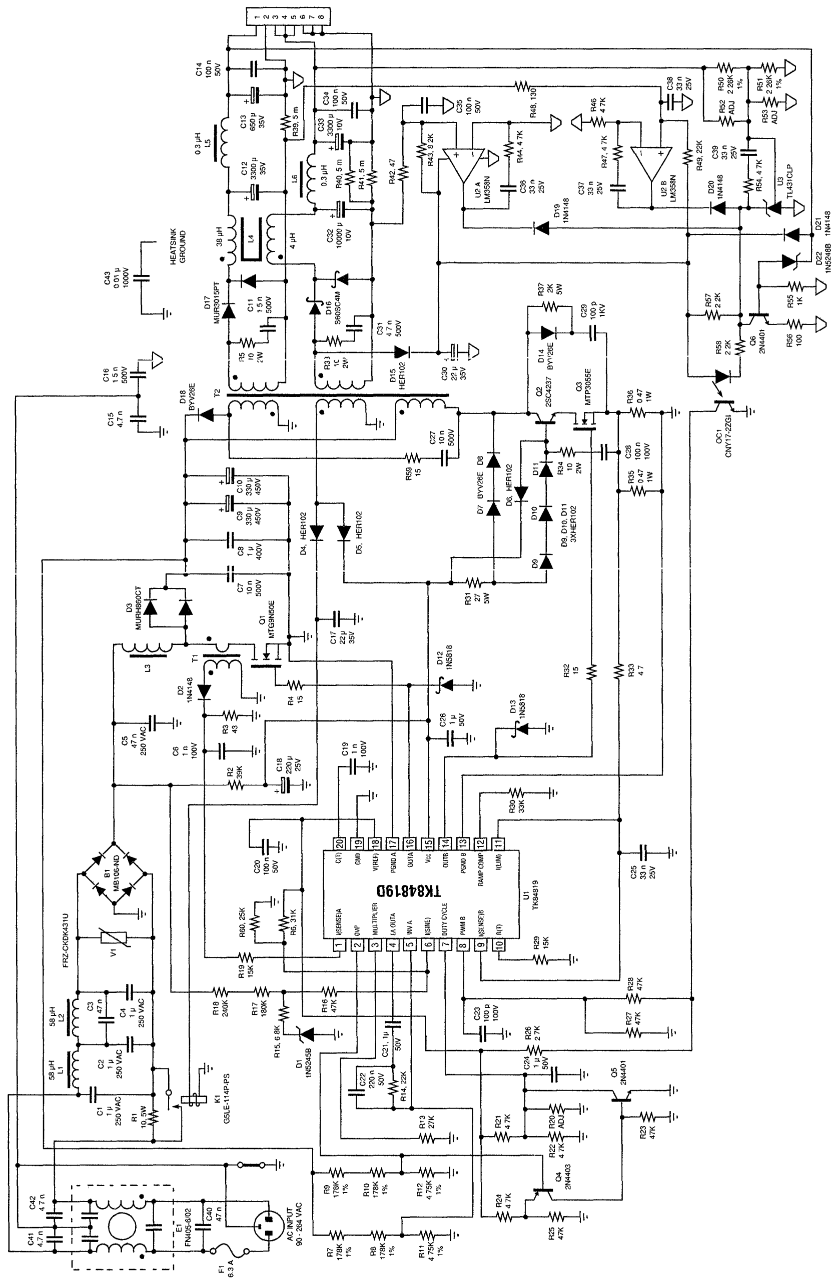
Application circuit for 180 watt Supply

180 WATT APPLICATIONS CIRCUIT PARTS LIST

ITEM	DESCRIPTION	MANUFACTURER	PART NO.
U1	TK84819	Toko	
U2	MOC8100	Motorola	
U3	TL431	Texas Instr.	
Q1 - Q3	IRF840	Interntl. Rectifier	
Q4, Q5	2N2222		
Q6	IRF821	Interntl. Rectifier	
D1 - 4	KBU8J Bridge Rectifier	G.I.	
D5	MUR160	Motorola	
D6	MUR850	Motorola	
D7, D8A, D8B, D10	1N4148		
D9	MUR110	Motorola	
D11, D12	MUR150	Motorola	
D13A,B	MBR1545	Motorola, G.I.	
D14, D16	1N5819		
D15	1N4001		
D17	IN5254		
D18	LED		
C1, C3	1 µF, 250 VAC		
C2	330 µF, 450 V		
C4	6.8 NF, 1 kV, Ceramic		
C5, C6	1000 pF		
C7	10 µF, 25 V	Panasonic	
C8, C15	1 µF, 35 V, Non-polarized		
C9, C21	0.1 µF, 50 V, Ceramic		
C10	1500 µF,25 V, Electrolytic	Illinois Capacitor	158CKR025M
C11 - C13, C16, C17	1 µF, Ceramic		
C14	2,000 pF, 50 V		
C18	1500 µF,16 V, Electrolytic	Illinois Capacitor	158CKR016M
C19	220 pF, 50 V		
C20	0.33 µF, 50 V		
C22	470 pF, 1 kV		
C23	.047 µF, 1 kV		
C24	0.1 µF, 50 V		
C25	0.47 µF, 250 VAC	Panasonic	
L1	2 mH, Ipeak=4 A Core: Powdered Iron toroid CTM-23891	CTM Magnetics 1419 W. 12th Place #102 Tempe, AZ 85281 (602) 967-9447	CTM-23891
L2	10µH	CTM	CTM-23991

180 WATT APPLICATION CIRCUIT PARTS LIST (CONT.)

ITEM	DESCRIPTION	MANUFACTURER	PART NO.
T1	Current transformer	Beckman Industrial	HM31-20100
T2	Toroid Core	Beckman Industrial	HM00-91878
	Np=Ns=15 turns bifilar #28		
	Teflon Insulated Wire		
T3	Output Transformer	CTM	CTM-24091
R1	330 k, 1/8 W		
R2	470 k, 1/8 W		
R3	5.15 k, 1%, 1/8 W		
R4	12 k, 1/8 W		
R5, R7	357 k, 1%, 1/4 W		
R6	4.75 k, 1%, 1/4 W		
R8	4.53 k, 1%, 1/4 W		
R9	27 k, 1/8 W		
R10, R18	33 k, 1/8 W		
R11	91 , 1/8 W		
R12, R22	10 , 1/4 W		
R13, R14	4.7 k, 1/8 W		
R15	1 k, 1/8 W		
R16	15 k, 1/8 W		
R17	3 , 1/8 W		
R19, R21	3k, 1/4 W		
R20	7.5 , 1/4 W		
R23	100 , 1/8 W		
R24, R25	1 , 1/4 W		
R26	2 k, 1/8 W		
R27	6.2 k, 1/8 W		
R28	8.66 k, 1%, 1/4 W		
R29	2.26 k, 1%, 1/4 W		
R30	2.2 k, 1 W		
R31	330 k, 1/8 W		
R32, R33	2 k, 1/8 W		
R34	560 , 1/8 W		
R35	2 k, 1 W		
R36	47 k, 1/8 W		
R37	47 k, 1/8 W		
R38	100 k, 1/8 W		
R39	22 k, 1/8 W		
R40, R41	10 k, 1/8 W		
R42	12 , 2 W		
R43	25 k, 1/8 W		



APPLICATION CIRCUIT FOR 350 WATT SUPPLY

350 WATT APPLICATION CIRCUIT PARTS LIST

ITEM	DESCRIPTION	MANUFACTURER	PART NO.
R1	10/5 W	Yageo	10W-5
R2	9 k / 3 W	Panasonic	P39KW-3
R3	43		
R4	15		
R5	10/ 2 W	Panasonic	P10W-2
R6	31 k		
R7	178 k, 1%		
R8	178 k, 1%		
R9	178 k, 1%		
R10	178 k, 1%		
R11	4.75 k, 1%		
R12	4.53 k, 1%		
R13	27 k		
R14	22 k		
R15	6.8 k		
R16	47 k		
R17	180 k		
R18	240 k		
R19	15 k		
R20	ADJ (22 k)		
R21	4.7 k		
R22	4.7 k		
R23	47 k		
R24	4.7 k		
R25	47 k		
R26	2.7 k		
R27	47 k		
R28	47 k		
R29	15 k, 1 %		
R30	33 k		
R31	27/ 5 W	Yageo	27 W-5
R32	15		
R33	4.7		
R34	10/ 2 W	Panasonic	P10W-2
R35	0.47, 1 W	Panasonic	P0.47W-1
R36	0.47, 1 W	Panasonic	P0.47W-1
R37	2 k ,/5 W	Yageo	2.0KW-5
R38	10/ 2 W	Panasonic	P10W-2
R39	5 m/ 3% 3 W	RCL	
R40	5 m, 3% 3 W	RCL	
R41	5 m/ 3% 3 W	RCL	
R42	47		
R43	8.2 k		
R44	4.7 k		
R45	4.7 k		
R46	4.7 k		
R47	4.7 K		

350 WATT APPLICATION CIRCUIT PARTS LIST (CONT.)

ITEM	DESCRIPTION	MANUFACTURER	PART NO.
R48	160		
R49	22 k		
R50	2.26 k/ 1%		
R51	2.26 k / 1%		
R52	ADJ		
R53	30.9 k / 1%		
R54	4.7 k		
R55	1 k		
R56	100		
R57	2.7 k		
R58	2.7 k		
R59	15		
R60	25 k		
C1	1 µ, 250 Vac, X	Panasonic	ECQ-U2A105MV
C2	1 µ, 250 Vac, X	Panasonic	ECQ-U2A105MV
C3	47 n, 100 V	Panasonic	ECQ-V1473JZ
C4	1 µ, 250 Vac, X	Panasonic	ECQ-U2A105MV
C5	47 n, 250 Vac, X	Panasonic	ECQ-U2A473MN
C6	1 n, 100 V	Panasonic	ECK-F2A102KBE
C7	10 n, 500 V	Panasonic	ECK-D2H103KBE
C8	1 µ, 400 V	Panasonic	ECQ-E4105KF
C9	330 µ, 450 V	Panasonic	ECQ-S2WU331Z
C10	330 µ, 450 V	Panasonic	ECQ-S2WU331Z
C11	1.5 n, 500 V	Panasonic	ECK-D2H152KBE
C12	3300 µ, 35 V	Panasonic	ECA-1VFQ332
C13	680 µ, 35 V	Panasonic	ECA-1VFQ681
C14	100 n, 50 V	Panasonic	ECF-F1H104ZF5
C15	4.7 n, 250 Vac, Y	Panasonic	ECQ-U2A472MF
C16	1.5 n, 500 V	Panasonic	ECK-D2H152KBE
C17	22 µ, 35 V	Panasonic	ECE-A1HGE220
C18	200 µ, 25 V	Panasonic	ECA-1EFQ221
C19	1 n, 100 V	Panasonic	ECC-F2A102JE
C20	100 n, 50 V	Panasonic	ECF-F1H104ZF5
C21	1 µ, 50 V	Panasonic	ECQ-V1H105JZ
C22	220 n, 50 V	Panasonic	ECQ-V1H224JZ
C23	100 p, 100 V	Panasonic	ECK-F2A101KBE
C24	1 µ, 50 V	Panasonic	ECQ-V1H105JZ
C25	33 n, 25 V	Panasonic	
C26	1 µ, 50 V	Panasonic	ECQ-V1H105JZ
C27	10 n, 500 V	Panasonic	ECK-D2H103KBE
C28	100 n, 100 V	Panasonic	ECQ-V1104JZ
C29	100 p, 1000V	Panasonic	ECK-D3A101KBN
C30	22 µ, 35 V	Panasonic	ECE-A1HGE220
C31	4.7 n, 500 V	Panasonic	ECK-D2H472KBE
C32	10,000 µ, 10 V	Panasonic	ECA-1AFQ103
C33	3,900 µ, 10 V	Panasonic	ECA-1AFQ392L

350 WATT APPLICATION CIRCUIT PARTS LIST (CONT.)

ITEM	DESCRIPTION	MANUFACTURER	PART NO.
C34	100 n, 50 V	Panasonic	ECF-F1H104ZF5
C35	100 n, 50 V	Panasonic	ECF-F1H104ZF5
C36	33 n, 25 V	Panasonic	ECF-F1E333MR
C37	33 n, 25 V	Panasonic	ECF-F1E333MR
C38	33 n, 25 V	Panasonic	ECF-F1E333MR
C39	33 n, 25 V	Panasonic	ECF-F1E333MR
C40	47 n, 250 Vac, X	Panasonic	ECQ-U2A473MN
C41	4.7 n, 250 Vac, Y	Panasonic	ECQ-U2A472MF
C42	4.7 n, 250 Vac, Y	Panasonic	ECQ-U2A472MF
C43	Ceramic Disc .01 µF, 1 kV		
U1	TK84819	TOKO	
U2	LM358N		
U3	TL431CLP	Motorola, TI	
OC1	CNY17-2ZGI	Quality Tech.	
Q1	MTG9N50E	Motorola	
Q2	2SC4237	Shindengen	
Q3	MTP3055E	Motorola	
Q4	2N4403		
Q5	2N4401		
Q6	2N4401		
D1	1N5245B	Motorola	
D2	1N4818		
D3	MURH850Ct	Motorola	
D4	HER102	Diodes, Inc.	
D5	HER102	Diodes, Inc.	
D6	HER102	Diodes, Inc.	
D7	BYV26C	Philips	
D8	BYV26C	Philips	
D9	HER102	Diodes, Inc.	
D10	HER102	Diodes, Inc.	
D11	HER102	Diodes, Inc.	
D12	1N5818		
D13	1N5818	Diodes, Inc.	
D14	BYV26E	Philips	
D15	HER102	Diodes, Inc.	
D16	S60SC4M	Shindengen	
D17	MUR3015PT	Motorola	
D18	BYV26E	Philips	
D19	IN4148		
D20	IN4148		
D21	IN4148		
D22	IN5248B	Motorola	
B1	MB106-ND	Diodes, Inc.	

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350 WATT APPLICATION CIRCUIT PARTS LIST (CONT.)

ITEM	DESCRIPTION	MANUFACTURER	PART NO.
K1	G5LE-114P-PS	OMRON	
L1	CTM 27591	CTM Magnetics	
L2	CTM 27591	1419 W. 12th Place	
L3	CTM 27291	Tempe, AZ 85281	
L4	CTM 27391	(602) 967-9447	
L5	*optional	2T AWG 18 Micrometals T51-52C Powered Iron Core	
L6	*optional	2T AWG 18 Micrometals T51-52C Powered Iron Core	
T1	HM31-2100	Beckman Industrial	
T2	CTM 27491	CTM Magnetics	
HS1	HS104-2	AAVID	
HS2	#11269	Thermalloy Extrusion 10.25"	
F1	6.3A SLO-BLO	5X20 MM	
FUSE CLIP	FO58-ND	Digi-Key (2 EA)	
E1	FN405-6/02	Schaffner EMI Filter	
V1	ERZ-C100K431U	Panasonic ZNR	
J2-J5	ED1601	Onshore Tech	

TABLE OF CONTENTS

RADIO FREQUENCY/MMIC

TOKO

TOKO

TK10420

DUAL CONVERSION FM IF AMPLIFIER

FEATURES

- **Wide Operating Voltage Range**
- **High Limiting Sensitivity**
- **Low Current Consumption**
- **60 MHz IF Input**
- **4 to 10 Volt Operation**

APPLICATIONS

- **Communications Equipment**
- **HAM Radio Transceivers**
- **VHF/UHF Handy Talkies**
- **Scanners**
- **Data Transponders**
- **Cordless Phones**
- **Cellular Phones**

DESCRIPTION

The TK10420 integrated circuit has been developed for the FM IF system in communications equipment. The circuit operates on 4 to 10 volts and has low current consumption. The IC is most suited for receivers using double conversion. The IF input can be as high as 60 MHz and the second IF is 455 kHz.

The TK10420 is available in DIP16 dual in-line and surface mount MFP20 packages.

4

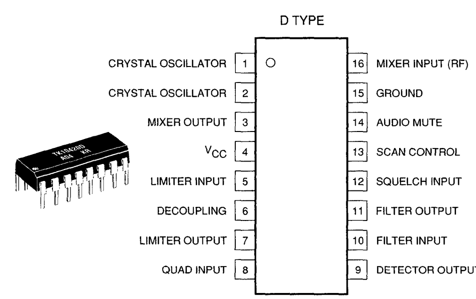
ORDERING INFORMATION

TK10420 □ □ □□

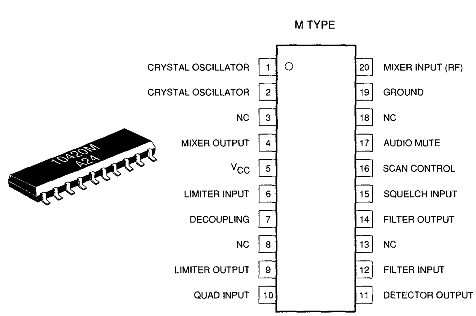
- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M : Surface Mount	C : -20 to +70 °C	BX : Bulk/Bag
D : Plastic Dip		TX : Paper Tape
		TR : Tape Right
		TL : Tape Left
		MG: Magazine

TK10420D



TK10420M



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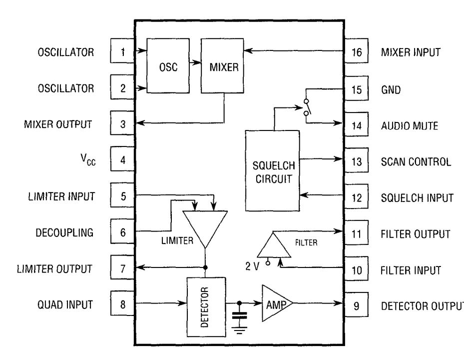


ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 12 V
Power Dissipation TK10420D (Note 1) .... 700 mW
Power Dissipation TK10420M (Note 2) .... 410 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +125 °C
Operating Temperature Range .... -30 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

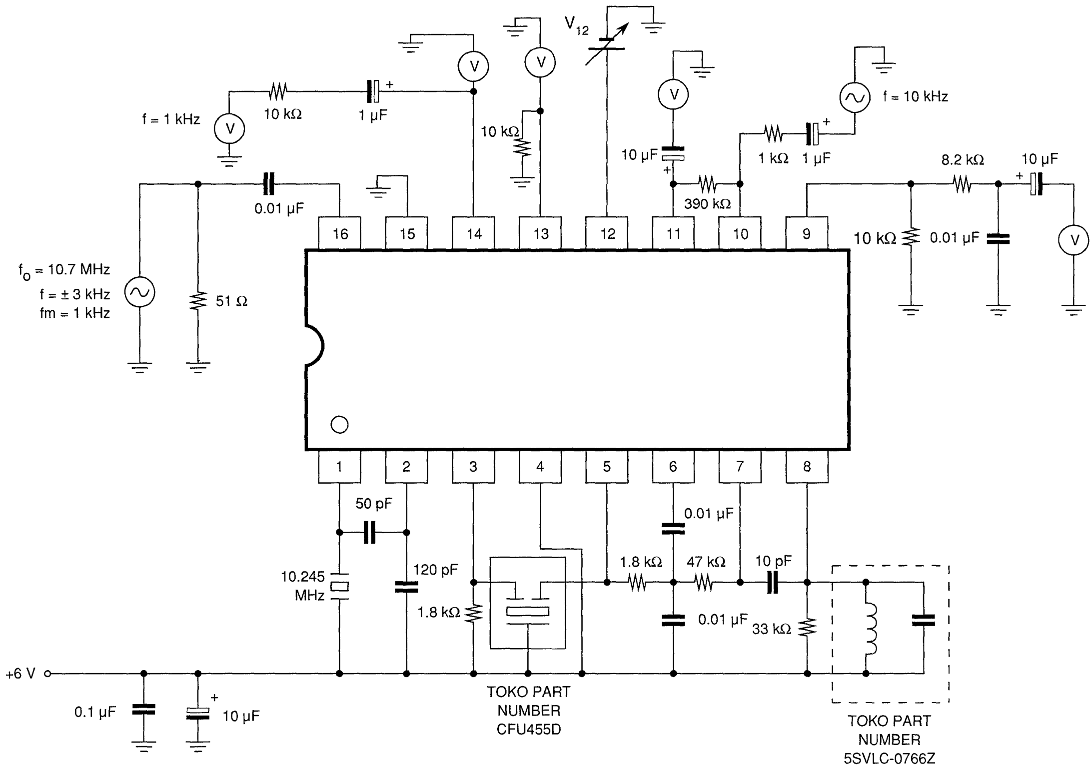
ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 6.0 V, f_O = 10.7 MHz, Δf = ±3.0 kHz, f_{MOD} = 1 kHz, T_A = 25°C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC1}	Current Consumption	V_{12} = 2 V_{DC}		2.5	3.5	mA
I_{CC2}	Current Consumption	V_{12} = 0 V_{DC}		4.0	5.5	mA
Limit	Limiting Sensitivity	-3 dB V_{OUT}		3.0	10.0	µV
V_{DC}	Detector Output Term. Voltage	V_{IN} = 10 mV (RF); no mod.		3.0		mV
Z_{OUT}	Detector Output Impedance	V_{IN} = 10 mV (RF)		400	990	Ω
V_{OUT}	Detector Output Voltage	V_{IN} = 10 mV (RF)	300	550.0		mV(rms)
F_{GAIN}	Filter Gain	f = 10 kHz, V_{IN} = 3 mV	40.0	46.0		dB
F_{DC}	Filter Terminal Voltage	At no input	1.8	2.0	2.5	V_{DC}
HYS	Trigger Hysteresis		50	100		mV
M_L	Mute Switch Resistance	V_{12} = 0 V_{DC}		15	50	Ω
M_H	Mute Switch Resistance	V_{12} = 2 V_{DC}	1	10		MΩ
S_L	Scan Control Voltage	V_{12} = 2 V_{DC}		0	0.5	V_{DC}
S_H	Scan Control Voltage	V_{12} = 0 V_{DC}	5			V_{DC}
M_G	Mixer Conversion Gain			20		dB
M_{INR}	Mixer Input Resistance			3.3		kΩ
M_{INC}	Mixer Input Capacitance			2.2		pF
F_{OP}	Operating Frequency Range			60		MHz

Note 1: Power dissipation must be derated at the rate of 5.6 mW/ °C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 3.3 mW/ °C for operation at T_A = 25 °C and above.

TEST CIRCUIT



Note: The input impedance of the audio voltmeter and harmonic distortion meter should be higher than 100 kΩ.

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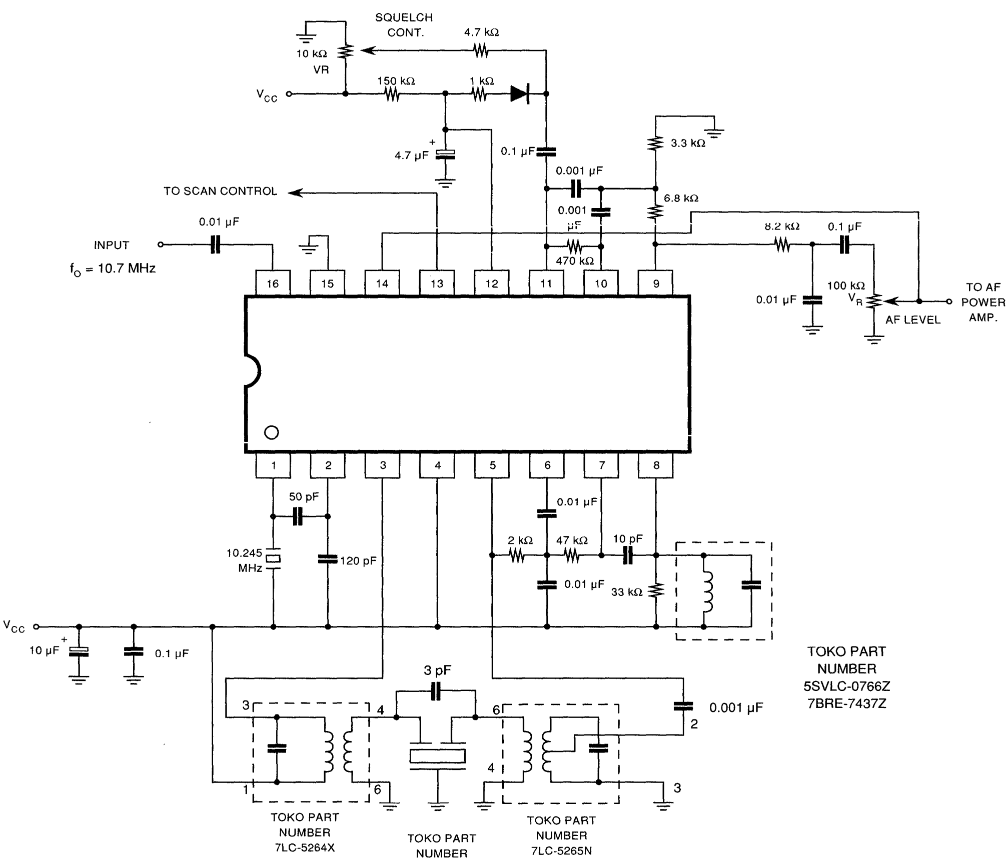
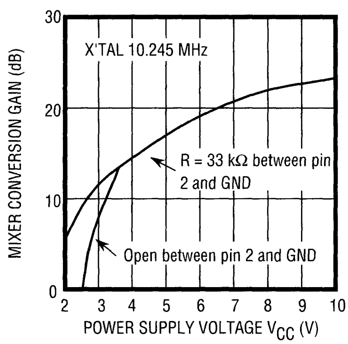
TYPICAL APPLICATION

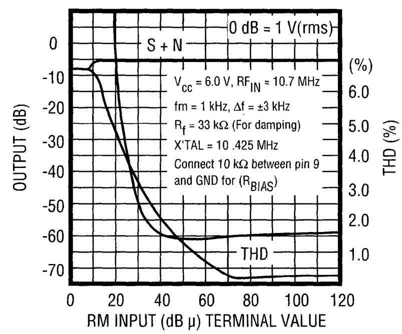


TYPICAL PERFORMANCE CHARACTERISTICS

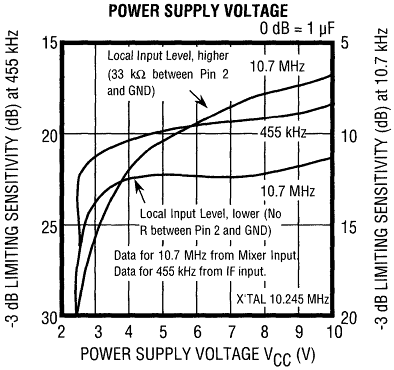
MIXER CONVERSION GAIN vs. POWER SUPPLY VOLTAGE



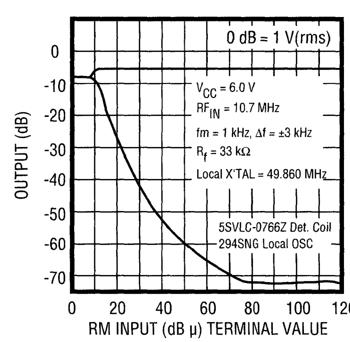
MIXER AND IF CHARACTERISTICS (10.7 MHz)



-3 dB LIMITING SENSITIVITY vs. POWER SUPPLY VOLTAGE



MIXER AND IF CHARACTERISTICS (50 MHz)



4

NOTES

TOKO

TK10421

IF AMPLIFIER

FEATURES

- MC3357 Compatible
- IF Amp, Local Osc, Squelch
- Ceramic Discriminator or Quad Coil
- 60 MHz Operation

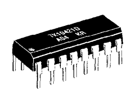
APPLICATIONS

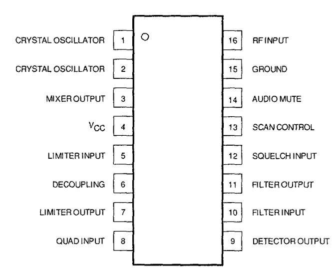
- Communications Equipment
- Cable TV Descramblers
- Telecommunications
- Data Receivers
- For Low-Voltage Operation

DESCRIPTION

The TK10421 is a Silicon Monolithic Bipolar Integrated Circuit that is the basis for a complete dual conversion narrow band IF system. Typical configurations include 10.7 MHz and 455 kHz IF frequencies although other frequencies may be used, up to 60 MHz. The mixer/oscillator combination converts the input down to 455 kHz with an external bandpass filter. The audio is recovered using a conventional quadrature coil or ceramic discriminator. The absence of an input signal is detected by the presence of noise above the normal audio band. This noise is monitored by an active filter and detector. This detector output can be used to control scanning, and at the same time, an internal switch is operated that can mute the audio output (squelch). The oscillator is an internally biased colpitts type with the collector, base and emitter brought out to pins 4, 1 and 2 respectively. A crystal or coil can be used. The mixer is doubly balanced to reduce spurious responses. The input impedance at pin 16 is set by an internal 3 kΩ resistor and has low capacitance, allowing the circuit to be preceded by a crystal filter. Pin 3 must be connected to B+ and can swing to 0.5 V below V_{CC}. After suitable bandpass filtering (either ceramic or LC) the signal is fed to the input of a limiter at pin 5. The limiter output on pin 7 drives a multiplier, both internally and directly, and externally through a quadrature coil or ceramic discriminator to detect the FM. Pin 7 is also used to supply DC feedback to the limiter input at pin 5. The other side of the first limiter stage is decoupled at pin 6. The recovered audio is partially filtered, then buffered giving an impedance of about 400 Ω at pin 9. A simple inverting opamp is provided with an output at pin 11, providing DC bias (external) to the input at pin 10, which is referred internally to 2.0 volts. An external filter can be made with external impedance elements to discriminate frequencies. With an external AM detector the filtered audio signal can be checked for the presence of noise above the normal audio band or a tone signal. This information is applied to pin 12. An external positive bias to pin 12 sets up the squelch trigger circuit so that pin 13 is low at an impedance level of around 60 kΩ and the audio mute pin 14 is open circuit. If pin 12 is pulled down to 0.7 V by the noise or tone detector, pin 13 will rise to about 0.5 V below V_{CC} and support a load current of around 500 uA, while pin 14 is internally short circuited to ground. There is 100 mV of hysteresis at pin 12 to prevent jitter. Audio muting is accomplished by connecting pin 14 to a high impedance ground reference point in the audio path between pin 9 and the audio amplifier.

TK10421D





4

ORDERING INFORMATION

TK10421 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
D: PLASTIC DIP	C : -30 to +70 °C	BX: Bulk/Bag MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 12 V
Power Dissipation (Note 1) .... 540 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +125 °C
Operating Temperature Range .... -30 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C
Operating Voltage Range .... 2.7 to 5.5 V

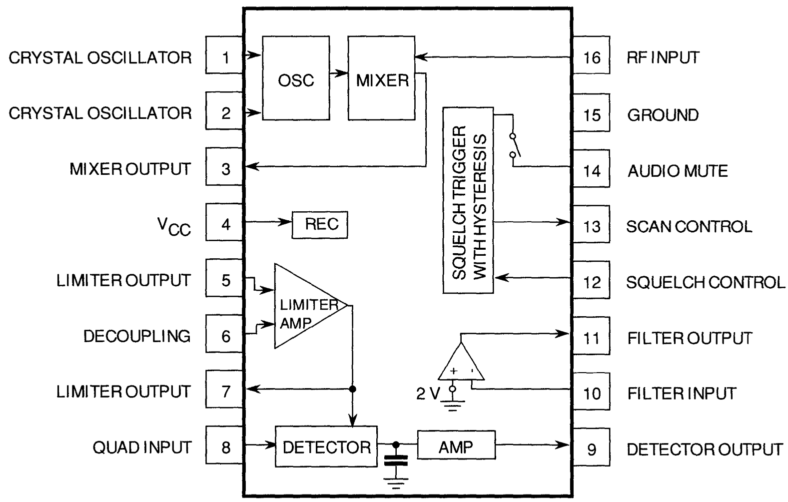
ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 3.0 V, f_O = 10.7 MHz, Δf = ±3.0 kHz, T_A = 25 °C, f_{MOD} = 1 kHz

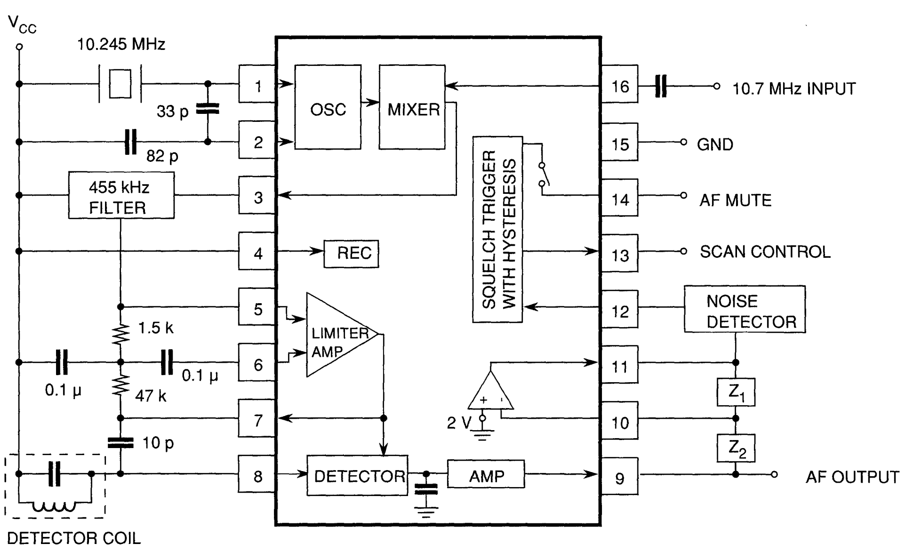
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC1}	Current Consumption	Squelch Off		1.5	2.8	mA
I_{CC2}	Current Consumption	Squelch On		2.3	4.0	mA
Limit	Limiting Sensitivity	-3 dB Point		6.0		µV
V_{DC}	Detector Output	at MOD OFF		1.3		Vdc
Terminal Voltage						
Z_{OUT}	Detector Output	V_{IN} = 10 mV (10.7 MHz)		700	1700	Ω
Impedance						
V_{OUT}	Detector Output Voltage	V_{IN} = 10 mV (10.7 MHz)	80	220		mV(rms)
F_{GAIN}	Filter Gain	V_{IN} = 5 mV (10 kHz)	39	44		dB
HYS	Trigger Hysteresis	V_{IN} = 5 mV (10 kHz)	15	40		mV_{DC}
ML	MUT. Function Low	V12 + 0 V_{DC}, V_{IN} = 1V(rms) = 1 kHz		30	90	Ω
MH	MUT. Function High	V12 = 2 V_{DC}, V_{IN} f = 1 kHz	1.0	10		MΩ
FDC	Filter Terminal Voltage	at V_{IN} = 0	1.0	1.3	1.7	V_{DC}
SL	Scan Function Low	V12 = 2 V_{DC}		0	0.5	V_{DC}
SH	Scan Function High	V12 = 0 V_{DC}	2.0	2.8		V_{DC}
G_C	Mixer Exchange Gain			1.6		dB
R_{IN}	Mixer Input Resistance			3.3		kΩ
C_{IN}	Mixer Input Capacitance			3.6		pF
Range	Operational Frequency			10.7	50	MHz

Note 1: Power dissipation must be derated at the rate of 6.6 mW/ °C for operation at T_A = 25 °C and above.

BLOCK DIAGRAM



TEST CIRCUIT



NOTES

TOKO

TK10440

IF AMPLIFIER

FEATURES

- Very Low Operating Current
- Low Operating Voltage
- Low Current Standby Mode
- Built In Voltage Regulator
- Seperate Voice and Data Outputs
- Built In Data Amp and Low Pass Filter
- Built In Low Battery Alarm

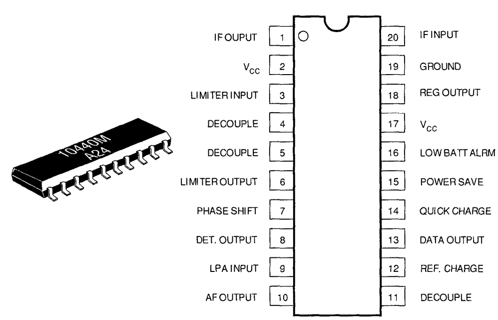
APPLICATIONS

- Pagers (POGSAG Code)
- Cordless Telephone
- Communications Devices

DESCRIPTION

The TK10440 is a low voltage, low current consumption IF circuit suited for pagers, cordless phones, and other communications devices. It features a standby mode in which the IC consumes only 5 µA. The TK10440 is ideal for battery operation and is capable of operating from a single 1.5 V cell. The TK10440M is available in a MFP20 surface mount package.

TK10440M



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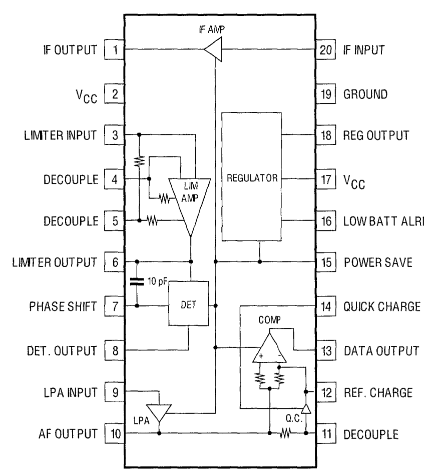


ORDERING INFORMATION

TK10440 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -30 to +70 °C	BX: Bulk/Bag TR: Tape Right TL: Tape Left MG: Magazine

4

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 7 V
Power Dissipation (Note 1) .... 410 mW
Operating Voltage Range .... 1.1 to 6.0 V
Input Frequency .... 1.0 MHz
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -30 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

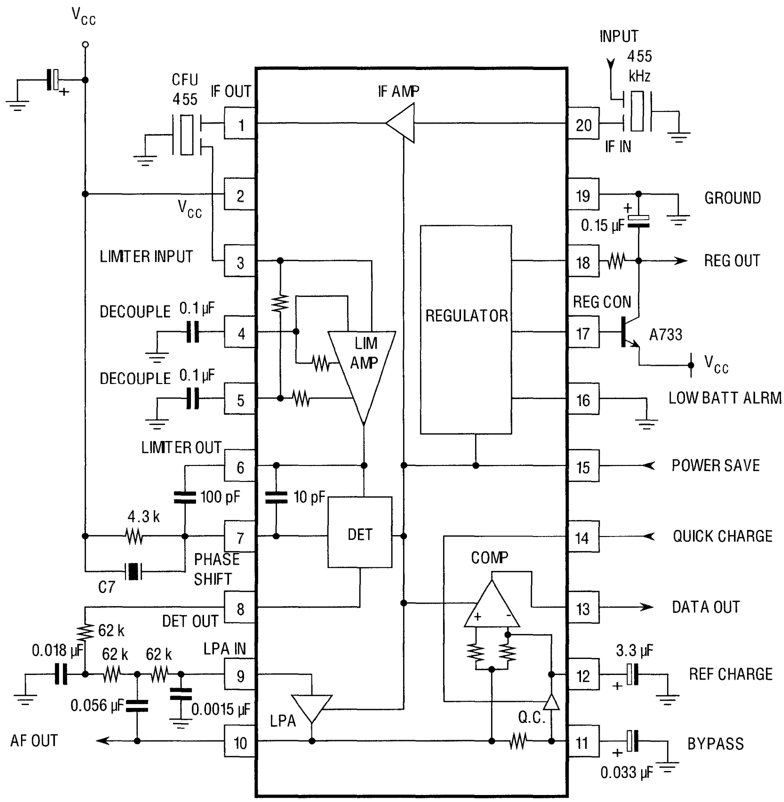
ELECTRICAL CHARACTERISTICS

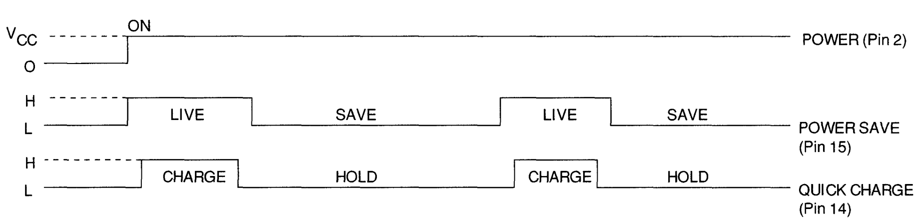
Test conditions: V_{CC} = 1.4 V, F_{IN} = 455 kHz, Δf ± 2.5 kHz, fm = 100 Hz, T_A = 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	Non Input, V_{CC} = 1.40 V		0.8		mA
$I_{CC\ bs}$	Supply Current at Battery Saving	Non Input, V_{CC} = 1.40 V Battery Save On			5.0	µA
IF Section						
Vlimit	Limiting Sensitivity	-3 dB Point		4	10	µV
V_{OUT}	Recovered Output	V_{IN} = 10 mV		30		mV
THD	Distortion	V_{IN} = 10 mV		3		%
Data Amp Section						
$V_{OUT\ H}$	Output Voltage High	Pull up to 1.4 V, 100 kΩ	1.1			V
$V_{OUT\ L}$	Output Voltage Low	Pull up to 1.4 V, 100 kΩ			0.15	V
DR	Duty Ratio			50		%
Regulator						
V_{REG}	Output Voltage	V_{IN} = 1.40 V, I_{OUT} = 5 mA		1.0		V

Note 1: Power dissipation must be derated at the rate of 3.3 mW/°C for operation at T_A = 25 °C and above.

TEST CIRCUIT





NOTES

LOW VOLTAGE NARROW BAND FM IF

FEATURES

- Narrow Band FM IF System
- Low (0.9 V) Voltage Operation
- Audio and Data Outputs
- Built in Voltage Regulator

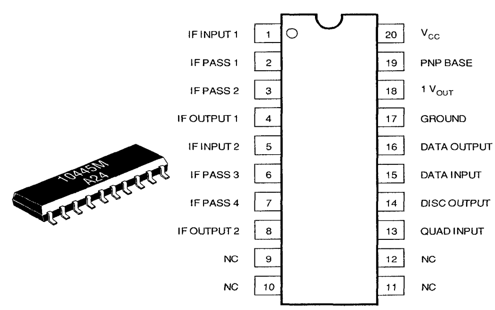
APPLICATIONS

- Pagers
- Cordless Telephones
- Portable Communications
- Portable Instruments

DESCRIPTION

TK10445M is an IF amplifier designed for telecommunications apparatus. The device features very low (0.9 V) operating voltage and low (1.2 mA) current consumption. The TK10445 has been designed to be the heart of a very compact narrow band receiver for pagers, cordless phones and other voice and data communicating devices, operating from a single battery cell. The IC is available in an MFP20 surface mount package.

TK10445M



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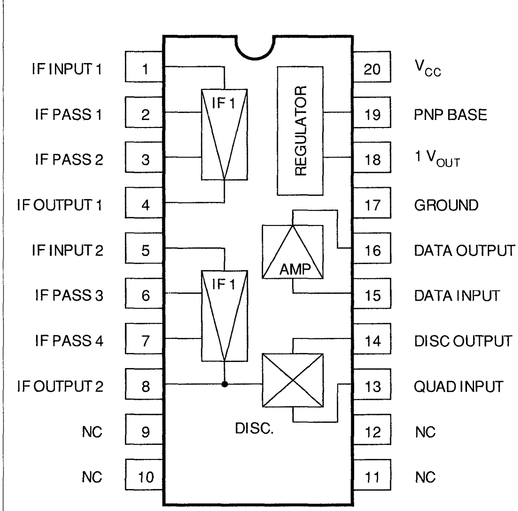


ORDERING INFORMATION

TK10445 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M : Surface Mount	C : -20 - 70 °C	BX : Bulk/Bag
		TX : Paper Tape
		TR : Tape Right
		TL : Tape Left
		MG: Magazine

4

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} ....5 V
Power Dissipation (Note1) ....410 mW
Operating Voltage Range ....0.9 to 3.5 V
Junction Temperature ....150 °C
Storage Temperature Range ....-55 to +150 °C
Operating Temperature Range ....-30 to +70 °C
Lead Soldering Temp. (10 sec.) ....300 °C

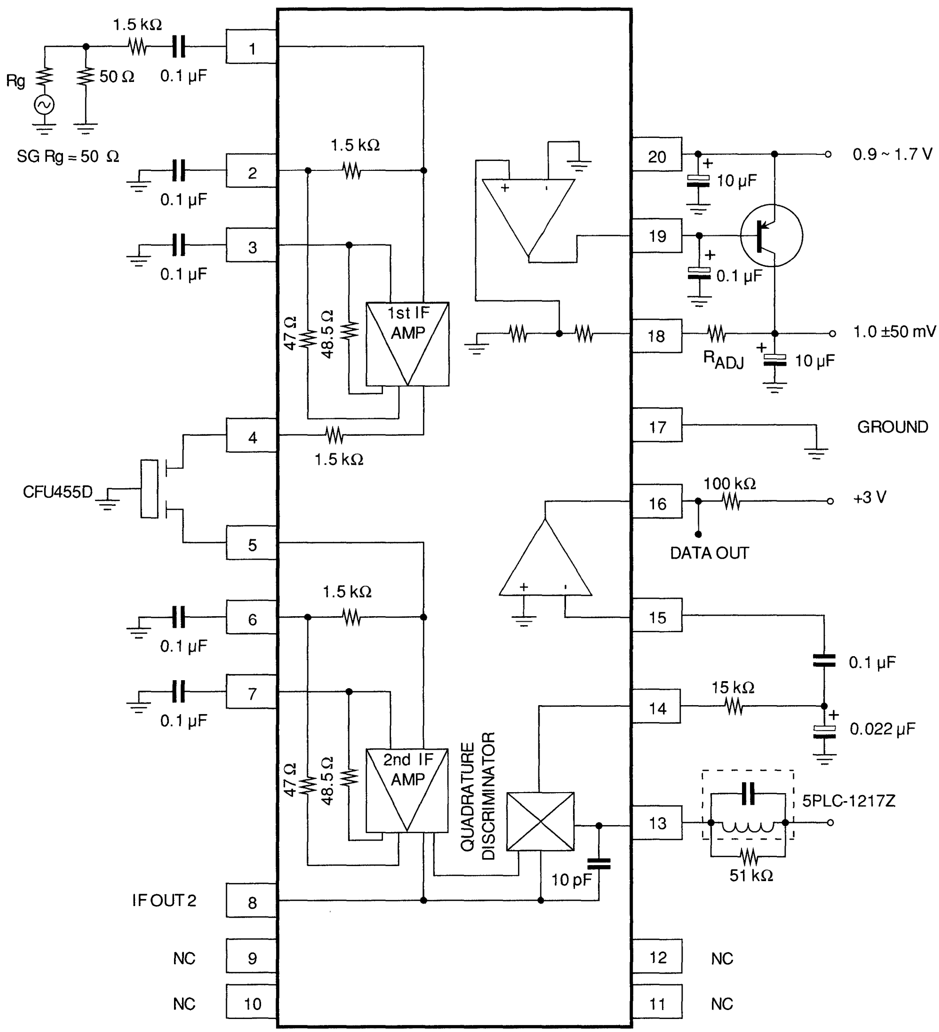
ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 1.05 V, F_{IN} = 455 kHz, Δ f = ±3 kHz, f_M = 1 kHz, T_A = 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	Non input, V_{CC} = 1.35 V		1.2	1.85	mA
IF Section						
Limit	Limiting Sensitivity	-3 dB Point		3	20	µV
V_{O1}	Output Voltage 1	V_{IN} = 10 mV	20	40		mV
THD	Distortion	V_{IN} = 10 mV		1	2.5	%
Z_O	Output Impedance			0.3	1.0	kΩ
DATA-AMP Section						
Z_{IN}	Input Impedance		65	100	135	kΩ
V_{O2}	Output Voltage 2	Output terminal is +3 V with 100 kΩ	2.3	2.8		V_{PP}
DR	Duty Ratio	V_{IN} = 17 mV(rms), F_{IN} = 1 kHz	45	50	55	%
Regulator Section (Note 2)						
V_{O3}	Output Voltage 3	V_{IN} = 1.1 V, I_O = 10 mA	0.93	0.98	1.03	V
V_{O4}	Output Voltage 4	V_{IN} = 1.7 V, I_O = 0 mA	0.97	1.02	1.07	V
V_{O5}	Output Voltage 5	V_{IN} = 0.9 V, I_O = 1 mA	0.83	0.88	1.93	V

Note 1: Power dissipation must be derated at the rate of 3.12 mW/°C for operation at T_A = 25 °C and above.
Note 2: Output voltage is adjusted to 1.0 V with R_{ADJ} . (V_{IN} = 1.35 V, I_{OUT} = 0 mA)

TEST CIRCUIT



NOTES

TOKO

TK10447

NARROW BAND FM IF SYSTEM

FEATURES

- Narrow Band FM IF System
- Separate Audio and Data Output
- Low (1 V) Voltage Operation
- Dual Conversion IF
- Input Frequency up to 30 MHz
- Built In Voltage Regulator

APPLICATIONS

- Pagers
- Cordless Telephones
- Communications Devices

DESCRIPTION

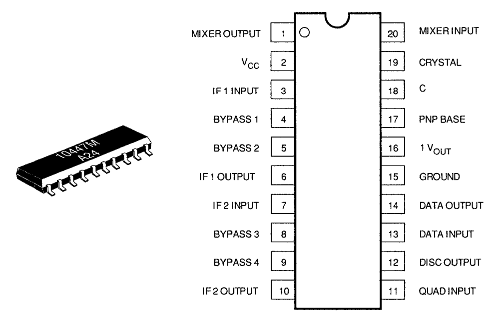
The TK10447 is a mixer IF amplifier combination, designed for pagers, cordless telephones, hand-held walkie-talkies, and other voice and data communications systems.

Due to its low quiescent current and ability to operate down to 1 V, this device is ideal for battery powered systems.

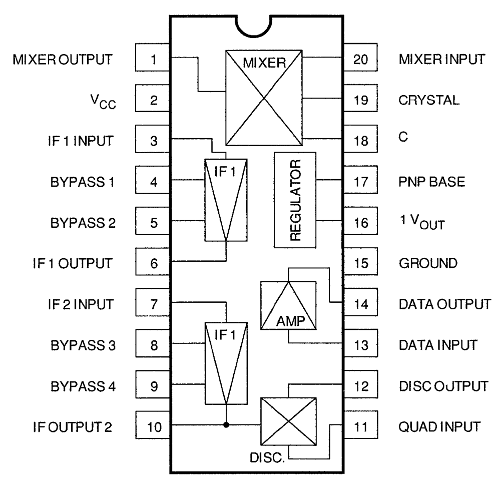
The TK10447 contains a mixer, IF amplifier, discriminator, voltage regulator and a data amplifier.

The device is available in an MFP20 surface mount package.

TK10447



BLOCK DIAGRAM



ORDERING INFORMATION

TK10447 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M : Surface Mount	C : -30 to +70 °C	BX : Bulk/Bag TX : Paper Tape TR : Tape Right TL : Tape Left MG: Magazine

4

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 5 V
Input Frequency .... ~ 30 MHz
Operating Voltage Range .... 1.0 to 3.5 V
Power Dissipation (Note 1) .... 410 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -30 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

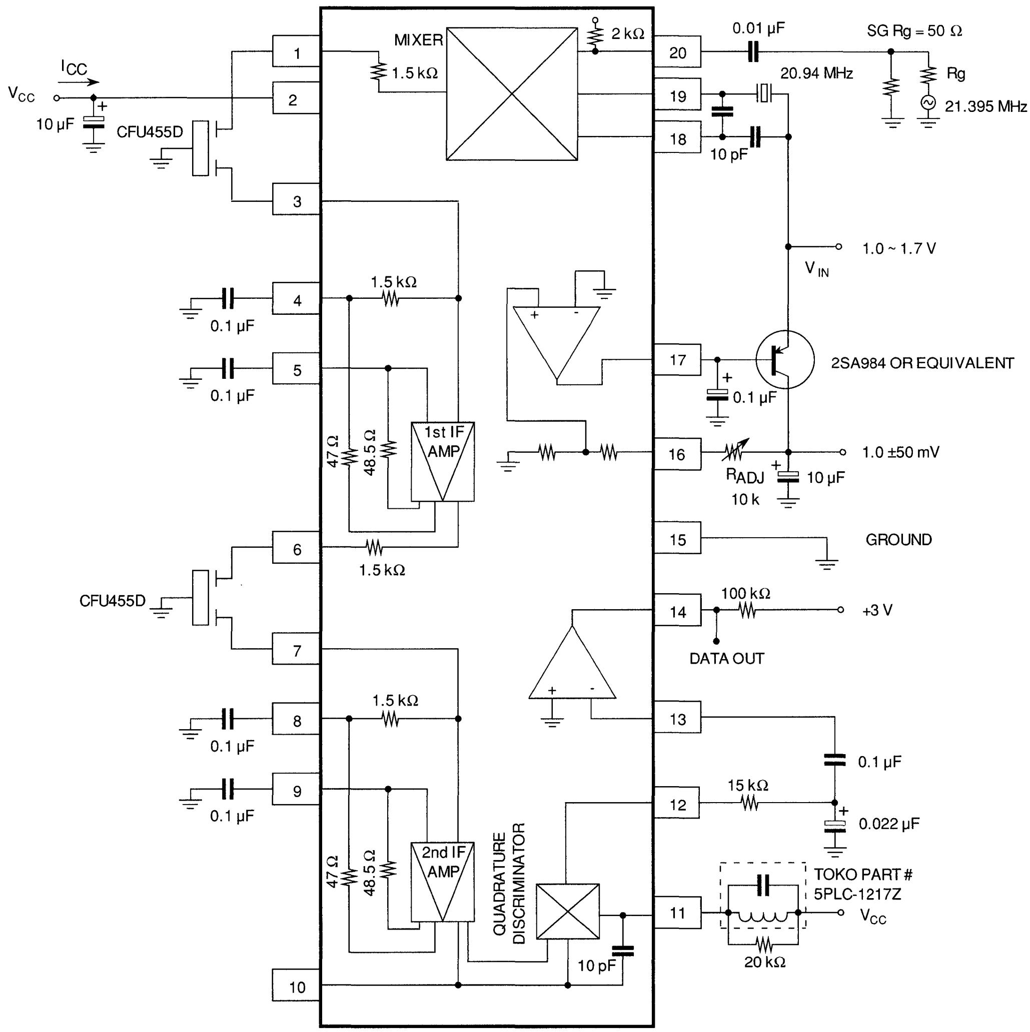
ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 1.1 V, F_{IN} = 21 MHz, $\Delta f = \pm 3$ kHz, f_M = 1 kHz, T_A = 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	Non input, V_{CC} = 1.35 V		2.2	3.5	mA
IF Section						
V_G	Voltage Gain	F_{IN} = 21 MHz, V_{IN} = 1 mV		10		dB
Limit	Limiting Sensitivity	-3 dB Point		5	20	µV
V_{O1}	Output Voltage 1	V_{IN} = 10 mV	15	35		mV
THD	Distortion	V_{IN} = 10 mV		2.0	3.0	%
Z_O	Output Impedance			0.5	1.0	kΩ
DATA-AMP Section						
Z_{IN}	Input Impedance		65	100	135	kΩ
V_{O2}	Output Voltage 2	Output terminal is +3 V with 100 kΩ	2.3	2.8		V_{pp}
DR	Duty Ratio	V_{IN} = 17 mV(rms), F_{IN} = 1 kHz	45	50	55	%
Regulator Section (Note 2)						
V_{O3}	Output Voltage 3	V_{IN} = 1.1 V, I_O = 10 mA	0.93	0.98	1.03	V
V_{O4}	Output Voltage 4	V_{IN} = 1.7 V, I_O = 0 mA	0.97	1.02	1.07	V
V_{O5}	Output Voltage 5	V_{IN} = 0.9 V, I_O = 1 mA	0.83	0.88	1.93	V

Note 1: Power dissipation must be derated at the rate of 3.3 mW/°C for operation at T_A = 25 °C and above.
Note 2: Output voltage is adjusted to 1.0 V with R_{ADJ}. (V_{IN} = 1.35 V, I_O = 0 mA)

TEST CIRCUIT



NOTES

FEATURES

- Small Footprint
- Wide Operating Supply Voltage Range
- Low Current Consumption
- Low External Parts Count

APPLICATIONS

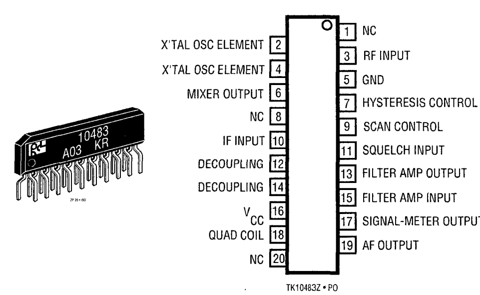
- Portable Instrumentation
- Cordless Telephones
- Portable Communications
- VHF Communications Equipment

DESCRIPTION

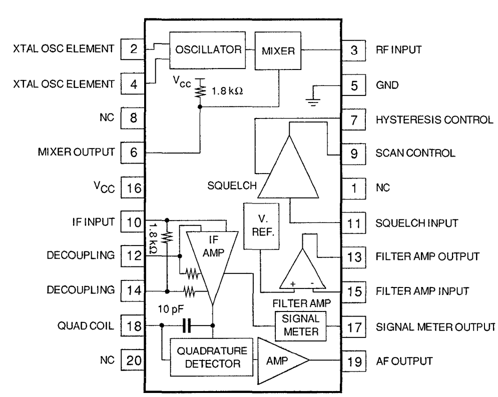
This IC has been developed for use in the FM IF system in communications equipment. It is designed with signal output meter terminals and is suited for use in dual conversion receiver circuits. In addition, squelch is provided for efficient noise reduction.

The IC comes in a compact ZIP 20 in-line package.

TK10483Z



BLOCK DIAGRAM



ORDERING INFORMATION

TK10483 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
Z : ZIP	C : -30 to +70 °C	BX : Bulk/Bag
		MG: Magazine

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 12 V
Power Dissipation (Note 1) .... 600 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -30 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 6.0 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC1}	Supply Current	No input, squelch off		4.4	6.6	mA
I_{CC2}	Supply Current	No input, squelch on		5.0	7.6	mA
Limit	Limiting Sensitivity	-3 dB Point		2.0	8.0	µV
V_{OUT}	Detector Output	V_{IN} = 10 mV; dev., ± 3 kHz	100	180	250	mV(rms)
Detector Output						
V_{DC}	Terminal Voltage	V_{IN} = 10 mV, unmodulated	0.8	1.3	2.0	V
Z_{OUT}	Impedance	V_{IN} = 10 mV		500	1500	Ω
THD	Distortion	V_{IN} = 10 mV		1.0	2.0	%
Filter Amplifier						
F_G	Filter Amplifier Gain	F_{IN} = 10 kHz; VO = 100 mV(rms)	33	38		dB
F_{DC}	Output Voltage	No input	0.8	1.2	1.5	V
HYS	Squelch Hysteresis	R_{HYS} = 1 kΩ		80		mV
Scan Control						
S_H	High Level	Squelch input = 0 V	2.3			V
S_L	Low Level	Squelch input = 2.5 V			0.5	V
S_H	High Level	Squelch input = 2.5 V	2.3			V
S_L	Low Level	Squelch input = 0 V			0.5	V

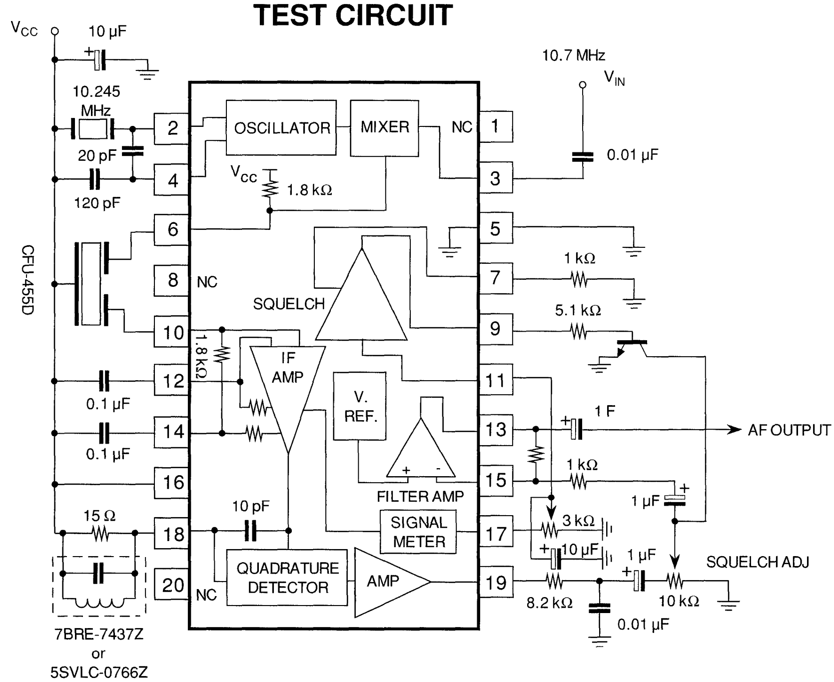
Note 1: Power dissipation must be derated at the rate of 4.8 mW/°C for operation at T_A = 25 °C and above.

ELECTRICAL CHARACTERISTICS (CONT.)

Test conditions: V_{CC} = 6.0 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Mixer						
M_G	Mixer Conversion Gain			25		dB
M_{INR}	Mixer Input Resistance	DC measurement		3.6		kΩ
M_{INC}	Mixer Input Capacitance			2.2		pF
Signal Meter Output						
S_{OUT1}	Signal Meter Output	V_{IN} = 10 mV, Rs = 3 kΩ	1.2	1.8	2.6	V
S_{OUT0}	Signal Meter Output	V_{IN} = 0 mV, Rs = 3 kΩ			0.3	V
$S_{OUT1/2}$	Signal Meter Output	RF Input at 1/2 S_{OUT1}	17	22	29	dBμ

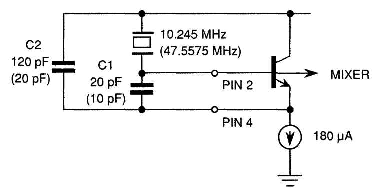
TEST CIRCUIT



APPLICATION INFORMATION

1. Local Oscillator Circuit

The transistor is biased by a constant current of about 180 µA, and it is stable to oscillate at a wide range of supply voltages. Connect a tuning circuit to pin 4 when using an overtone type crystal. Refer to the Test Circuit.

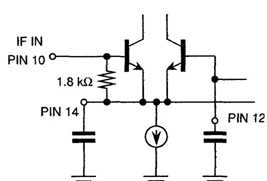


2. Mixer Circuit

The mixer consists of a double balanced multiplier and a buffer circuit. There is a matching resistor of about 3.6 kΩ in the RF side and a matching resistor of 1.8 kΩ at the IF side (mixer output).

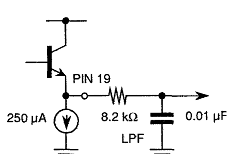
3. IF Amplifier

The IF amplifier consists of six direct-coupled differential amplifiers. A 1.8 kΩ resistor at pin 10 assures matching to the ceramic filter. The capacitor at pin 12 and 14 serves as a decoupling capacitor and can be connected to either V_{CC} or GND. Parasitic oscillation may occur, leading to incorrect limiting sensitivity if this bypass is not done correctly. It is necessary to obtain the lowest possible impedance on the printed circuit board.



4. FM Demodulator

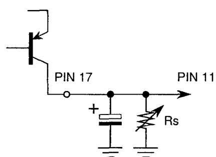
The FM signal is demodulated by a quadrature detector, with a phase shifter capacitor of 10 pF. The capacitor is connected to pin 18 and synchronized with the tank circuit tuned to 455 kHz. Adjust the band width, distortion, detection output, etc. by using the damping resistor connected parallel with the coil. The quadrature detector output is buffered with an emitter follower at pin 19 audio output terminal. The DC bias of pin 19 is nearly half of V_{CC}. The output impedance is about 500 Ω. Use a Low Pass FIlter to eliminate noise caused by 455 kHz components included at pin 19 output.



APPLICATION INFORMATION (CONT.)

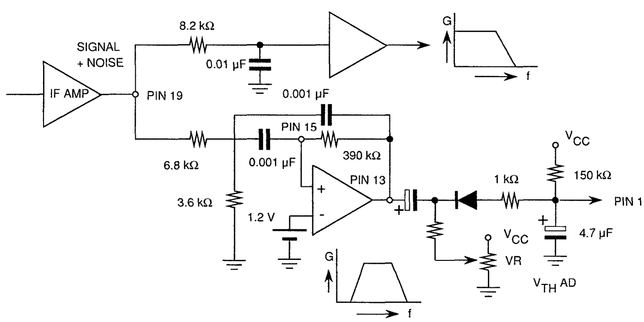
5. Signal Strength Detector

The Signal Strength detector receives the signal from the IF amplifier stages and its output at pin 17. The maximum output current is 600 µA. Adjust the level by using a load resistor for proper triggering of the squelch. The dynamic range is about 30 dB (input signal). For correct temperature characteristics, use a resistor with 2400 PPM/°C temperature coefficient.



6. Noise Amplifier

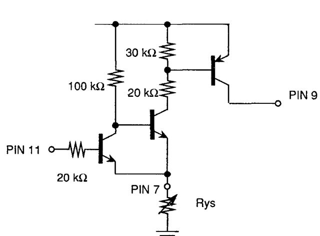
Since the inverting input of the noise amplifier is biased to 1.2 V, an active filter may be easily formed, using a few external components as shown below. The amplifier can be used for noise muting.



When the RF input signal decreases, the output of the noise amplifier increases due to increased noise. The "-" excursion of the output is detected and pin 11 becomes negative. If there is no noise, the 4.7 µF will be charged through a 150 kΩ and pin 11 will be at a high level.

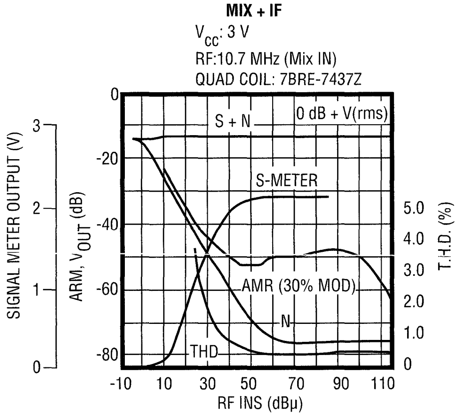
7. Squelch Trigger Circuit

The comparator is composed of circuits connected to pin 7, pin 9 and pin 11. The hysteresis can be changed by varying the resistor value connected to pin 7.

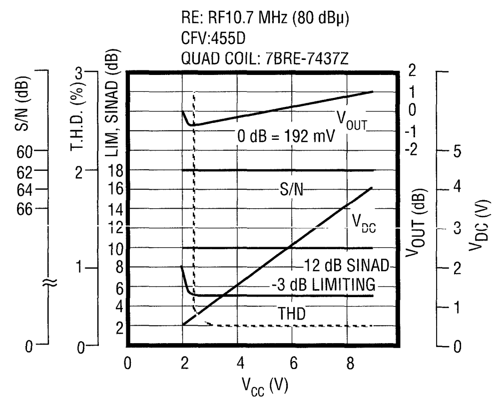


TYPICAL PERFORMANCE CHARACTERISTICS

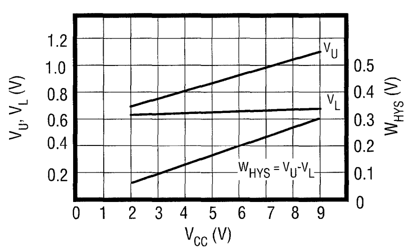
MIX + IF

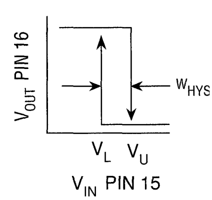


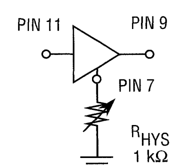
SUPPLY VOLTAGE CHARACTERISTICS WITH QUAD COIL



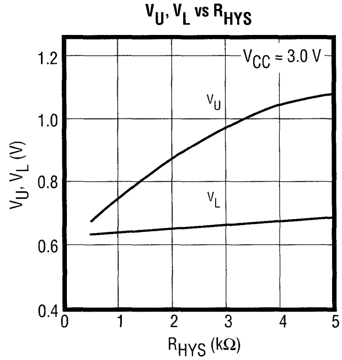
V_U, V_L vs V_{CC}

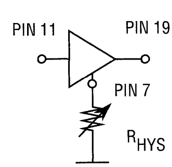






V_U, V_L vs R_{HYS}





TOKO

NARROW BAND FM-IF AMPLIFIER

FEATURES

- Built-in Signal Meter Driver
- Wide Operating Voltage Range
- High Limiting Sensitivity
- Wide Frequency Range
- Built In Mixer

APPLICATIONS

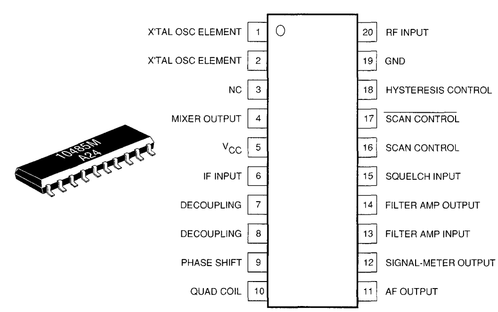
- Scanners
- Cordless Telephones
- VHF Radio
- Communications Equipment

DESCRIPTION

The TK10485 has been developed for double conversion FM receivers. It has built-in mixer, oscillator, IF amplifier, FM demodulator, received signal strength indicator drive and squelch circuitry. IF frequencies up to 30 MHz can be accomodated. Supply current and supply voltage was minimized for use in battery powered systems.

The TK10485 is available in an MFP20 surface mount package.

TK10485



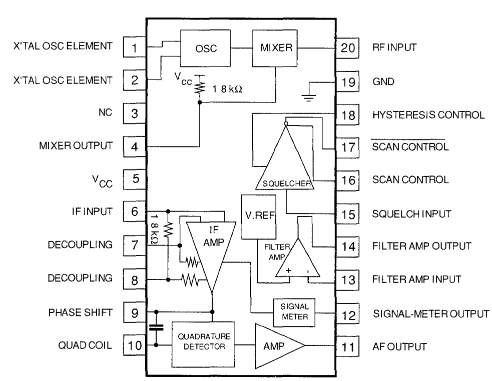
ORDERING INFORMATION

TK10485 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -30 to +70 °C	BX: Bulk/Bag
		TR: Tape Right
		TL: Tape Left
		MG: Magazine

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 10 V
Operating Voltage Range .... 2.5 to 8.5 V
Power Dissipation (Note 1) .... 350 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -30 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 6.0 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC1}	Supply Current	No input, squelch off		4.4		mA
I_{CC2}	Supply Current	No input, squelch on		5.0		mA
Limit	Limiting Sensitivity	-3 dB V_{OUT}		2.0		µV
V_{OUT}	Detector Output	V_{IN} = 10 mV; dev., ±3 kHz		180		mV(rms)
Detector Output						
V_{DC}	Terminal Voltage	V_{IN} = 10 mV, unmodulated		1.3		V
Z_{OUT}	Impedance	V_{IN} = 10 mV		500		Ω
THD	Distortion	V_{IN} = 10 mV		1.0		%
Filter Amplifier						
F_G	Filter Amplifier Gain	F_{IN} = 10 kHz; VO = 100 mV(rms)		38		dB
F_{DC}	Output Voltage	No input		1.2		V
Hys	Squelch Hysteresis	R_{HYS} = 1 kΩ		80		mV
Scan Control						
S_H	High Level	Squelch input = 0 V	2.3			V
S_L	Low Level	Squelch input = 2.5 V			0.5	V
S_H	High Level	Squelch input = 2.5 V	2.3			V
S_L	Low Level	Squelch input = 0 V			0.5	V

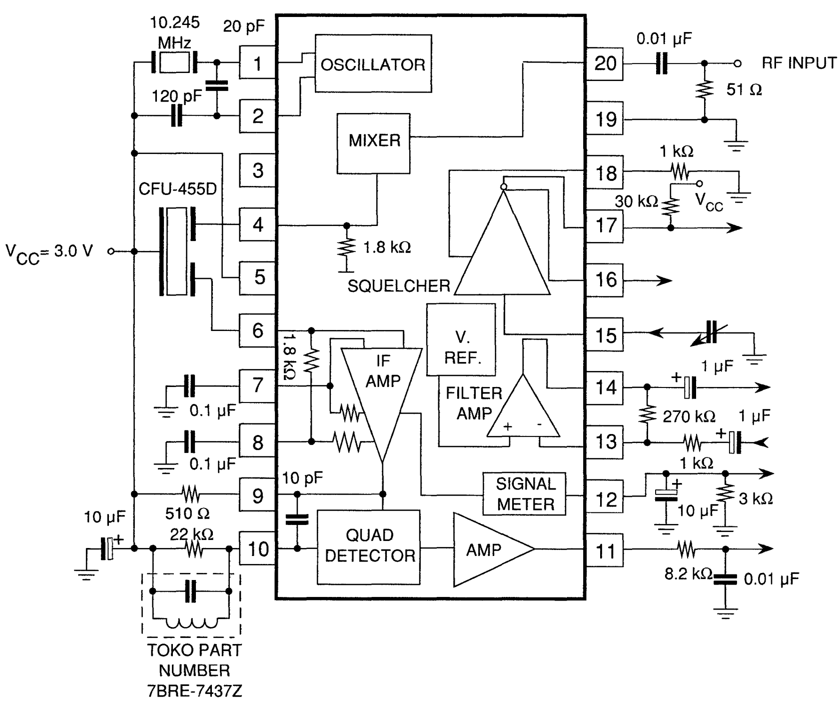
Note 1: Power dissipation must be derated at the rate of 3.3 mW/°C for operation at T_A = 25 °C and above.

ELECTRICAL CHARACTERISTICS (CONT.)

Test conditions: V_{CC} = 6.0 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Mixer						
M_G	Conversion Gain			25.0		dB
M_{INR}	Input Resistance	DC measurement		3.6		kΩ
Scan Control						
S_{OUT1}	Signal Meter Output	V_{IN} = 10 mV, Rs = 3 kΩ		2.0		V
$S_{OUT1/2}$	Signal Meter Output	V_{IN} = 0 mV, Rs = 3 kΩ			0.3	V
S_{OUT0}	Signal Meter Output	RF input at 1/2 $S_{OUT\ 1}$		22		dBμ

TEST CIRCUIT



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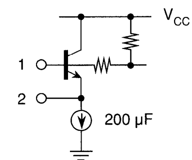
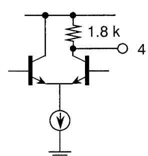
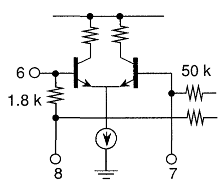
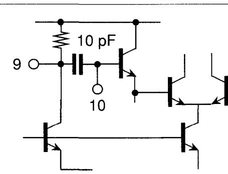
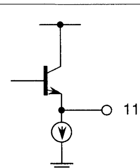
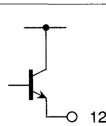
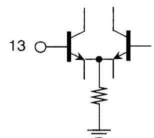
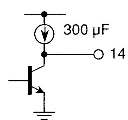
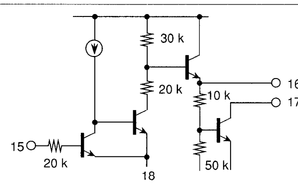
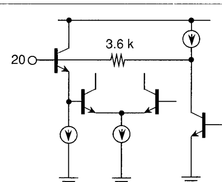
PIN INFORMATION

PIN NO	SYMBOL	PIN VOLTAGE		PIN FUNCTION
PIN1 PIN2	OSC (B) OSC (E)	2.97 V 2.3 V		Connects to a quartz oscillator tank circuit and forms a Colpits oscillator.
PIN3	NC			The NC pin is not wired to the IC. As a mask option it can be used for a ground line, etc.
PIN4	MIX OUT	2.7 V		Mixer Output Pin
PIN5	V_{CC}	3.0 V		Power Supply Pin
PIN6 PIN7 PIN8	IF INPUT DECOUPLING DECOUPLING	2.1 V 2.1 V 2.1 V		IF Input Pin. Pins 7 and 8 are AC grounded decoupling pins.
PIN9 PIN10	PHASE SHIFT QUAD COIL	2.95 V		This pin connects to the phase shifter circuit.
PIN11	AF OUTPUT	1.5 V		The demodulated signal is available at this pin.
PIN12	S. METER OUT			The current output at this pin depends on the IF AMP's signal level.

PIN INFORMATION (CONT.)

PIN NO	SYMBOL	PIN VOLTAGE	PIN FUNCTION
PIN13	FILTER AMP INPUT	1.25 V 	This is the input pin of the inverting amplifier.
PIN14	FILTER AMP OUTPUT	1.25 V 	This is the output pin of the inverting amplifier.
PIN15 PIN16 PIN17 PIN18	SQUELCH INPUT SCAN CONTROL $\overline{\text{SCAN CONTROL}}$ HYSTERESIS CONTROL		15) Squelch Input Pin 16, 17) Output Pins. 18) Hysteresis Width Control Pin
PIN19	GND	0 V	Ground Connection Pin
PIN20	RF INPUT	1.8 V 	Mixer Input Pin

Note: The listed pin voltages correspond to V_{CC} = 3.0 V

4

APPLICATIONS INFORMATION

OPERATION

The TK10485 is a narrow band FM IF system.

1. The signal from pin 20 (RF INPUT) is mixed in with the local oscillator signal. The IF signal is available at pin 4 (MIX OUT). The mixer output is passed through a narrow-band pass filter and fed to the IF AMP input at pin 6. The signal (amplitude limited by the IF AMP) is then demodulated, using a quadrature detector (pin 10). The demodulated signal appears at pin 11 (AF OUTPUT).

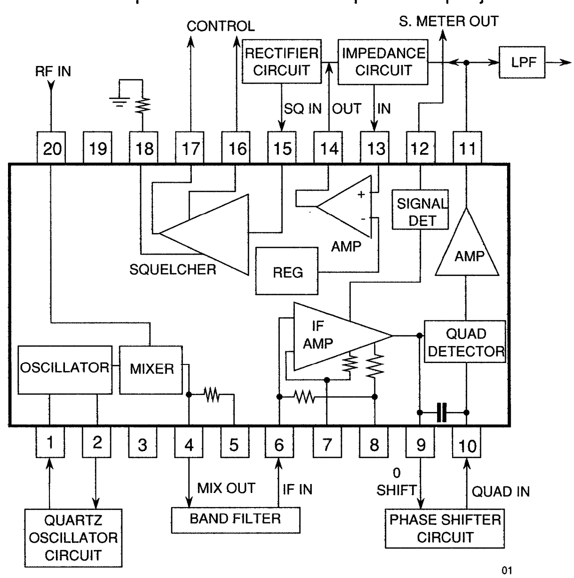
2. The signal that branches from the middle of the IF AMP is converted to current. The value of this current is determined by the RF signal strength. It is available at pin 12 (S. METER OUT) to drive a signal strength indicator.

3. The noise level, which increases as the signal level weakens, passes through the active filter that is set to a frequency centered above the upper edge of the audio spectrum. This signal is rectified, and fed to the squelch trigger circuit.

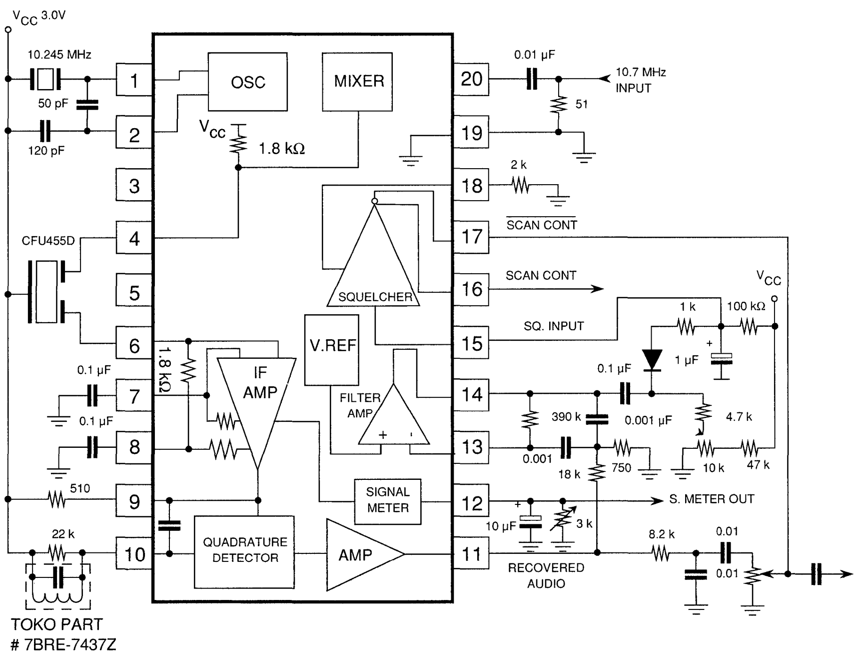
   The active filter is formed by adding an impedance circuit to the inverting Opamp connected to pins 13 (FILTER AMP INPUT) and 14 (FILTER AMP OUTPUT).

   The rectifier circuit is external to the device.

4. The rectifier output, controlled according to the noise level, is fed to pin 15 (SQUELCH INPUT). When more than 0.7 V is applied to pin 15, pin 16 (SCAN CONTROL) is at GND level and pin 17 (SCAN CONTROL) is turned off. When pin 15 has less than 0.7 V, pin 16 is high and the SCAN CONTROL is ON. The resistor between pin 18 and GND sets the hysteresis in the squelch circuit in order to prevent input jitter.



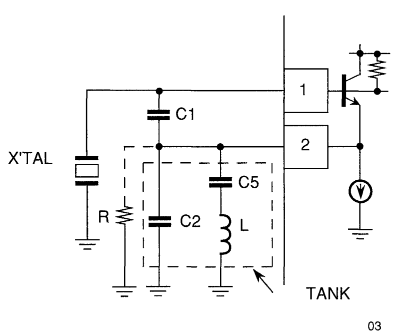
APPLICATIONS INFORMATION



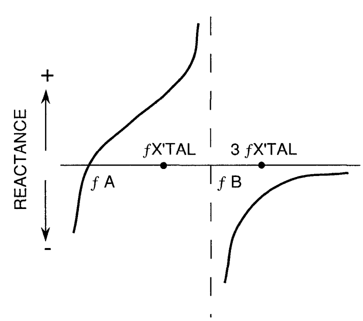
APPLICATIONS INFORMATION (CONT.)

1.) OSCILLATOR

The diagram below shows a third order overtone quartz Colpits oscillator.



Colpits-Type Quartz Oscillator Circuit



Reactance Characteristics of the tank circuit

APPLICATIONS INFORMATION (CONT.)

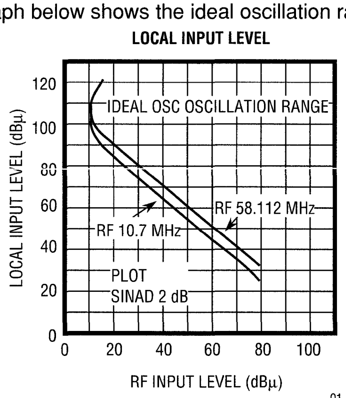
The tank circuit must satisfy the following equations:

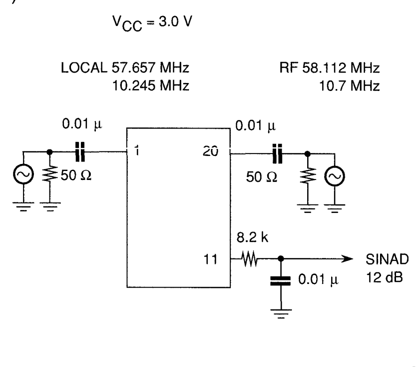
3fX'TAL>fB $fA = \frac{1}{2\pi\sqrt{LC3}}$ (Where the fA is the series resonance frequency of the tank circuit.)

fX'TAL>fA $fB = fA\sqrt{1+\frac{C3}{C2}}$ (Where fB is the parallel resonance frequency of the tank circuit.)

The effective capacitance and the equivalent resistance of the circuit at the X'TAL terminal must be appropriately selected. When the equivalent resistance at X'TAL is insufficient, add an external resistor between pin 2 and ground and increase the bias and current of Tr.

The graph below shows the ideal oscillation range. (TYP 200 mVrms)

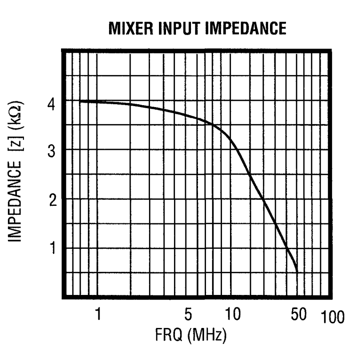


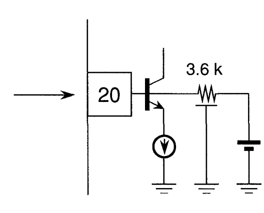


2.) MIXER

In the double balance mixer, input (pin 20) controls the internal bias. The IF signal appears at pin 4. The internal 1.8 kΩ resistor load matches the IF output impedance to the IF filter input inpedance.

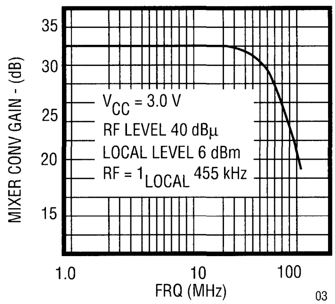
The mixer input impedance varies with the frequency, as shown in the diagram.



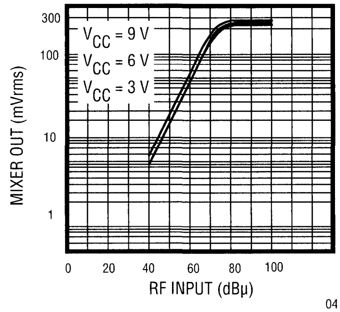


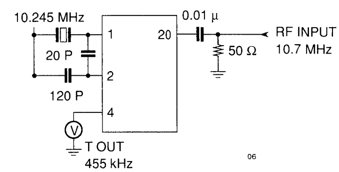
APPLICATIONS INFORMATION (CONT.)

MIXER GAIN/FREQUENCY CHARACTERISTICS



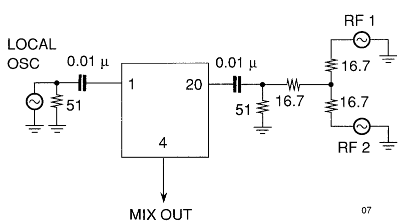
MIXER VOLTAGE GAIN

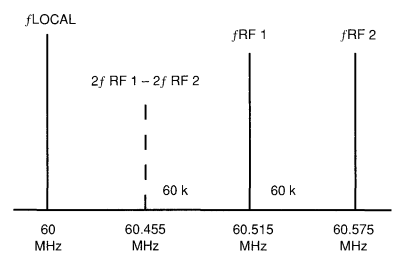




Mixer Third Order Intermodulation Distortion Output

Third order intermodulation characteristics are measured as shown below.

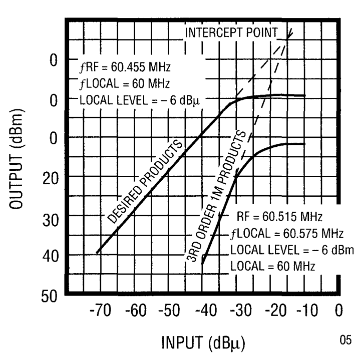


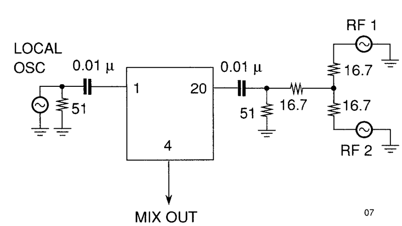


(IMP dB = 2 RF1 dB + RF2 dB + C dB)

The graph below shows the Third Order Intermodulation Output and the Desired Signal Output.

THIRD ORDER INTERMODULATION CHARACTERISTICS





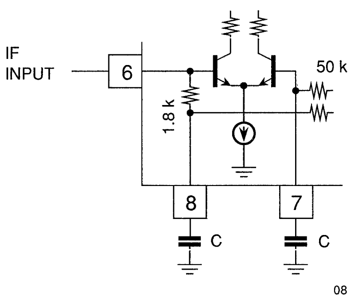
APPLICATIONS INFORMATION (CONT.)

3.) IF LIMITER AMPLIFIER

The limiter amplifier has six DC-coupled differential stages. The input resistance is 1.8 kΩ.

The decoupling capacitors at pin 7 and 8 should be connected as close as possible to the IC pins. Also, minimize the ground line impedance at these pins.

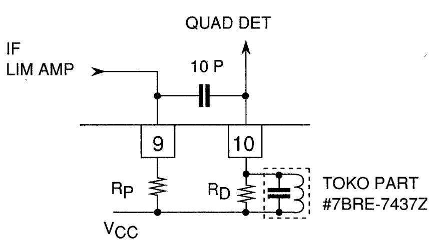
Insufficient grounding will have undesirable effects, such as reduced sensitivity.



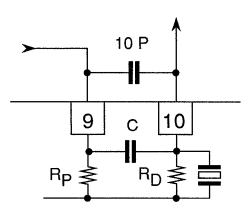
4.) PHASE SHIFTER

In order to facilitate quadrature detection, the phase of the IF AMP output signal is shifted by 90°.

A parallel resonant circuit or ceramic resonator is used for phase shifting. The required 10 pF capacitor is built into the TOKO resonant circuit.



Phase Shifter



Ceramic Discriminator

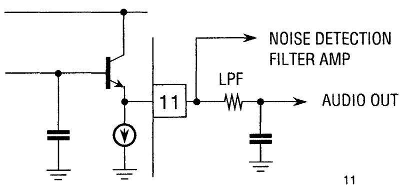
The audio output level is determined by R_P, the load resistance of the IF limiter amp output and R_D, the damping resistor. When ceramic discriminator is used, supplement the phase shift capacitance by adding a capacitor externally.

APPLICATIONS INFORMATION (CONT.)

5.) AUDIO OUTPUT

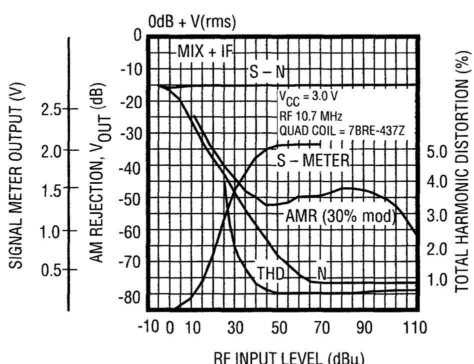
Following quadrature detection, the audio signal is available at pin 11 emitter follower output.

The output impedance of pin 11 is about 300 . An external R-C Low-pass filter is used to eleiminate residual IF components.



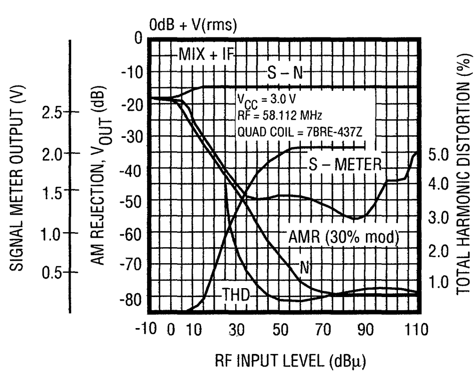
11

The following graphs show the electrical characteristics from the MIXER input to the audio output.



06

V_{CC} = 3.0 V
RF INPUT = 10.7 MHz
X'TAL = 10.245 MHz
Fm = 1 kHz
DEV= 3 kHz
FILTER = CFU455D
QUAD COIL = 7BRE-437Z
Rdamp = 22 k
R_P = 510
R_D = 3.0 k

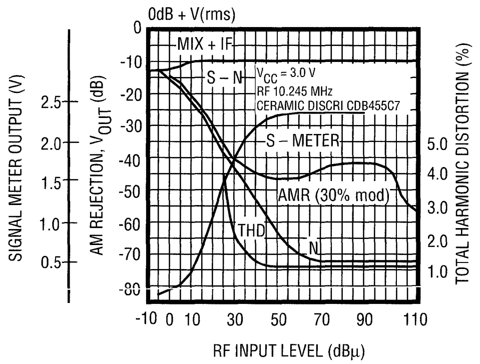


07

V_{CC} = 3.0 V
RF INPUT = 58.112 MHz
X'TAL = 57.6575 MHz
Fm = 1 kHz
DEV= 3 kHz
FILTER = CFU455D
QUAD COIL = 7BRE-437Z
Rdamp = 22 k
R_P = 510
R_D = 3.0 k

4

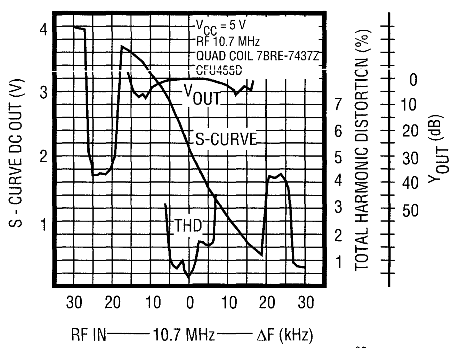
APPLICATIONS INFORMATION (CONT.)



08

V_{CC} = 5.0 V
RF INPUT = 10.7 MHz
X'TAL = 10.245 MHz
Fm = 1 kHz
DEV= 3 kHz
FILTER = CFU455D
CERAMIC DISCRIMINATION = CDB455C7
Rdamp = 2 k
R_P = 510
R_D = 3.0 k

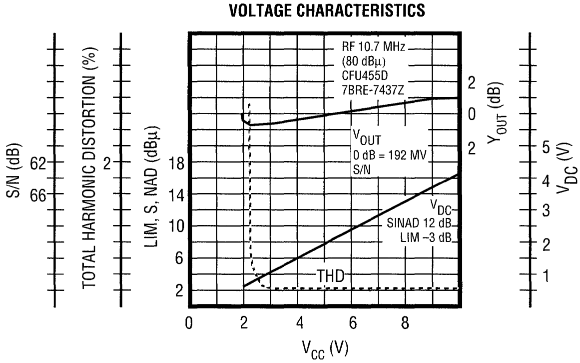
S-CURVE CHARACTERISTICS



09

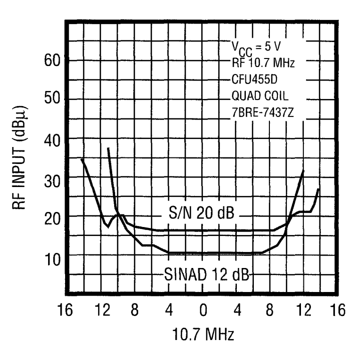
V_{CC} = 5.0 V
RF INPUT = 10.7 MHz
X'TAL = 10.245 MHz
Fm = 1 kHz
DEV= 3 kHz
FILTER = CFU455D
QUAD COIL = 7BRE-7437Z
Rdamp = 22 k
R_P = 510

POWER SUPPLY VOLTAGE CHARACTERISTICS



10

S/N 20 dB Q.S. CHARACTERISTICS

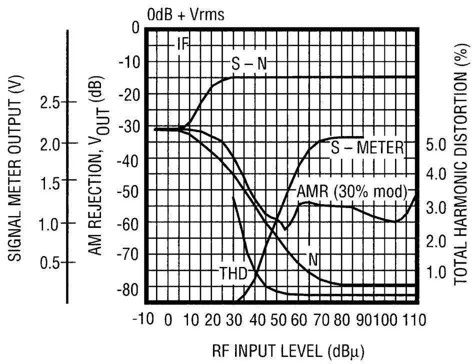


11

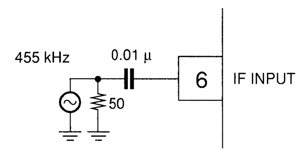
APPLICATIONS INFORMATION (CONT.)

The following graphs show the characteristics when 455 kHz IF is used.

AUDIO RECOVERY CHARACTERISTICS

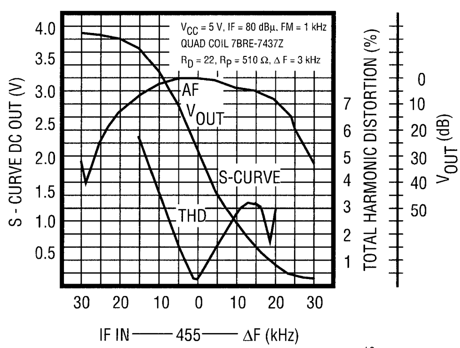


V_{CC} = 3.0 V
IF INPUT = 455 kHz
Fm = 1 kHz
DEV= 3 kHz
QUAD COIL = 7BRE-437Z
Rdamp = 22 k
R_P = 510
R_D = 3 k



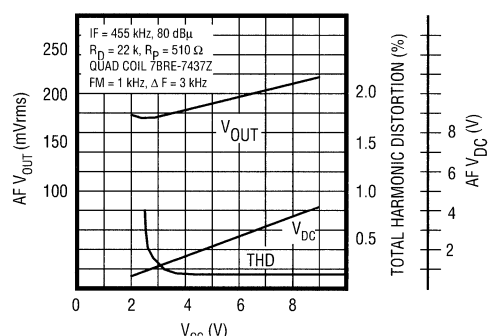
12

S-CURVE CHARACTERISTICS



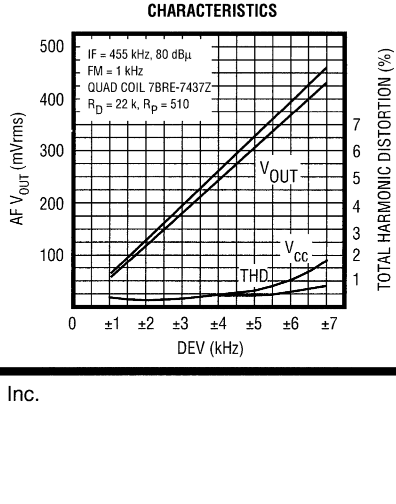
13

POWER SUPPLY VOLTAGE CHARACTERISTICS

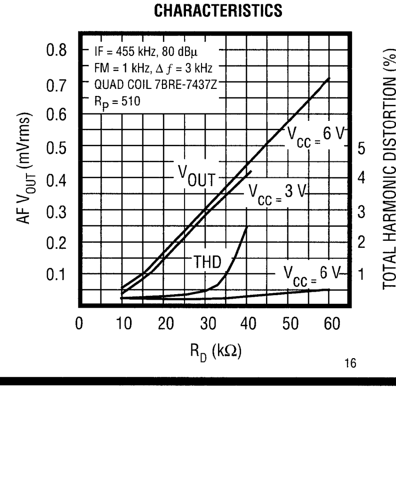


14

MODULATION/AUDIO OUTPUT CHARACTERISTICS



MODULATION/AUDIO OUTPUT CHARACTERISTICS

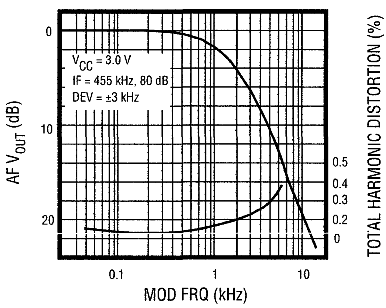


16

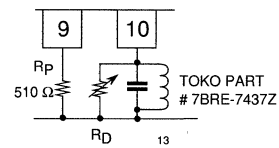
4

APPLICATIONS INFORMATION (CONT.)

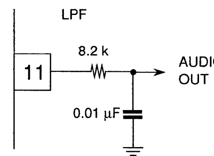
LPF CHARACTERISTICS



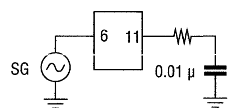
17



13



14



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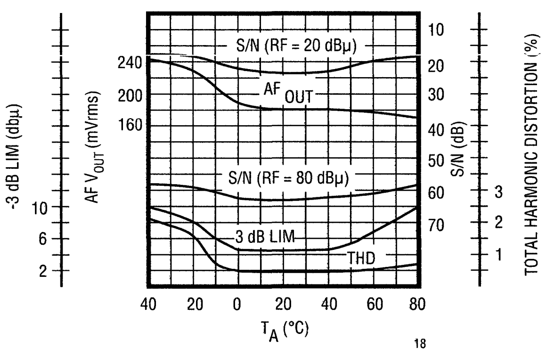
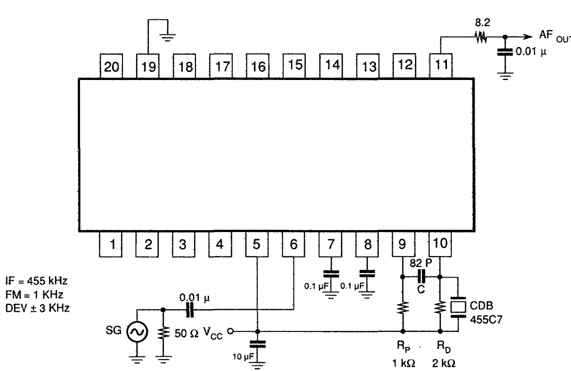
TEMPERATURE CHARACTERISTICS



18

V_{CC} = 3.0 V
RF INPUT = 10.7 MHz
X'TAL = 10.245 MHZ
FM = 1 kHz
DEV = 3 kHz
FILTER = CFU455D
QUAD COIL = 7BRE-7437Z
R_{DAMP} = 22 k
R_P = 510

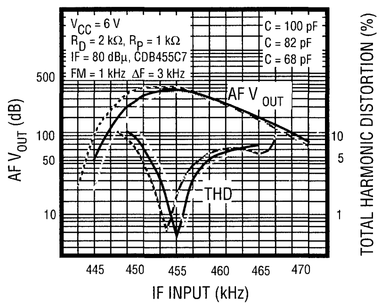
Receiver Characteristics When Ceramic Discriminator Is Used



APPLICATIONS INFORMATION (CONT.)

The following graphs show the characteristicsat various C, R_D, and R_P values.

FREQUENCY CHARACTERISTICS



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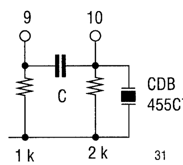

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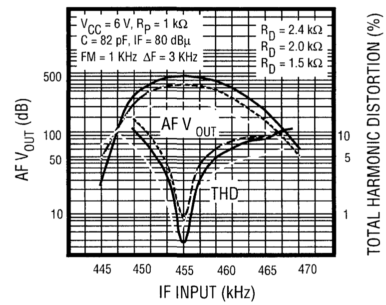
FREQUENCY CHARACTERISTICS



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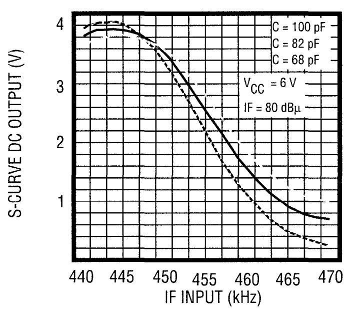
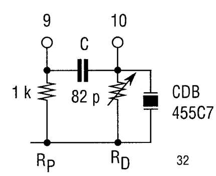
S-CURVE CHARACTERISTICS

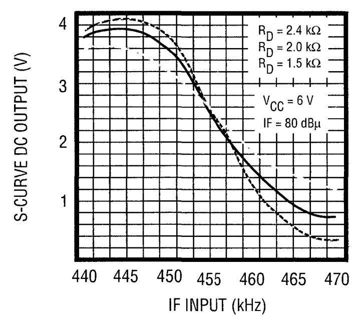


20



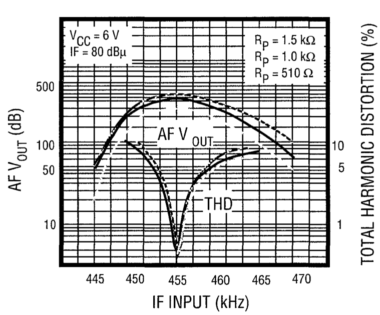
32

S-CURVE CHARACTERISTICS

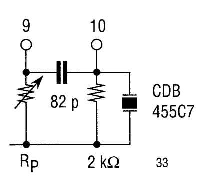


22

FREQUENCY CHARACTERISTICS

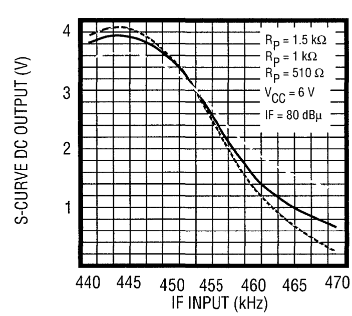


23



33

S-CURVE CHARACTERISTICS



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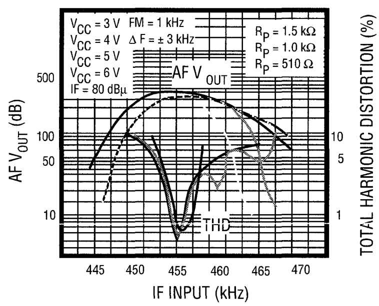
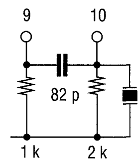
APPLICATIONS INFORMATION (CONT.)

FREQUENCY CHARACTERISTICS

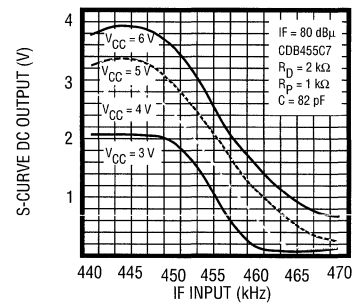


25



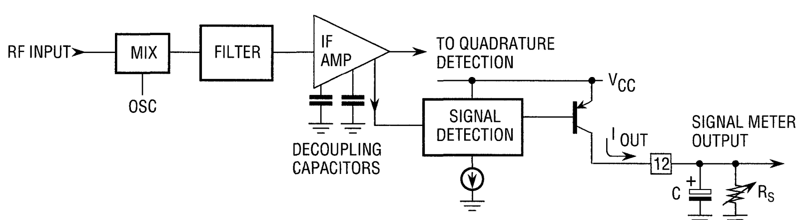
34

S-CURVE CHARACTERISTICS



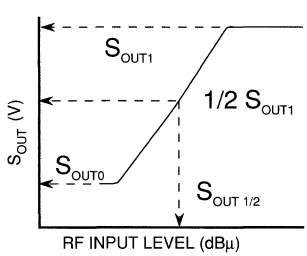
26

The signal extracted from the middle stages of the IF limiter amplifier is fed to the Signal Meter Detection circuit and then to pin 12 in the form of a current.



When a voltage output is needed, use a resistor to convert from acurrent to a voltage. C is a smoothing capacitor. The maximum output current is 650 μA. (TYP).

The standard characteristics of the signal meter are described below.



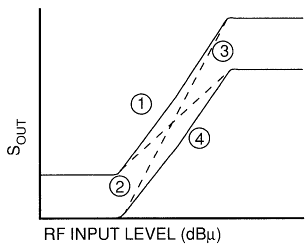
03

S_{OUT1}: Strong Input
S_{OUT0}: No Input
$S_{OUT1/2}$: RF Input Level = 1/2 Strong Input
(V_{CC} = 3.0 V, R_S = 3.0 k)

$1.3 < S_{OUT1} < 2.7$ [V]
$S_{OUT0} < 0.3$ [V]
$17 < S_{OUT1/2} < 29$ [dBμ]

APPLICATIONS INFORMATION (CONT.)

Variations of Signal Meter Characteristics

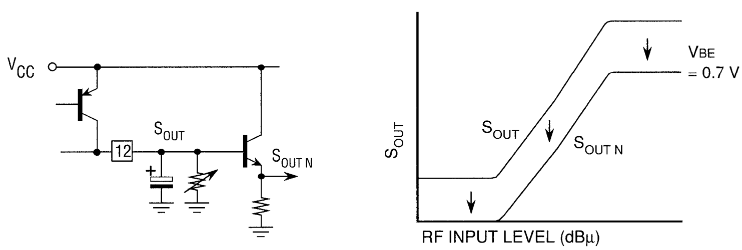


04

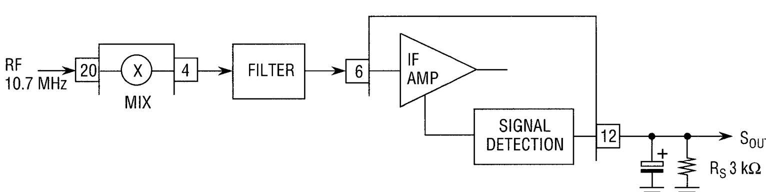
The S_{OUT0} value will change depending on power line noise, the narrow band filter's pass band, the way the IF AMP's decoupling capacitor is bridged, etc.

The representative variations of the Signal Meter Characteristics is shown in the graph and marked by number 1, 2, 3, and 4.

If the offset voltage of S_{OUT0} is a problem, use an emitter follower as shown in the diagram below.



05



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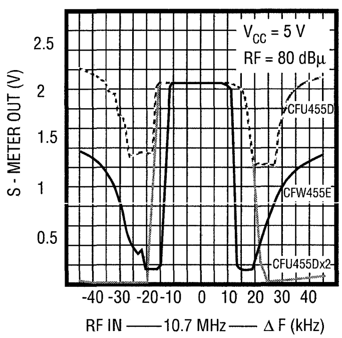
APPLICATIONS INFORMATION (CONT.)

SIGNAL METER OUTPUT BANDWIDTH CHARACTERISTICS



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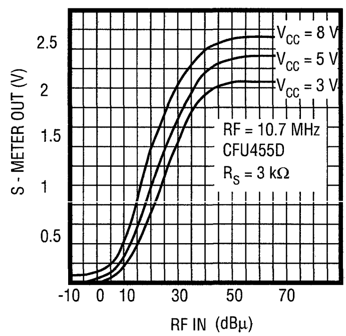
SIGNAL METER OUTPUT CHARACTERISTICS



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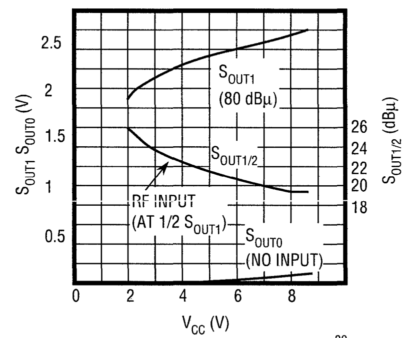
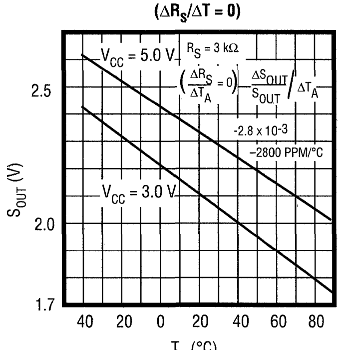
POWER SUPPLY VOLTAGE CHARACTERISTICS



29

S_{OUT} vs. AMBIENT TEMPERATURE ($\Delta R_S/\Delta T = 0$)



30

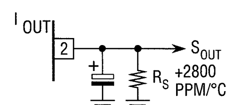
If the Signal Meter Output current is I_{OUT} and the load resistance is Rs, than $S_{OUT} = I_{OUTX}$ Rs and the temperature dependence is:

$$\frac{\Delta S_{OUT}}{\Delta T} = Rs\frac{\Delta I_{OUT}}{\Delta T} + I_{OUT}\frac{\Delta Rs}{\Delta T}$$

The equation below must be satisfied in order to eliminate variation in S_{OUT} with respect to temperature (S_{OUT}/ T = 0).

$$\frac{\Delta Rs}{Rs} = -\frac{\Delta I_{OUT}}{I_{OUT}}$$

The graph to the left shows the temperature dependence of S_{OUT} when (Rs/ T = 0). (S_{OUT} = Rs X I_{OUT}) When a +2800 PPM/°C positive temperature coefficient resistor is used for Rs, the temperature variation of S_{OUT} can be suppressed.



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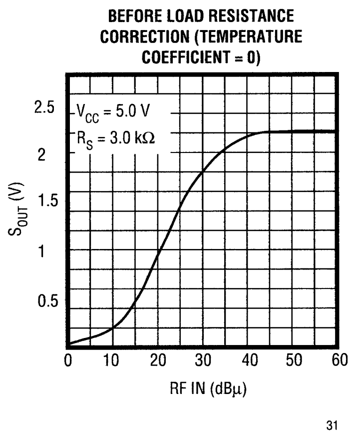
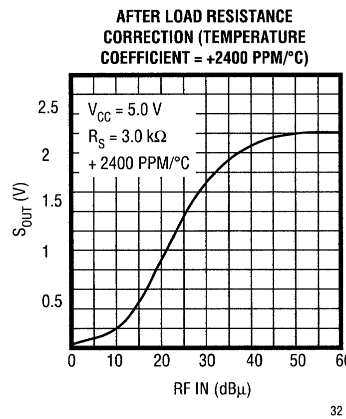
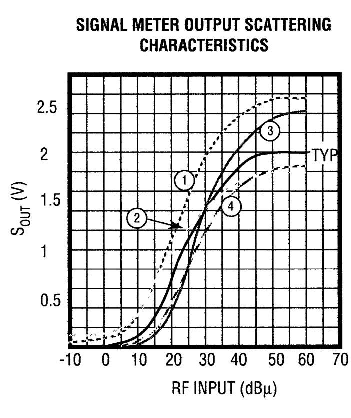
APPLICATIONS INFORMATION (CONT.)

The graphs below show S_{OUT} vs. T_A when the load resistance Rs has a temperature coefficient of 0 (left graph) and +2400 PPM/°C (right graph).





The graph below shows representative examples of variations in Signal Meter Characteristics.

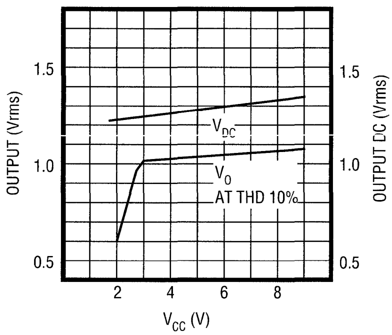


APPLICATIONS INFORMATION (CONT.)

6.) OPAMP

The Opamp is an inverting type. It is biased to 1.25 V by a bandgap reference circuit. The opamp can be used as a noise detection filter amplifier with excellent temperature characteristics.

LARGE SIGNAL RESPONSE



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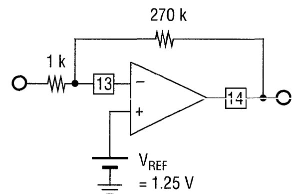
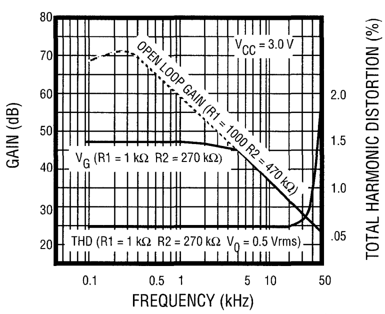
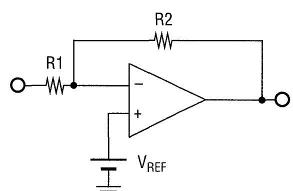


19

FREQUENCY RESPONSE AND DISTORTION

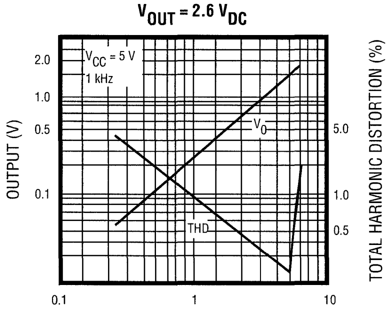


35



25

OP AMP I/O CHARACTERISTICS
V_{OUT} = 2.6 V_{DC}



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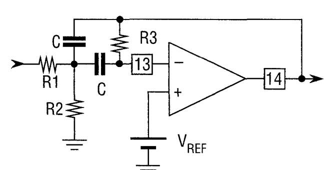
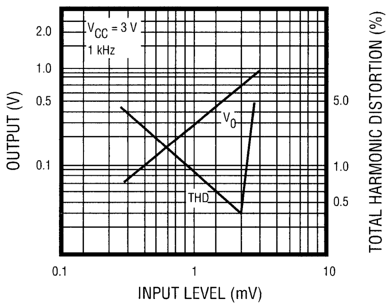


20

APPLICATIONS INFORMATION (CONT.)

OP AMP I/O CHARACTERISTICS
V_{OUT} = 1.25 V_{DC}



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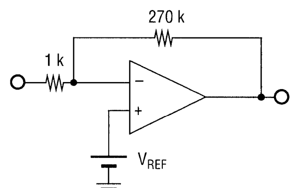
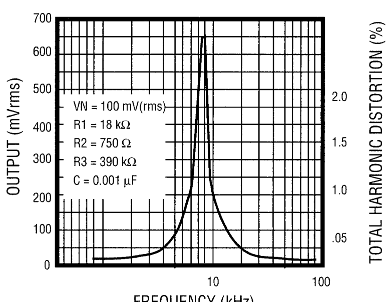


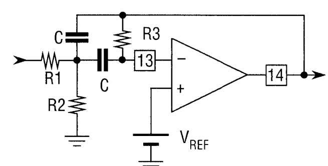
26

The example below shows the opamp when used as a band pass filter.

FIGURE 38: BAND PASS FILTER CHARACTERISTICS



38



20

G_0 = gain at central fo

$$Q = fo / BW$$

$$R_3 = \frac{Q}{\pi foC}$$

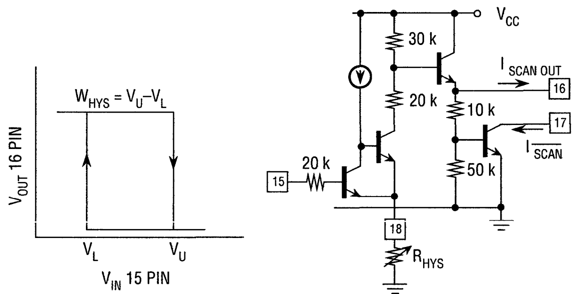
$$R_1 = \frac{R_3}{2G_0}$$

$$R_2 = \frac{R_1 \bullet R_3}{4Q^2 R_1 - R_3}$$

06

APPLICATIONS INFORMATION (CONT.)

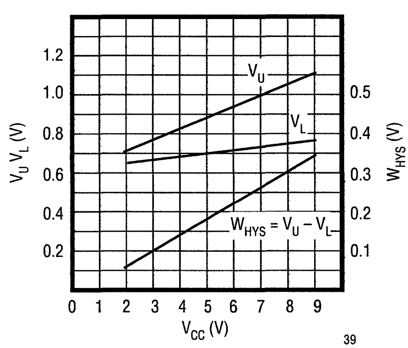
Squelch Trigger Circuit



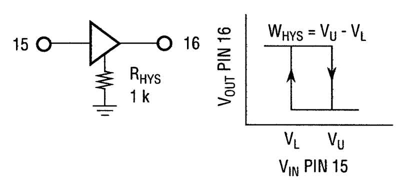
21

The hysteresis width (W_{HYS}) can be changed with a resistor connected to pin 18 (R_{HYS}). Pin 17 is an open collector output. The hysteresis characteristics are shown on below.

HYSTERESIS vs V_{CC} CHARACTERISTICS



39



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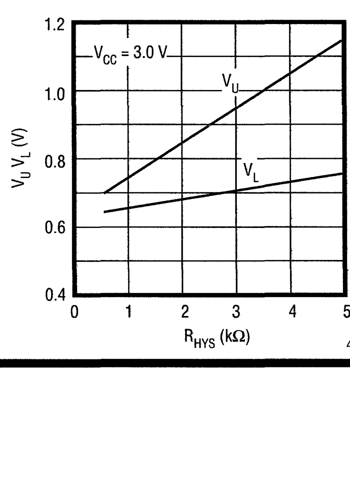
HYSTERESIS vs R_{HYS}



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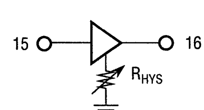

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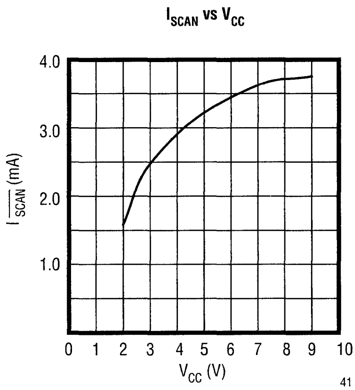
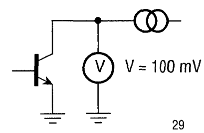
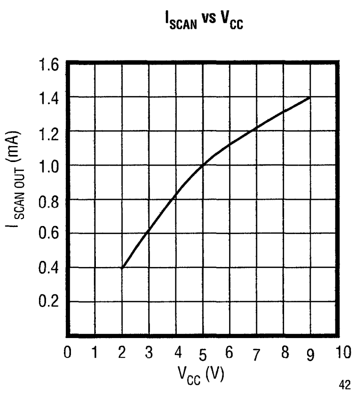
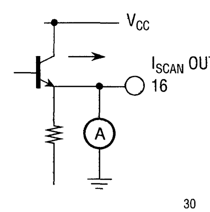
APPLICATIONS INFORMATION (CONT.)



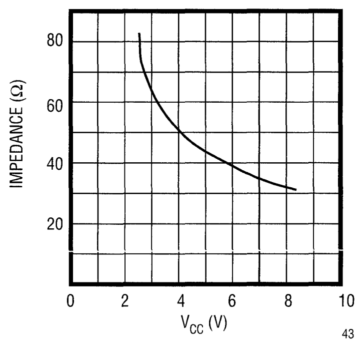


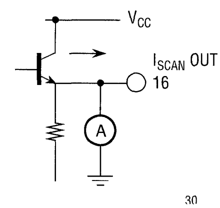




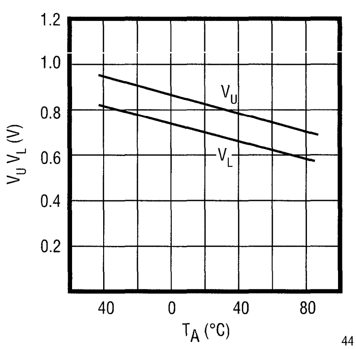
APPLICATIONS INFORMATION (CONT.)

PIN 16 OUTPUT RESISTANCE vs SUPPLY VOLTAGE

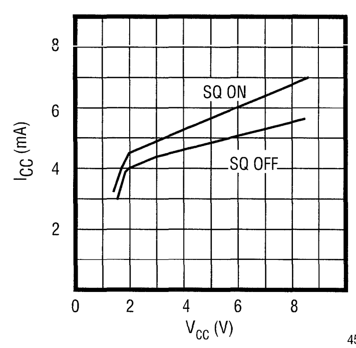




TEMPERATURE CHARACTERISTICS



SUPPLY CURRENT vs SUPPLY VOLTAGE



TOKO

NARROW BAND FM-IF AMPLIFIER

FEATURES

- Built-in Signal Meter Driver
- Wide Operating Voltage Range
- High Limiting Sensitivity
- Wide Frequency Range
- Built-in Mixer

APPLICATIONS

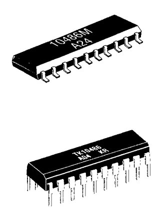
- Scanners
- Cordless Telephones
- VHF Radio
- Communications Equipment

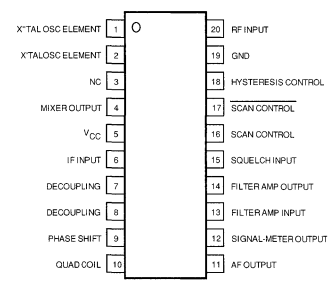
DESCRIPTION

The TK10486 has been developed for double conversion FM receivers. It has a built-in mixer, oscillator, IF amplifier, FM demodulator, received signal strength indicator drive and squelch circuitry. IF frequencies up to 30 MHz can be accommodated. Supply current and supply voltage has been minimized for use in battery powered systems. The signal meter output is typically 37 dBµ.

The TK10486 is available in MFP20 and DIP20 packages.

TK10486





ORDERING INFORMATION

TK10486 ☐ ☐ ☐☐

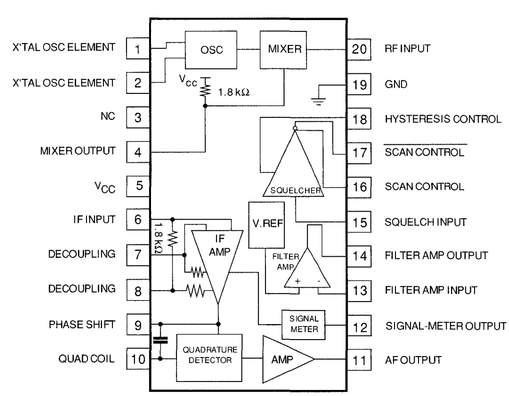
- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE
M: Surface Mount
D: PLASTIC DIP

TEMP. RANGE
C : -30 to +70 °C

TAPE/REEL CODE
BX: Bulk/Bag
TX: Paper Tape
TR: Tape Right
TL: Tape Left
MG: Magazine

BLOCK DIAGRAM



4

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 10 V
Power Dissipation (M Package) Note 1 .... 410 mW
Power DIssipation (D Package) Note 2 .... 1000 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -30 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 6.0 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC1}	Supply Current	No input, squelch off		4.4	6.6	mA
I_{CC2}	Supply Current	No input, squelch on		5.0	7.6	mA
Limit	Limiting Sensitivity	-3 dB V_{OUT}		2.0	8.0	µV
V_{OUT}	Detector Output	V_{IN} = 10 mV; dev., ± 3 kHz	100	180	250	mV(rms)
Detector Output						
V_{DC}	Terminal Voltage	V_{IN} = 10 mV, unmodulated	0.8	1.3	2.0	V
Z_{OUT}	Impedance	V_{IN} = 10 mV		500	1500	Ω
THD	Distortion	V_{IN} = 10 mV		1.0	2.0	%
Filter Amplifier						
F_G	Filter Amplifier Gain	F_{IN} = 10 kHz; V_O = 100 mV(rms)	33	38		dB
F_{DC}	Output Voltage	No input	0.8	1.2	1.5	V
HYS	Squelch Hysteresis	R_{HYS} = 1 kΩ		80		mV
Scan Control						
S_H	High Level	Squelch input = 0 V	2.3			V
S_L	Low Level	Squelch input = 2.5 V			0.5	V
S_H	High Level	Squelch input = 2.5 V	2.3			V
S_L	Low Level	Squelch input = 0 V			0.5	V

Note 1: Power dissipation must be derated at the rate of 4.8 mW/°C at T_A = 25 °C and above .
Note 2: Power dissipation must be derated at the rate of 8 mW/°C at T_A = 25 °C and above .

ELECTRICAL CHARACTERISTICS (CONT.)

Test conditions: V_{CC} = 6.0 V, T_A = 25 °C, unless otherwise specified.

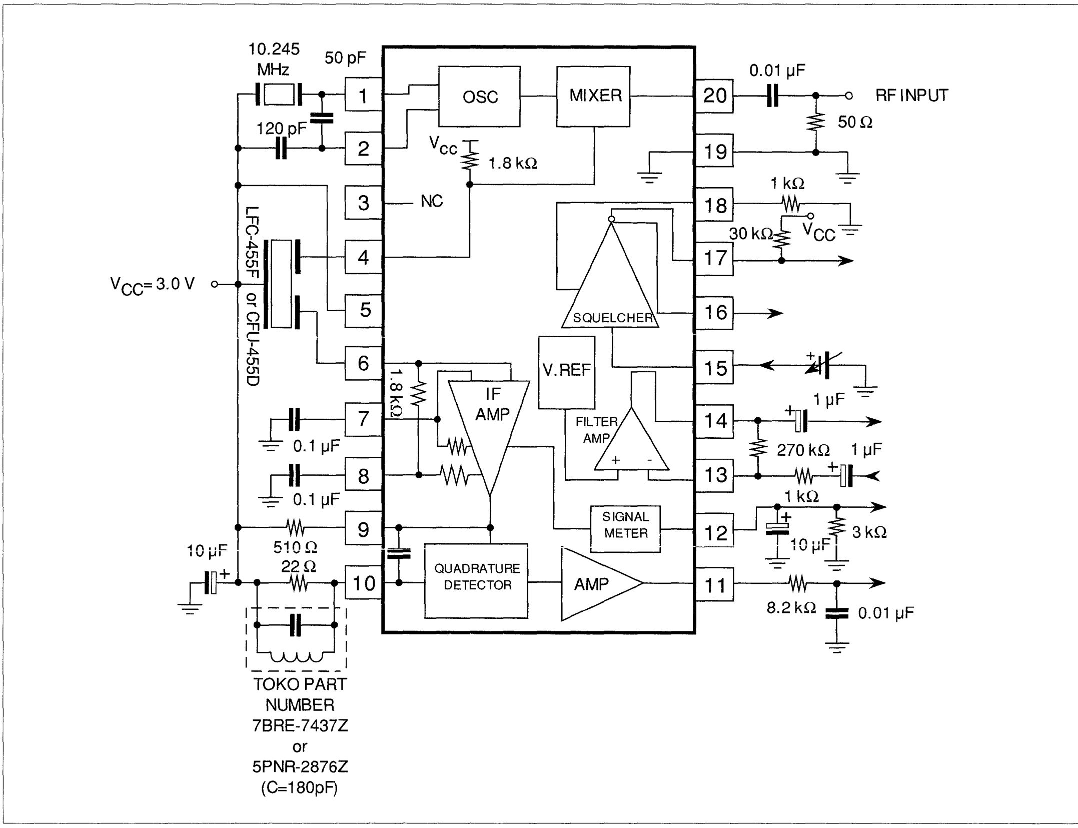
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Mixer						
M_G	Mixer Conversion Gain			25		dB
M_{INR}	Mixer Input Resistance	DC measurement		3.6		kΩ
M_{INC}	Mixer Input Capacitance			2.2		pF
Signal Meter Output						
S_{OUT1}	Signal Meter Output	V_{IN} = 10 mV, Rs = 3 kΩ	1.3	2.0	2.7	V
S_{OUT0}	Signal Meter Output	V_{IN} = 0 mV, Rs = 3 kΩ			0.3	V
$S_{OUT\ 1/2}$	Signal Meter Output	RF Input at 1/2 S_{OUT1}	32	37	41	dBμ

METER OUTPUT RANGE

RANK/SPEC	SIGNAL OUTPUT		
	MIN (V)	TYP(V)	MAX(V)
A	1.3		1.72
B	1.70		2.32
C	2.30		2.70

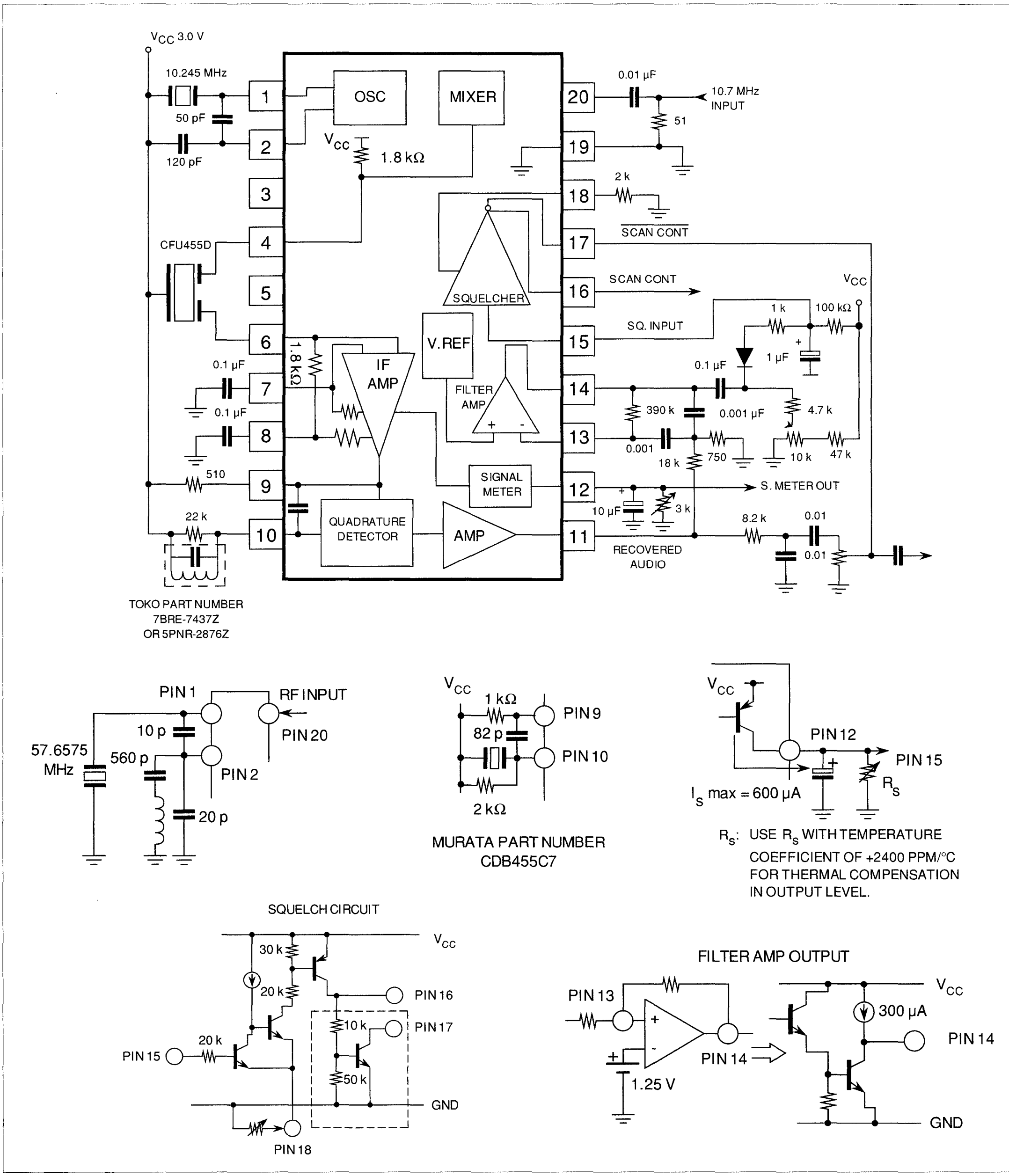
4

TEST CIRCUIT



NOTES

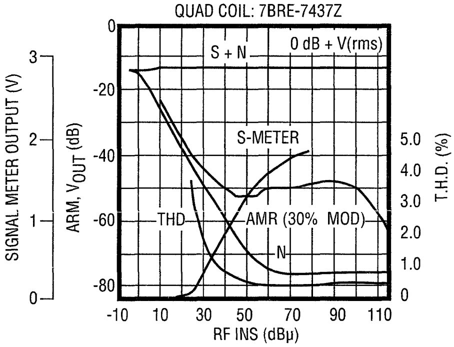
TYPICAL APPLICATION



TYPICAL PERFORMANCE CHARACTERISTICS

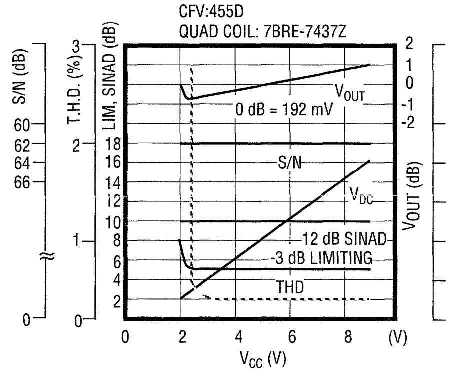
RECEIVER CHARACTERISTICS

V_{CC}: 3 V
RF:10.7 MHz (Mix IN)
QUAD COIL: 7BRE-7437Z

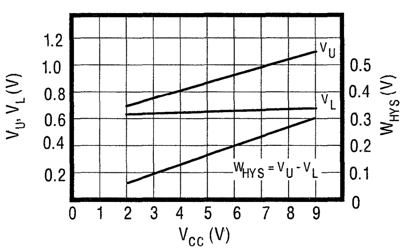


SUPPLY VOLTAGE CHARACTERISTICS WITH QUAD COIL

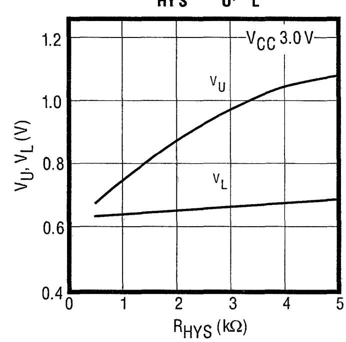
RE: RF10.7 MHz (80 dBμ)
CFV:455D
QUAD COIL: 7BRE-7437Z



V_{CC} vs V_U, V_L



R_{HYS} vs V_U, V_L



NARROW BAND FM-IF AMPLIFIER

FEATURES

- Built-in Signal Meter Driver
- Wide Operating Voltage Range
- High Limiting Sensitivity
- Wide Frequency Range
- Built-in Mixer

APPLICATIONS

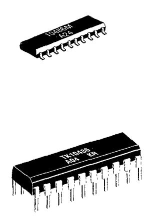
- Cellular Phones
- Cordless Telephones
- VHF Radio
- Scanners

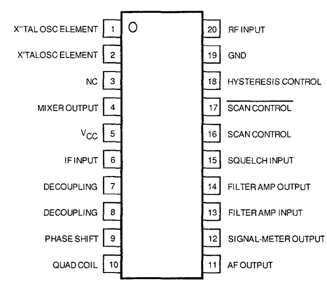
DESCRIPTION

The TK10487 has been developed for double conversion FM receivers. It has a built-in mixer, oscillator, IF amplifier, FM demodulator, received signal strength indicator drive and squelch circuitry. IF frequencies up to 30 MHz can be accommodated. Supply current and supply voltage has been minimized for use in battery powered systems. The signal meter output is typically 38 dBμ.

The TK10487 is available in MFP20 and DIP20 packages.

TK10487





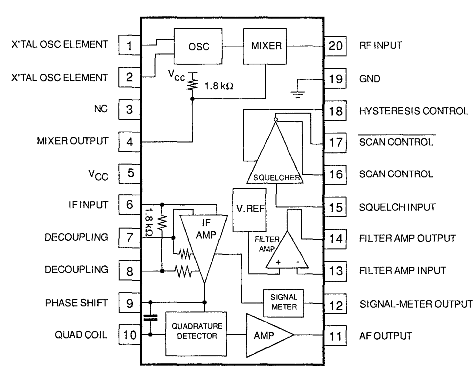
ORDERING INFORMATION

TK10487 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: Surface Mount	C : -30 to +70 °C	BX: Bulk/Bag
D: PLASTIC DIP		TX: Paper Tape
		TR: Tape Right
		TL: Tape Left
		MG: Magazine

BLOCK DIAGRAM



4

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 10 V
Power Dissipation (M Package) Note 1 .... 410 mW
Power DIssipation (D Package) Note 2 .... 1000 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -30 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 6.0 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC1}	Supply Current	No input, squelch off		4.4	6.6	mA
I_{CC2}	Supply Current	No input, squelch on		5.0	7.6	mA
Limit	Limiting Sensitivity	-3 dB V_{OUT}		2.0	8.0	µV
V_{OUT}	Detector Output	V_{IN} = 10 mV; dev., ± 3 kHz	100	180	250	mV(rms)
Detector Output						
V_{DC}	Terminal Voltage	V_{IN} = 10 mV, unmodulated	0.8	1.3	2.0	V
Z_{OUT}	Impedance	V_{IN} = 10 mV		500	1500	Ω
THD	Distortion	V_{IN} = 10 mV		1.0	2.0	%
Filter Amplifier						
F_G	Filter Amplifier Gain	F_{IN} = 10 kHz; V_O = 100 mV(rms)	33	38		dB
F_{DC}	Output Voltage	No input	0.8	1.2	1.5	V
HYS	Squelch Hysteresis	R_{HYS} = 1 kΩ		80		mV
Scan Control						
S_H	High Level	Squelch input = 0 V	2.3			V
S_L	Low Level	Squelch input = 2.5 V			0.5	V
S_H	High Level	Squelch input = 2.5 V	2.3			V
S_L	Low Level	Squelch input = 0 V			0.5	V

Note 1: Power dissipation must be derated at the rate of 4.8 mW/°C at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 8 mW/°C at T_A = 25 °C and above.

ELECTRICAL CHARACTERISTICS (CONT.)

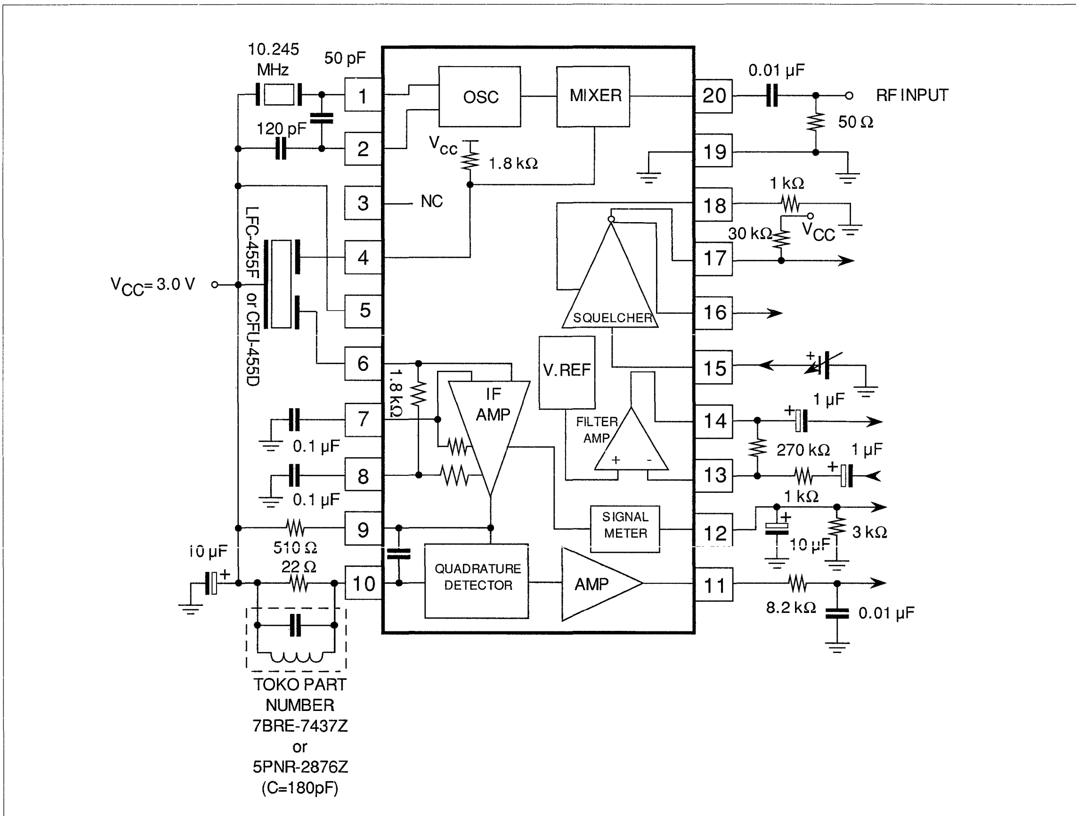
Test conditions: V_{CC} = 6.0 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Mixer						
M_G	Mixer Conversion Gain			25		dB
M_{INR}	Mixer Input Resistance	DC measurement		3.6		kΩ
M_{INC}	Mixer Input Capacitance			2.2		pF
Signal Meter Output						
S_{OUT1}	Signal Meter Output	V_{IN} = 10 mV, R_S = 3 kΩ	1.3	2.0	2.7	V
S_{OUT0}	Signal Meter Output	V_{IN} = 0 mV, R_S = 3 kΩ			0.3	V
$S_{OUT\ 1/2}$	Signal Meter Output	RF Input at 1/2 S_{OUT1}	33	38	45	dBμ

METER OUTPUT RANGE

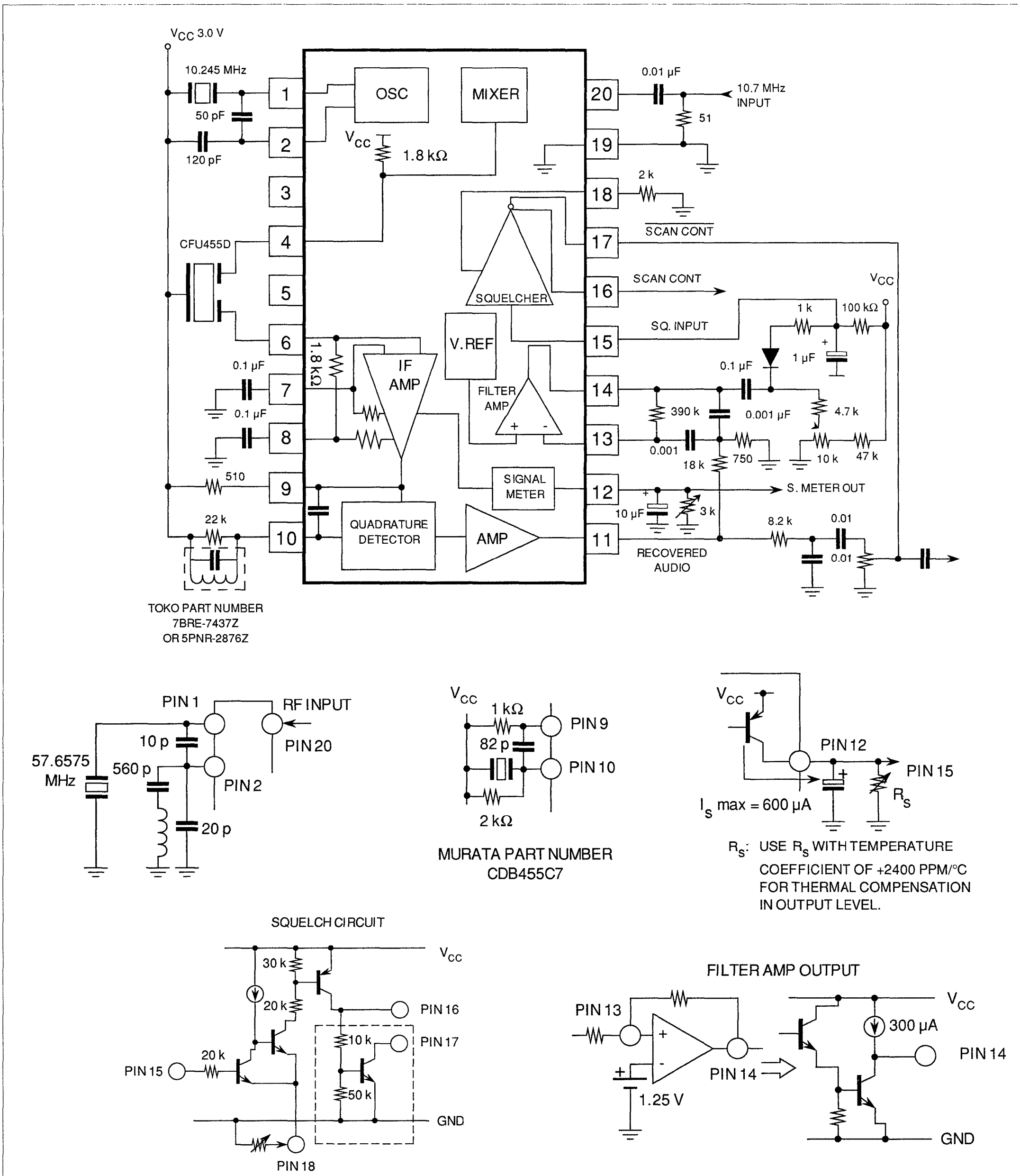
RANK/SPEC	SIGNAL OUTPUT		
	MIN (V)	TYP(V)	MAX(V)
A	1.3		1.72
B	1.70		2.32
C	2.30		2.70

TEST CIRCUIT



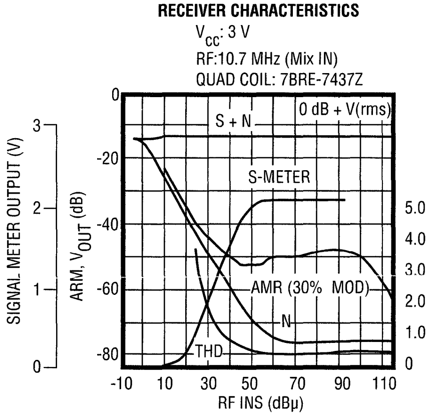
NOTES

TYPICAL APPLICATION

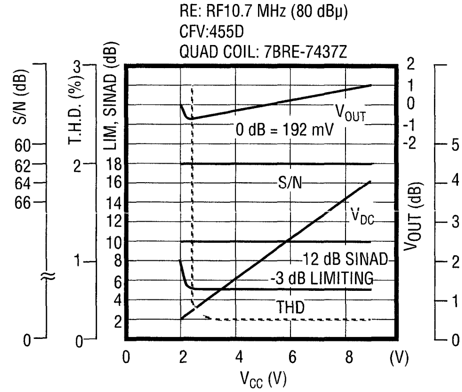


TYPICAL PERFORMANCE CHARACTERISTICS

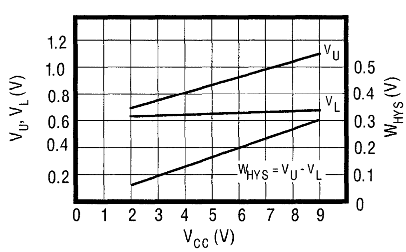
RECEIVER CHARACTERISTICS



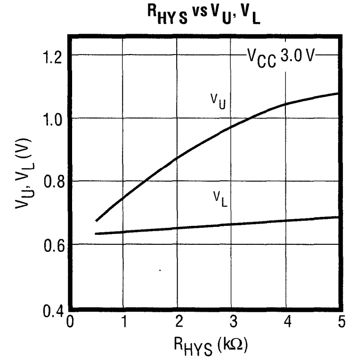
SUPPLY VOLTAGE CHARACTERISTICS WITH QUAD COIL



V_{CC} vs V_U, V_L



R_{HYS} vs V_U, V_L



NARROW BAND FM IF AMPLIFIER

FEATURES

- **Input Frequency 60 MHz**
- **Low Operating Current**
- **Low Operating Voltage**
- **Signal Strength Meter Output**
- **Small Surface Mount Package**

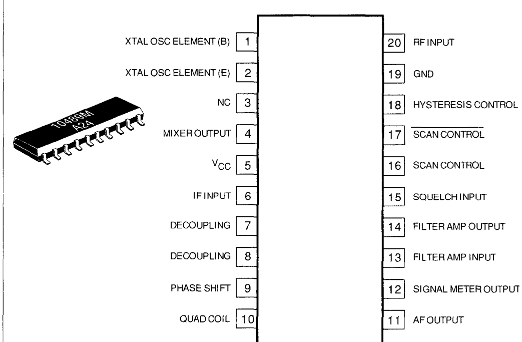
APPLICATIONS

- **Amateur Radio Transceivers**
- **Cordless Telephones**
- **Scanners**
- **Communications Devices**

DESCRIPTION

The TK10489 is a narrow band FM IF IC with built-in squelch, filter amp and mixer for dual conversion IF applications. The RF input can be as high as 60 MHz and the mixer output frequency is typically 455 kHz, suitable for ceramic filtering. The device has a signal strength meter output, and adjustable squelch. The TK10489 is available in an MFP-20 surface mount package.

TK10489M



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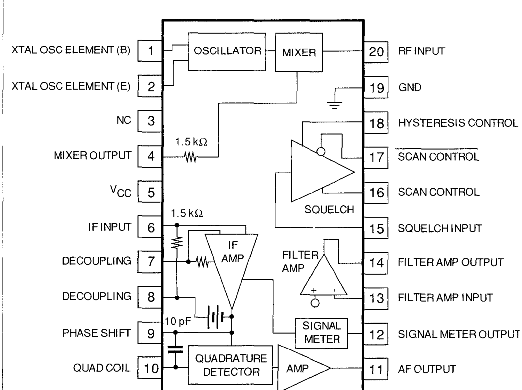


ORDERING INFORMATION

TK10489 ☐ ☐ ☐☐

- **Tape/Reel Code**
- **Temp. Range**
- **Package Code**

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M: SURFACE MOUNT	C : -30 to +70 °C	BX : Bulk/Bag
		MG: Magazine
		TR: Tape Right
		TL: Tape Left

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 10 V
Power Dissipation (Note 1) .... 410 mW
Junction Temperature .... 150 °C
Operating Voltage Range .... 2.5 to 8.0 V
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -30 to +70 °C
Lead Soldering Temp. (10 sec.) .... 300 °C

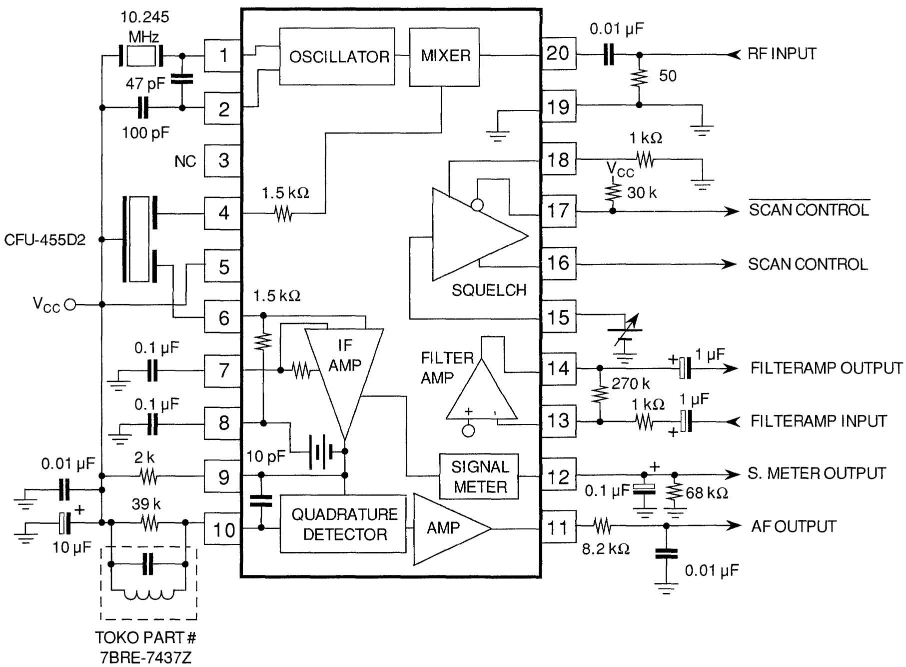
ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 5.0 V, T_A = 25 °C, $F_{(RF\ IN)}$ = 10.7 MHz, Δf = ±3 kHz, fm = 1 kHz, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC1}	Supply Current	No input, squelch off		2.6	4.0	mA
I_{CC2}	Supply Current	No input, squelch on		3.2	5.0	mA
Limit	Limiting Sensitivity	-3 dB Point		2.0	6.0	µV
V_{OUT}	Detector Output	V_{IN} = 10 mV; dev., ± 3 kHz	170	250	350	mV(rms)
Z_{OUT}	Impedance	V_{IN} = 10 mV		800		Ω
THD	Distortion	V_{IN} = 10 mV		1.0	2.5	%
F_G	Filter Amplifier Gain	F_{IN} = 10 kHz; V_{IN} = 3 mV	40	46		dB
F_{DC}	Output Voltage	No input		0.7		V
S_H	Scan Control High Level	Squelch input = 0 V	4.3			V
S_L	Scan Control Low Level	Squelch input = 2.5 V			0.5	V
$\overline{S_H}$	$\overline{\text{Scan Control High Level}}$	Squelch input = 2.5 V	2.3			V
$\overline{S_L}$	$\overline{\text{Scan Control Low Level}}$	Squelch input = 0 V			0.5	V
HYS	Squelch Hysteresis	R_{HYS} = 1 kΩ		80		mV
M_G	Mixer Conversion Gain			28		dB
M_{INR}	Mixer Input Resistance	DC measurement		3.6		kΩ
S_{DY}	Signal Meter Output Dynamic Range		70	80		dB
S_{OUT0}	Signal Meter Output (0)	V_{IN} = 0 mV, Rs = 68 kΩ		0.25	0.50	V
S_{OUT1}	Signal Meter Output (1)	V_{IN} = 0.01 mV, Rs = 68 kΩ	0.15	0.50	0.80	V
S_{OUT2}	Signal Meter Output (2)	V_{IN} = 0.1 mV, Rs = 68 kΩ	0.70	1.05	1.40	V
S_{OUT3}	Signal Meter Output (3)	V_{IN} = 1 mV, Rs = 68 kΩ	1.25	1.65	2.00	V
S_{OUT4}	Signal Meter Output (4)	V_{IN} = 10 mV, Rs = 68 kΩ	1.85	2.20	2.60	V
S_{OUT5}	Signal Meter Output (5)	V_{IN} = 100 mV, Rs = 68 kΩ	2.05	2.40	2.80	V

Note 1: Power dissipation must be derated at the rate of 3.3 mW/°C for operation at T_A = 25 °C and above.

TEST CIRCUIT



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NOTES

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TK10491/10492

PRELIMINARY INFORMATION

DUAL CONVERSION FM IF AMPLIFIERS

FEATURES

- Small Package
- Wide Operating Voltage Range
- Low Power Dissipation
- High Sensitivity
- Internal Squelch Circuit
- Ceramic Discriminator

APPLICATIONS

- Cordless Phones
- Portable Communications Equipment
- Scanners
- Handy Talkies
- CB Radios
- Data Tranceivers
- R/C Toys/Models
- UHF Tranceivers

DESCRIPTION

The TK10491M/10492M are FM IF amplifiers mixers designed for cordless and cellular phones.

The TK10491 is designed to use a ceramic discriminator and the TK10492 is designed for a coil type discriminator.

ORDERING INFORMATION

TK1049 □ □ □ □□

- IC Type
- Tape/Reel Code
- Temp. Range
- Package Code

IC TYPE
1: Ceramic Quad Detector
2: Quad Coil

PACKAGE CODE
M: Surface Mount

TEMP. RANGE
C : -30 to +70 °C

TAPE/REEL CODE
BX: Bulk/Bag
TR: Tape Right
TL: Tape Left
MG: Magazine

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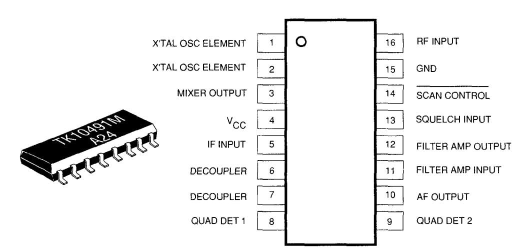
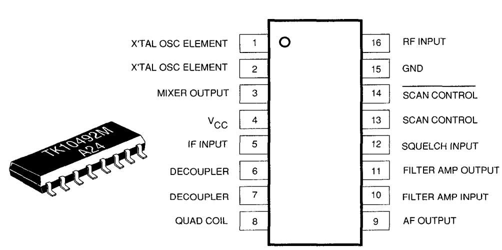
TK10491



TK10492



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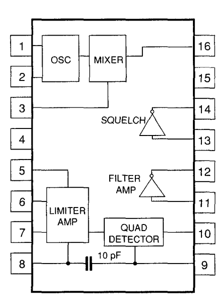
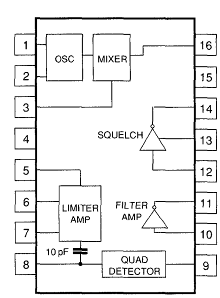
TK10491M



TK10492M



ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CCMAX} .... 10 V
Power Dissipation (Note 1) .... 600 mW
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -30 to +75 °C
Operating Voltage Range .... 2.5 to 8.0 V
Junction Temperature .... 150 °C
Lead Soldering Temp. (10 sec.) .... 300 °C
Input Frequency .... ~60 MHz

ELECTRICAL CHARACTERISTICS

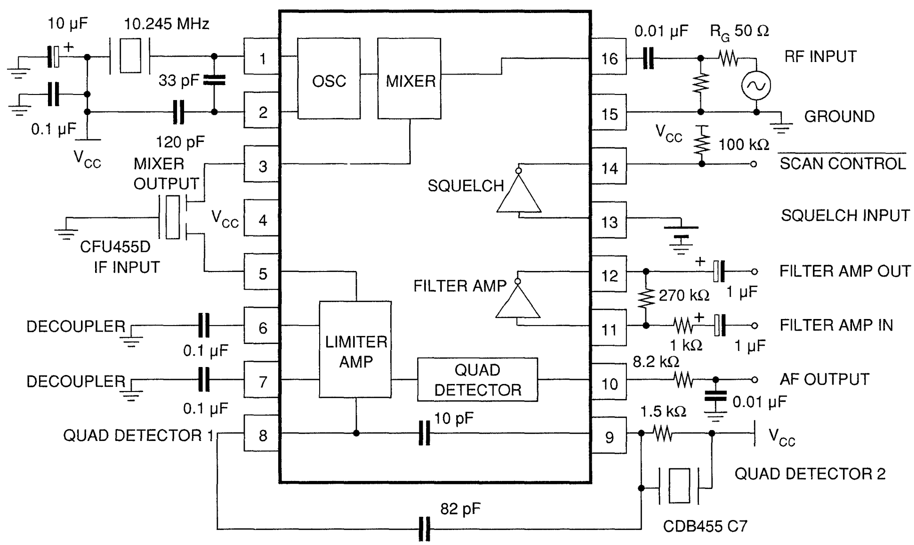
Test conditions: V_{CC} = 3.0 V, T_A = 25 °C, F_{IN} = 10.7 MHz, F_{MOD} = 1 kHz, ±3 kHz Dev.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC1}	Supply Current 1	Squelch Off		2.8	3.8	mA
I_{CC2}	Supply Current 2	Squelch On		3.3	4.4	mA
Limit	Limiting Sensitivity	F_{MOD} 1 kHz, ±3 kHz Dev		2.0	6.0	µV
V_{OUT}	Output Voltage	V_{IN} = 10 mV		100	180	mA
THD	Total Harmonic Distortion	V_{IN} = 10 mV		1.0	2.5	%
Z_{OUT}	Output Impedance			600		kΩ
F_G	Filter Gain	f = 10 kHz, V_{IN} = 1 mV	40	46		dB
S_L	SQ Output Level (on)	Squelch Input 2.5 V			0.5	V
S_H	SQ Output Level (off)	Squelch Input 0.0 V	2.5			V
M_G	Mixer Conversion Gain		21	28		dB
M_R	Mixer Input Impedance			3.6		kΩ

Note 1: Power dissipation must be derated at the rate of 4.8 mW/ °C for operation at T_A = 25 °C and above.

NOTES

TEST CIRCUIT FOR 10491



Ceramic Quad Detector

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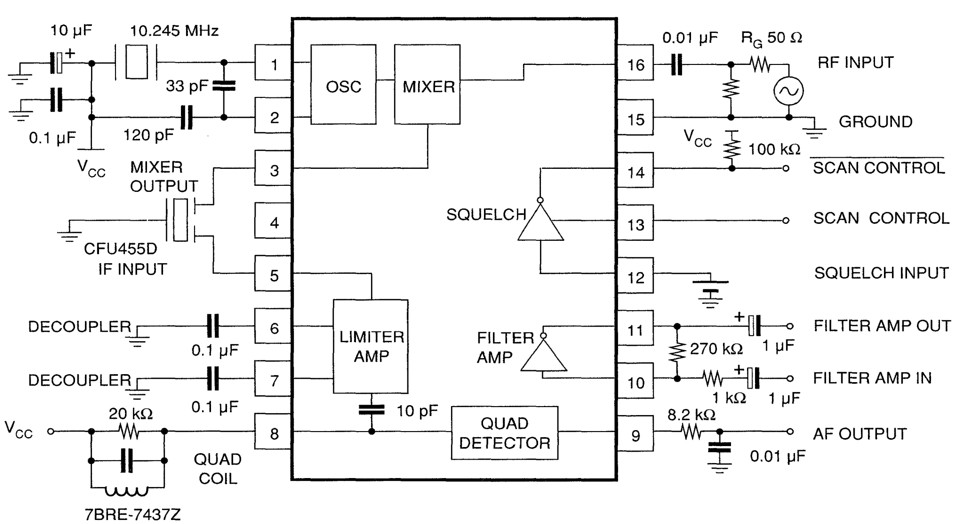
TEST CIRCUIT FOR 10492



Quad Coil

NOTES

AM/FM IF DETECTOR

FEATURES

- **AM/FM Simultaneous Detection**
- **Low Voltage Operation**
- **Low Operation Current AM & FM (6.8 mA TYP)**
  FM Only (3.9 mA TYP)
- **Small Surface Mount Package**

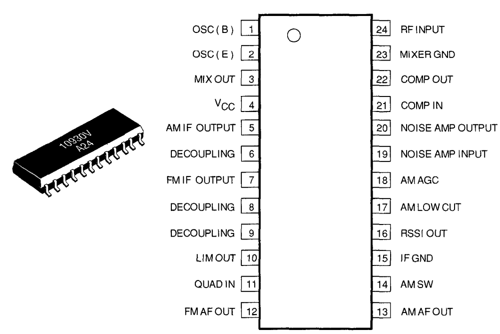
APPLICATIONS

- **Portable Instrumentation**
- **Communications Receivers**
- **Amateur Radio Transceivers**
- **Scanners**

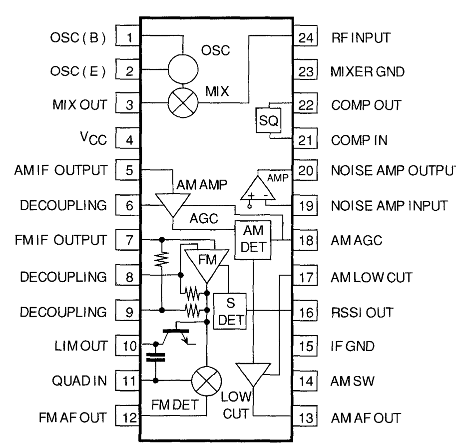
DESCRIPTION

The TK10930 is a AM/FM Detector IF IC specially suited where simultaneous AM and FM signal detection is required. This makes the device suited for portable scanners, aircraft receivers, amateur radio, and is specially designed for portable operation due to low voltage and current requirements. The TK10930 is available in a VSOP-24 surface mount package.

TK10930V



BLOCK DIAGRAM



ORDERING INFORMATION

TK10930 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
V: Surface Mount	C : -30 to +75 °C	BX: Bulk/Bag TX: Paper Tape TR: Tape Right TL: Tape Left MG: Magazine

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ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} ....10 V
Operating Voltage Range ....2.5 to 8.5 V
Power Dissipation (Note 1) ....400 mW
Junction Temperature ....150 °C
Storage Temperature Range....................-55 to +150 °C
Operating Temperature Range ....-30 to +75 °C
Lead Soldering Temp. (10 sec.) ....300 °C

ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 3.0 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC1}	Supply Current 1	No input		6.8	8.9	mA
I_{CC2}	Supply Current 2	No input		3.9	5.3	mA
M_C	Mixer Conversion Gain			20		dB
M_Z	Mixer Input Resistance	Measurement		3.6		kΩ
FM Section						
Limit 1	Limiting Sensitivity	-3 dB Point		2.0	8.0	µV
$V_{OUT\ 1}$	Demodulation Output Voltage	V_{IN} = 10 mV, ± 3 kHz DEV	85	150	230	mV(rms)
THD 1	Total Harmonic Distortion	V_{IN} = 10 mV, ± 3 kHz DEV		1.0	2.0	%
Z_{OUT}	Output Impedance	V_{IN} = 10 mV		800		Ω
THD	Total Harmonic Disortion	V_{IN} = 10 mV		1.0	2.0	%
F_G	Filter Amplifier Gain	F_{IN} = 30 kHz, V_O = 100 mV	30	38		dB
S_H	Scan Control High Level	2.5 V Squelch Input	2.3			V
S_L	Scan Control Low Level	0 V Squelch Input			0.3	V
HYS	Squelch Hysteresis			30		mV
S_0	Output Voltage	V_{IN} = 0.00 mV, R_S = 68 kΩ		0.05	0.5	V
S_1	Output Voltage 1	V_{IN} = 0.01 mV, R_S = 68 kΩ	0.05	0.5	0.9	V
S_2	Output Voltage 2	V_{IN} = 0.1 mV, R_S = 68 kΩ	0.7	1.2	1.7	V
S_3	Output Voltage 3	V_{IN} = 1 mV, R_S = 68 kΩ	1.2	1.8	2.5	V

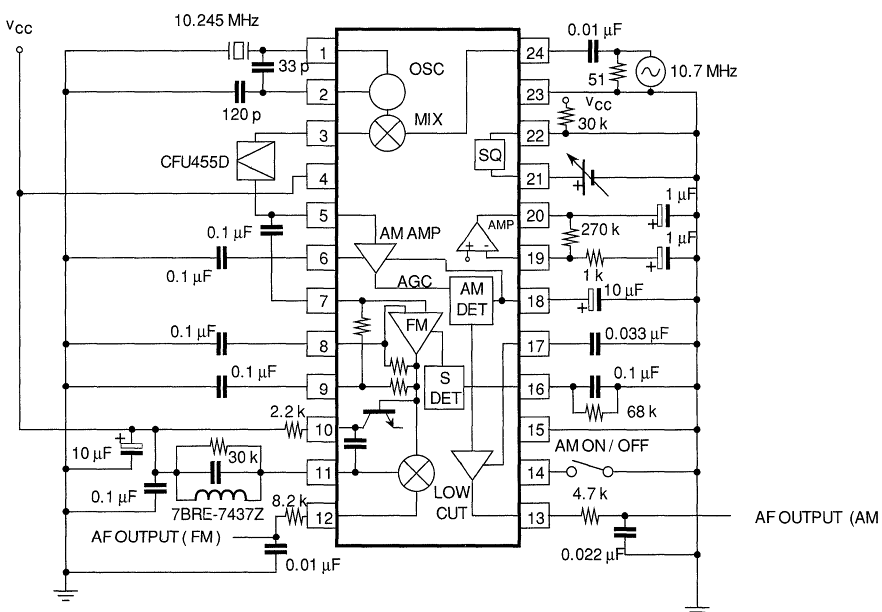
Note 1: Power dissipation must be derated at the rate of 3.3 mW/°C at T_A = 25 °C and above.

ELECTRICAL CHARACTERISTICS (CONT.)

Test conditions: V_{CC} = 3.0 V, T_A = 25 °C, unless otherwise specified.

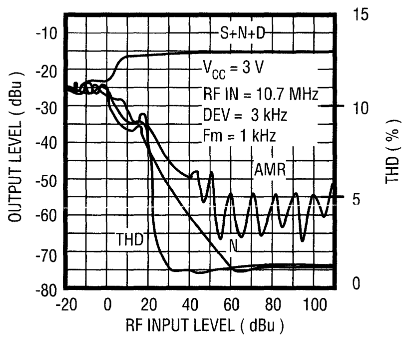
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
S_4	Output Voltage 4	V_{IN} = 10 mV, R_S = 68 kΩ	1.6	2.3	2.9	V
S_5	Output Voltage 5	V_{IN} = 100 mV, R_S = 68 kΩ	1.8	2.4	2.9	V
AM Section						
US	Sensitivity	20 mV(rms)	20	15		dBμ
$V_{OUT\ 2}$	Demodulation Output Voltage	1 kHz 30%, V_{IN} = 1 mV	60	120	160	mV(rms)
THD 2	Total Harmonic Distortion 1	1 kHz 30%, V_{IN} = 1 mV		1.0	2.0	%
THD 3	Total Harmonic Distortion 2	1 kHz 80%, V_{IN} = 1 mV		2.0	4.0	%
S/N	S/N	1 kHz 30%, V_{IN} = 1 mV	40	48		dB
V_{OUT}	AM On DC Level (Pin 14)		-0.3		0.3	V

TEST CIRCUIT

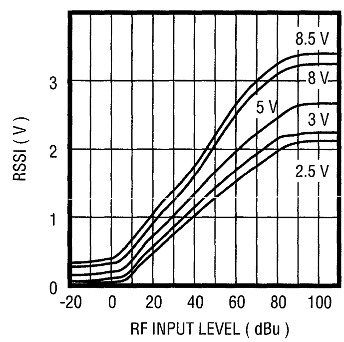


TYPICAL PERFORMANCE CHARACTERISTICS

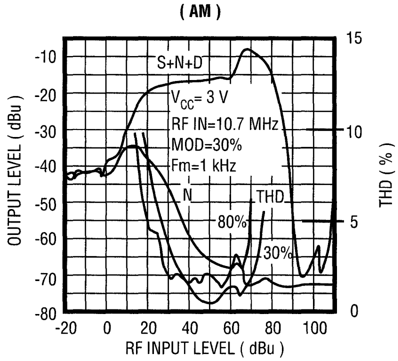
GENERAL CHARACTERISTICS (FM)



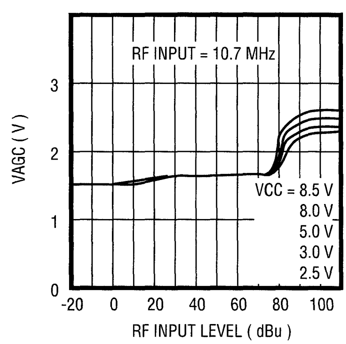
RSSI CHARACTERISTICS



GENERAL CHARACTERISTICS (AM)



VAGC CHARACTERISTICS



DUAL CONVERSION FM IF AMPLIFIER

FEATURES

- **Wide Operating Voltage Range**
- **High Limiting Sensitivity**
- **Low Current Consumption**
- **60 MHz IF Input**
- **2 to 8 V Low Volt Operation**
- **Good RSSi Stability**
- **Internal SiQ Rectifier**

DESCRIPTION

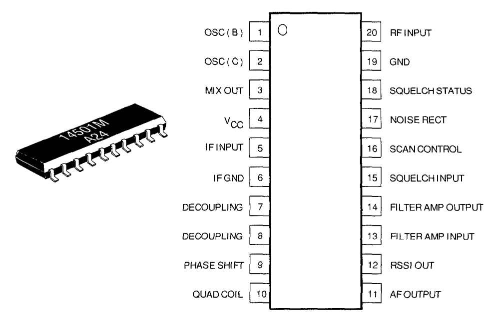
The TK14501 integrated circuit has been developed for the FM IF system in communications equipment. The circuit operates on 2.0 to 8.0 volts and has low current consumption. This IC is most suited for receivers using double conversion. The first IF input can be as high as 60 MHz and the second IF is 455 kHz.

The TK14501 is available in dual in-line as well as surface mount packages to meet your requirements.

APPLICATIONS

- **Communications Equipment**
- **HAM Radio Transceivers**
- **VHF/UHF Talkie-Walkies**
- **Scanners**
- **Data Transponders**
- **Cordless Phones**
- **Cellular Phones**

TK14501



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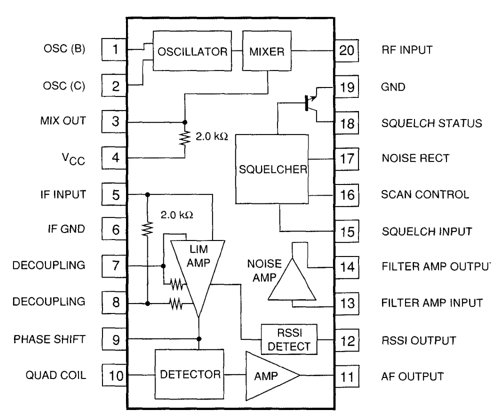

ORDERING INFORMATION

TK14501 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
M : Surface Mount	C : -30 to +70 °C	BX : Bulk/Bag
		TX : Paper Tape
		TR : Tape Right
		TL : Tape Left
		MG: Magazine

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ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{CCMAX} .... 10 V
Power Dissipation (Note 1) .... 410 mW
Junction Temperature .... 150 °C
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -30 to +70 °C
Operating Voltage Range .... 2.0 to 8.0 V
Operating Frequency Range .... 60 MHz
Lead Soldering Temp. (10 sec.) .... 300 °C

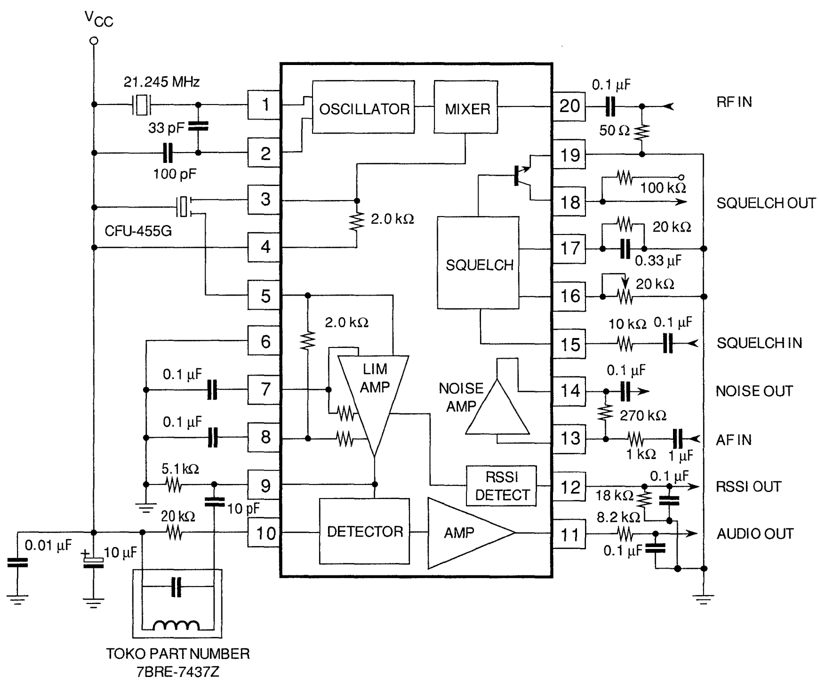
ELECTRICAL CHARACTERISTICS

Test conditions: V_{CC} = 2.0 V, f = 21.7 MHz, dev = ± 1.5 kHz, fm = 1 kHz, T_A = 25 °C

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC1}	Supply Current 1	Squelch Off	2.8	3.7	4.6	mA
I_{CC2}	Supply Current 2	Squelch On	2.9	4.0	5.0	mA
Limit	Limiting Sensitivity	-3 dB V_{OUT}		2.0	5.0	µV
V_O	Output Voltage	V_{IN} = 10 mV	70	100	140	mV
V_{DC}	Output Terminal Voltage	V_{IN} = 10 mV	0.6	0.8	1.2	V
Z_{OUT}	Output Impedance	V_{IN} = 10 mV		1.0	2.0	KΩ
THD	Total Harmonic Distortion	V_{IN} = 10 mV		1.0	3.0	%
F_C	Noise Amplifier Gain	Input, f = 30 kHz	42	48	50	dB
F_{DC}	Noise Amp, Output Terminal	No input	0.7	0.9	1.1	V
Terminal Voltage						
V 16	Squelch Adjust	Squelch Input, 20 kΩ	0.40	0.50	0.60	V
V 17	Noise Reduction	Squelch Input, 20 kΩ	0.75	0.95	1.15	V
V 17	Noise Reduction	Squelch Input, f = 30 kHz V = 400 mVrms	0.35	0.55	0.75	V
V 18_L	Squelch Status	Squelch Input, f = 30 kHz V = 650 mVrms			0.2	V
V 18_H	Squelch Status	Squelch Input, f = 30 kHz V = 300 mVrms	1.8			V
M_C	Mixer Conversion Gain		18	24	30	dB
S_0	Output Voltage	V_{IN} = 0.00 mV	0.00	0.05	0.20	V
S_1	Output Voltage 1	V_{IN} = 0.01 mV	0.20	0.40	0.60	V
S_2	Output Voltage 2	V_{IN} = 0.1 mV	0.60	0.90	1.10	V
S_3	Output Voltage 3	V_{IN} = 1 mV	1.05	1.30	1.60	V
S_4	Output Voltage 4	V_{IN} = 10 mV	1.40	1.70	1.95	V

Note 1: Power dissipation must be derated at a rate of 3.3 mW/°C at T_A = 25 °C and above.

TEST CIRCUIT



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NOTES

NOTES

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TK16201

PRELIMINARY INFORMATION

1 GHz RF AMPLIFIER

FEATURES

- **1000 MHz Bandwidth**
- **10 dB Insertion Gain**
- **Single 6-10 V Supply**
- **Input and Output Impedances Matched to 50 Ω Systems**
- **Surface Mount Package**
- **Available on Tape and Reel**

APPLICATIONS

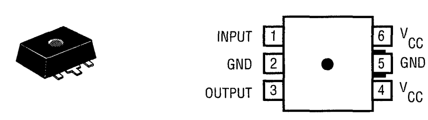
- **RF Communications**
- **Telecommunications**
- **Local Area Networks**
- **Personal Communications Equipment**
- **Portable Instrumentation**
- **Portable Consumer Equipment**
- **Radio Control Systems**

DESCRIPTION

The TK16201U is a high frequency amplifier with an insertion gain of 10 dB. The -3 dB bandwidth is 1000 MHz. Normally, the device operates on 10 V single supply and it requires no external components other than input and output decoupling capacitors. When an RF choke is connected between the output and V_{CC}, the device can operate on a single 6 volt supply with no performance degradation. The TK16201U has a 1 dB compression point of +5 dBm at the output and a total power supply consumption of 28 mA.

The device is available in a plastic UPACK-5 package. Pin configuration has been optimized for convenient ground plane connections and the use of controlled impedance lines.

TK16201



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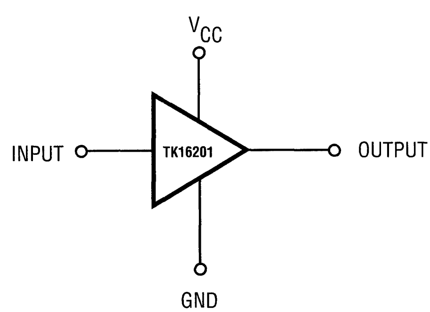


ORDERING INFORMATION

TK16201 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
U: Surface Mount	C : -40 to +85 °C	BX: Bulk/Bag
		TL: Tape Left

ABSOLUTE MAXIMUM RATINGS

Supply Voltage .... 12 V
Power Dissipation (Note 1) .... 1 W
Storage Temperature Range.................... -55 to +150 °C
Operating Temperature Range .... -40 to +85 °C
Lead Soldering Temp. (10 sec.) .... 240 °C
Junction Temperature .... 150 °C

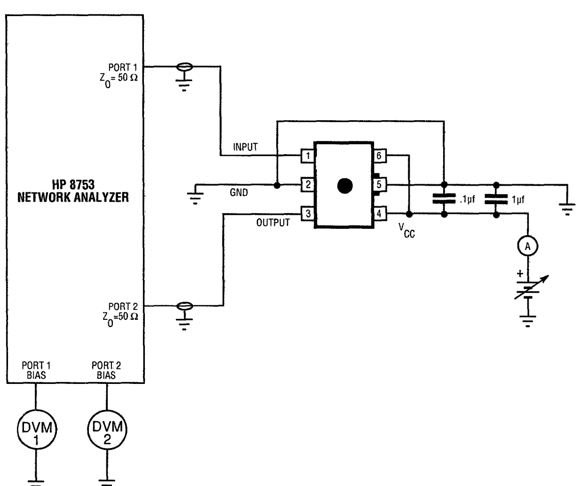
ELECTRICAL CHARACTERISTICS

T_A=25 °C, V_{CC} = 10 V unless otherwise specified

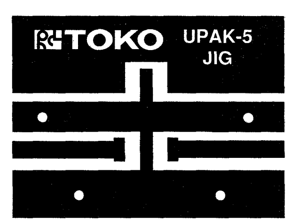
SYMBOL	PARAMETER	TEST CONDITIONS	TK16201U			UNITS
			MIN	TYP	MAX	
V_{CC}	Supply Voltage Range		9.5	10	10.5	V
I_{CC}	Supply Current		23	25	30	mA
S_{21}	Forward Gain		9	10	11	dB
S_{12}	Reverse Gain	F=500 MHz		-17		dB
S_{11}	Input Reflection	F=500 MHz		-13		dB
S_{22}	Output Reflection	F=500 MHz		-15		dB
BW	3dB Bandwidth		900	1000		MHz
P_{-1dB}	Power Out @ 1db Compression	F=100 MHz		+5		dBm
IP_3	Third Order Intercept Point	F=100 MHz		+15		dBm

Note 1: Power dissipation must be derated at the rate of 8 mW/°C for operation at T_A = 25 °C and above. Maximize pad under GND and V_{CC} terminals for good heat conduction.

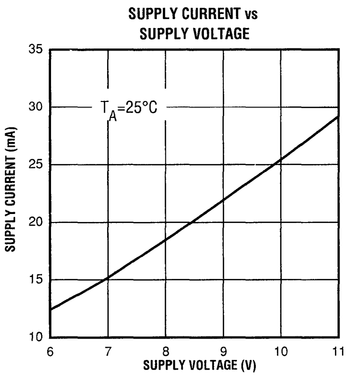
TEST CIRCUIT 1

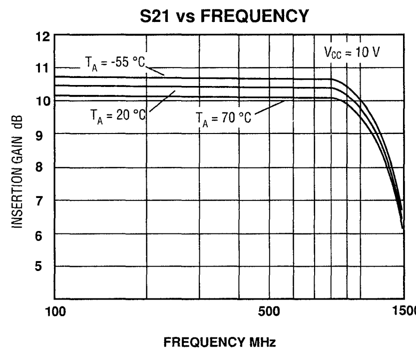


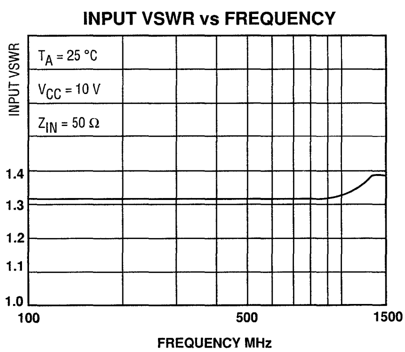
APPLICATION PRINTED CIRCUIT BOARD
SCALE 3:1

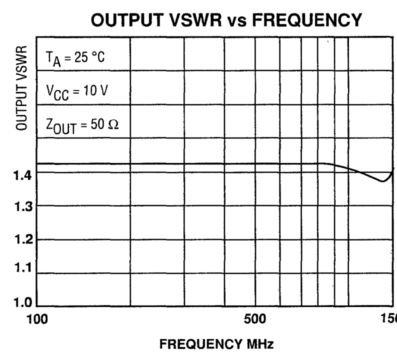


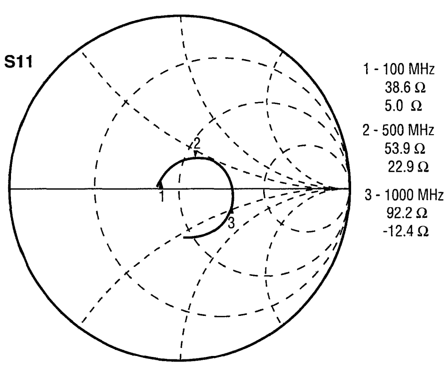
TYPICAL PERFORMANCE CHARACTERISTICS

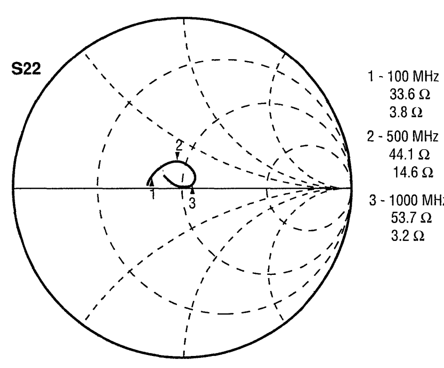












4

APPLICATIONS INFORMATION

As shown in Figure A. , internal DC bias voltages appear at the device input and output terminals, therefore DC coupling is only permitted when the external circuitry does not modify the internal bias voltages. Use of capacitive coupling on the input/output terminals is recommended for most applications. For wideband applications a 0.1µF monolithic ceramic capacitor works well down to 100 kHz. The input/output coupling capacitor value must be chosen to give an impedance of : $Xc = \frac{1}{2 fC} << 50$ at the frequency of interest.

TK16201 EQUIVALENT SCHEMATIC

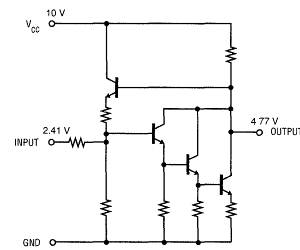
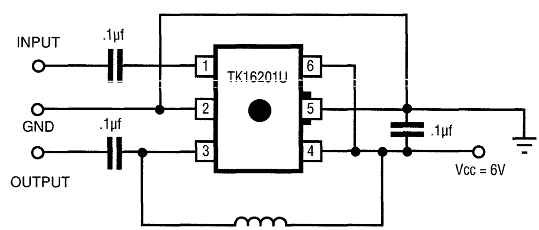


FIGURE A.

Figure B. shows connection for lower voltage operation. When an RF Choke is connected between V_{CC} and the output , the device can operate with no performance degradation down to 6 volts. If the frequency of operation is high an inductor with high self resonance is required. In Figure B the coil is wound on a Fair-Rite #2664666611 core and 5 turns of # 30 wire is used. Although current consumption remains essentially the same, power dissipation is reduced due to the lower operating voltage. A monolithic ceramic bypass capacitor of 0.1µF is required on the V_{CC} pin as close as possible to pin1.

CONNECTION FOR OPERATION AT 6 VOLTS



L1* - Fair-Rite #2664666611
with 5 turns #30

FIGURE B.

Figure C. shows the response curve with the TK16201 operating at 6 volts and connected as in Figure B.

S21 vs FREQUENCY @ 6 VOLT OPERATION

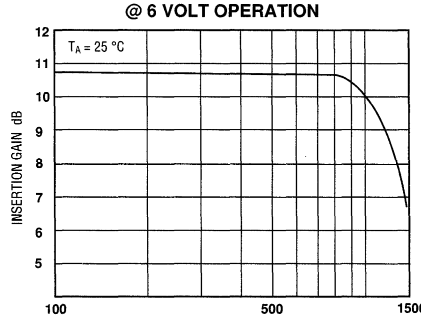


FIGURE C.

TOKO

TK16202

PRELIMINARY INFORMATION

250 MHz RF AMPLIFIER

FEATURES

- 15 dB Insertion Gain
- +11 dBm 1 dB Compression
- Input and Output Impedances Matched to 50 Ω Systems
- 40 dB Isolation
- Surface Mount Package
- Available on Tape and Reel

APPLICATIONS

- RF Communications
- Telecommunications
- Local Area Networks
- Personal Communications Equipment
- Instrumentation
- Consumer Equipment
- Radio Control Systems

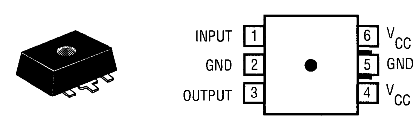
DESCRIPTION

The TK16202 is a high frequency class A/B amplifier with an insertion gain of 15 dB. The -3 dB bandwidth is typically 270 MHz. The device operates on 6 to 9 V single supply and requires no external components other than input and output decoupling capacitors.

The TK16202 has a 1 dB compression point of +11 dBm at the output and a total power supply consumption of 36 mA. Output to input isolation (reverse gain) is 40 dB, which is one of the highest available in the industry.

The device is available in a plastic U-PAK-5 package. Pin configuration has been optimized for convenient ground plane connections and the use of controlled impedance lines.

TK16202



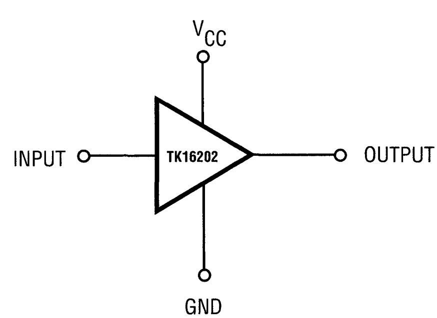
ORDERING INFORMATION

TK16202 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
U: Surface Mount	C : -40 to +85 °C	BX: Bulk/Bag
		TL: Tape Left

BLOCK DIAGRAM



4

ABSOLUTE MAXIMUM RATINGS

Supply Voltage .... 12 V
Power Dissipation (Note1) .... 1000 mW
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range .... -40 to +85 °C
Lead Soldering Temp. (10 sec.) .... 240 °C
Junction Temperature .... 150 °C

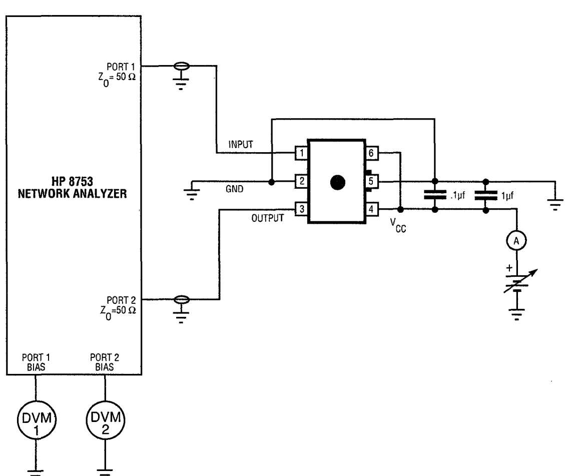
ELECTRICAL CHARACTERISTICS

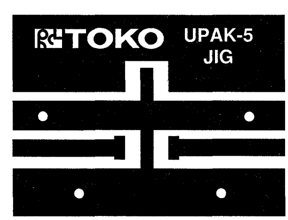
Test Conditions: T_A= 25 °C, Z_S = Z_L = 50 Ω, V_{CC} = 9 V unless otherwise specified

SYMBOL	PARAMETER	TEST CONDITIONS	TK16202U			UNITS
			MIN	TYP	MAX	
V_{CC}	OperatingVoltage Range		6	9	10.5	V
I_{CC}	Supply Current		30	36	43	mA
S_{21}	Forward Gain	F=100 MHz	14	15		dB
S_{12}	Reverse Gain	F=100 MHz		-40		dB
S_{11}	Input Reflection	F=100 MHz		-20		dB
S_{22}	Output Reflection	F=100 MHz		-17		dB
IP_3	Third Order Intercept Point	F=100 MHz		+20		dBm
BW	-3 dB Bandwidth		250	270		MHz
P_{OUT}	Power Out @1dB Compression	F=100 MHz		+11		dBm

Note 1: Power dissipation must be derated at the rate of 8 mW/°C for operation at T_A = 25 °C and above. Maximize pad size under GND and V_{CC} terminals for good heat conduction.

TEST CIRCUIT 1

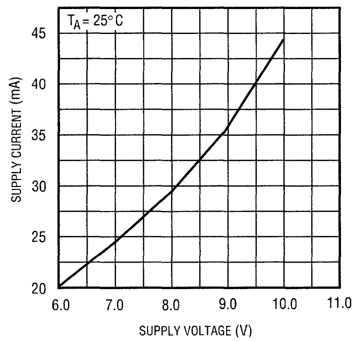




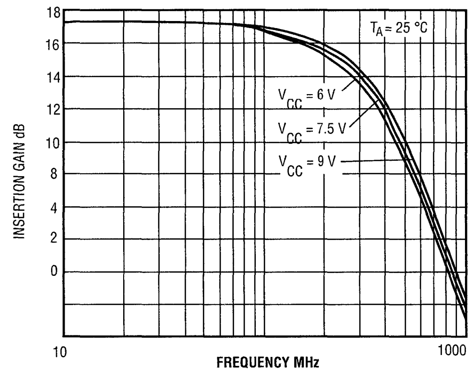
APPLICATION BOARD ARTWORK 3:1 SCALE

TYPICAL PERFORMANCE CHARACTERISTICS

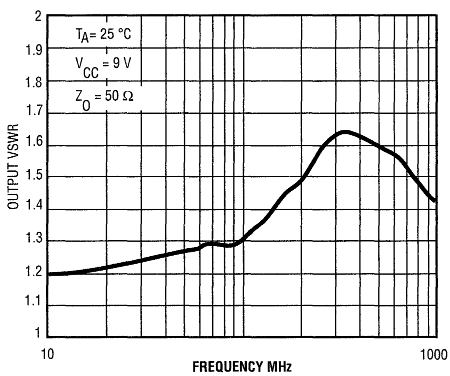
SUPPLY CURRENT vs SUPPLY VOLTAGE



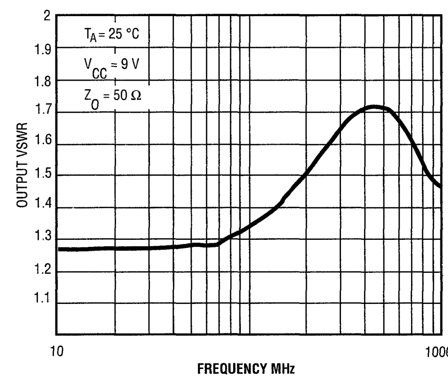
S21 vs FREQUENCY

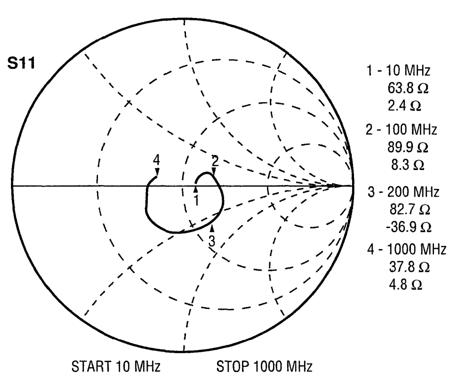


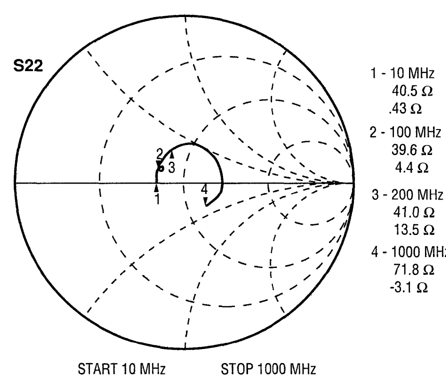
INPUT VSWR vs FREQUENCY



OUTPUT VSWR vs FREQUENCY







NOTES

TOKO

TK16203

PRELIMINARY INFORMATION

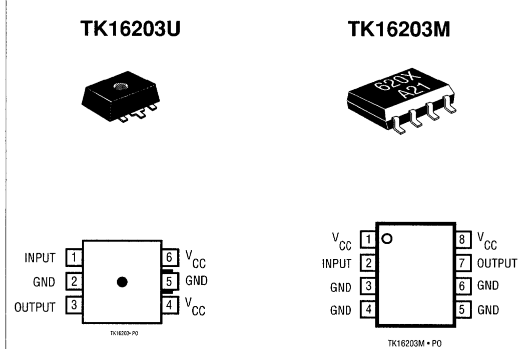
500 MHz RF AMPLIFIER

FEATURES

- 500 MHz Bandwidth
- 5.0 dB Noise Figure
- 23 dB Insertion Gain
- +4 dBm 1 dB Compression Point
- Adaptive Impedance Matching (Input and Output Impedances Matched to 50 or 75 Ω)
- Small Surface Mount Package
- Available on Tape and Reel

APPLICATIONS

- RF Communications
- Telecommunications
- Local Area Networks
- Personal Communications Equipment
- Portable Instrumentation
- Portable Consumer Equipment
- Radio Control Systems



DESCRIPTION

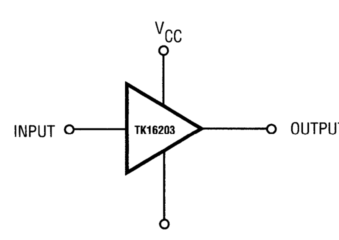
The TK16203 is a high frequency amplifier with an insertion gain of 23 dB. The -3 dB bandwidth is 500 MHz. The device operates on 5 or 6 V single supply and it requires no external components other than input and output decoupling capacitors.

A unique feature of this device is its ability to achieve good impedance matching in both 50 and 75 Ω systems. This is possible because the external source and termination impedances have an effect on the internal feedback network in such a way that input and output impedances tend to adapt to the external source and termination impedances.

The TK16203 has a 1 dB compression point of +4 dBm at the output and a total power supply consumption of 23 mA.

The device is available in a U-PAK-5, or MFP-8 plastic surface mount package. Pin configuration has been optimized for convenient ground plane connections and the use of controlled impedance lines.

BLOCK DIAGRAM



ORDERING INFORMATION

TK16203 □ □ □□

- Tape/Reel Code
- Temp. Range
- Package Code

PACKAGE CODE	TEMP. RANGE	TAPE/REEL CODE
U: U-Pack 5	C : -40 to +85 °C	BX: Bulk/Bag
M : SURFACE MOUNT		TL: Tape Left

ABSOLUTE MAXIMUM RATINGS

Supply Voltage .... 12 V
Power Dissipation MFP-8 (Note 1)........................ 600 mW
Power Dissipation U-PAK-5 (Note 2).................. 1000 mW
Storage Temperature Range...................... -55 to +150 °C
Operating Temperature Range.................... -40 to +85 °C
Lead Soldering Temp. (10 sec.).............................. 240 °C
Junction Temperature.. 150 °C

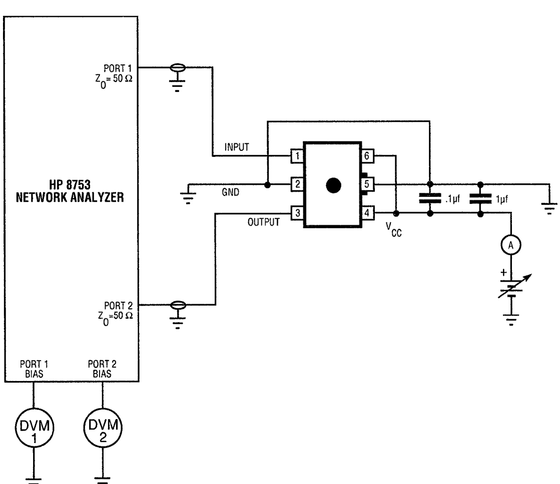
ELECTRICAL CHARACTERISTICS

Test Conditions: V_{CC} = 6 V, T_A = 25 °C, unless otherwise specified

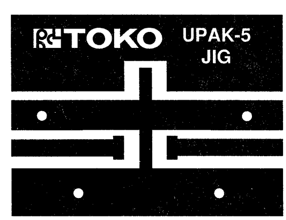
SYMBOL	PARAMETER	TEST CONDITIONS	MFP-8			UPAK-5			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{CC}	Operating Voltage Range		4.5	6	6.5		6		V
I_{CC}	Supply Current		20	23	28		23		mA
S_{21}	Forward Gain	F = 100 MHz	21	23	25		23		dB
S_{12}	Reverse Gain	F = 100 MHz		-30			-30		dB
S_{11}	Input Reflection	F = 100 MHz		-17			-17		dB
S_{22}	Output Reflection	F = 100 MHz		-25			-25		dB
IP_3	Third Order Intercept Point	F = 100 MHz		+12			+12		dBm
NF	Noise Figure	F = 100 MHz		5.0			5.0		dB
BW	-3dB Bandwidth		450	500			470		MHz
P_{OUT}	Output Power at 1 dB Comp.	F = 100 MHz		+4			+4		dBm

Note 1: Power dissipation must be derated at the rate of 4 mW/ °C for operation at T_A = 25 °C and above.
Note 2: Power dissipation must be derated at the rate of 8 mW/ °C for operation at T_A = 25 °C and above. Maximize pad size under GND and V_{CC} terminals for good heat conduction.

TEST CIRCUIT

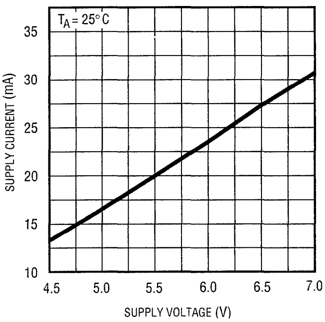


3X APPLICATIONS BOARD LAYOUT

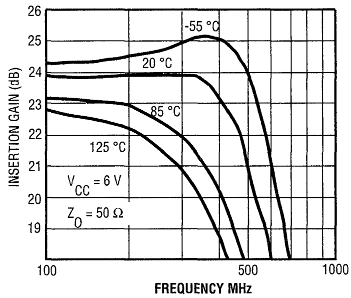


TYPICAL PERFORMANCE CHARACTERISTICS

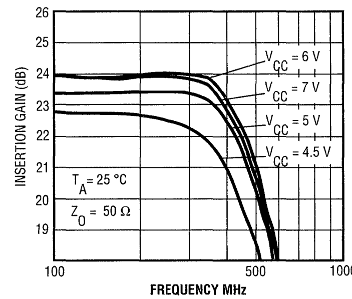
SUPPLY CURRENT vs SUPPLY VOLTAGE



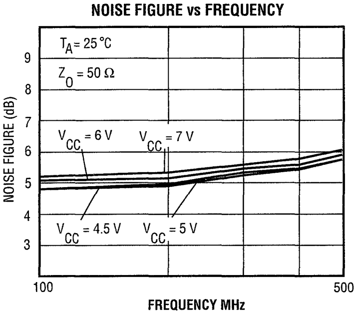
S21 vs FREQUENCY



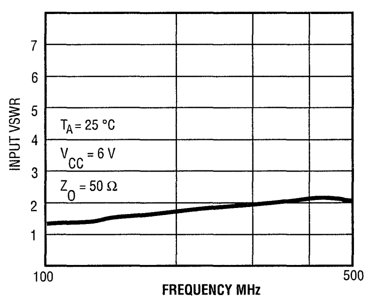
S21 vs FREQUENCY



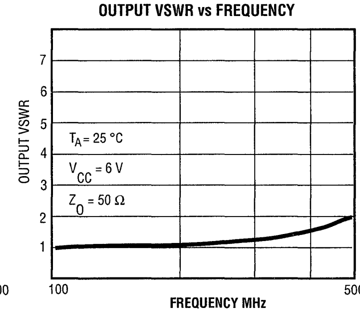
NOISE FIGURE vs FREQUENCY



INPUT VSWR vs FREQUENCY



OUTPUT VSWR vs FREQUENCY



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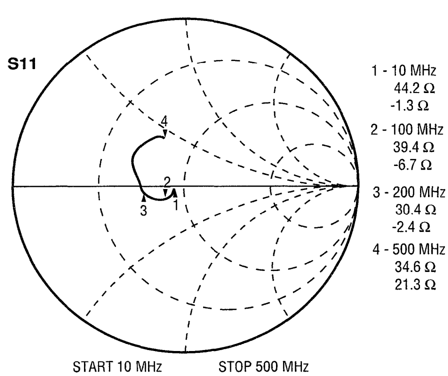
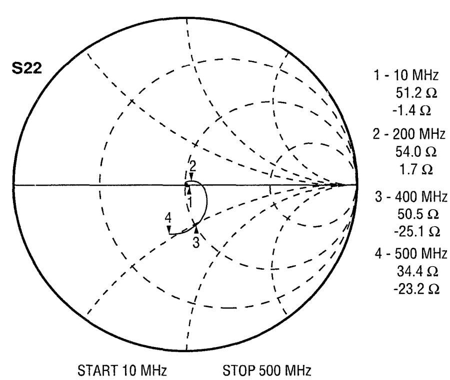




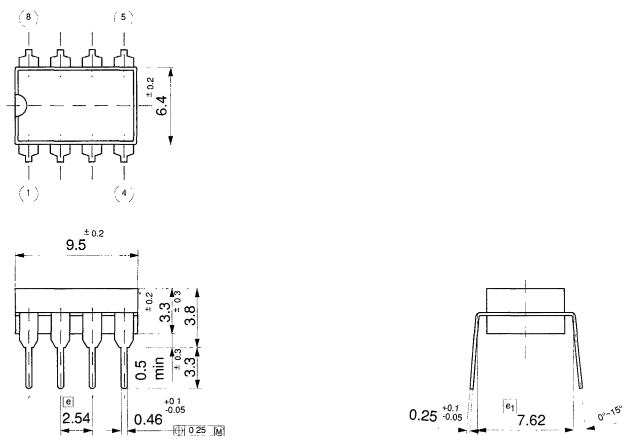
NOTES

PACKAGE OUTLINES

TOKO

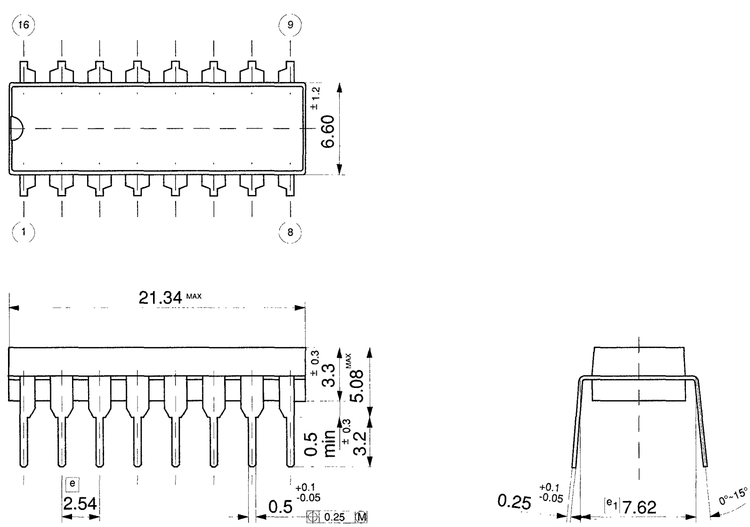
THROUGH HOLE DEVICES

CERDIP8



Unit:mm

CERDIP16

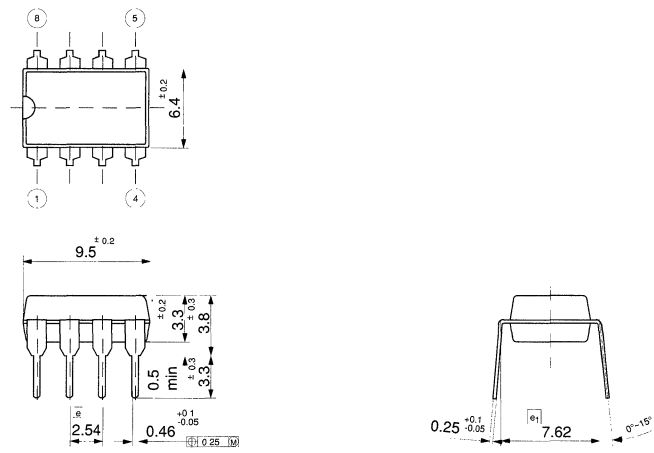


Unit:mm

5

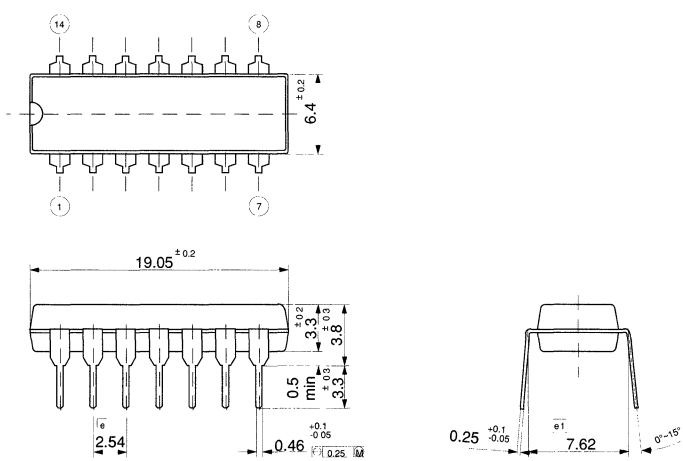
THROUGH HOLE DEVICES

DIP8



Unit:mm

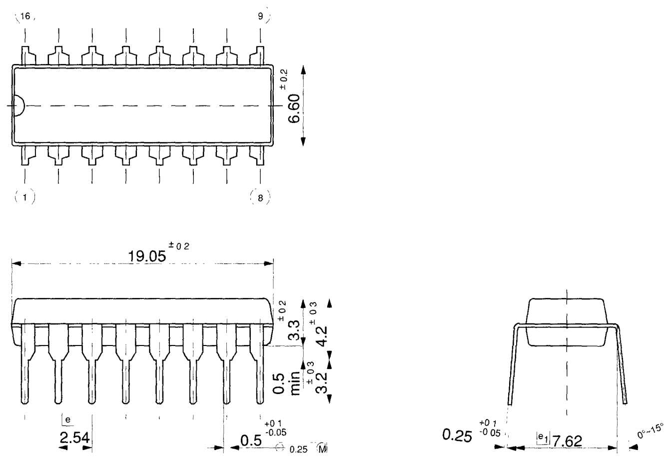
DIP14



Unit:mm

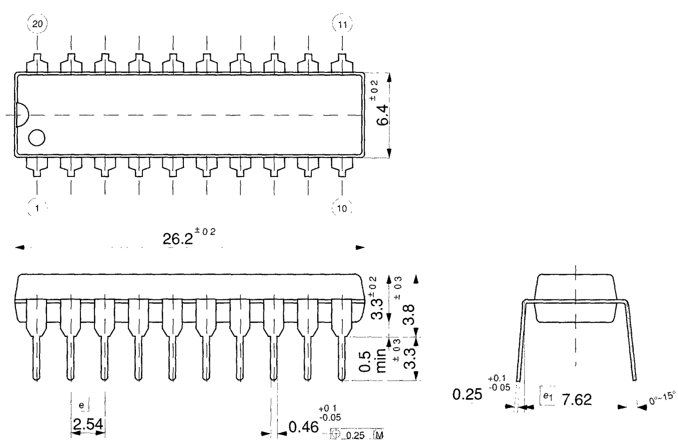
THROUGH HOLE DEVICES

DIP16



Unit:mm

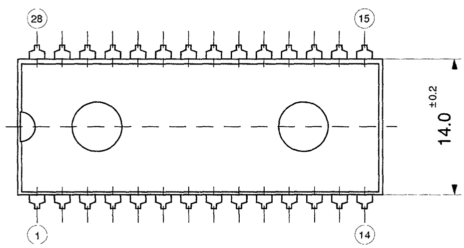
DIP20

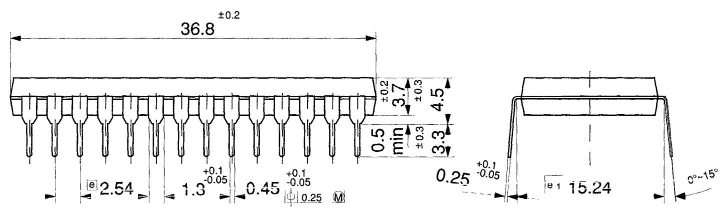


Unit:mm

THROUGH HOLE DEVICES

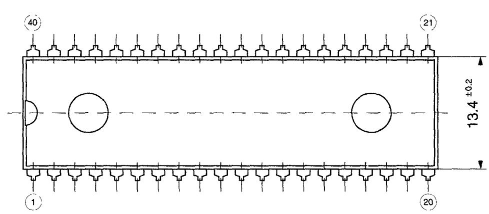
DIP28

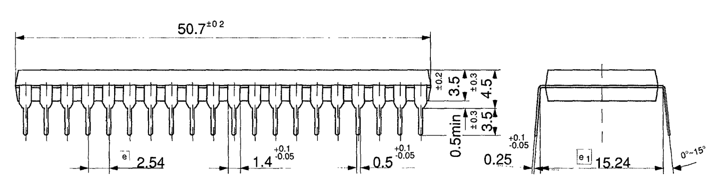




Unit:mm

DIP40

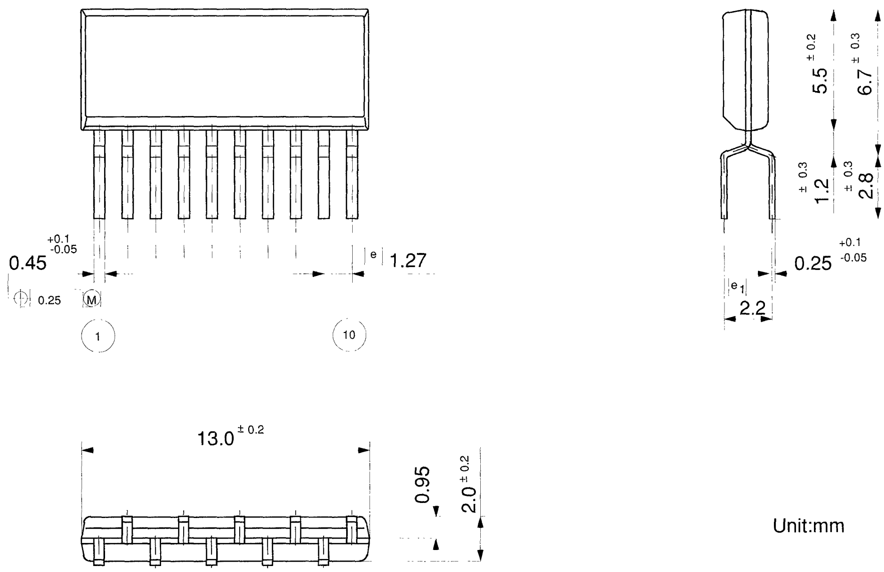




Unit:mm

THROUGH HOLE DEVICES

ZIP10



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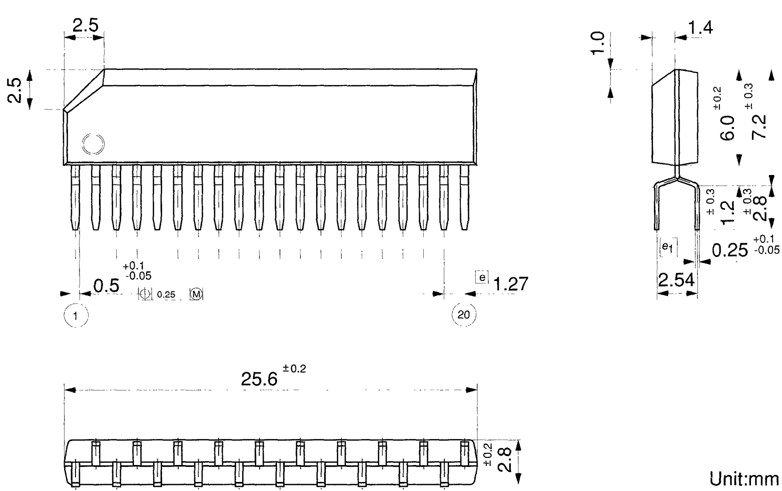
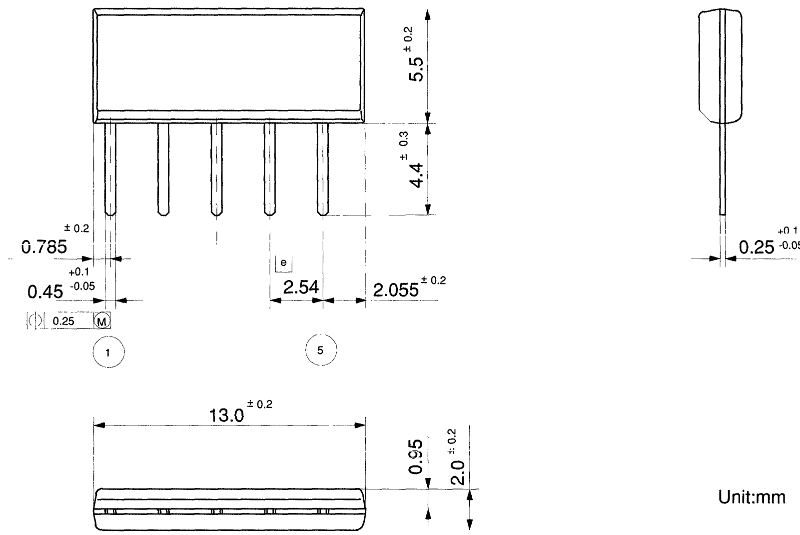


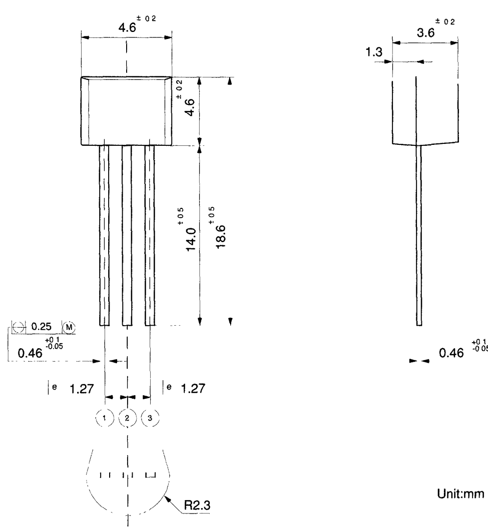
THROUGH HOLE DEVICES

SIP5



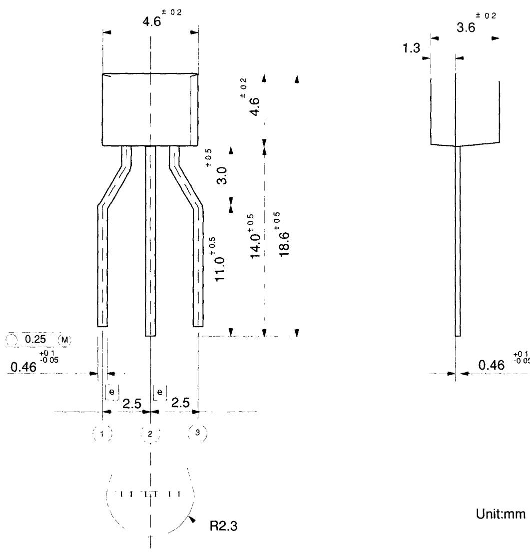
Unit:mm

TO-92J



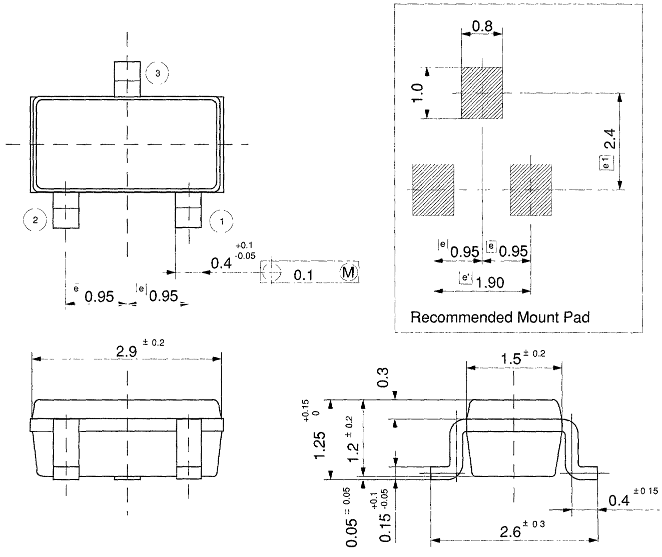
THROUGH HOLE DEVICES

TO-92N



SURFACE MOUNT DEVICES

SOT23



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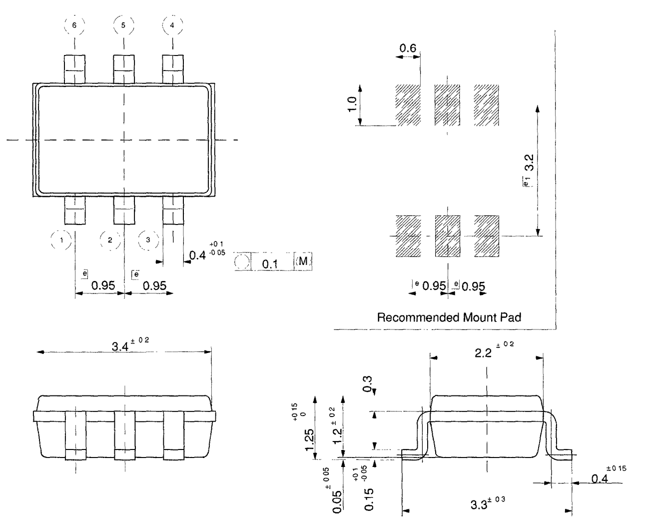
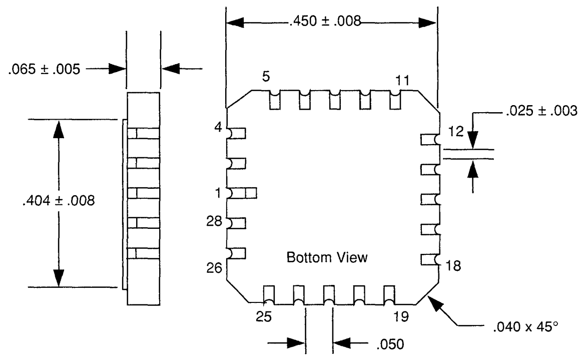
SOT23L



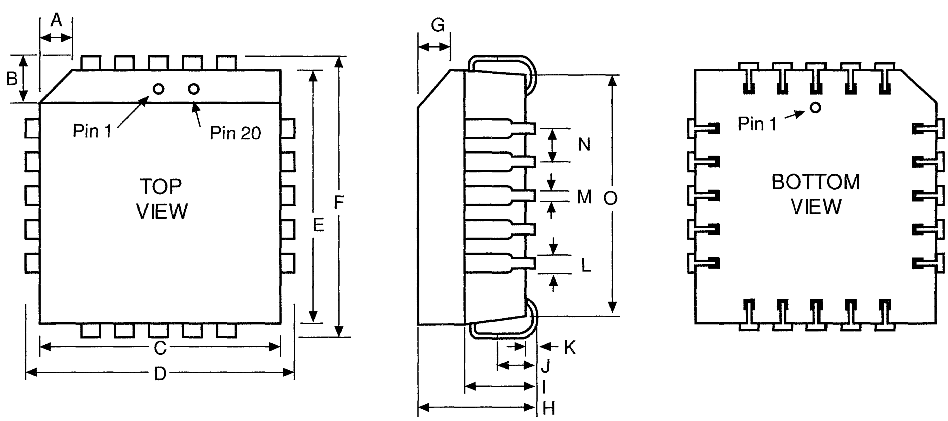
Unit:mm

SURFACE MOUNT DEVICES

LCC



PLCC

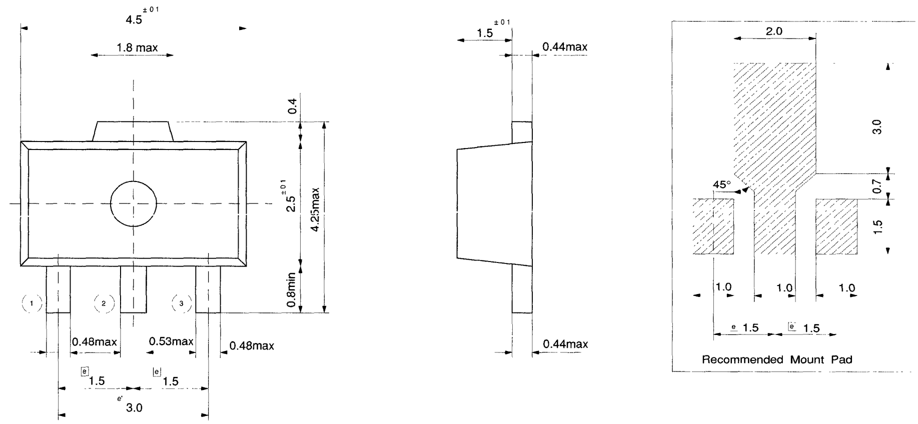


5

PACKAGE OUTLINES

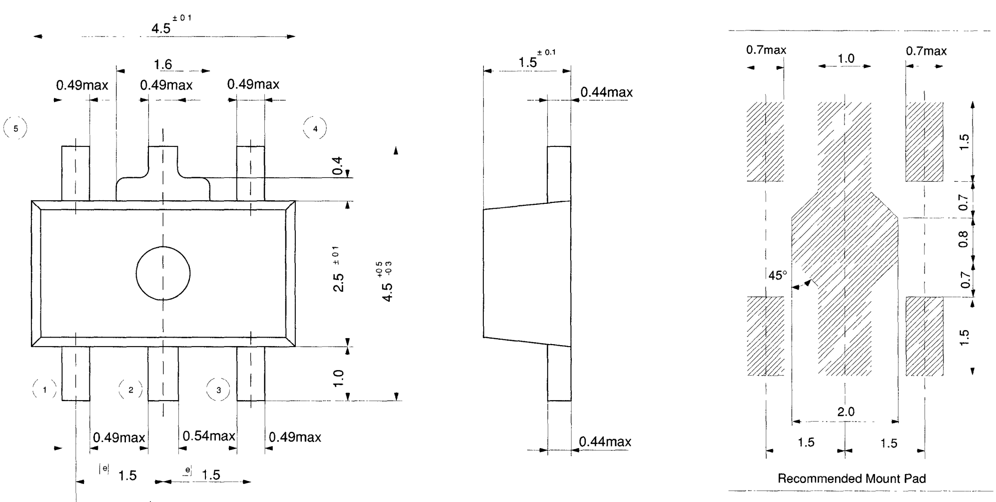
SURFACE MOUNT DEVICES

U-PACK 3



Unit:mm

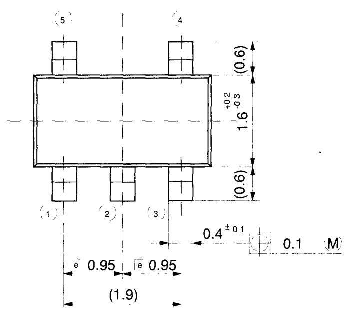
U-PACK 5

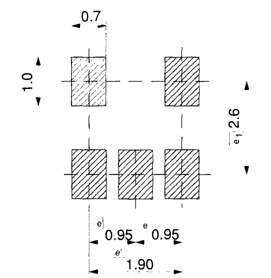


Unit:mm

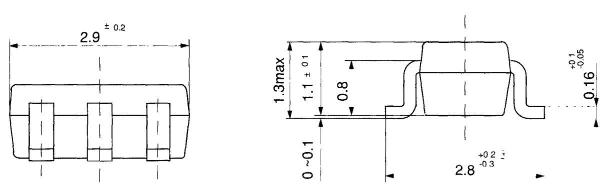
SURFACE MOUNT DEVICES

M-PACK 5



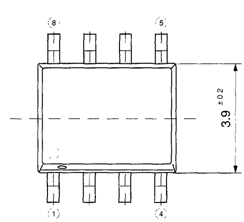


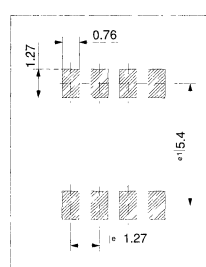
Recommended Mount Pad



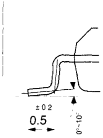
Unit:mm

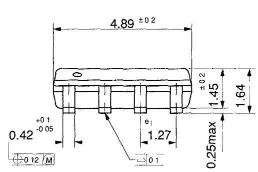
SOP8

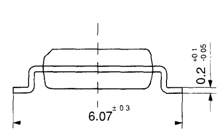




Recommended Mount Pad





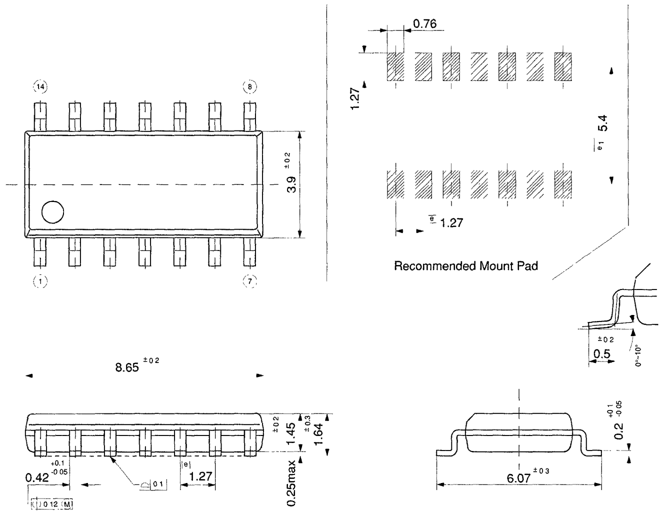


Unit:mm

5

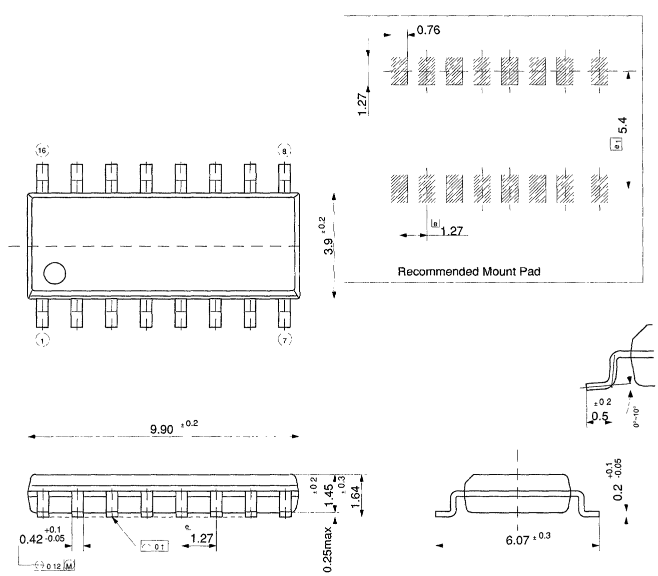
SURFACE MOUNT DEVICES

SOP14



Unit:mm

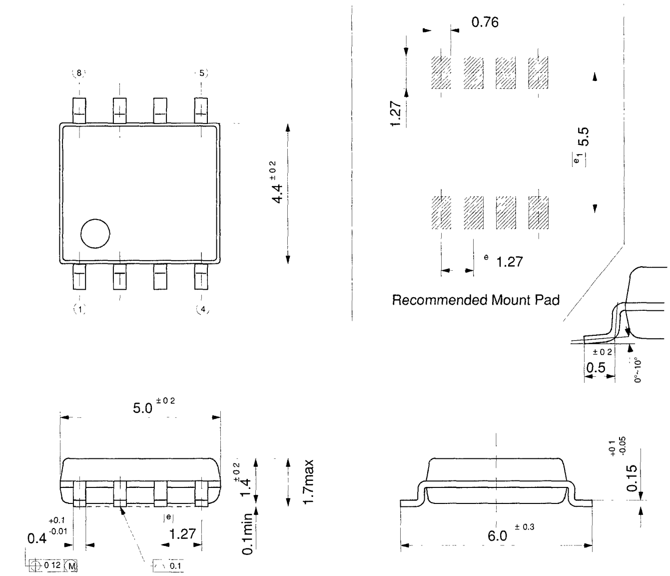
SOP16



Unit:mm

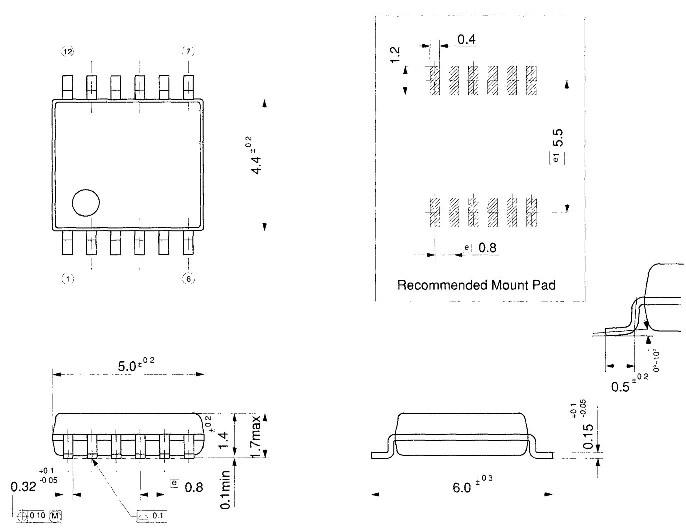
SURFACE MOUNT DEVICES

MFP8



Unit:mm

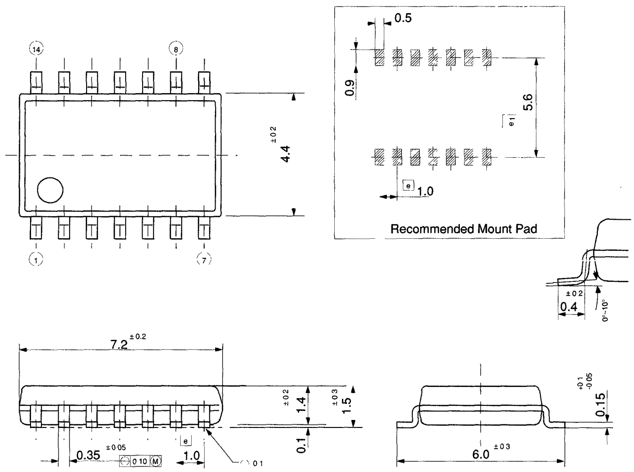
MFP12



Unit:mm

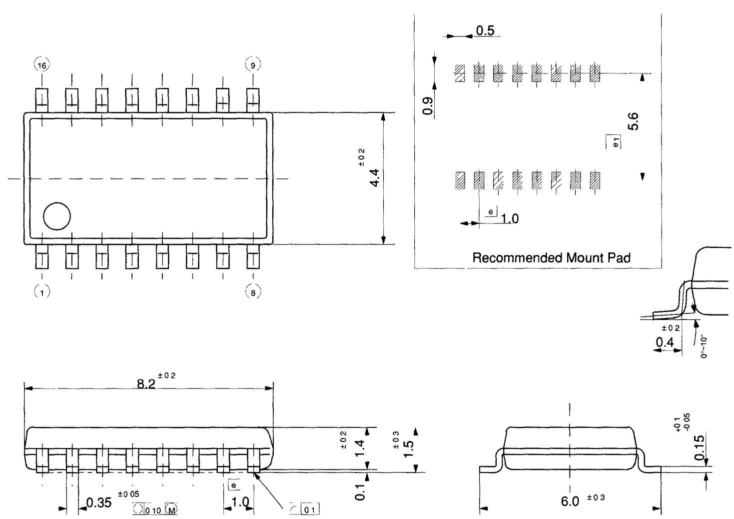
SURFACE MOUNT DEVICES

MFP14



Unit:mm

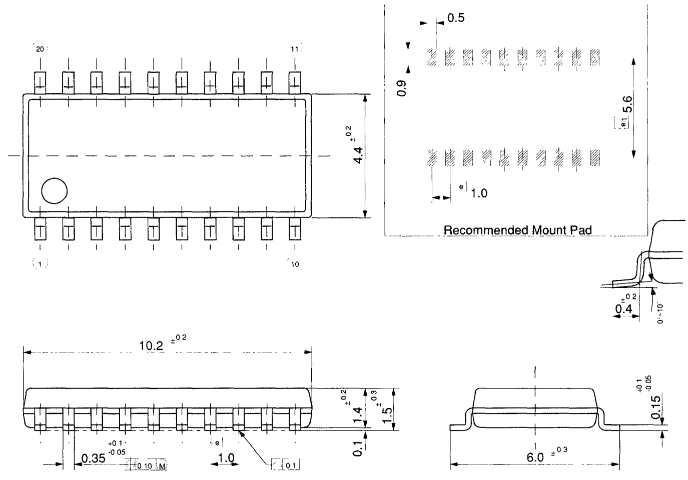
MFP16



Unit:mm

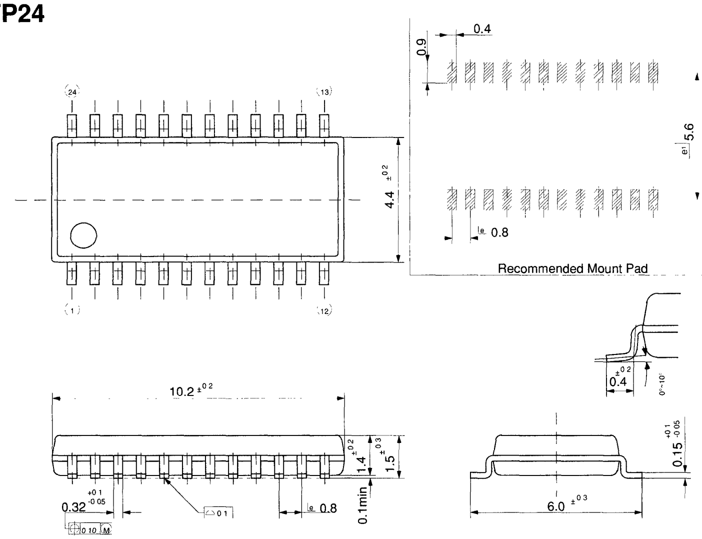
SURFACE MOUNT DEVICES

MFP20



Unit:mm

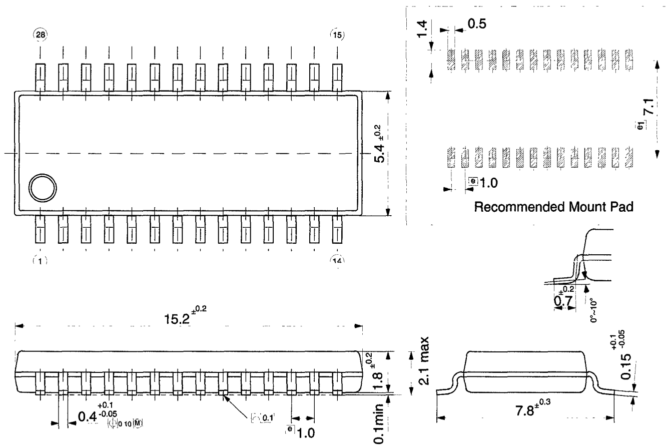
MFP24



Unit:mm

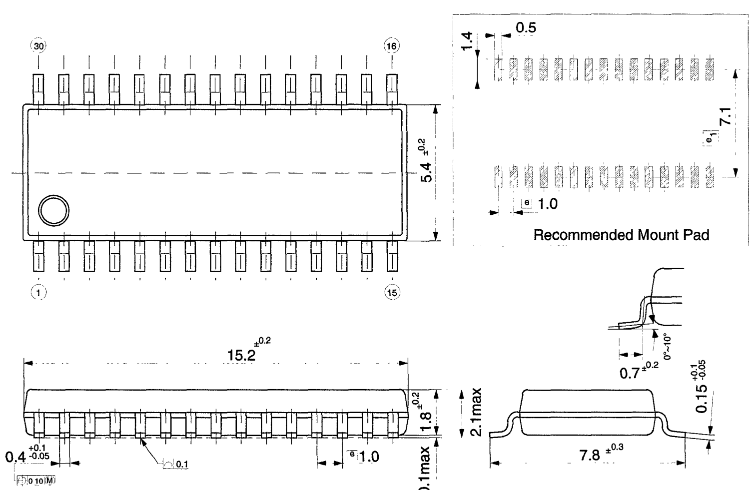
SURFACE MOUNT DEVICES

MFP28



Unit:mm

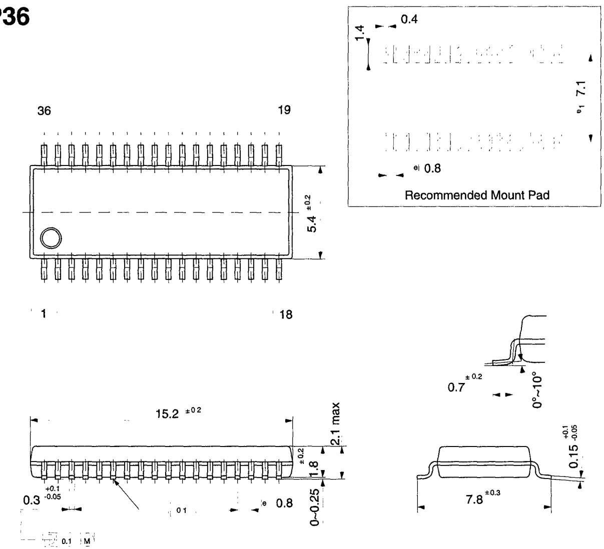
MFP30



Unit:mm

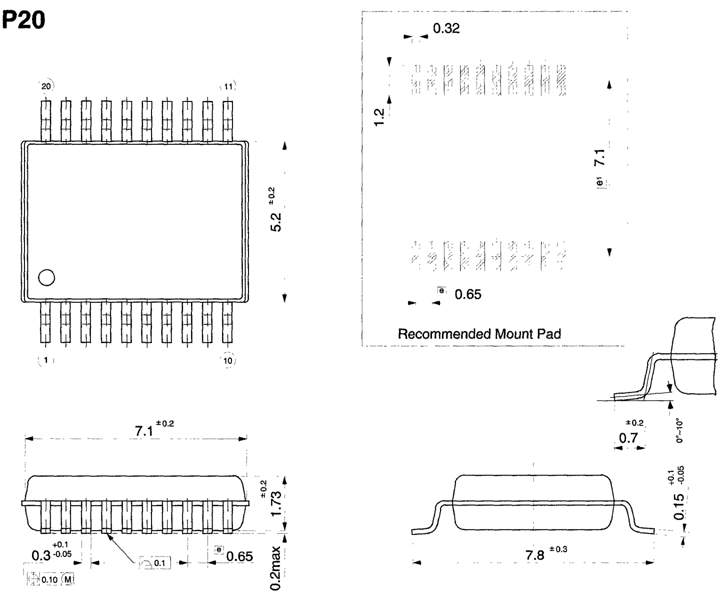
SURFACE MOUNT DEVICES

MFP36



Unit:mm

VSOP20

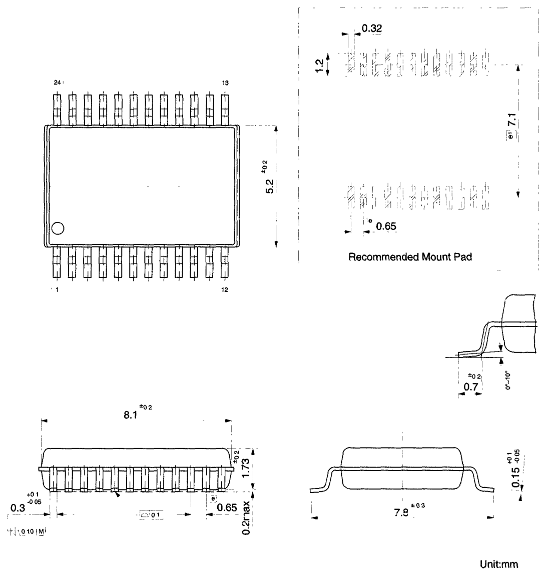


Unit:mm

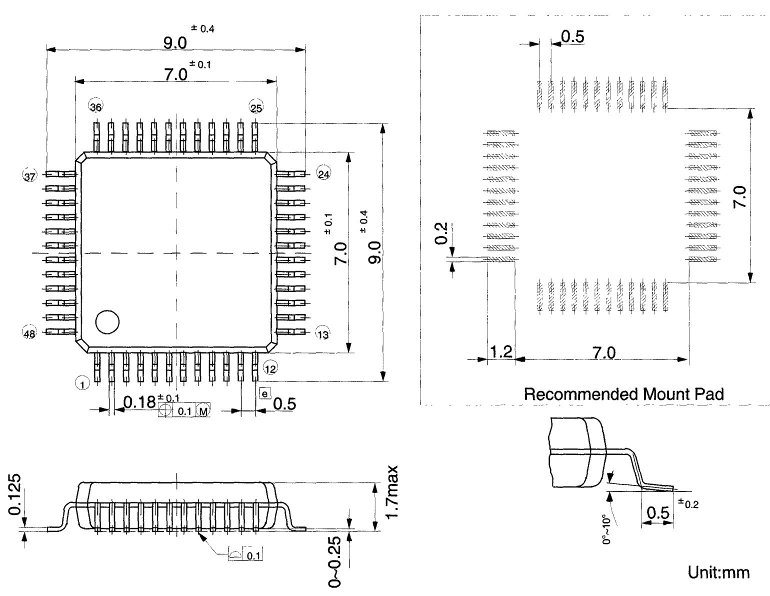
5

SURFACE MOUNT DEVICES

VSOP24

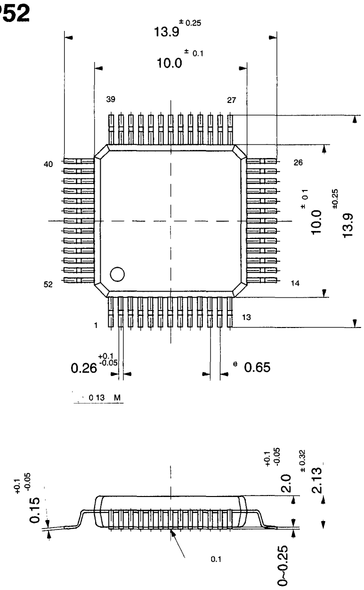


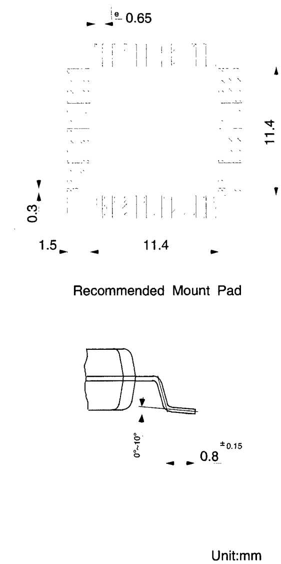
QFP48



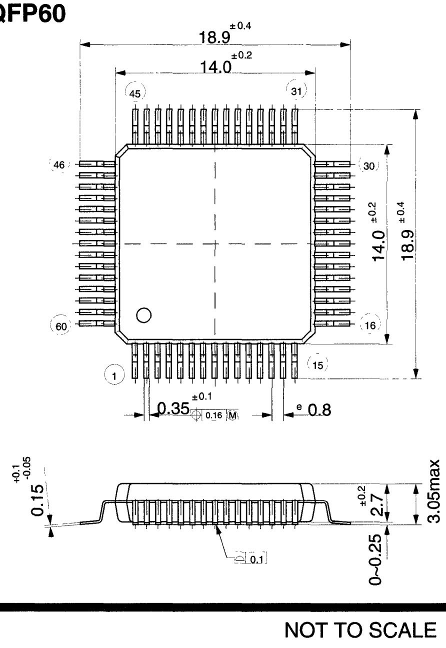
SURFACE MOUNT DEVICES

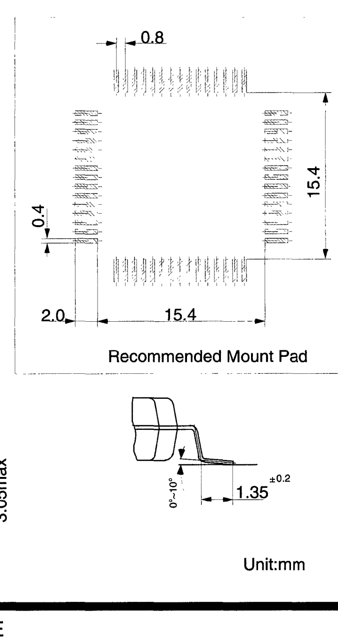
QFP52





QFP60

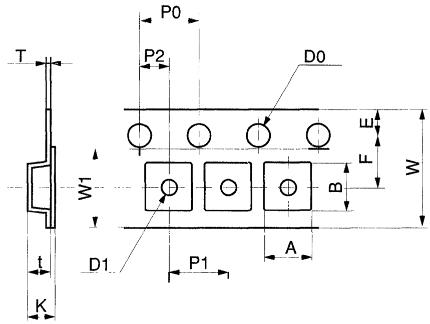




5

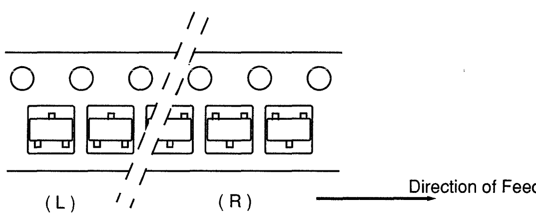
TAPE AND REEL INFORMATION

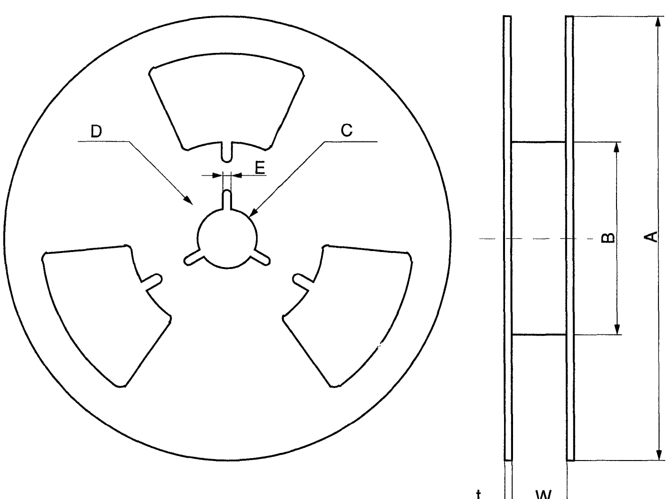
SOT23



UNIT : mm

Sign	Dimension
A	3.15 ± 0.1
B	3.25 ± 0.1
W	8.0 ± 0.2
W1	5.5 ± 0.2
F	3.5 ± 0.05
E	1.75 ± 0.1
P1	4.0 ± 0.1
P2	2.0 ± 0.05
P0	4.0 ± 0.1
D0	ø1.55 ± 0.05
D1	ø1.05 ± 0.05
T	0.3 ± 0.05
t	1.5 ± 0.1
K	1.6 ± 0.1

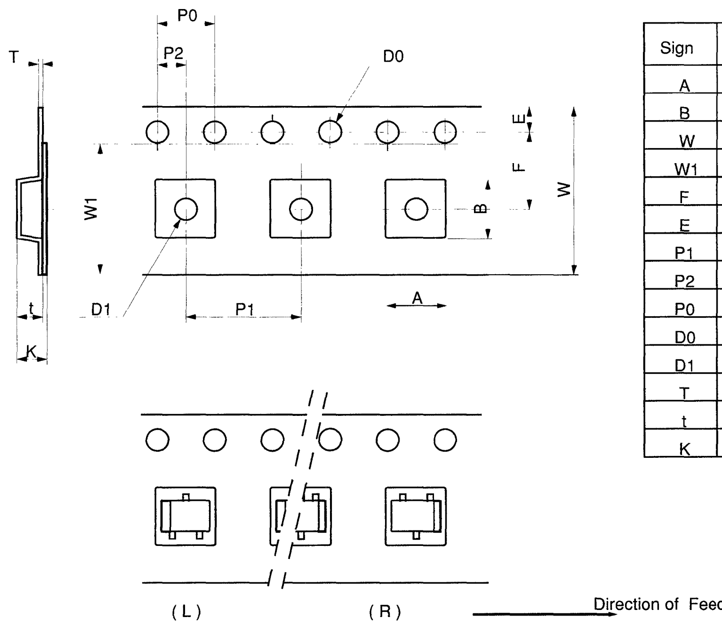




UNIT : mm

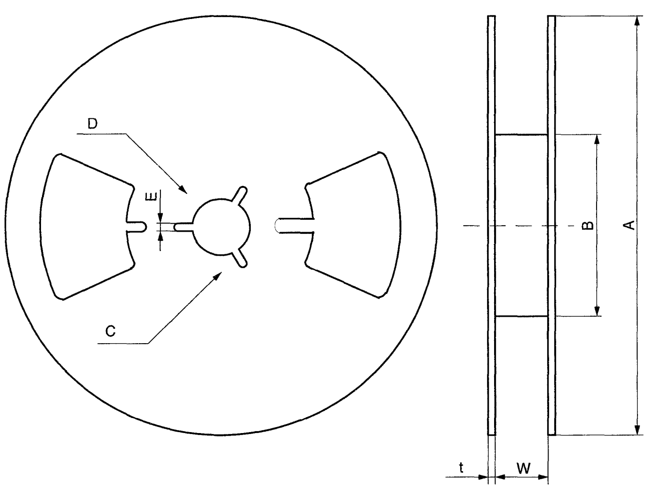
Sign	Dimension
A	ø178.0 ± 2.0
B	ø 66.0 ± 1.0
C	ø 13.0 ± 0.3
D	ø 21.0 ± 0.5
E	2.0 ± 0.5
W	9.5 ± 1.0
t	1.5 ± 0.5

SOT23L (3 PIN)



UNIT : mm

Sign	Dimension
A	4.20 ± 0.1
B	4.15 ± 0.1
W	12.0 ± 0.3
W1	9.5 ± 0.2
F	5.5 ± 0.05
E	1.75 ± 0.1
P1	8.0 ± 0.1
P2	2.0 ± 0.05
P0	4.0 ± 0.1
D0	ø1.55 ± 0.05
D1	ø1.55 ± 0.05
T	0.3 ± 0.05
t	1.7 ± 0.1
K	1.8 ± 0.1

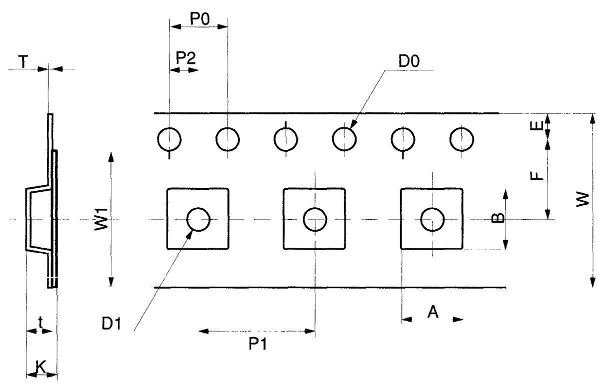


UNIT : mm

Sign	Dimension
A	ø178.0 ± 2.0
B	ø 66.0 ± 1.0
C	ø 13.0 ± 0.3
D	ø 21.0 ± 0.5
E	2.0 ± 0.5
W	9.5 ± 1.0
t	1.5 ± 0.5

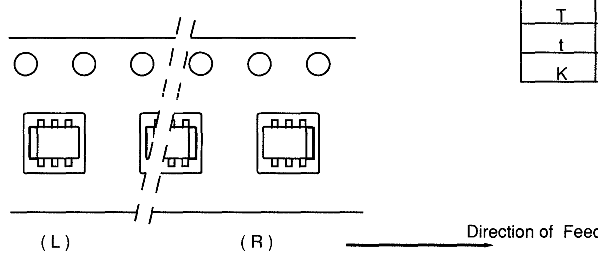
TAPE AND REEL INFORMATION

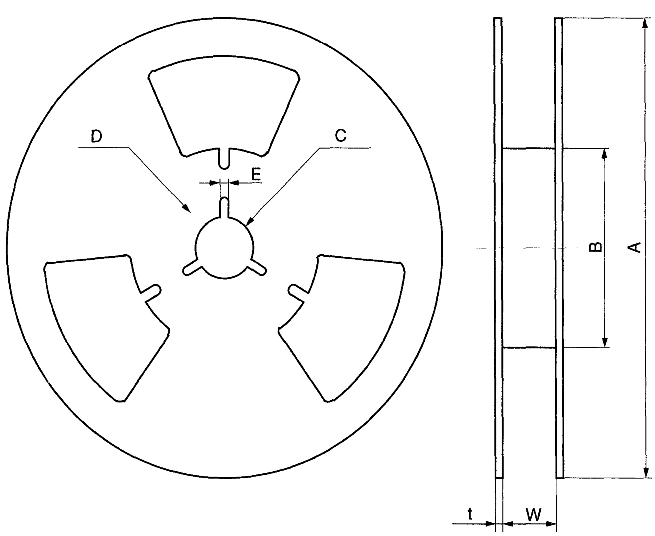
SOT23L (6 PIN)



UNIT : mm

Sign	Dimension
A	3.90 ± 0.1
B	3.50 ± 0.1
W	12.0 ± 0.3
W1	9.5 ± 0.2
F	5.5 ± 0.05
E	1.75 ± 0.1
P1	8.0 ± 0.1
P2	2.0 ± 0.05
P0	4.0 ± 0.1
D0	ø1.55 ± 0.05
D1	ø1.55 ± 0.05
T	0.3 ± 0.05
t	1.7 ± 0.1
K	1.8 ± 0.1

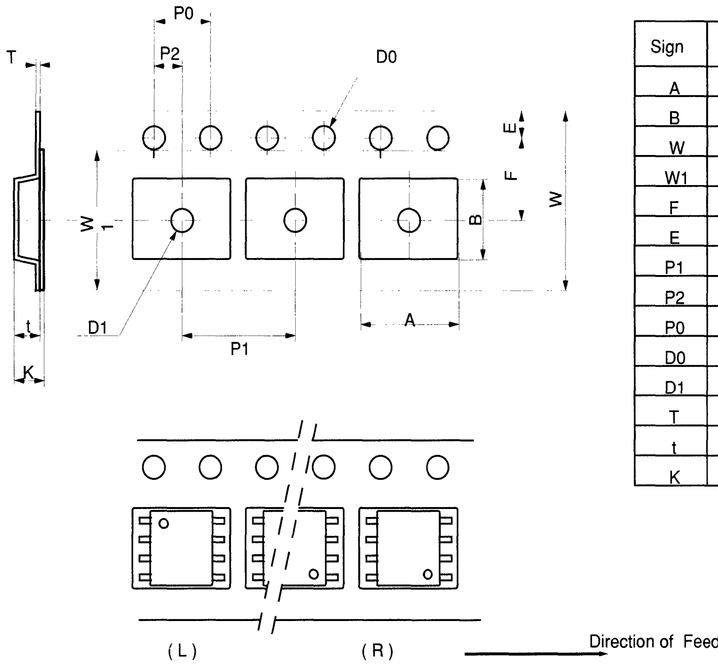




UNIT : mm

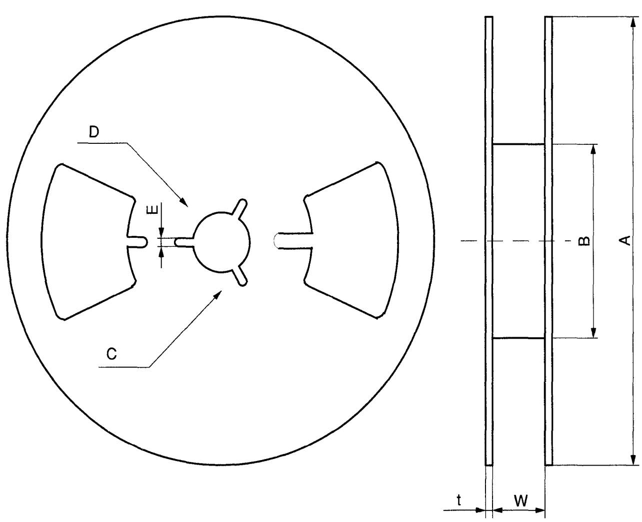
Sign	Dimension
A	ø178.0 ± 2.0
B	ø 66.0 ± 1.0
C	ø 13.0 ± 0.5
D	ø 21.0 ± 0.5
E	2.0 ± 0.5
W	13.5 ± 1.0
t	1.5 ± 0.5

MFP8



UNIT : mm

Sign	Dimension
A	6.90 ± 0.1
B	5.40 ± 0.1
W	12.0 ± 0.3
W1	9.5 ± 0.2
F	5.5 ± 0.05
E	1.75 ± 0.1
P1	8.0 ± 0.1
P2	2.0 ± 0.05
P0	4.0 ± 0.1
D0	ø1.55 ± 0.05
D1	ø1.55 ± 0.05
T	0.3 ± 0.05
t	2.1 ± 0.1
K	2.2 ± 0.1

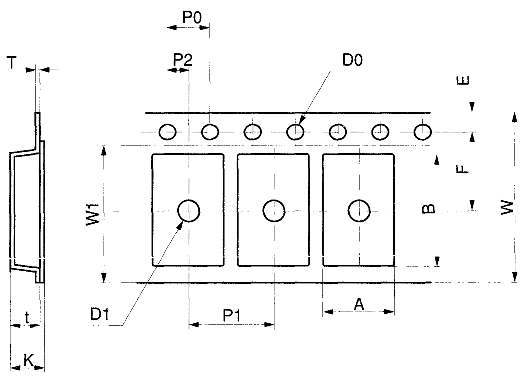


UNIT : mm

Sign	Dimension
A	ø178.0 ± 2.0
B	ø 66.0 ± 1.0
C	ø 13.0 ± 0.3
D	ø 21.0 ± 0.5
E	2.0 ± 0.5
W	9.5 ± 1.0
t	1.5 ± 0.5

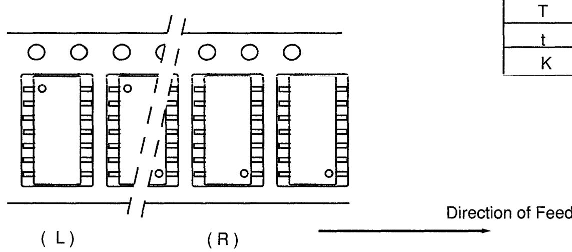
5

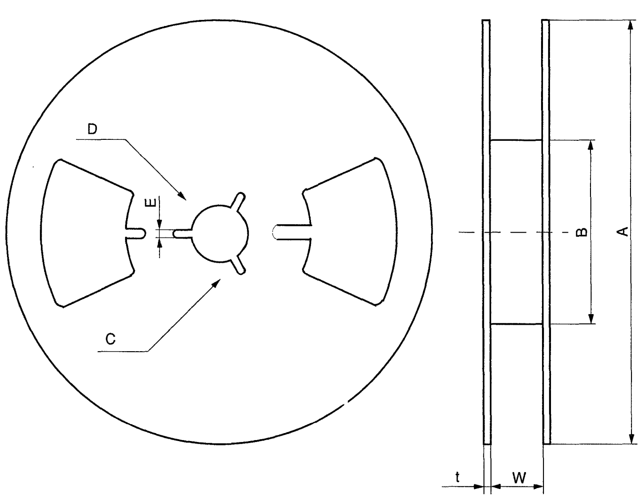
MFP14



UNIT : mm

Sign	Dimension
A	6.70 ± 0.1
B	9.2 ± 0.1
W	16.0 ± 0.2
W1	13.5 ± 0.2
F	7.5 ± 0.1
E	1.75 ± 0.1
P1	8.0 ± 0.1
P2	2.0 ± 0.05
P0	4.0 ± 0.1
D0	ø1.55 ± 0.05
D1	ø1.7 ± 0.1
T	0.3 ± 0.05
t	2.0 ± 0.1
K	2.1 ± 0.1

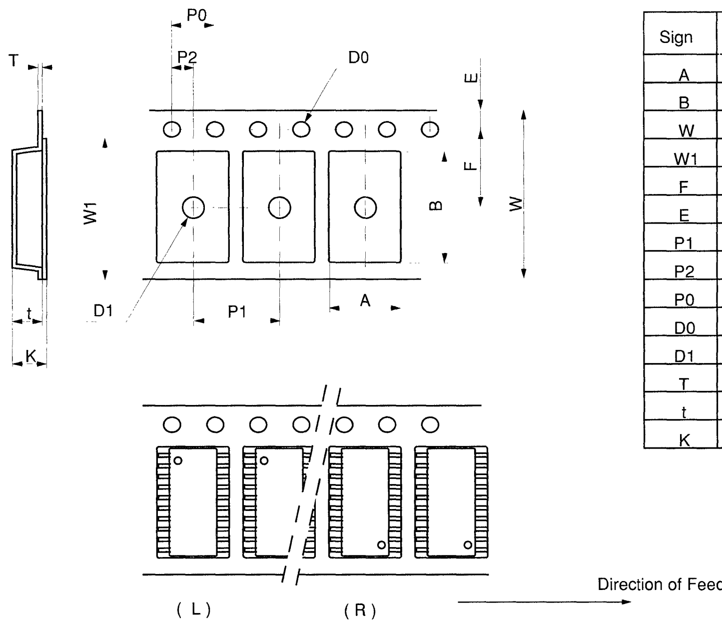




UNIT : mm

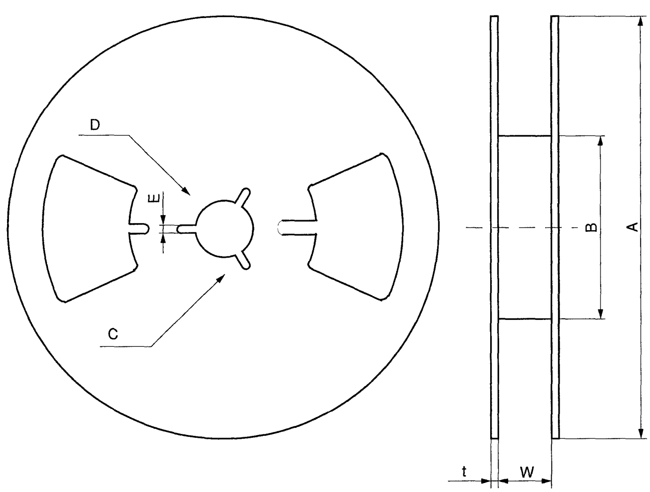
Sign	Dimension
A	ø 178.0 ± 2.0
B	ø 66.0 ± 1.0
C	ø 13.0 ± 0.5
D	ø 21.0 ± 0.5
E	2.0 ± 0.5
W	9.5 ± 1.0
t	1.5 ± 0.5

MFP20 (178)



UNIT : mm

Sign	Dimension
A	6.70 ± 0.1
B	10.55 ± 0.1
W	16.0 ± 0.2
W1	13.5 ± 0.2
F	7.5 ± 0.05
E	1.75 ± 0.1
P1	8.0 ± 0.1
P2	2.0 ± 0.05
P0	4.0 ± 0.1
D0	ø1.55 ± 0.05
D1	ø2.0 ± 0.05
T	0.3 ± 0.05
t	2.2 ± 0.1
K	2.3 ± 0.1



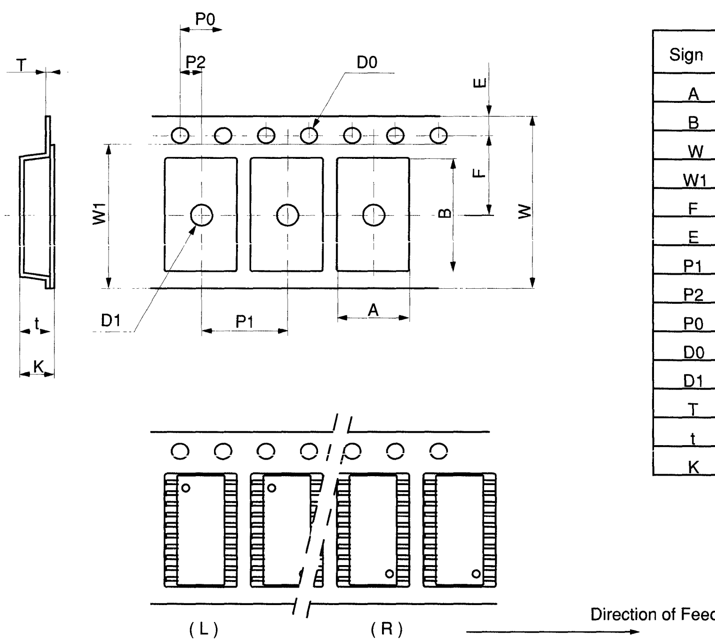
UNIT : mm

Sign	Dimension
A	ø178.0 ± [illegible]
B	ø 66.0 ± [illegible]
C	ø 13.0 ± [illegible]
D	ø 21.0 ± [illegible]
E	2.0 ± 0.5
W	9.5 ± 1.0
t	1.5 ± 0.5

5

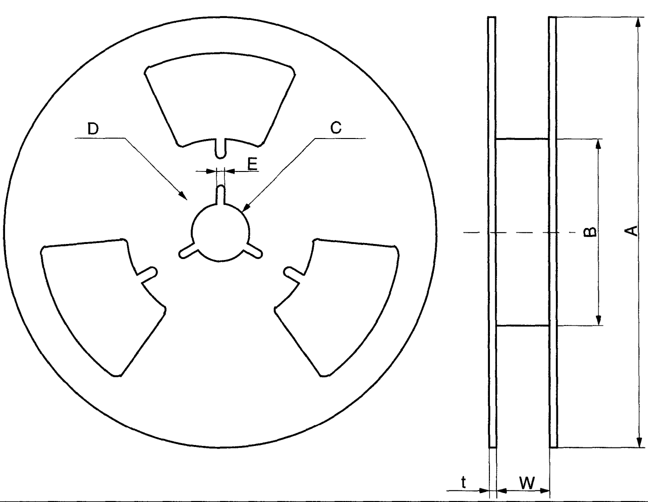
NOT TO SCALE

MFP20 (330)



UNIT : mm

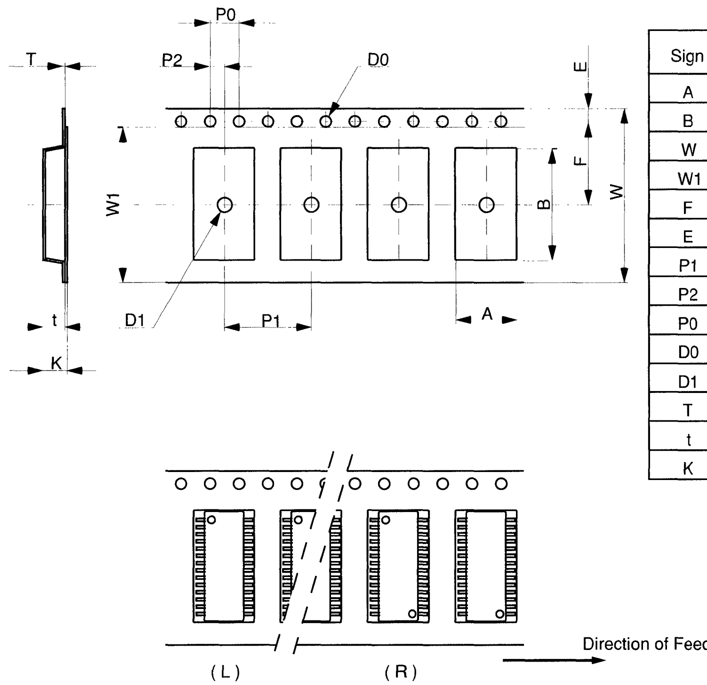
Sign	Dimension
A	6.70 ± 0.1
B	10.55 ± 0.1
W	16.0 ± 0.2
W1	13.5 ± 0.2
F	7.5 ± 0.05
E	1.75 ± 0.1
P1	8.0 ± 0.1
P2	2.0 ± 0.05
P0	4.0 ± 0.1
D0	ø1.55 ± 0.05
D1	ø2.0 ± 0.05
T	0.3 ± 0.05
t	2.2 ± 0.1
K	2.3 ± 0.1



UNIT : mm

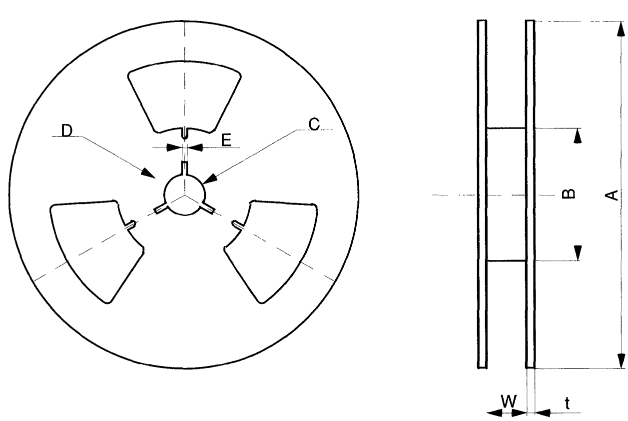
Sign	Dimension
A	ø330.0 ± 2.0
B	ø 80.0 ± 1.0
C	ø 13.0 ± 0.3
D	ø 21.0 ± 0.5
E	2.0 ± 0.5
W	17.5 ± 1.0
t	1.5 ± 0.5

MFP28/30



UNIT : mm

Sign	Dimension
A	8.4 ± 0.1
B	15.5 ± 0.1
W	24.0 ± 0.3
W1	21.5 ± 0.2
F	11.5 ± 0.1
E	1.75 ± 0.1
P1	12.0 ± 0.1
P2	2.0 ± 0.1
P0	4.0 ± 0.1
D0	ø1.5 ± 0.1
D1	ø2.0 ± 0.1
T	0.3 ± 0.05
t	2.75 ± 0.1
K	2.85 ± 0.1

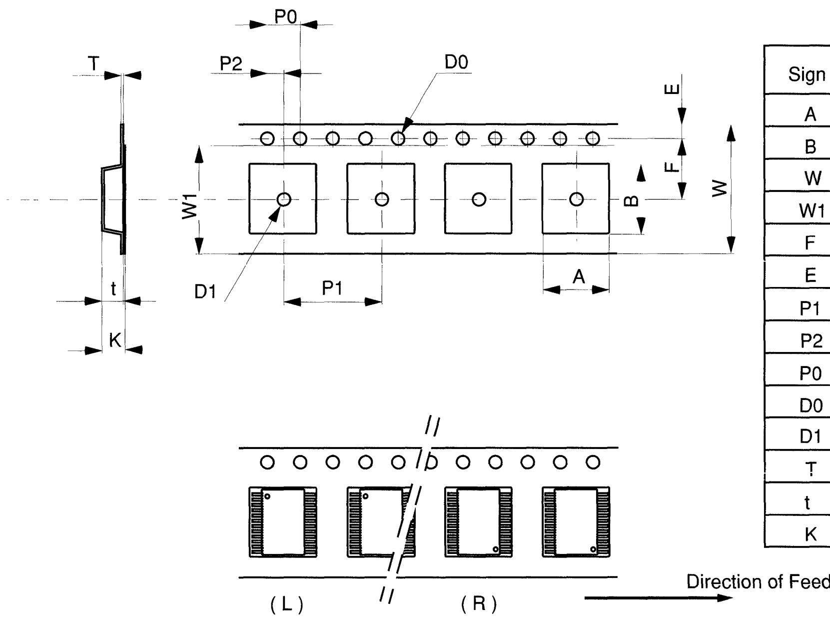


UNIT : mm

Sign	Dimension
A	ø330.0 ± 2.0
B	ø 80.0 ± 1.0
C	ø 13.0 ± 0.5
D	ø 21.0 ± 0.5
E	2.0 ± 0.5
W	25.5 ± 1.0
t	2.0 ± 0.5

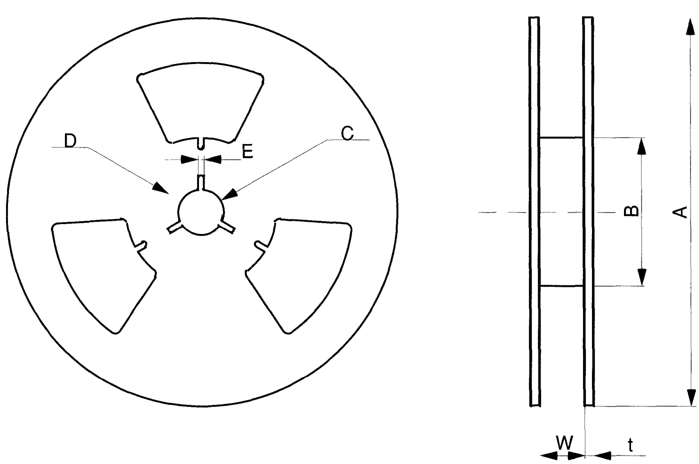
5

VSOP24



UNIT : mm

Sign	Dimension
A	8.2 ± 0.1
B	8.6 ± 0.1
W	16.0 ± 0.2
W1	13.5 ± 0.2
F	7.50 ± 0.05
E	1.75 ± 0.1
P1	12.0 ± 0.1
P2	2.0 ± 0.05
P0	4.0 ± 0.1
D0	ø1.55 ± 0.05
D1	ø1.55 ± 0.05
T	0.3 ± 0.05
t	2.48 ± 0.1
K	2.58 ± 0.1

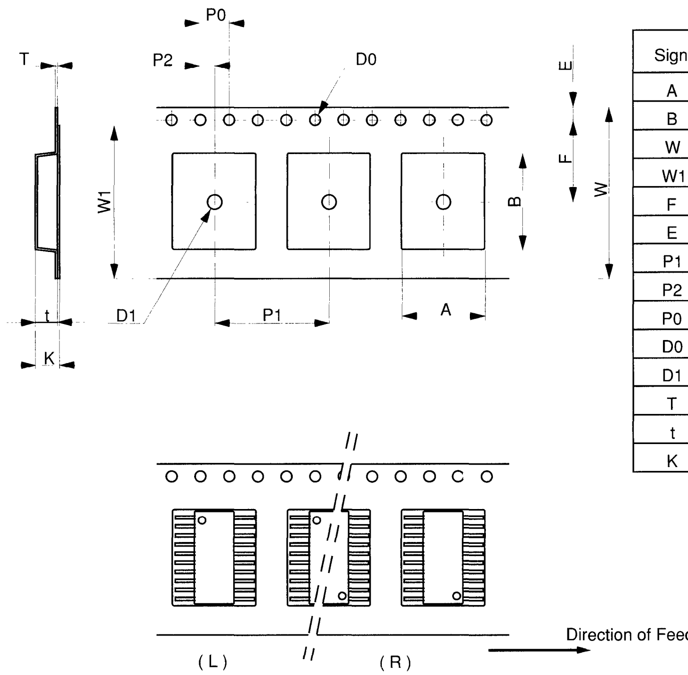


UNIT : mm

Sign	Dimension
A	ø330.0 ± 2.0
B	ø 80.0 ± 1.0
C	ø 13.0 ± 0.5
D	ø 21.0 ± 0.5
E	2.0 ± 0.5
W	17.5 ± 1.0
t	2.0 ± 0.5

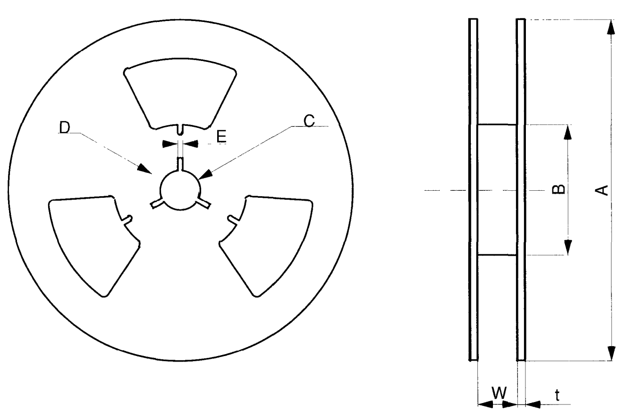
NOT TO SCALE

FP20



UNIT : mm

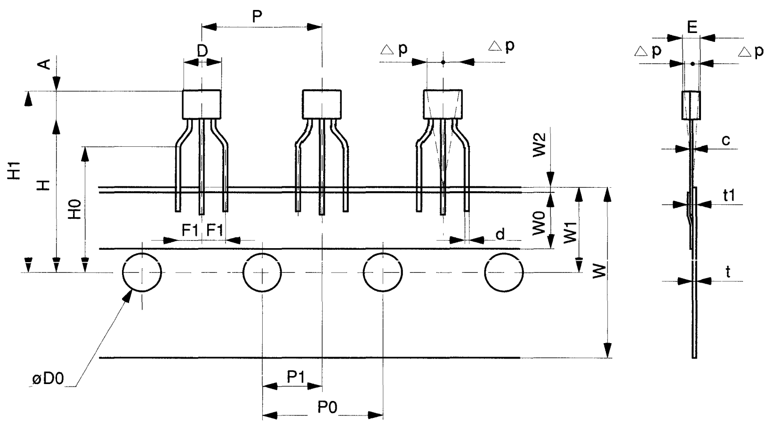
Sign	Dimension
A	11.6 ± 0.1
B	13.5 ± 0.1
W	24.0 ± 0.3
W1	21.5 ± 0.2
F	11.5 ± 0.1
E	1.75 ± 0.1
P1	16.0 ± 0.1
P2	2.0 ± 0.1
P0	4.0 ± 0.1
D0	ø1.55 ± 0.1
D1	ø2.0 ± 0.1
T	0.3 ± 0.05
t	3.2 ± 0.1
K	3.3 ± 0.1



UNIT : mm

Sign	Dimension
A	ø330.0 ± 2.0
B	ø 80.0 ± 1.0
C	ø 13.0 ± 0.5
D	ø 21.0 ± 0.5
E	2.0 ± 0.5
W	25.5 ± 1.0
t	2.0 ± 0.5

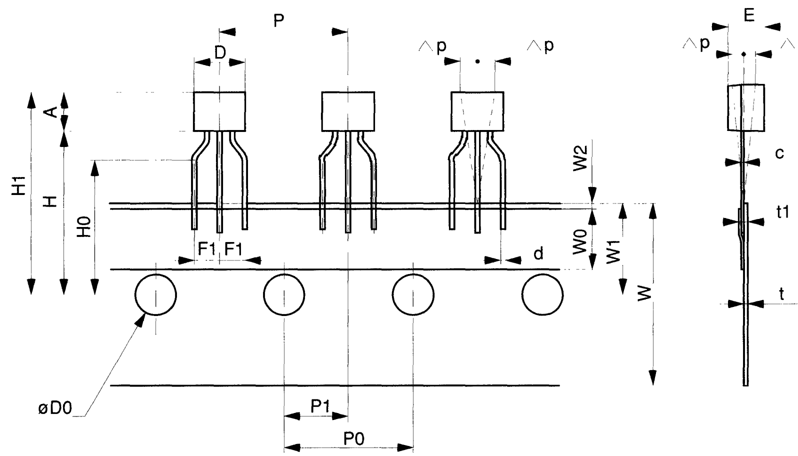
S-Pack



Unit : mm

Sign	Name	Dimension
A	Height of package body	3.0 ± 0.1
D	Length of package	4.0 ± 0.1
d	Lead wire width	0.46 ± 0.1
P	Pitch between parts	12.7 ± 1.0
P0	Feed hole pitch	12.7 ± 0.3
P1	Feed hole position	6.35 ± 0.4
F	Lead space	5.0 ± 0.3
F1	Lead pitch	2.5 ± 0.3
△h	Part drop	1.0 MAX
W	Tape width	$18.0^{+1.0}_{-0.5}$
W0	Adhering tape width	6.0 ± 0.5
W1	Feed hole position	9.0 ± 0.5
W2	Adhering tape position	0.5 MAX
H	Minimum work position	19.0 ± 0.5
H0	Lead wire clinch height	16.0 ± 0.5
H1	Maximum work position	23.6 ± 0.5
øD0	Feed hole diameter	ø4.0 ± 0.2
△p	Part drop	1.0 MAX
C	Lead thickness	0.48 ± 0.1
E	Package thickness	1.85 ± 0.1
t	Tape thickness	$0.38^{+0.2}_{-0.1}$
t1	Total tape thickness	1.5 MAX

TO-92



Unit : mm

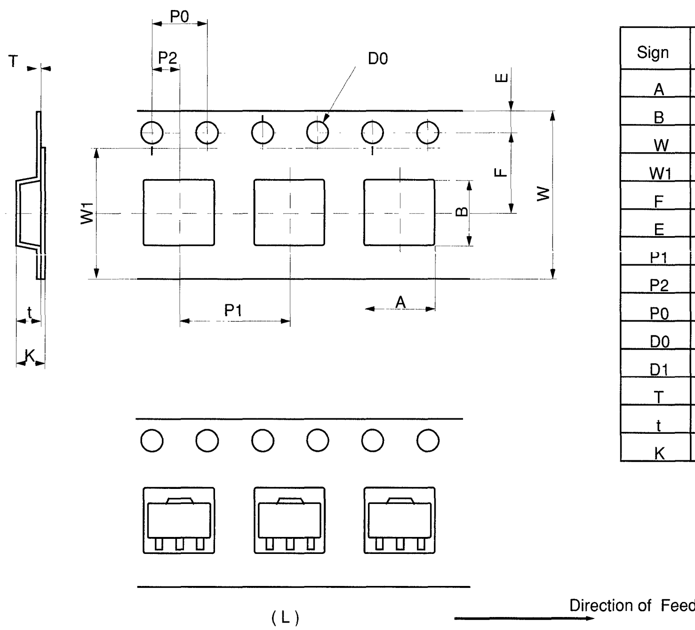
Sign	Name	Dimension
A	Height of package body	4.6 ± 0.1
D	Length of package	4.6 ± 0.1
d	Lead wire width	0.46 ± 0.1
P	Pitch between parts	12.7 ± 1.0
P0	Feed hole pitch	12.7 ± 0.3
P1	Feed hole position	6.35 ± 0.4
F	Lead space	5.0 ± 0.3
F1	Lead pitch	2.5 ± 0.3
△h	Part drop	1.0 MAX
W	Tape width	$18.0^{+1.0}_{-0.5}$
W0	Adhering tape width	6.0 ± 0.5
W1	Feed hole position	9.0 ± 0.5
W2	Adhering tape position	0.5 MAX
H	Minimum work position	19.0 ± 0.5
H0	Lead wire clinch height	16.0 ± 0.5
H1	Maximum work position	23.6 ± 0.5
øD0	Feed hole diameter	ø4.0 ± 0.2
△p	Part drop	1.0 MAX
C	Lead thickness	0.46 ± 0.1
E	Package thickness	3.6 ± 0.1
t	Tape thickness	$0.38^{+0.2}_{-0.1}$
t1	Total tape thickness	1.5 MAX

5

NOT TO SCALE

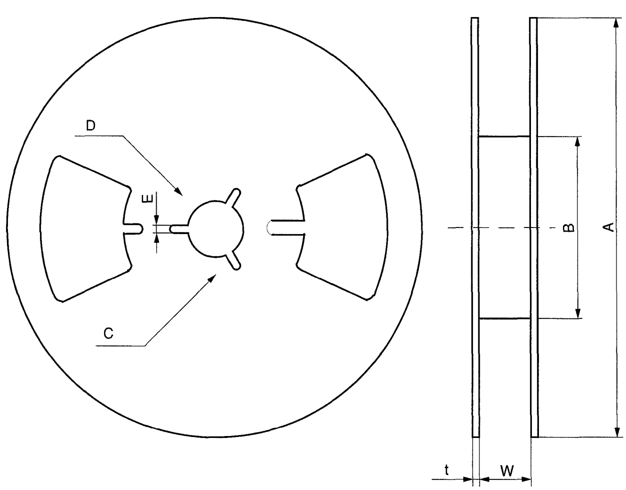
TAPE AND REEL INFORMATION

U-Pack 3



UNIT : mm

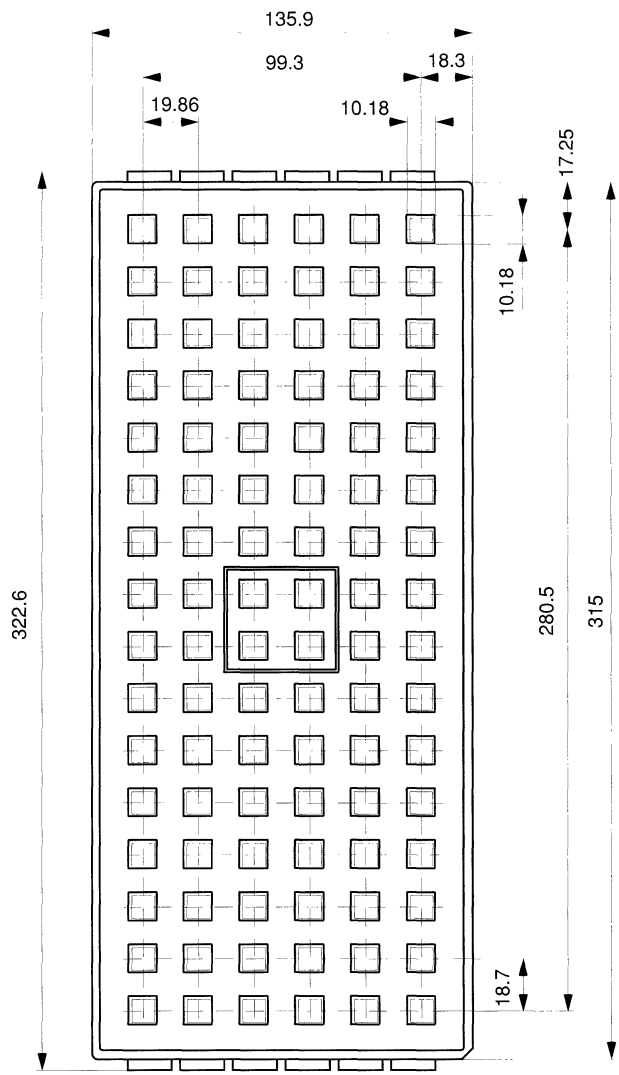
Sign	Dimension
A	5.1 ± 0.1
B	4.7 ± 0.1
W	12.0 ± 0.3
W1	9.5 ± 0.2
F	5.65 ± 0.05
E	1.5 ± 0.1
P1	8.0 ± 0.1
P2	2.0 ± 0.05
P0	4.0 ± 0.1
D0	ø1.55 ± 0.05
D1	
T	0.3 ± 0.05
t	2.1 ± 0.1
K	2.2 ± 0.1



UNIT : mm

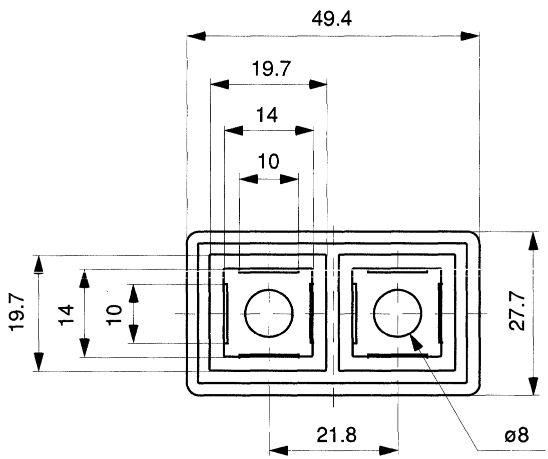
Sign	Dimension
A	ø178.0 ± 2.0
B	ø 66.0 ± 1.0
C	ø 13.0 ± 0.3
D	ø 21.0 ± 0.5
E	2.0 ± 0.5
W	9.5 ± 1.5
t	1.5 ± 0.5

QFP52



UNIT : mm
TOLERANCE : ± 1.0

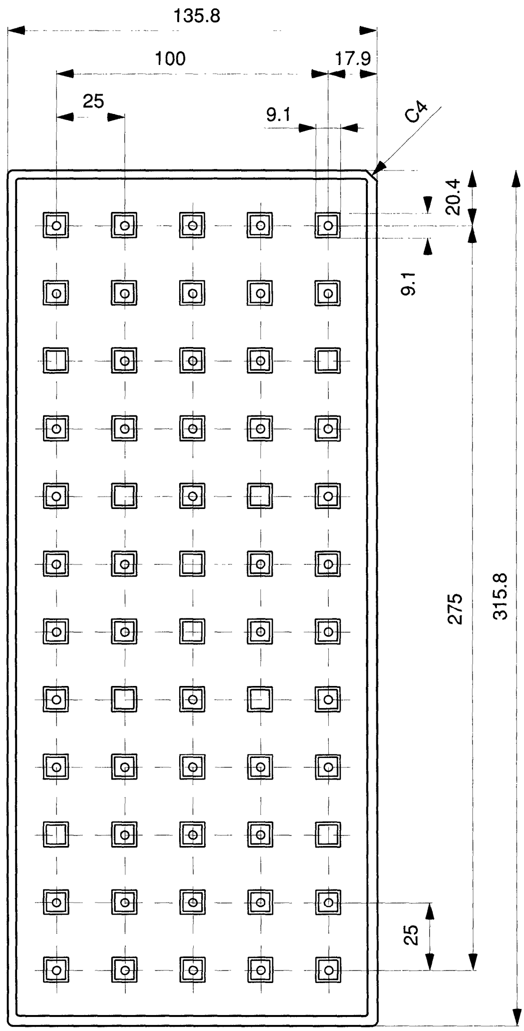
QFP60



UNIT : mm

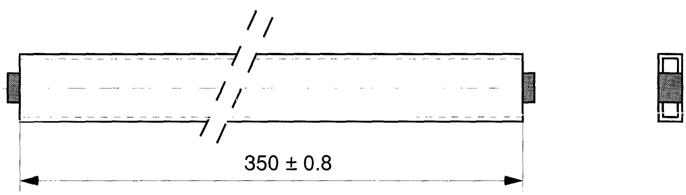
TOLERANCE : ± 0.2

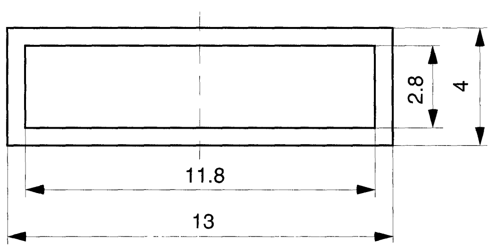
QFP52



UNIT : mm
TOLERANCE : ± 0.2

20 FP Magazine

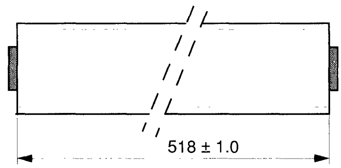


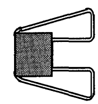


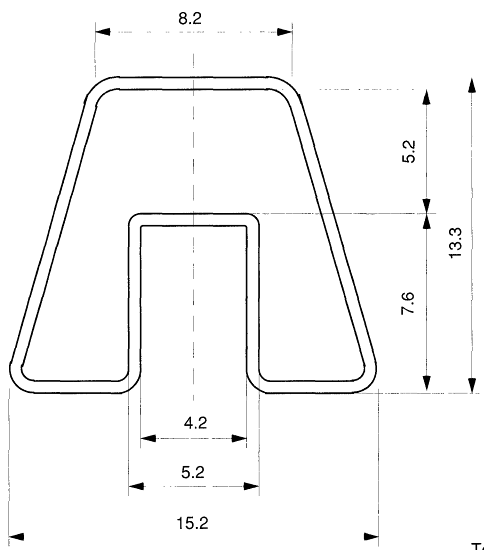
Unit : mm
Tolerance ± 0.2

Name	20FP Magazine
Thickness	0.6 ± 0.2 mm
Material	PVC
Treatment	Anti-static
Stopper	Rubber both ends
Quantity	F06C-20 : 25 pcs / cartridge

300 mil Magazine



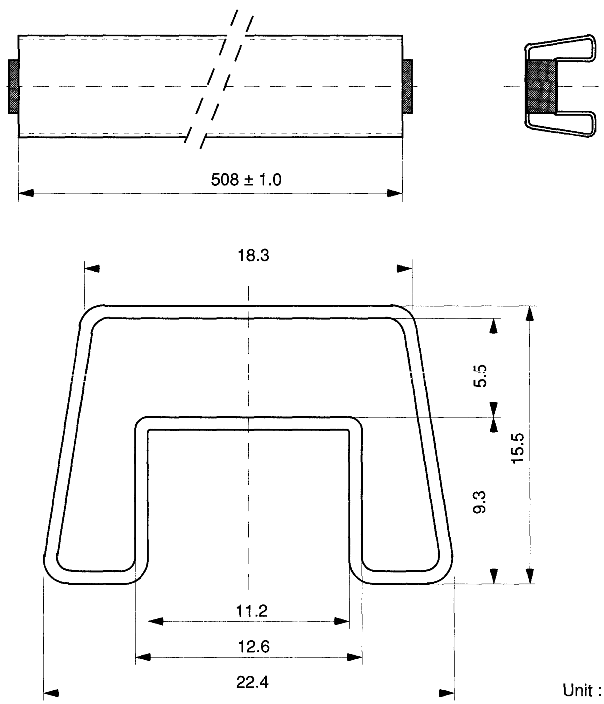




Unit : mm
Tolerance ± 0.3

Name	300 mil Magazine
Thickness	0.5 ± 0.2 mm
Material	PVC
Treatment	Anti-static
Stopper	Rubber both ends
Quantity	D01A-16 : 25 pcs / cartridge

600 mil Magazine

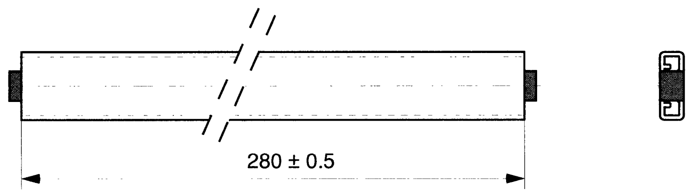


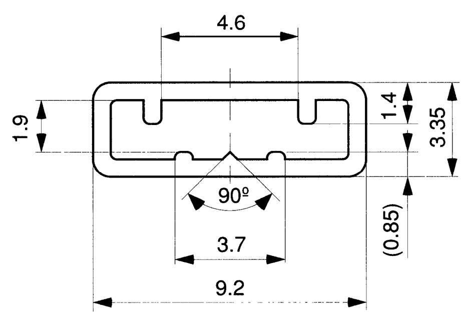
Unit : mm

Tolerance ± 0.3

Name	600 mil Magazine
Thickness	0.7 ± 0.15mm
Material	PVC
Treatment	Anti-static
Stopper	Rubber both ends
Quantity	

MFP20 Magazine



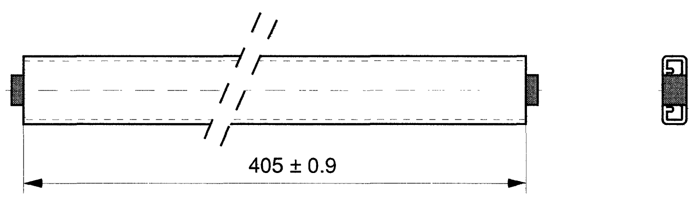


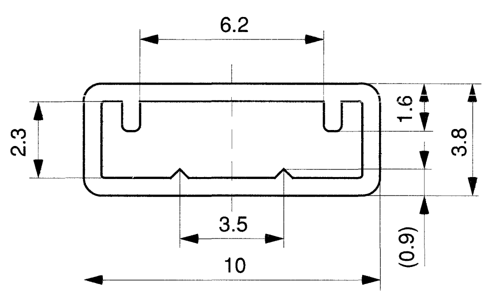
Unit : mm

Tolerance ± 0.2

Name	MFP20 MAGAZINE
Thickness	0.6 ± 0.15 mm
Material	PVC
Treatment	Anti-static
Stopper	Rubber stopper both ends
Quantity	F08A-20 : 25 pcs / cartridge F08E-14 : 30 pcs / cartridge

MFP28 Magazine



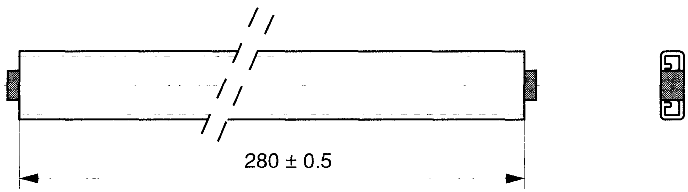


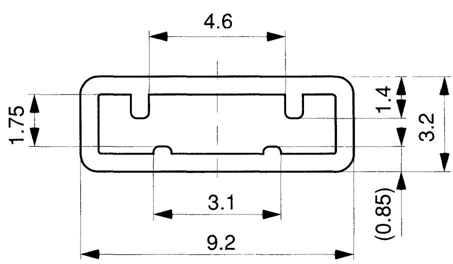
Unit : mm

Tolerance ± 0.2

Name	MFP28 Magazine
Thickness	0.6 ± 0.1 mm
Material	PVC
Treatment	Anti-static
Stopper	Rubber both ends
Quantity	F08C-28 : 25 pcs / cartridge F08C-30 : 25 pcs / cartridge

MFP8 Magazine





Unit : mm

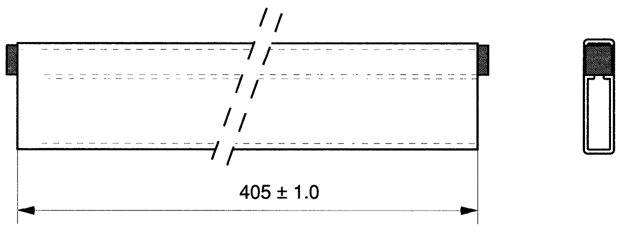
Tolerance ± 0.2

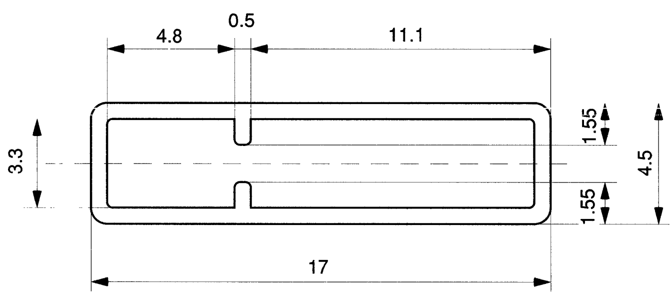
Name	MFP8 Magazine
Thickness	0.6 ± 0.15 mm
Material	PVC
Treatment	Anti-static
Stopper	Rubber both ends
Quantity	F08B-08 : 50 pcs / cartridge F08E-08 : 50 pcs / cartridge

5

MAGAZINE INFORMATION

SO7B-06 Magazine



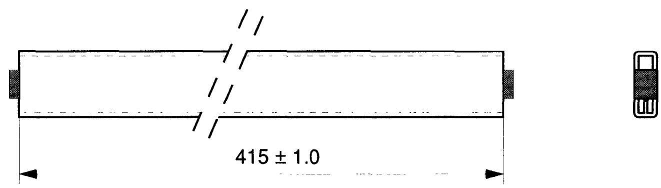


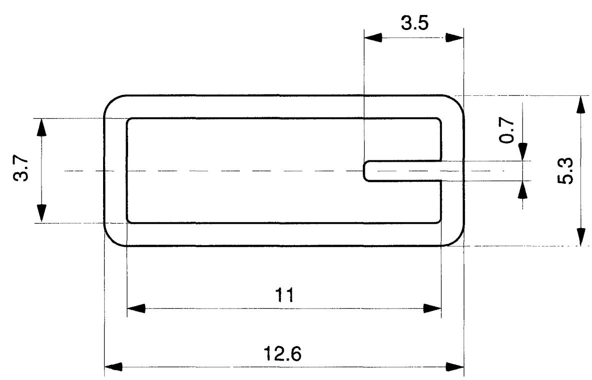
Unit : mm

Tolerance ± 0.3

Name	S07B-06 (2) Magazine
Thickness˙	0.6 ± 0.1 mm
Material	PVC
Traetment	Anti-static
Stopper	Rubber both ends
Quantity	S07B-06 : 25 pcs / cartridge S07G-06 : 25 pcs /cartridge S07N-06 : 35 pcs / cartridge

S11A-20 Magazine



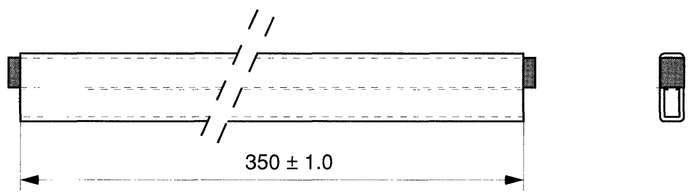


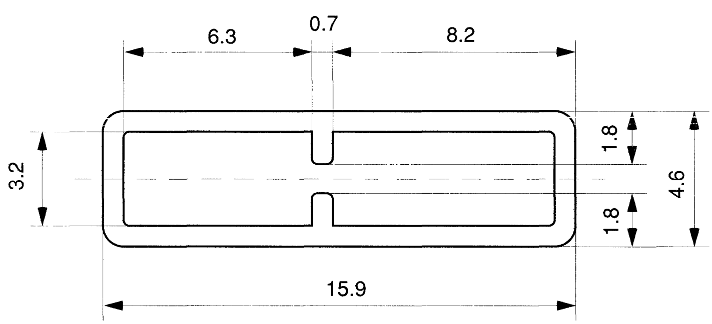
Unit : mm
Tolerance ± 0.2

Name	S11A-20 Magazine
Thickness	0.8 ± 0.1 mm
Material	PVC
Treatment	Anti-static
Stopper	Rubber both ends
Quantity	S05E-10 : 30 pcs / cartridge S11A-20 : 15 pcs / cartridge S11A-10 : 30 pcs / catridge

5

SIP5 Magazine





Unit : mm
Tolerance ± 0.2

Name	SIP5 Magazine
Thickness	0.7 ± 0.1 mm
Material	PVC
Treatment	Anti-static
Stopper	Rubber both ends
Quantity	S05C-05 : 25 pcs / cartridge S05C-10 : 25 pcs / cartridge

QUALITY ASSURANCE

TOKO

QUALITY ASSURANCE AND RELIABILITY

1. PREFACE

Electronic apparatus made in Japan is known for its high quality. This high quality is achieved by both the design technology of the electronic apparatus and the quality of the electronic components supporting this design technology. Recently, electronic equipment has become more and more complex with ever increasing component count and reduced component sizes, therefore the quality requirements have become much stricter. There is no future for an electronic component manufacturer and supplier if it cannot understand and satisfy the customers' requirements for quality. Quality is considered to be the most important issue in all aspects of manufacturing, not only in the production of electronic components. This concept is called Total Quality Control (TQC). Moreover, quality is the most important factor for an electronic component manufacturer because the reliability of the final product is directly influenced by the parts supplied.

Toko, Inc. has established “absolute quality assurance” as its basic policy and has developed methods of quality control as outlined in Toko’s "General Rule of Quality Control" document. The entire Toko group is involved with constant enhancement of quality and quality assurance methods.

2. QUALITY POLICY

The quality control and quality assurance activities of Toko Inc., are based upon the following categories.

2.1 Quality Assurance:

Toko guarantees to its customers the following items:

2.1.1 Toko will supply defect-free products for proper use.

2.1.2 Toko will determine the requirements to maintain a defect-free supply of components.

2.1.3 Toko will do its best to correct any kind of quality problem that may occur.

2.2 Quality Assurance Policy:

Toko’s policy of quality assurance is stated in the following paragraphs:

2.2.1 Each employee will do his or her best to realize the targeted quality by using Toko's method of quality control. Quality control involves everyone and is required for both the design process and the production process.

2.2.2 Statistical Quality Control (SQC) will be used.

2.2.3 The activities will be conducted systematically, based upon the control principle of “Plan - Do - Check - Action”.

3. QUALITY ASSURANCE SYSTEM

Toko's quality assurance system is defined in the "General Rules of Quality Control" document, directly controlled by Toko's president. The Semiconductor Division's quality assurance system is established based on the General Rules of Quality Control and consist of quality policy, documentation control, quality target, organization, product development, quality assurance contract, design, reliability test, test equipment control, preparation for production and sales, quality monitoring, quality improvement plan, education and training for quality control, handling of defects, quality claim, etc.

3.1 Quality Assurance for New Product Development:

The quality requirements of the customer are placed above all other requirements during new product design. New product design is conducted by following Toko's Product Development Control Rules, established in consideration of the inconsistency of controlled items in our process and their electrical characteristics. Quality is assured by the following procedures:

3.1.1 Based on the results of market investigation, the Engineering Dept. will discuss needs, required quality (reliability), price, and electrical characteristics with other departments and propose a development plan.

3.1.2 The Design Dept. will develop new products by using the newest process technology and circuit design techniques and it will take into consideration the customers' quality objectives as well.

3.1.3 The samples will be made in consideration of anticipated inconsistency of process or material used during mass production. The final specification will be determined after statistical evaluation of each item.

3.1.4 The Engineering Dept. is the leader during new product design, sampling, and sample evaluation. Production engineering, packaging engineering and quality assurance staff will be asked to review the basic design and offer their ideas. Related departments will assist in the sample evaluation under direction of the Engineering Dept. The head of the Engineering Dept. will determine the mass production sampling process.

3.1.5 During the pre-production process, after investigating the inconsistency characteristics in each process, the head of the Engineering Dept. will call a meeting to determine if the transfer to mass production is possible based on the results of reliability test and product approval activity conducted by the Quality Assurance Dept.

3.1.6 After the transfer to mass production is approved, the Production Dept. will propose a production plan including selection of an assembly plant, standard documentation, equipment procurement, material procurement and manpower.

3.2 Quality Assurance for Mass Production:

The quality assurance of materials in the mass production process is implemented by the purchase of high quality materials, use of controlled environment, controlled equipment and statistical quality control.

3.2.1 Plant Environment Control:

A very clean environment is required for semiconductor manufacturing. The necessary cleanliness of the wafer process and assembly process are guaranteed. High purity water is used in the wafer fabrication process, water purity is guaranteed by continuous monitoring.

3.2.2 Purchased Material Control:

A material evaluation test (reliability test) of the materials purchased by our Material Division is conducted by the Quality Assurance Dept. prior to their use. The Material Division will also conduct an incoming inspection to guarantee material quality.

3.2.3 Manufacturing Process Control:

The manufacturing process control is based on the premise that in order to achieve high quality in the manufacturing process, one must implement environment control, equipment maintenance control, control charts, inspection during process, QA during process, etc.. Automation is used as much as possible to minimize quality inconsistencies.

3.2.4 Product Inspection:

As a final quality assurance to the customer, product inspection is conducted for 100% of the products. A control restriction is established based on the results of product inspection. The Quality Assurance Dept. is responsible for analyzing the causes and determine whether or not to ship lots based upon such restrictions.

3.2.5 Lot Quality Assurance/Periodic Reliability Test:

In order to assure lot quality, the Quality Assurance Dept. will conduct a sampling test of those lots that passed 100% inspection in the manufacturing process. A sampling test of electrical characteristics and visual inspection is conducted and a reliability test is performed periodically for each package type.

3.2.6 Control for Any Change:

Control in the event of design, material, process, or equipment change is implemented in accordance with Toko's internal rules and eventually must be approved by the Quality Assurance Dept. However, those changes related to specifications and characteristics must be approved by the customer prior to implementation.

3.2.7 Quality Claim:

The quality claim is the most important control item. The Quality Dept. is responsible for correction of any quality claim with help from all related departments.

4. RELIABILITY TEST

The reliability tests are implemented for new product development, design change, process change (process equipment, process, material, etc.). Periodical product reliability confirmation is performed during mass production. The test items, methods, and conditions are listed in Toko's Standard which is determined based on EIAJ ED-70 and in consideration of the level required by the market. An example of Toko's test method is shown below. Toko can also conduct reliability tests according to customer requirements.

RELIABILITY TEST EXAMPLE

TEST ITEM	CONDITION
THERMAL SHOCK	-65 °C / 5 MIN TO +150 °C / 5 MIN 100 TIMES
RESISTANCE TO SOLDERING HEAT	SOLDER TEMP 260 °C 10 SEC WITH FLUX
AUTOCLAVE	AFTER SOLDERING TEST 121 °C, 1000 % RH, 96 HRS
HIGH TEMP LIFE TEST	MAX OPERATING V, MAX OPERATING TEMP, 1000 HRS
HIGH TEMP HIGH HUMIDITY LIFE TEST	AFTER SOLDERING TEST, TYPICAL OPERATING V,85 °C, 85% RH, 100HRS. (IF OVER 100 mW : 1 HR ON, 3 HR OFF)
SOLDERABILITY	SOLDER TEMP 230 °C FOR 3 SEC WITH FLUX
ESD TEST	V = 200 V, C = 200 pF, R = 0 Ω

5. HANDLING QUALITY CLAIMS

5.1 Toko will do its best to correct any quality claim when it occurs. The Quality Assurance Dept. is responsible for all quality claims related to the Semiconductor Division.

5.2 The quality claim handling system chart is attached (see figure 1)

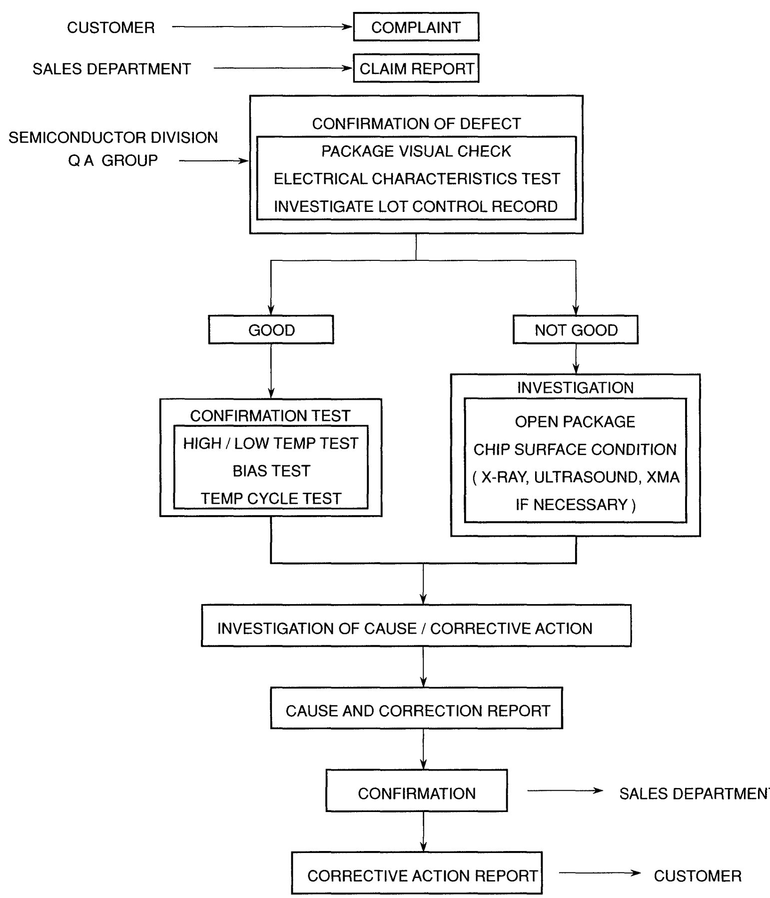
5.2.1 Quality Claim Report:

The sales office will write this report with information and help from the customer. This report will be sent to the Quality Assurance Dept. of the Semiconductor Division located in the Toko Saitama Facilities along with the defective products.

5.2.2 Cause Analysis and Other Investigations:

With the assistance of other departments if necessary, the Quality Assurance Dept. will analyze the defect that caused the product to be returned . The cause analysis will be conducted according to the procedure outlined on the chart below.

CORRECTIVE ACTION ROUTE



5.2.3 Corrective Action:

As the cause of the defect is confirmed, the Quality Assurance Dept. will request corrective action by issuing a Quality Claim Corrective Action Instruction. This will include the corrective actions taken to the inventory in process, product inventory, products in process, products in transportation and material inventory. If necessary, the Quality Assurance Dept. will meet with related departments to discuss the cause and required corrective action.

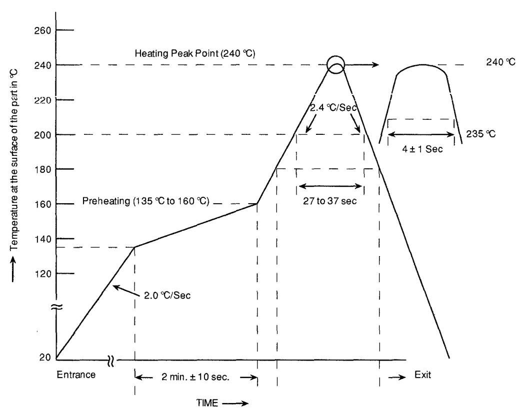
5.2.4 Cause Analysis and Corrective Action Report:

The Quality Assurance Dept. will submit this report of defect cause and corrective action to the customer. If necessary, the corrective action will be reviewed with the customer.

MOUNTING METHODS OF TOKO'S SEMICONDUCTOR PRODUCTS

1. SOLDER REFLOW

There are many methods for solder reflow. In the case of infrared heating method, which is most often used, please determine the reflow condition based on Toko's recommended condition as shown in the figure below. Do not use reflow more than twice.



REFLOW CONDITION

2. SOLDER DIPPING (SOLDER FLOW)

In the case of solder dipping, a preheat must be done based on Toko's recommended preheat at 90 to 130 °C for 30 to 60 seconds. Please determine the duration of solder dipping based on Toko's recommended condition of 230 to 235 °C for 3 to 4 seconds. The solder dipping must be done only once.

3. SOLDERING BY IRON

In the case of soldering by iron, please determine the soldering requirements based on Toko's recommendations for iron temperature. Soldering iron tip temperature should be lower than 350 °C and applied for less than 3 seconds. Lower temperatures may be required for some packages.

4. FLUX AND WASHING REQUIREMENTS

Rosin flux is recommended for the soldering process. Please avoid using chlorine flux because the remaining chlorine may corrode the aluminum portions of Toko's products. Please use a washing solvent with low surface tension, (high permeability), and minimize both soldering and washing time as much as possible. Also, please minimize the use of ultrasonic washing as much as possible.

5. RECOMMENDED MOUNTING METHODS

Though all the above methods are recommended, certain types of surface mount packages may require only reflow soldering or soldering by an iron.

SECTION 1

GENERAL GUIDE OF QUALITY CONTROL IN TOKO'S QUALITY CONTROL DEPARTMENT

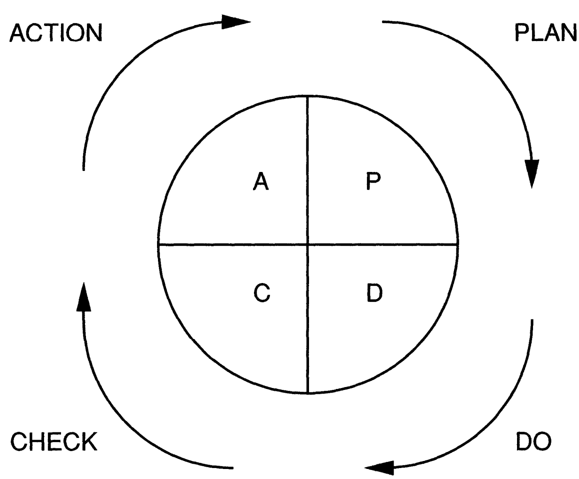
1. Policy

1.1 Quality Assurance Concept

1. All products are guaranteed to be of good quality.
2. Effective methods of quality control are used at all times.
3. In the case of any defective materials being supplied, Toko makes every effort to replace or repair such items.

1.2 Quality Assurance Policy

1. Quality is regarded as an essential ingredient in the design and manufacturing process.
2. Toko continuously applies Statistical Quality Control (S.Q.C.).
3. Our formula for control is the plan-do-check-action circle which should be performed continuously.



2. Outline of TO-QC

2.1 Guiding Principles

1. Quality Assurance
2. Development of New Products
3. Employee Productivity
4. QC Circle and Proposal of Idea
5. Activity by Functional Project Teams (TO-QC Teams)
6. Study methods of SQC within every division or department of Toko

SECTION 2

EDUCATION

Toko has an education system consisting of Quality Control, Technique, QC Circle and Technical Skill, as listed below:

1. Statistical Quality Control

    1. Statistical Quality Control
    2. Design of Experiments
    3. Reliability Theory

2. Technique

    1. Wafer Process
    2. Electronic Circuit
    3. Assembly Process
    4. Computer Programming

3. Technical Skill

    1. General Guidance for Semiconductor Processing
    2. Basic Education
    3. Diffusion
    4. Photo-Chemical

SECTION 3

RECEIVING INSPECTION

1. Toko has a system in place to assure that materials meet physical, chemical, visual, functional and dimensional requirements.

2. Toko uses "$\overline{X}$-R Control Chart". Refer to an example in Figure 1-1.

3. Toko will return the materials to the suppliers as rejected lots whenever the rejected quantity of sampling inspection is over our lot acceptance limit.

4. Toko will perform inspections according to receiving inspection specifications issued by production engineering.

5. Toko uses lot history records and keeps them for 3 years.

6. If a lot is out of specification (non-conforming lot), the entire lot will be returned and a corrective action will be requested from the supplier.

   By evaluating the quality of corrected materials received, Toko will decide whether or not suppliers took adequate corrective action.

7. Toko will select its suppliers by the following criteria:

   A. Quality Characteristics
   B. Capability of Quality Control
   C. Supply Capacity
   D. Cost

8. Incoming Sampling Plans

   Incoming Sampling Plans are as listed below:

			C = Critical Info
Lead Frame:	Visual Inspection:	n = 50/lot	c = 0
	Temperature-Proof:	n = 50 /lot	c = 0
	Plating:	n = 50/lot	c = 0
Wafer:	Characteristics:	n = 50/lot	c = 0
	Visual Inspection:	n = 50/lot	c = 0
Epoxy Resin:		n = 5/lot	c = 0

6

SECTION 4

MANUFACTURING PROCESS

1. $\bar{x}$-R Control Chart

Toko mainly uses $\bar{x}$-R control charts and $\bar{X}$-σ charts for all processes. Please refer to Table 4-1 and Figure 4-1.

Table 4-1 Example of $\bar{x}$-R Control Chart

PROCESS	CHARACTERISTIC	EVALUATION METHOD
INCOMING INSPECTION	DIMENSION	CALIPER
WAFER PROCESS	EPITAXIAL RESISTIVITY OXIDE FILM THICKNESS WAFER CHARACTERISTIC	RESISTIVITY TEST SYSTEM AUTO FILM THICKNESS MEASUREMENT SYSTEM PARAMETER TESTER
ASSEMBLY PROCESS	WIRE STRENGTH	TENSION GUAGE
OUTGOING INSPECTION	ELECTRICAL CHARACTERISTICS	TESTER

3. Process Capability

Toko determines process capabilities based upon $\bar{x}$-R Charts. Please refer to Table 4-2.

Table 4-2 Process Capability

PROCESS	CHARACTERISTIC	EVALUATION METHOD
INCOMING INSPECTION	EPITAXIAL THICKNESS	t Cp=1.33
WAFER PROCESS	EPITAXIAL RESISTIVITY OXIDE FILM THICKNESS WAFER CHARACTERISTIC	ρ Cp=1.48 t Cp=1.87 C1v Cp=3.96 C1.2v Cp=1.40
ASSEMBLY PROCESS	WIRE STRENGTH	Cp=1.50
OUTGOING INSPECTION	ELECTRICAL CHARACTERISTICS	C1.2v Cp=1.80

Figure 4-1

EPI THICKNESS $\overline{X}$-R CONTROL CHART

CONTROL GRAPH

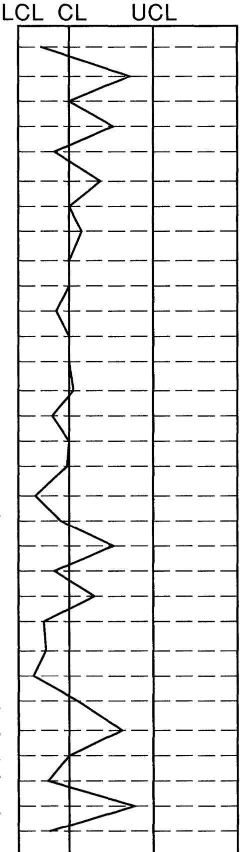
$\overline{X}$	UCL 8.232		$\overline{R}$	UCL 0.588
	CL 8.044			CL 0.258
	LCL 7.856			LCL 0.000

SCALE : σ 0.125 SCALE : 0.258

No.	DATE	BATCH	NAME	LOT
1	1022	0001	KKC936GB	6489
2	1022	0002	KKC936GB	6489
3	1022	0003	KKC936GB	6492
4	1022	0005	KKC936GB	6491
5	1022	0006	KKC936GB	6494
6	1022	0007	KKC936GB	6493
7	1022	0008	KKC936GB	6496
8	1022	0009	KKC936GB	6495
9	1022	0010	KKC936GB	6498
10	1022	0013	KKC936GB	6499
11	1022	0015	KKC936GB	6497
12	1023	0001	KKC936GB	6500
13	1023	0002	KKC936GB	6501
14	1023	0003	KKC936GB	6502
15	1023	0004	KKC936GB	6503
16	1023	0005	KKC936GB	6503
17	1023	0006	KKC936GB	6505
18	1023	0007	KKC936GB	6506
19	1023	0008	KKC936GB	6507
20	1023	0009	KKC936GB	6508
21	1023	0010	KKC936GB	6509
22	1023	0011	KKC936GB	6510
23	1023	0012	KKC936GB	6511
24	1023	0013	KKC936GB	6512
25	1023	0014	KKC936GB	6513
26	1023	0015	KKC936GB	6514
27	1023	0016	KKC936GB	6516
28	1023	0018	KKC936GB	6515
29	1023	0020	KKC936GB	6517
30	1023	0021	KKC936GB	6518
31	1024	0001	KKC936GB	6519

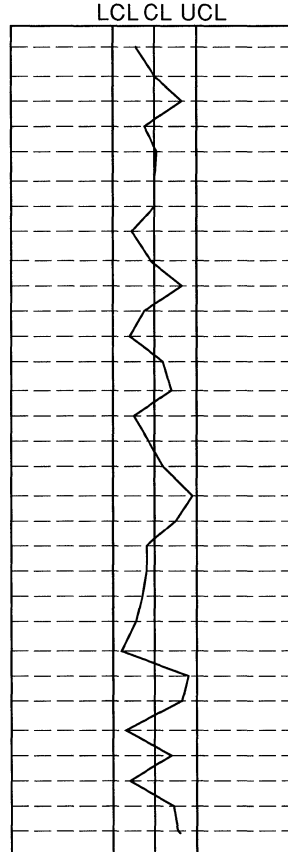
R

LCL CL UCL



$\overline{X}$

LCL CL UCL



SECTION 5

RELIABILITY TESTING

1. Reliability tests are performed to verify quality of new parts in mass production.
2. Reliability testing is not involved in final outgoing inspection.
3. Usually, reliability tests listed in Table 5-1 are performed.
4. Reliability testing of parts in production are taken randomly whenever required.
5. Toko's reliability test specifications conform to well known industry standards and targeted to specific market requirements.

TABLE 5-1 Standard Reliability Test Specifications

STANDARD RELIABILITY TEST SPECIFICATIONS

1. ENVIRONMENTAL TESTS

TEST ITEM	TEST CONDITION AND METHOD	ACCEPTABILITY CRITERIA			CHARACTERISTICS EVALUATED
		n	c	LTPD	
HIGH TEMPERATURE OPERATING LIFE TEST	T_A : * Top. MAX. V : * Vop. MAX. 1.000 H * LOAD CONDITION : WITHIN A MAX. POWER DISSIPATION ACCORDING TO THE TEMPERATURE DERATING CURVE.	32	0	7%	ELECTRICAL CHARACTERISTICS
HIGH TEMPERATURE OPERATING LIFE BIASED LIFE TEST	T_A : 85 °C, V: * Vop TYP. 500 HRS. SOT, SOP, VSOP AND QFP PKGS. Vop TYP . 1000 HRS. * WHEN THE POWER DISSIPATION EXCEEDS 100 mW, A CYCLE CONSISTS OF 1 HOUR-ON AND 3 HOURS-OFF.	32	0	7%	ELECTRICAL CHARACTERISTICS
HIGH TEMPERATURE STORAGE LIFE TEST	T_A : +150 °C 1000 HRS.	22	0	10%	ELECTRICAL CHARACTERISTICS
LOW TEMPERATURE STORAGE LIFE TEST	T_A : -55 °C 1000 HRS.	22	0	10%	ELECTRICAL CHARACTERISTICS
HIGH TEMPERATURE HIGH HUMIDITY STORAGE LIFE TEST	T_A : +65 °C RH : 90% 1000 HRS.	32	0	7%	ELECTRICAL CHARACTERISTICS
PRESSURE COOKER STORAGE TEST (AUTOCLAVE)	T_A : +121 °C RH : 100 % 96 HRS. SOT, SOP, VSOP AND QFP 72 HRS.	32	0	7%	ELECTRICAL CHARACTERISTICS

TABLE 5-1 Standard Reliability Test Specifications (Cont.)

STANDARD RELIABILITY TEST SPECIFICATIONS

1. ENVIRONMENTAL TESTS (CONT'D)

TEST ITEM	TEST CONDITION AND METHOD	ACCEPTABILITY CRITERIA			CHARACTERISTICS JUDGED
		n	c	LTPD	
THERMAL SHOCK TEST	(1) +100 °C 5 MINUTES ↓ (2) 0 °C 5 MINUTES (1 → 2 , 2 → 1 WITHIN 10 SEC.) 100 CYCLES 100 °C : BOILING WATER 0 °C : ICE WATER, LIQUID PHASE	15	0	15 %	ELECTRICAL CHARACTERISTICS AND VISUAL
ELECTROSTATIC DISCHARGE SENSITIVITY CLASSIFICATION TEST	C = 200 PF V = 200 V R = 0 Ω GROUND A V_{CC} OR GND LEAD. APPLY THE VOLTAGE TO EACH LEAD TERMINAL OF THE SAMPLE DEVICE. (BOTH POSITIVE AND NEGATIVE DIRECTIONS, SEPARATELY.)	4 x 5 —— 20			ELECTRICAL CHARACTERISTICS AND VISUAL
RESISTANCE TO SOLDERING HEAT	T_A: +260 °C 10 SECONDS	15	0	15 %	ELECTRICAL CHARACTERISTICS AND VISUAL

TABLE 5-2 Standard Reliability Test Specifications (Cont.)

STANDARD RELIABILITY TEST SPECIFICATIONS

1. MECHANICAL TESTS

TEST ITEM	TEST CONDITION AND METHOD	ACCEPTABILITY CRITERIA			CHARACTERISTICS JUDGED
		n	c	LTPD	
VARIABLE FREQUENCY VIBRATION TEST	20 Hz - 2000 Hz - 20 Hz 1.5 mm (20 G) 1 CYCLE FOR 4 MINUTES X . Y . Z . 4 TIMES EACH AXIS TOTAL TEST TIME : 48 MINUTES	15	0	15 %	ELECTRICAL CHARACTERISTICS AND VISUAL
MECHANICAL SHOCK TEST	1500 G 0.5 MILLI-SECONDS X . Y . Z. 5 TIMES EACH AXIS	15	0	15 %	ELECTRICAL CHARACTERISTICS AND VISUAL
DROP TEST (LOAD DUMP)	DROP SAMPLES 3 TIMES ONTO A WOODEN BOARD FROM 75 cm. HIGH	15	0	15 %	ELECTRICAL CHARACTERISTICS AND VISUAL
SOLDERABILITY TEST	T_A: +230 °C 3 SECONDS WITH ROSIN FLUX	15	0	15 %	VISUAL (SOLDERABILITY)
LEAD INTEGRITY	(1) PULL (TENSION) 500 g 30 SECONDS 250 g FOR SMD PKGS. TO THE AXIS OF THE LEAD	15	0	15 %	VISUAL
	(2) BEND (BENDING) 250 g 90 ° 2 TIMES BEND IS NOT APPLIED TO SMD PKGS.	15	0	15 %	VISUAL

NOTES

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USA
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San Jose, CA 95131
USA
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GERMANY
TOKO Electronic Europe GMBH
Burgmullerstr. 7
D-4000 Dusseldorf 1, Germany
Tel: (0211) 682281
Fax: (0211) 679-9567
Telex: 8582643

UNITED KINGDOM
TOKO (U.K.) Ltd.
Ward Royal Parade, Alma Road
Windsor, Berks, SL4 3HR, England
Tel: (0753) 854057~9
Fax: (0753) 850323
Telex: 848095

FRANCE
Les Composants TOKO S.a.r.l.
34 Rue Balard
F-75015 Paris, France
Tel: (01) 4557-4465
Fax: (01) 4554-2837
Telex: 204248

ITALY (Agent)
TOKOs S.r.l.
Via delle Querce, 1, I-20156
Milano, Italy
Tel: (02) 325384, 39267131
Fax: (02) 3493947
Telex: 315029

TOKO FAR EAST SALES LOCATIONS

JAPAN

Toko, Inc.
1-17, Higashi-yukigaya 2-chome,
Ohta-ku, Tokyo, 145 Japan
Tel: (03) 3727-1161
Fax: (03) 3728-4690, 4697
Telex: J22696

SINGAPORE

TOKO, Inc., Singapore Branch
No. 1, Lorong 2,
Toa Payoh. #03-00
Singapore 1231
Tel: (255) 4000
Fax: (250) 8134
Telex: 21444

HONG KONG

TOKO, Inc., Hong Kong Branch
45-Hoi Yuen Road, Yau Lee Center
7/F,8/F, and 9/F, Kwun-Tong, Kowloon
Hong Kong
Tel: (03) 428131~9
Fax: 7978262, 7979161, 3419570
Telex: 39126

KOREA

Korea TOKO Co., Ltd.
BG. 7, Masan Free Export Zone No. 975,
Yang-Douk-Dong, Masan,
Kyung-Sang-Nam-Do, Korea
Tel: (0551) 93-1101~3
Fax: (0551) 93-1110
Telex: 53434

Korea TOKO Co., Ltd., Seoul Office
RM 706, 7th Floor, Poonglim Bldg, 823-1,
Yeogsam-Dong, Kangnam-ku, Seoul, Korea
Tel: (02) 556-2754
Fax: (02) 556-9962

TAIWAN

Taiwan TOKO Electronics Co., Ltd.
Nan-Tze Export Processing Zone
Kaohsiung 81120, Taiwan
Tel: (07) 361-2011~18
Fax: (07) 361-7010, (07) 362-3267

Huacheng TOKO Electronics Co., Ltd.
Room 2, 4th Fl., CHI-DER Bldg No. 16
Nanking East Road, Sec. 5
Taipei, Taiwan
Tel: (02) 768-4131~4
Fax: (02) 763-1139
Telex: 21791

MALAYSIA

TOKO Electronic Malaysia Sdn. Bhd.
Lot No. 1, Phase 1, Sungai Way,
Free Trade Zone
47300 Petaling Jaya, Selangor,
Malaysia
Tel: (03) 7761927
Fax: (03) 7753031
Telex: 37552

TOKO Electronic Malaysia Sdn. Bhd.
Penang Liaison Office,
Lot No. 345E, Tingkat Satu
Bangunan Kelab Gelugor
Jalan Sultan Azlan Shah,
11700 Gelugor
Pulau Penang, Malaysia
Tel: (04) 870851
Fax: (04) 870852

NOTES

TOKO

1-17, Higashi-yukigaya 2-chome, Ohta-ku, Tokyo, 145 Japan
Tel: (03) 3727-1161 Fax: (03) 3728-4690, 4697 Telex: J22696

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