Wide Bandwidth
PRECISION ANALOG MULTIPLIER

FEATURES

- **WIDE BANDWIDTH: 10MHz typ**
- **±0.5% MAX FOUR-QUADRANT ACCURACY**
- **INTERNAL WIDE-BANDWIDTH OP AMP**
- **EASY TO USE**
- **LOW COST**

APPLICATIONS

- **PRECISION ANALOG SIGNAL PROCESSING**
- **MODULATION AND DEMODULATION**
- **VOLTAGE-CONTROLLED AMPLIFIERS**
- **VIDEO SIGNAL PROCESSING**
- **VOLTAGE-CONTROLLED FILTERS AND OSCILLATORS**

DESCRIPTION

The MPY634 is a wide bandwidth, high accuracy, four-quadrant analog multiplier. Its accurately laser-trimmed multiplier characteristics make it easy to use in a wide variety of applications with a minimum of external parts, often eliminating all external trimming. Its differential X, Y, and Z inputs allow configuration as a multiplier, squarer, divider, square-rooter, and other functions while maintaining high accuracy.

The wide bandwidth of this new design allows signal processing at IF, RF, and video frequencies. The internal output amplifier of the MPY634 reduces design complexity compared to other high frequency multipliers and balanced modulator circuits. It is capable of performing frequency mixing, balanced modulation, and demodulation with excellent carrier rejection.

An accurate internal voltage reference provides precise setting of the scale factor. The differential Z input allows user-selected scale factors from 0.1 to 10 using external feedback resistors.
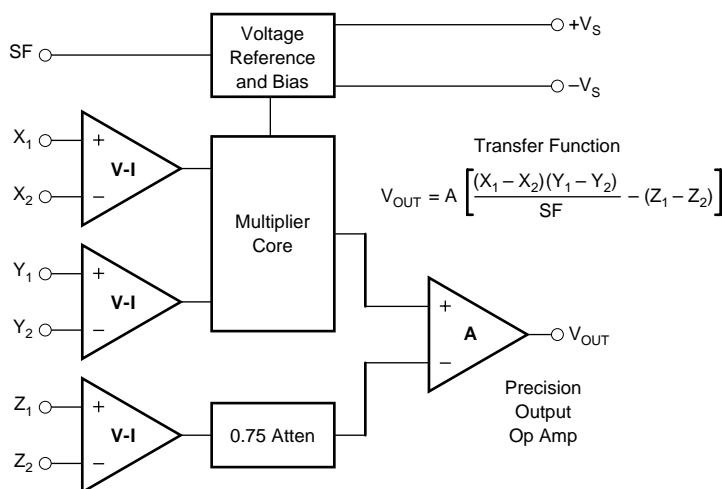
Transfer Function

$$V_{OUT} = A \left[\frac{(X_1 - X_2)(Y_1 - Y_2)}{SF} - (Z_1 - Z_2) \right]$$

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SPECIFICATIONS

ELECTRICAL

At T_A = +25°C and V_S = ±15VDC, unless otherwise noted.

MODEL	MPY634KP/KU MIN	TYP	MAX	MPY634AM (OBSOLETE) MIN	TYP	MAX	MPY634BM (OBSOLETE) MIN	TYP	MAX	MPY634SM (OBSOLETE) MIN	TYP	MAX	UNITS
MULTIPLIER PERFORMANCE													
Transfer Function		$\frac{(X_1-X_2)(Y_1-Y_2)}{10V}+Z_2$			$\frac{(X_1-X_2)(Y_1-Y_2)}{10V}+Z_2$			*			*		
Total Error[1]													
(−10V ≤ X, Y ≤ +10V)			±2.0			±1.0			±0.5		*		%
T_A = min to max		±2.5			±1.5			±1.0				±2.0	%
Total Error vs Temperature		±0.03			±0.022			±0.015				±0.02	%/°C
Scale Factor Error													
(SF = 10.000V Nominal)[2]		±0.25			±0.1			*			*		%
Temperature Coefficient of													
Scaling Voltage		±0.02			±0.01			±0.01			*		%/°C
Supply Rejection (±15V ±1V)		±0.01			±0.01			*			*		%
Nonlinearity													
X (X = 20Vp-p, Y = 10V)		±0.4			±0.4			0.2	±0.3		*		%
Y (Y = 20Vp-p, X = 10V)		±0.01			±0.01			*	±0.1		*		%
Feedthrough[3]													
X (Y Nulled, X = 20Vp-p, 50Hz)		±0.3			±0.3			±0.15	±0.3		*		%
Y (X Nulled, Y = 20Vp-p, 50Hz)		±0.01			±0.01			*	±0.1		*		%
Both Inputs (500kHz, 1Vrms)													
Unnulled	40	50		45	55		*	60		*	*		dB
Nulled	55	60		55	65		60	70		*	*		dB
Output Offset Voltage		±50	±100		±5	±30		*	±15		*	*	mV
Output Offset Voltage Drift		*			±200			±100			*	±500	µV/°C
DYNAMICS													
Small Signal BW,													
(V_{OUT} = 0.1Vrms)	6	10		8	10		*	*		6	*		MHz
1% Amplitude Error													
(C_{LOAD} = 1000pF)		100			100			*			*		kHz
Slew Rate (V_{OUT} = 20Vp-p)		20			20			*			*		V/µs
Settling Time													
(to 1%, ΔV_{OUT} = 20V)		2			2			*			*		µs
NOISE													
Noise Spectral Density:													
SF = 10V		0.8			0.8			*			*		µV/√Hz
Wideband Noise:													
f = 10Hz to 5MHz		1			1			*			*		mVrms
f = 10Hz to 10kHz		90			90			*			*		µVrms
OUTPUT													
Output Voltage Swing	±11			±11			*			*			V
Output Impedance (f ≤ 1kHz)		0.1			0.1			*			*		Ω
Output Short Circuit Current													
(R_L = 0, T_A = min to max)		30			30			*			*		mA
Amplifier Open Loop Gain													
(f = 50Hz)		85			85			*			*		dB
INPUT AMPLIFIERS (X, Y and Z)													
Input Voltage Range													
Differential V_{IN} (V_{CM} = 0)		±12			±12			*			*		V
Common-Mode V_{IN} (V_{DIFF} = 0)		±10			±10			*			*		V
(see Typical Performance Curves)													
Offset Voltage X, Y		±25	±100		±5	±20		±2	±10		*	*	mV
Offset Voltage Drift X, Y		200			100			50			*		µV/°C
Offset Voltage Z		±25	±100		±5	±30		±2	±15		*	*	mV
Offset Voltage Drift Z		200			200			100			*	500	µV/°C
CMRR	60	80		60	80		70	90		*	*		dB
Bias Current		0.8	2.0		0.8	2.0		*	*		*	*	µA
Offset Current		0.1			0.1			*			*	2.0	µA
Differential Resistance		10			10			*			*		MΩ
DIVIDER PERFORMANCE													
Transfer Function ($X_1 > X_2$)		$10V\frac{(Z_2-Z_1)}{(X_1-X_2)}+Y_1$			$10V\frac{(Z_2-Z_1)}{(X_1-X_2)}+Y_1$			*			*		
Total Error[1] untrimmed													
(X = 10V, −10V ≤ Z ≤ +10V)		1.5			±0.75			±0.35			±0.75		%
(X = 1V, −1V ≤ Z ≤ +1V)		4.0			±2.0			±1.0			*		%
(0.1V ≤ X ≤ 10V, −10V ≤ Z ≤ 10V)		5.0			±2.5			±1.0			*		%
SQUARE PERFORMANCE													
Transfer Function		$\frac{(X_1-X_2)^2}{10V}+Z_2$			$\frac{(X_1-X_2)^2}{10V}+Z_2$			*			*		
Total Error (−10V ≤ X ≤ 10V)		±1.2			±0.6			±0.3			*		%

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SPECIFICATIONS (CONT)

ELECTRICAL

At T_A = +25°C and V_S = ±15VDC, unless otherwise noted.

MODEL	MPY634KP/KU			MPY634AM			MPY634BM			MPY634SM			UNITS
	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
SQUARE-ROOTER PERFORMANCE Transfer Function ($Z_1 \leq Z_2$)	$\sqrt{10V\,(Z_2 - Z_1)} + X_2$			$\sqrt{10V\,(Z_2 - Z_1)} + X_2$									
Total Error[1] (1V ≤ Z ≤ 10V)		±2.0			±1.0		* ±0.5			* *			%
POWER SUPPLY Supply Voltage:													
Rated Performance		±15			±15			*			*		VDC
Operating	±8		±18	±8		±18	*		*	*		±20	VDC
Supply Current, Quiescent		4	6		4	6		*	*		*	*	mA
TEMPERATURE RANGE													
Specification	−40		+85	−25		+85	*		*	−55		+125	°C
Storage	−40		+85	−65		+150	*		*	*		*	°C

* Specification same as for MPY634AM.
Gray indicates obsolete parts.
NOTES: (1) Figures given are percent of full scale, ±10V (i.e., 0.01% = 1mV). (2) May be reduced to 3V using external resistor between −V_S and SF. (3) Irreducible component due to nonlinearity; excludes effect of offsets.

PIN CONFIGURATIONS

TO-100: MPY634AM/BM/SM **DIP: MPY634KP** **SOIC: MPY634KU**
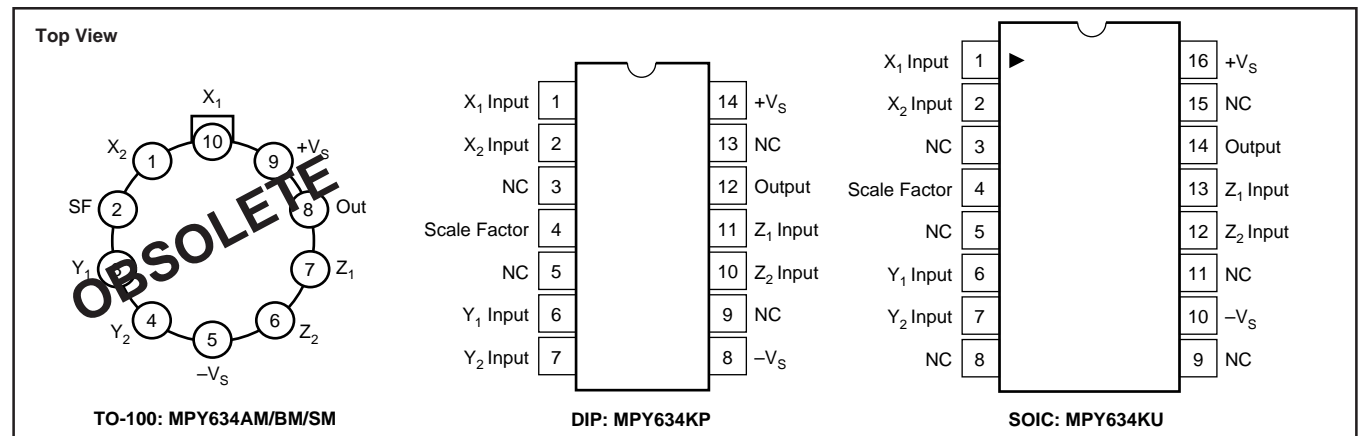
ABSOLUTE MAXIMUM RATINGS

PARAMETER	MPY634AM/BM	MPY634KP/KU	MPY634SM
Power Supply Voltage	±18	*	±20
Power Dissipation	500mW	*	*
Output Short-Circuit to Ground	Indefinite	*	*
Input Voltage (all X, Y and Z)	±V_S	*	*
Temperature Range:			
Operating	−25°C/+85°C	−40°C/+85°C	−55°C/+125°C
Storage	−65°C/+150°C	−40°C/+85°C	*
Lead Temperature (soldering, 10s)	+300°C	*	*
SOIC 'KU' Package		+260°C	

* Specification same as for MPY634AM/BM.
NOTE: Gray indicates obsolete parts.

ORDERING INFORMATION

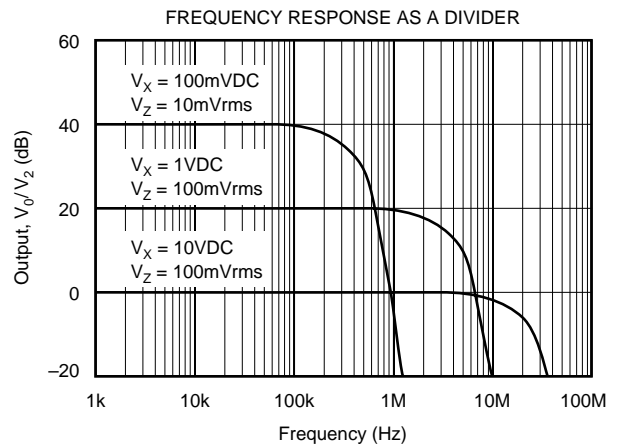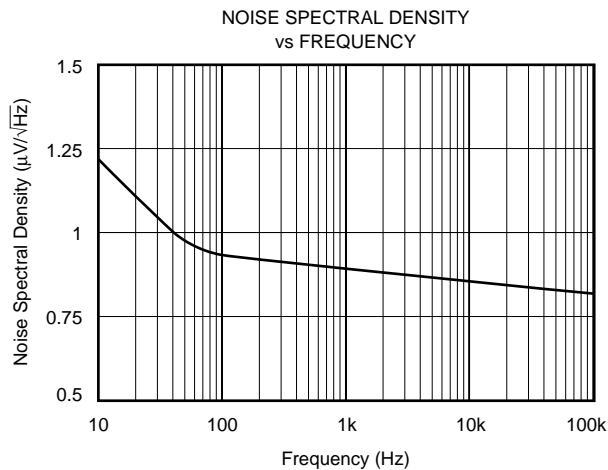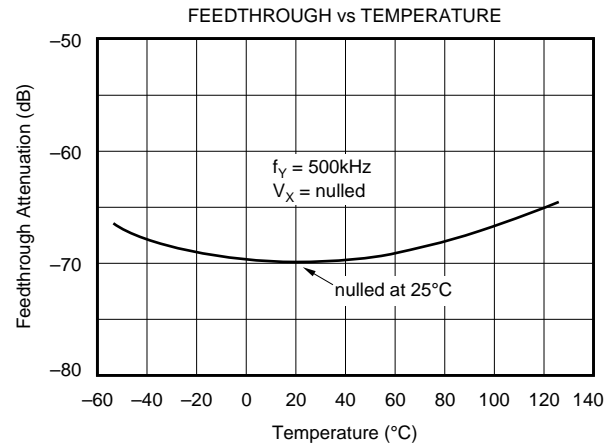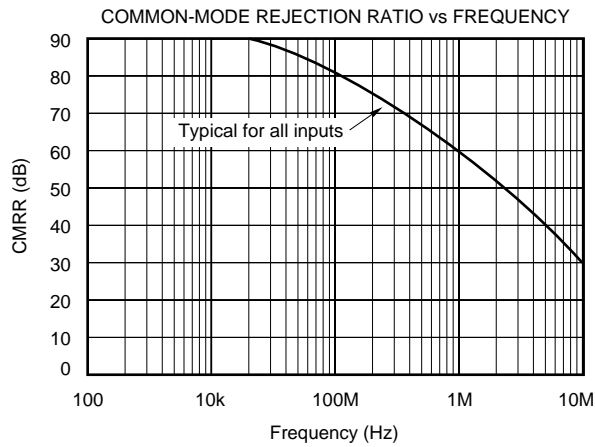Basic Model Number — MPY634 ( ) ( )
Performance Grade[1]
  K: U: −40°C to +85°C
Package Code
  P: Plastic 14-pin DIP
  U: 16-pin SOIC
NOTE: (1) Performance grade identifier may not be marked on the SOIC package; a blank denotes "K" grade.
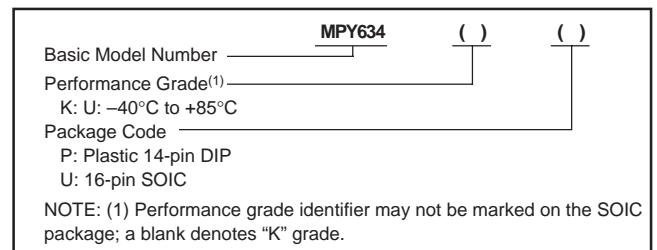
PACKAGE INFORMATION[1]

PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER
MPY634KP	14-Pin PDIP	010
MPY634KU	16-Pin SOIC	211

NOTE: (1) For the most current package and ordering information, see the Package Option Addendum located at the end of this data sheet.
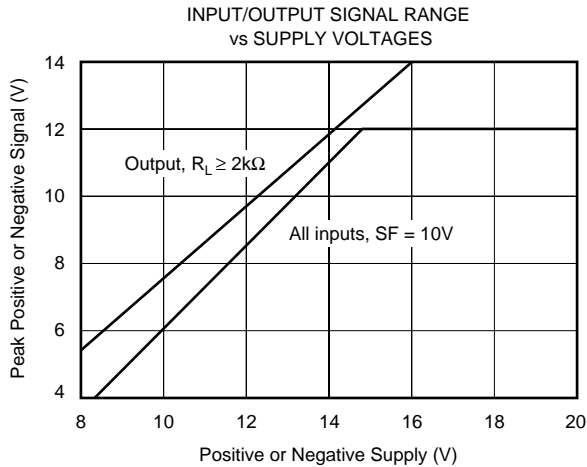
MPY634

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3

TYPICAL PERFORMANCE CURVES

At $T_A = +25°C$, $V_S = ±15VDC$, unless otherwise noted.

FEEDTHROUGH vs FREQUENCY

X Feedthrough

Y Feedthrough

FREQUENCY RESPONSE AS A MULTIPLIER

Normal Connection

$C_L = 1000pF$

$C_L = 0pF$

With X10 Feedback
Attenuator

COMMON-MODE REJECTION RATIO vs FREQUENCY

Typical for all inputs

FEEDTHROUGH vs TEMPERATURE

$f_Y = 500kHz$
$V_X = nulled$

nulled at 25°C

NOISE SPECTRAL DENSITY
vs FREQUENCY

FREQUENCY RESPONSE AS A DIVIDER

$V_X = 100mVDC$
$V_Z = 10mVrms$

$V_X = 1VDC$
$V_Z = 100mVrms$

$V_X = 10VDC$
$V_Z = 100mVrms$

MPY634

SBFS017A

TYPICAL PERFORMANCE CURVES (CONT)

INPUT/OUTPUT SIGNAL RANGE vs SUPPLY VOLTAGES

A graph plotting Peak Positive or Negative Signal (V) on the vertical axis (from 4 to 14) against Positive or Negative Supply (V) on the horizontal axis (from 8 to 20). Two lines are shown: the upper labeled "Output, $R_L ≥ 2k\Omega$" and the lower labeled "All inputs, SF = 10V".

THEORY OF OPERATION

The transfer function for the MPY634 is:

$$V_{OUT} = A \left[\frac{(X_1 - X_2)(Y_1 - Y_2)}{SF} - (Z_1 - Z_2) \right]$$

where:

A = open-loop gain of the output amplifier (typically 85dB at DC).

SF = Scale Factor. Laser-trimmed to 10V but adjustable over a 3V to 10V range using external resistors.

X, Y, Z are input voltages. Full-scale input voltage is equal to the selected SF. (Max input voltage = $±1.25$ SF).

An intuitive understanding of transfer function can be gained by analogy to the op amp. By assuming that the open-loop gain, A, of the output operational amplifier is infinite, inspection of the transfer function reveals that any V_{OUT} can be created with an infinitesimally small quantity within the brackets. Then, an application circuit can be analyzed by assigning circuit voltages for all X, Y and Z inputs and setting the bracketed quantity equal to zero. For example, the basic multiplier connection in Figure 1, $Z_1 = V_{OUT}$ and $Z_2 = 0$. The quantity within the brackets then reduces to:

$$\frac{(X_1 - X_2)(Y_1 - Y_2)}{SF} - (V_{OUT} - 0) = 0$$

This approach leads to a simple relationship which can be solved for V_{OUT} to provide the closed-loop transfer function.

The scale factor is accurately factory adjusted to 10V and is typically accurate to within 0.1% or less. The scale factor may be adjusted by connecting a resistor or potentiometer between pin SF and the $-V_S$ power supply. The value of the external resistor can be approximated by:

MPY634
SBFS017A

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$$R_{SF} = 5.4k\Omega \left[\frac{SF}{10 - SF} \right]$$

Internal device tolerances make this relationship accurate to within approximately 25%. Some applications can benefit from reduction of the SF by this technique. The reduced input bias current, noise, and drift achieved by this technique can be likened to operating the input circuitry in a higher gain, thus reducing output contributions to these effects. Adjustment of the scale factor does not affect bandwidth.

The MPY634 is fully characterized at $V_S = \pm15V$ but operation is possible down to $\pm8V$ with an attendant reduction of input and output range capability. Operation at voltages greater than $\pm15V$ allows greater output swing to be achieved by using an output feedback attenuator (Figure 1).

As with any wide bandwidth circuit, the power supplies should be bypassed with high frequency ceramic capacitors. These capacitors should be located as near as practical to the power supply connections of the MPY634. Improper by-passing can lead to instability, overshoot, and ringing in the output.
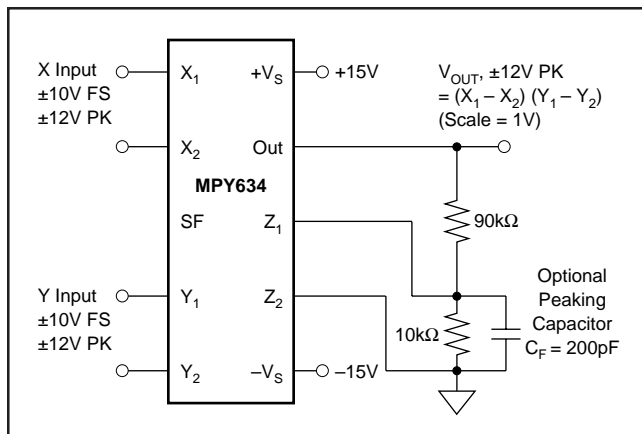
FIGURE 1. Connections for Scale-Factor of Unity.

BASIC MULTIPLIER CONNECTION

Figure 2 shows the basic connection as a multiplier. Accuracy is fully specified without any additional user-trimming circuitry. Some applications can benefit from trimming of one or more of the inputs. The fully differential inputs facilitate referencing the input quantities to the source voltage common terminal for maximum accuracy. They also allow use of simple offset voltage trimming circuitry as shown on the X input.

The differential Z input allows an offset to be summed in V_{OUT}. In basic multiplier operation, the Z_2 input serves as the output voltage ground reference and should be connected to the ground of the driven system for maximum accuracy.

A method of changing (lowering) SF by connecting to the SF pin was discussed previously. Figure 1 shows an alternative method of changing the effective SF of the overall circuit by using an attenuator in the feedback connection to Z_1. This method puts the output amplifier in a higher gain and is thus accompanied by a reduction in bandwidth and an
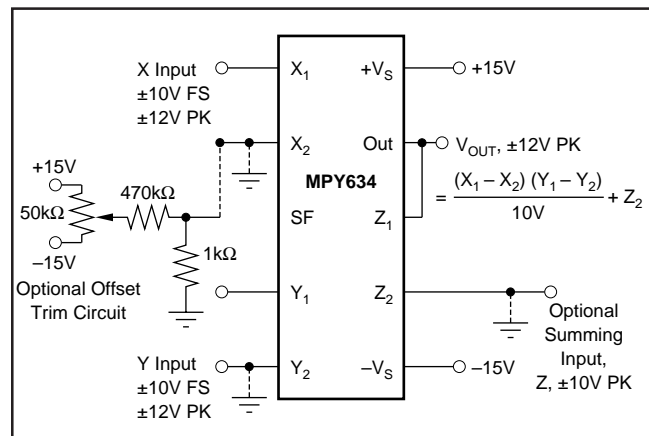

FIGURE 2. Basic Multiplier Connection.

increase in output offset voltage. The larger output offset may be reduced by applying a trimming voltage to the high impedance input, Z_2.

The flexibility of the differential Z inputs allows direct conversion of the output quantity to a current. Figure 3 shows the output voltage differentially-sensed across a series resistor forcing an output-controlled current. Addition of a capacitor load then creates a time integration function useful in a variety of applications such as power computation.
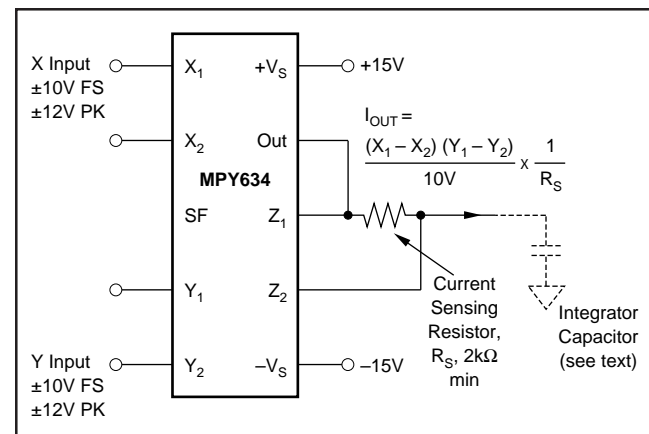

FIGURE 3. Conversion of Output to Current.

SQUARER CIRCUIT (FREQUENCY DOUBLER)

Squarer, or frequency doubler, operation is achieved by paralleling the X and Y inputs of the standard multiplier circuit. Inverted output can be achieved by reversing the differential input terminals of either the X or Y input. Accuracy in the squaring mode is typically a factor of two better than the specified multiplier mode with maximum error occurring with small (less than 1V) inputs. Better accuracy can be achieved for small input voltage levels by reducing the scale factor, SF.

DIVIDER OPERATION

The MPY634 can be configured as a divider as shown in Figure 4. High impedance differential inputs for the numerator and denominator are achieved at the Z and X inputs,

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respectively. Feedback is applied to the Y_2 input, and Y_1 is normally referenced to output ground. Alternatively, as the transfer function implies, an input applied to Y_1 can be summed directly into V_{OUT}. Since the feedback connection is made to a multiplying input, the effective gain of the output op amp varies as a function of the denominator input voltage. Therefore, the bandwidth of the divider function is proportional to the denominator voltage (see Typical Performance Curves).
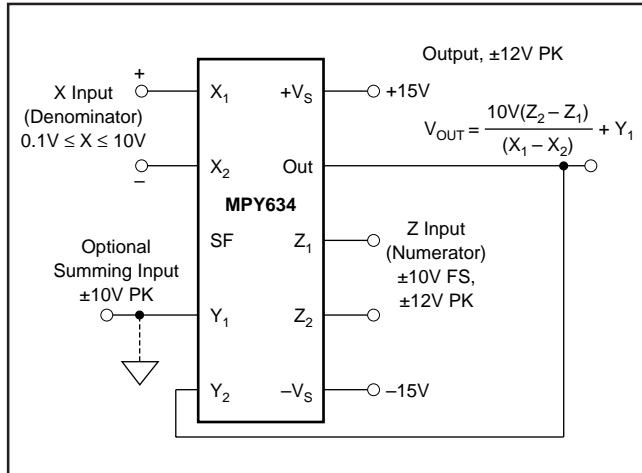

FIGURE 4. Basic Divider Connection.

Accuracy of the divider mode typically ranges from 1.0% to 2.5% for a 10 to 1 denominator range depending on device grade. Accuracy is primarily limited by input offset voltages and can be significantly improved by trimming the offset of the X input. A trim voltage of ±3.5mV applied to the "low side" X input (X_2 for positive input voltages on X_1) can produce similar accuracies over 100 to 1 denominator range. To trim, apply a signal which varies from 100mV to 10V at a low frequency (less than 500Hz). An offset sine wave or ramp is suitable. Since the ratio of the quantities should be constant, the ideal output would be a constant 10V. Using AC coupling on an oscilloscope, adjust the offset control for minimum output voltage variation.

SQUARE-ROOTER

A square-rooter connection is shown in Figure 5. Input voltage is limited to one polarity (positive for the connection shown). The diode prevents circuit latch-up should the input go negative. The circuit can be configured for negative input and positive output by reversing the polarity of both the X and Y inputs. The output polarity can be reversed by reversing the diode and X input polarity. A load resistance of approximately 10kΩ must be provided. Trimming for improved accuracy would be accomplished at the Z input.
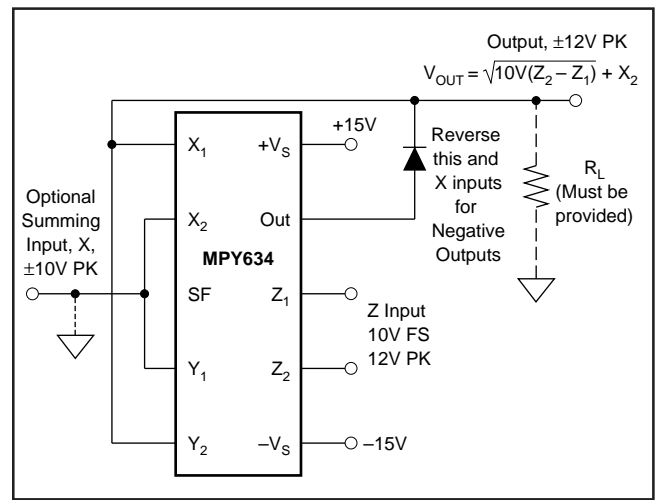
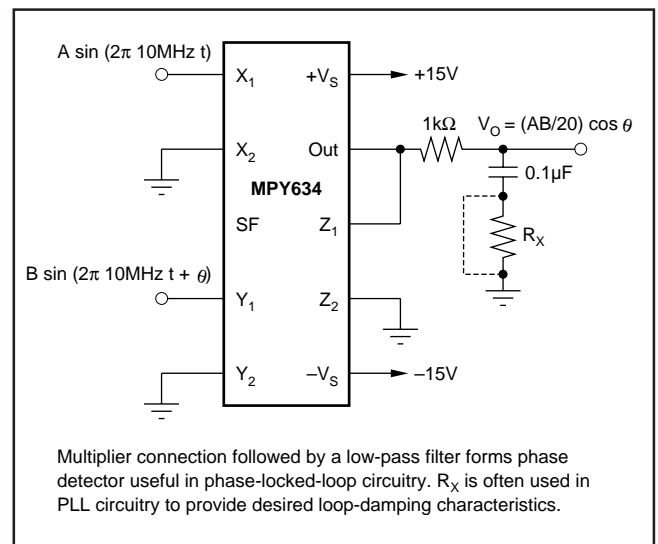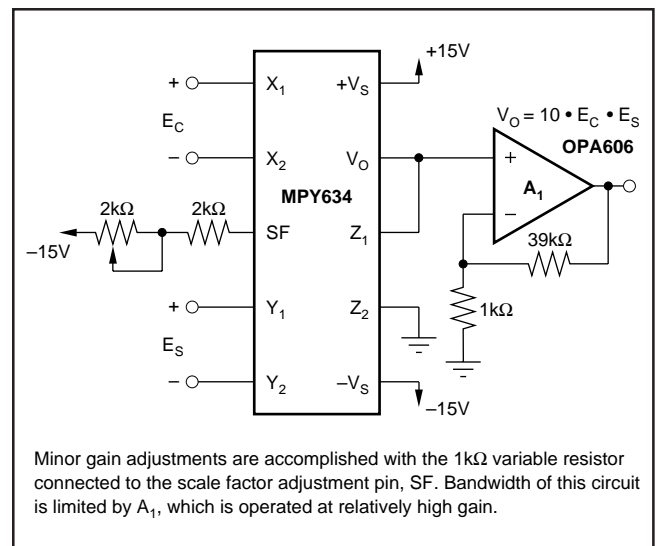FIGURE 5. Square-Rooter Connection.

APPLICATIONS

Multiplier connection followed by a low-pass filter forms phase detector useful in phase-locked-loop circuitry. R_X is often used in PLL circuitry to provide desired loop-damping characteristics.

FIGURE 6. Phase Detector.

Minor gain adjustments are accomplished with the 1kΩ variable resistor connected to the scale factor adjustment pin, SF. Bandwidth of this circuit is limited by A_1, which is operated at relatively high gain.

FIGURE 7. Voltage-Controlled Amplifier.

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7
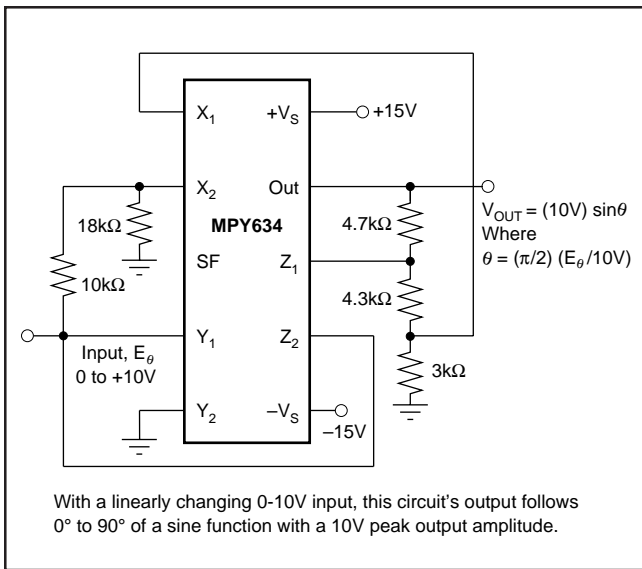
FIGURE 8. Sine-Function Generator.

With a linearly changing 0-10V input, this circuit's output follows 0° to 90° of a sine function with a 10V peak output amplitude.

$V_{OUT} = (10V)\sin\theta$
Where
$\theta = (\pi/2)(E_\theta/10V)$

18kΩ
10kΩ
Input, E_θ
0 to +10V
4.7kΩ
4.3kΩ
3kΩ
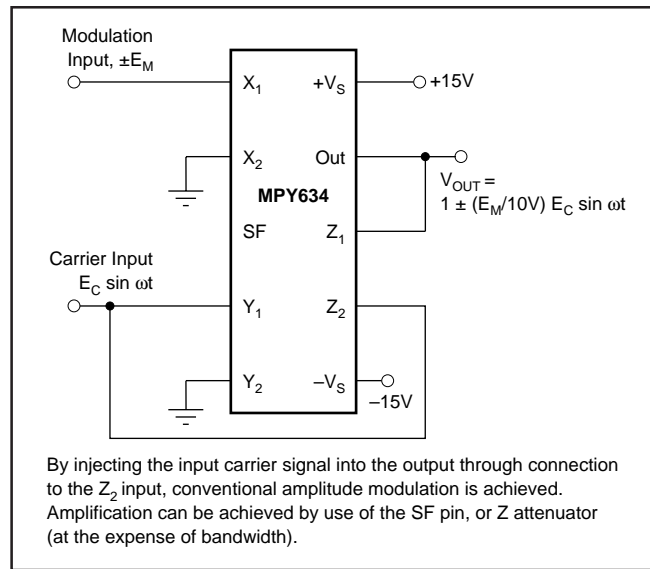
FIGURE 9. Linear AM Modulator.

Modulation Input, $\pm E_M$

Carrier Input $E_C \sin \omega t$

$V_{OUT} = 1 \pm (E_M/10V)\,E_C \sin \omega t$

By injecting the input carrier signal into the output through connection to the Z_2 input, conventional amplitude modulation is achieved. Amplification can be achieved by use of the SF pin, or Z attenuator (at the expense of bandwidth).

$A \sin \omega t$

$(A^2/20)\cos(2\omega t)$

Squaring a sinusoidal input creates an output frequency of twice that of the input. The DC output component is removed by AC-coupling the output.

FIGURE 10. Frequency Doubler.

Frequency Doubler

Input Signal: 20Vp-p, 200kHz
Output Signal: 10Vp-p, 400kHz

Modulation Input, $\pm E_M$

470kΩ
1kΩ
Carrier Null
+15V
−15V
Carrier Input $E_C \sin \omega t$

V_{OUT}

The basic muliplier connection performs balanced modulation. Carrier rejection can be improved by trimming the offset voltage of the modulation input. Better carrier rejection above 2MHz is typically achieved by interchanging the X and Y inputs (carrier applied to the X input).

Carrier: f_C = 2MHz, Amplitude = 1Vrms
Signal: f_S = 120kHz, Amplitude = 10V peak

FIGURE 11. Balanced Modulator.

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PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
MPY634AM	OBSOLETE	TO-100	LME	10		TBD	Call TI	Call TI
MPY634BM	OBSOLETE	TO-100	LME	10		TBD	Call TI	Call TI
MPY634KP	ACTIVE	PDIP	N	14	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
MPY634KPG4	ACTIVE	PDIP	N	14	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
MPY634KU	ACTIVE	SOIC	DW	16	48	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
MPY634KU/1K	ACTIVE	SOIC	DW	16	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
MPY634KU/1KE4	ACTIVE	SOIC	DW	16	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
MPY634KUE4	ACTIVE	SOIC	DW	16	48	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR

[1] The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

[2] Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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TAPE AND REEL INFORMATION

REEL DIMENSIONS

TAPE DIMENSIONS

A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
MPY634KU/1K	SOIC	DW	16	1000	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
MPY634KU/1K	SOIC	DW	16	1000	375.0	340.0	57.0

LME (O–MBCY–W10)   **METAL CYLINDRICAL PACKAGE**
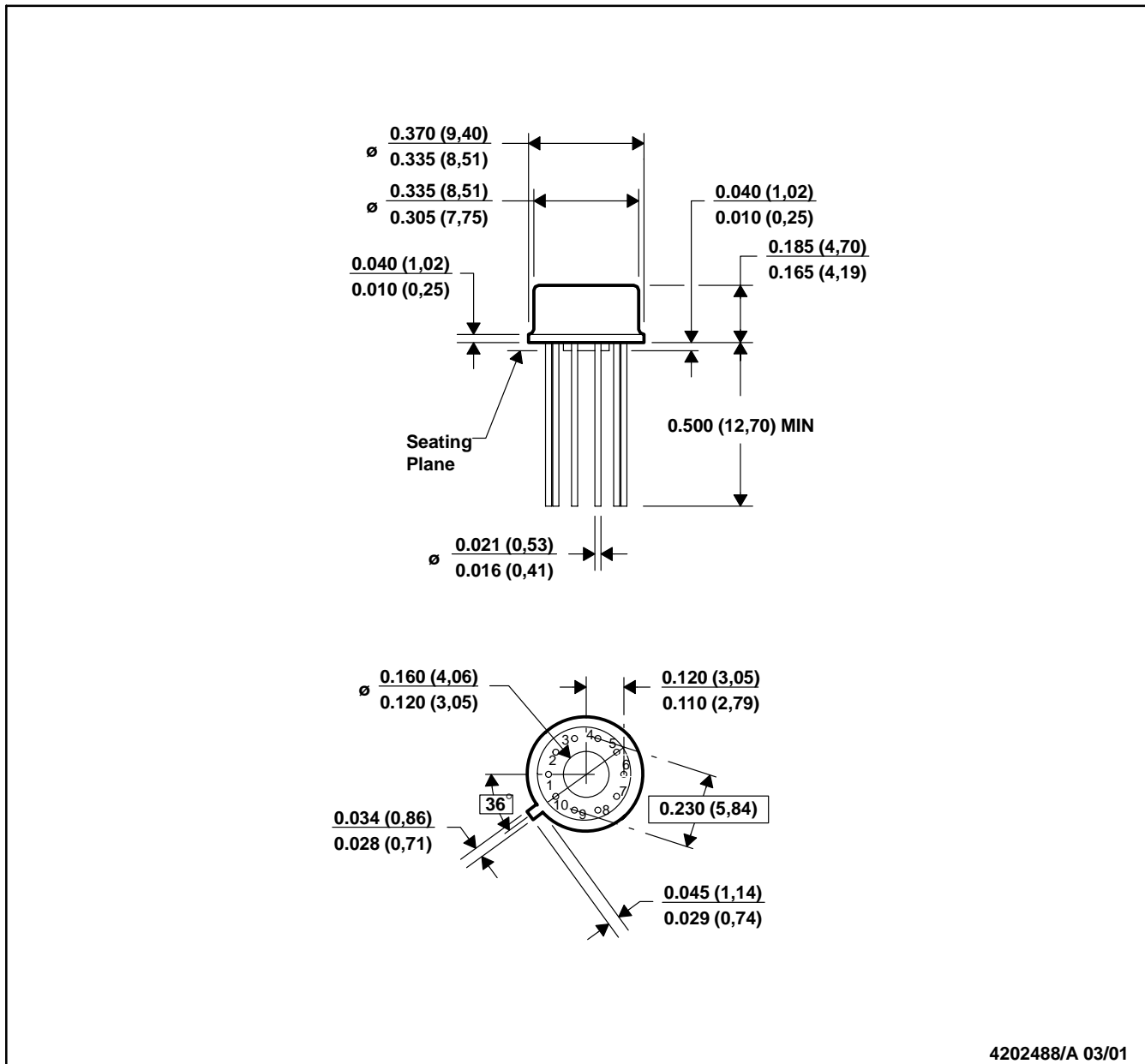
ø $\frac{0.370\ (9,40)}{0.335\ (8,51)}$

ø $\frac{0.335\ (8,51)}{0.305\ (7,75)}$

$\frac{0.040\ (1,02)}{0.010\ (0,25)}$

$\frac{0.040\ (1,02)}{0.010\ (0,25)}$

$\frac{0.185\ (4,70)}{0.165\ (4,19)}$

Seating Plane

0.500 (12,70) MIN

ø $\frac{0.021\ (0,53)}{0.016\ (0,41)}$

ø $\frac{0.160\ (4,06)}{0.120\ (3,05)}$

$\frac{0.120\ (3,05)}{0.110\ (2,79)}$

36°

0.230 (5,84)

$\frac{0.034\ (0,86)}{0.028\ (0,71)}$

$\frac{0.045\ (1,14)}{0.029\ (0,74)}$

4202488/A 03/01

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Leads in true position within 0.010 (0,25) R @ MMC at seating plane.
D. Pin numbers shown for reference only. Numbers may not be marked on package.
E. Falls within JEDEC MO–006/TO-100.
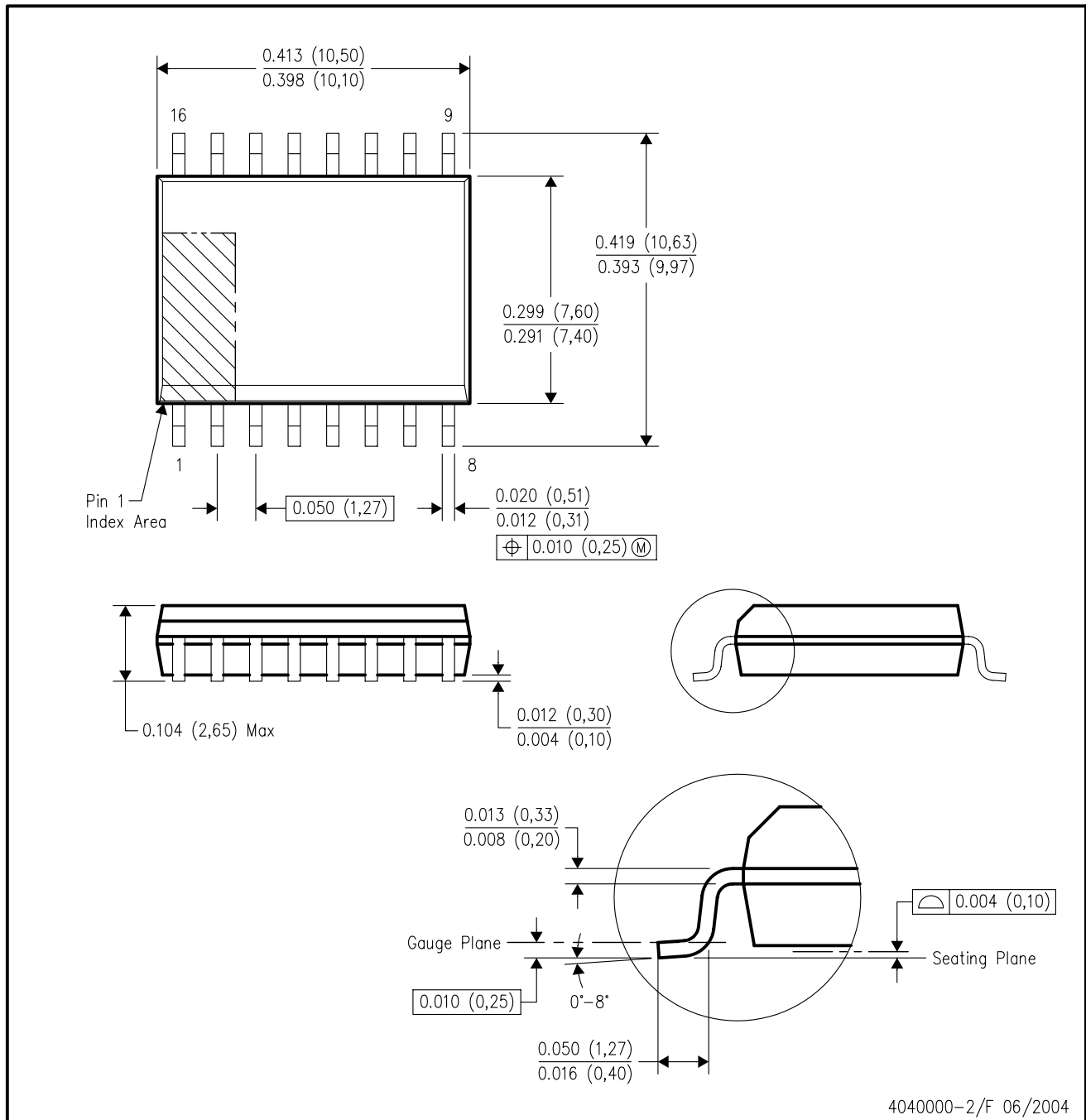
0.413 (10,50)
0.398 (10,10)

16   9

0.419 (10,63)
0.393 (9,97)

0.299 (7,60)
0.291 (7,40)

Pin 1
Index Area

1   8

0.050 (1,27)

0.020 (0,51)
0.012 (0,31)

⊕ | 0.010 (0,25) Ⓜ

0.104 (2,65) Max

0.012 (0,30)
0.004 (0,10)

0.013 (0,33)
0.008 (0,20)

0.004 (0,10)

Gauge Plane

Seating Plane

0.010 (0,25)

0°−8°

0.050 (1,27)
0.016 (0,40)

4040000−2/F 06/2004

NOTES: A.   All linear dimensions are in inches (millimeters).
         B.   This drawing is subject to change without notice.
         C.   Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
         D.   Falls within JEDEC MS−013 variation AA.

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