ZMX40M

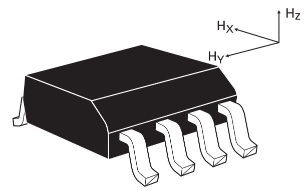
DUAL MAGNETIC FIELD SENSOR

DESCRIPTION

This device is a special tangential field difference sensor with two AMR (Anisotropic Magneto-Resistive) bridges for field movement measurements or field comparative measurements.

The ZMX40M contains two extremely sensitive magnetic sensor chips, mounted parallel to each other in an SM8 package, employing the magneto-resistive effect of thin film permalloy. It allows the measurement of magnetic fields or the detection of magnetic parts. The sensors each consist of a chip covered with thin film permalloy stripes which form a Wheatstone bridge, whose output voltage is proportional to the magnetic field component Hy. A field Hx, which is perpendicular to Hy, is necessary to suppress the hysteresis and to bias the sensors into the linear region. This field Hx is provided by an internal permanent magnet.

The chips are mounted in the package 3mm apart. If a magnet travels horizontally above the sensor, each chip will give an output which will peak as the magnet passes above it and the two peaks will be spatially separated by 3mm.

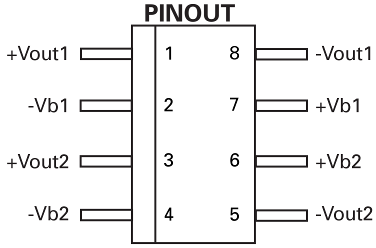


When the two peaks are the same amplitude, the magnet must be mid-way between the two chips. Therefore this double sensor can be used to measure position of, for example, a wheel tooth very accurately for automotive and machine-tool applications. With calibration to allow for the tolerances on the bridge outputs being slightly different, the ZMX40M has been used in machine tool applications to resolve distances down to 30µm. By comparing the two outputs and adding some hysteresis, a large-geometry magnetic tape reader (for example for a magnetic tape ruler) can be made. By combining both bridge outputs a current sensor can be also made by adding an external current loop over or under the ZMX40M. This loop is outside the package and therefore provides excellent galvanic isolation.

FEATURES

- Output voltage proportional to magnetic field Hy across each chip
- Both chips are in the same orientation and chip centres are 3mm apart in Y direction
- Magnetic fields vertical to the chip level Hz are not effective
- Disturbing fields Hx up to 30 kA/m are allowed
- Extremely small chip distance from the top side of package for accurate measurement
- Internal magnet each chip for creation of auxiliary field Hx

PINOUT



Top View

APPLICATIONS

- Linear position measurement for process control, door interlocks, proximity detectors and precision machine tools
- H-field movement measurement for a magnetic tape recognition
- High voltage isolated current measurement up to many amps range by using a suitable current loop over or under the IC
- Detection of rotating magnets in the presence of a disturbing field by comparisons of maximum values of individual sensors

DEVICE MARKING

- ZMX40M

CONNECTION DIAGRAM

AMR chip 1: supply voltage between +Vb1 and -Vb1 output voltage of bridge between $+V_{out}1$ and $-V_{out}1$

AMR chip 2: supply voltage between +Vb2 and -Vb2 output voltage of bridge between $+V_{out}2$ and $-V_{out}2$

ZMX40M

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	LIMIT	UNIT
Supply voltage for each sensor chip (1,2)	V_B	12	V
Total power dissipation	P_{TOT}	240	mW
Operating temperature range	T_{amb}	-25 to +125	°C
Storage temperature range	T_{stg}	-25 to +125	°C

ELECTRICAL CHARACTERISTICS (at T_{amb}=25°C and H_X=3 kA/m unless otherwise stated)

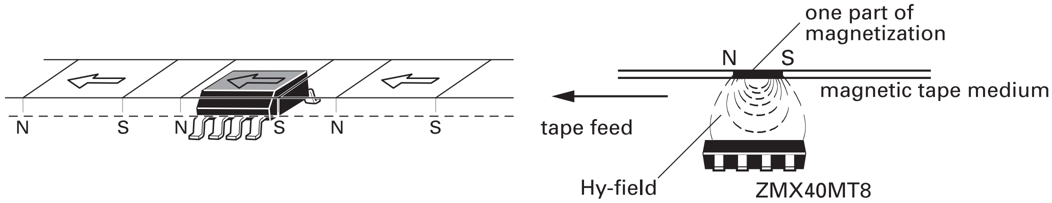
PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	TEST CONDITIONS
Bridge resistance	R_{br}	1.4	-	2.2	kΩ	
Output voltage range	V_O/V_B	12	-	24	mV/V	
Open circuit sensitivity	S	3.0	-	5.0	(mV/V)/(kA/m)	V_B=const.
Hysteresis of output voltage	V_{OH}/V_B	-	-	50	μV/V	
Offset voltage	V_{off}/V_B	-1.5	-	+1.5	mV/V	
Operating frequency	f_{max}	0	-	1	MHz	
Temp. coeff. of offset voltage	TCV_{off}	-3	-	+3	(μV/V)/K	T_{amb}= -25 to +125°C
Temp. coeff. of bridge resistance	TCR_{br}	+0.25	+0.3	+0.35	%/K	T_{amb}= -25 to +125°C
Temp. coeff. of open circuit sensitivity V_B=5V	TCS_V	-0.25	-0.3	-0.35	%/K	T_{amb}= -25 to +125°C
Temp. coeff. of open circuit sensitivity I_B=3mA	TCS_I	-	-0.1	-	%/K	T_{amb}= -25 to +125°C

ORDERING INFORMATION

DEVICE	REEL SIZE	TAPE WIDTH	QUANTITY PER REEL
ZMX40MT8TA	7"	12mm	1000 units
ZMX40MT8TC	13"	12mm	4000 units

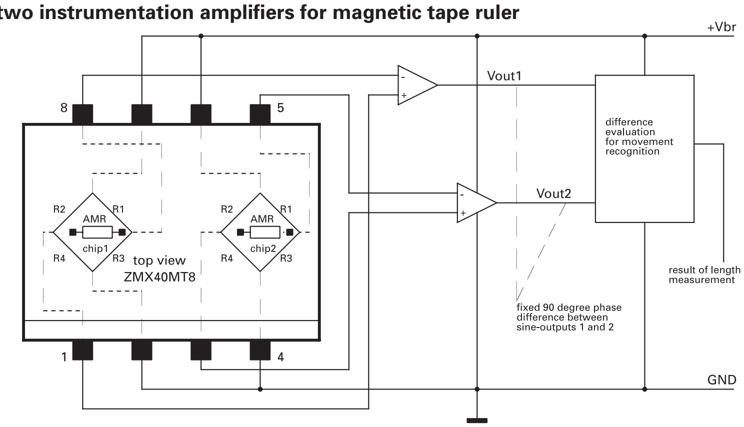
TYPICAL APPLICATIONS

Magnetic tape scanning (field movement measurement for magnetic tape ruler):

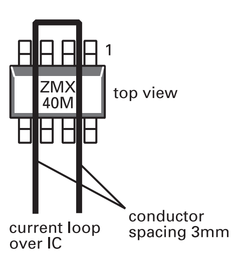


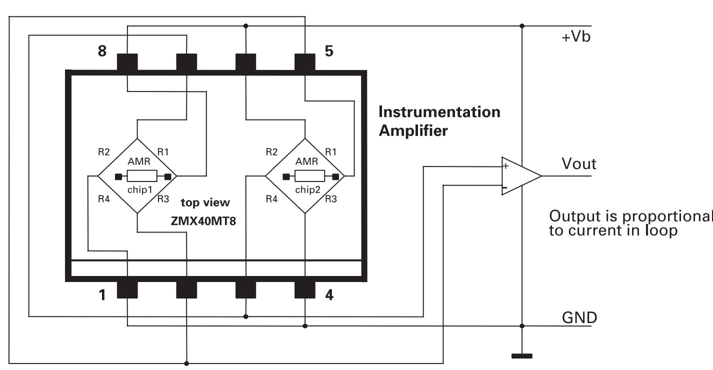
The changing voltage peaks in both AMR bridges are used for the tape movement measurement.

ZMX40M plus two instrumentation amplifiers for magnetic tape ruler



Current sensor (by combining both bridge outputs and a high isolation voltage)



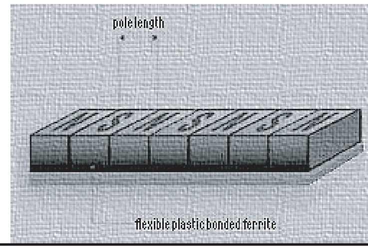


This double chip solution with the current loop conductor guarantees good rejection of external fields and a high isolation voltage.

ISSUE 2 - JUNE 2005

ZETEX SEMICONDUCTORS

ACCESSORIES – Flexible Magnet Material[*1] for Length Measuring Systems with ZMX40M



type of magnetic structure[*2] (flexible magnets 9/28p[*3], remanence B_r=220mT)					parameter of length measuring system (sensor ZMX40M , chip distance s=3mm)				
pole length (N or S) [mm]	distance of magnetic period (N/S) [mm]	middle magnet distance [mm]	neutral zone length [mm]	thickness of material [mm]	gap between tape (or strip) and sensor [mm]	sine form error [%]	sine area of field strength in sensor [kA/m]	90°-condition of length measurement with Arc Tangent Interpolation [tan(α)=]	movement area for each tangent segment --- resolution [mm --- µm]
2,00	4,00	2,00	0	0,50	1,70	±0,07	±2,6	sin(α)/-cos(α+180°)	±1,000 --- 10
2,00	4,00	2,00	0	0,75	1,90	±0,05	±2,7	sin(α)/-cos(α+180°)	±1,000 --- 10
2,00	4,00	2,00	0	1,00#	2,00	±0,03	±2,7	sin(α)/-cos(α+180°)	±1,000 --- 10
2,00	4,00	2,00	0	1,25	2,10	±0,02	±2,4	sin(α)/-cos(α+180°)	±1,000 --- 10
2,00	4,00	2,00	0	1,50#	2,20	±0,02	±2,3	sin(α)/-cos(α+180°)	±1,000 --- 10
1,20	2,40	1,20	0	0,50	1,20	±0,04	±2,7	sin(α)/cos(α+360°)	±0,600 --- 6
1,20	2,40	1,20	0	0,75	1,30	±0,03	±2,5	sin(α)/cos(α+360°)	±0,600 --- 6
1,20	2,40	1,20	0	1,00#	1,30	±0,02	±2,4	sin(α)/cos(α+360°)	±0,600 --- 6
1,20	2,40	1,20	0	1,25	1,30	±0,02	±2,6	sin(α)/cos(α+360°)	±0,600 --- 6
1,20	2,40	1,20	0	1,50#	1,40	±0,02	±2,3	sin(α)/cos(α+360°)	±0,600 --- 6
6,00	12,00	6,00	0	0,50	3,60	±0,40	±2,5	sin(α)/cos(α)	±3,000 --- 30
6,00	12,00	6,00	0	0,75	4,10	±0,25	±2,7	sin(α)/cos(α)	±3,000 --- 30
6,00	12,00	6,00	0	1,00#	4,70	±0,12	±2,5	sin(α)/cos(α)	±3,000 --- 30
6,00	12,00	6,00	0	1,25	5,00	±0,09	±2,6	sin(α)/cos(α)	±3,000 --- 30
6,00	12,00	6,00	0	1,50#	5,20	±0,08	±2,7	sin(α)/cos(α)	±3,000 --- 30

type of magnetic structure[*2] (flexible magnets 3/24p[*4], remanence B_r=127mT)					parameter of length measuring system (sensor ZMX40M , chip distance s=3mm)				
pole length (N or S) [mm]	distance of magnetic period (N/S) [mm]	middle magnet distance [mm]	neutral zone length [mm]	thickness of material [mm]	gap between tape (or strip) and sensor [mm]	sine form error [%]	sine area of field strength in sensor [kA/m]	90°-condition of length measurement with Arc Tangent Interpolation [tan(α)=]	movement area for each tangent segment --- resolution [mm --- µm]
2,00	4,00	2,00	0	0,50	1,40	±0,20	±2,6	sin(α)/-cos(α+180°)	±1,000 --- 10
2,00	4,00	2,00	0	0,75	1,60	±0,13	±2,6	sin(α)/-cos(α+180°)	±1,000 --- 10
2,00	4,00	2,00	0	1,00#	1,60	±0,10	±2,7	sin(α)/-cos(α+180°)	±1,000 --- 10
2,00	4,00	2,00	0	1,25	1,70	±0,07	±2,6	sin(α)/-cos(α+180°)	±1,000 --- 10
2,00	4,00	2,00	0	1,50#	1,80	±0,06	±2,6	sin(α)/-cos(α+180°)	±1,000 --- 10
1,20	2,40	1,20	0	0,50	1,00	±0,12	±2,7	sin(α)/cos(α+360°)	±0,600 --- 6
1,20	2,40	1,20	0	0,75	1,10	±0,06	±2,4	sin(α)/cos(α+360°)	±0,600 --- 6
1,20	2,40	1,20	0	1,00#	1,10	±0,05	±2,3	sin(α)/cos(α+360°)	±0,600 --- 6
1,20	2,40	1,20	0	1,25	1,20	±0,04	±2,3	sin(α)/cos(α+360°)	±0,600 --- 6
1,20	2,40	1,20	0	1,50#	1,20	±0,03	±2,3	sin(α)/cos(α+360°)	±0,600 --- 6
6,00	12,00	6,00	0	0,50	2,40	±1,40	±2,7	sin(α)/cos(α)	±3,000 --- 30
6,00	12,00	6,00	0	0,75	3,20	±0,65	±2,5	sin(α)/cos(α)	±3,000 --- 30
6,00	12,00	6,00	0	1,00#	3,50	±0,45	±2,7	sin(α)/cos(α)	±3,000 --- 30
6,00	12,00	6,00	0	1,25	3,90	±0,33	±2,7	sin(α)/cos(α)	±3,000 --- 30
6,00	12,00	6,00	0	1,50#	4,20	±0,23	±2,6	sin(α)/cos(α)	±3,000 --- 30

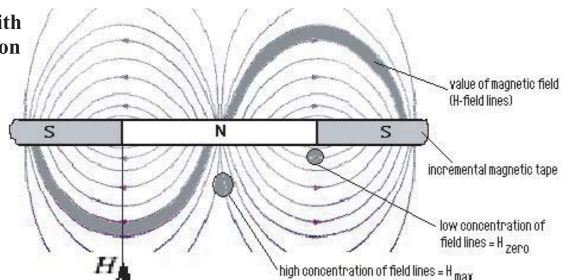
[*1] **Possible source of the flexible magnet accessories, Max Baermann GmbH (51429 Bergisch Gladbach, Germany) (www.max-baermann.de).**

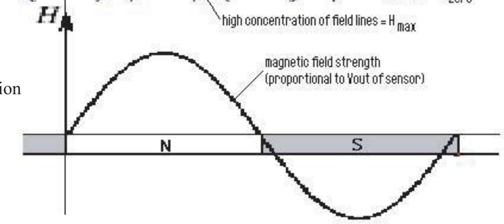
[*2] According to the application two different forms can be used.
a.) magnetic strips for length measuring systems of short distances up to approximately 100mm
[flexible plastic material filled with magnetic north-south-parts in a defined raster , for example thickness 1,5mm and width 5mm and magnet pole length 2mm with transverse unilateral magnetization , separably from magnetized foils of the company Max Baermann GmbH , contact address Sales & Applications, Mr. Nass : email → h.nass@max-baermann.de **and phone → (+49) (02204) 8309-118]**
b.) magnetic tapes for steel-stabilized length measuring systems of large distances more than 100mm (only the thicknesses $x^{\#}$ in above tables)
[flexible plastic material without multipolar magnetization by company Max Baermann GmbH , for example, tapes with thickness 1mm and width 5mm and tape length 30m , transverse unilateral multipolar magnetization must be implemented by a suitable third-party]

[*3] Parameter of TROMAFLEX 928 by company Max Baermann GmbH :
flexible plastic bonded ferrite material 9/28p according to DIN 17410 , anisotropic Strontium Ferrite ,
B_r = 220mT , $_{B}Hc$ = 170 kA/m , $_{I}Hc$ = 280 kA/m , $BH_{max.}$ = 9,0 kJ/m³ , density = 3,5 g/m³ , middle strain coefficient = $4{,}49 \cdot 10^{-5}$ m/K to 1m length ,
operating temperature range = -20°C to +70°C

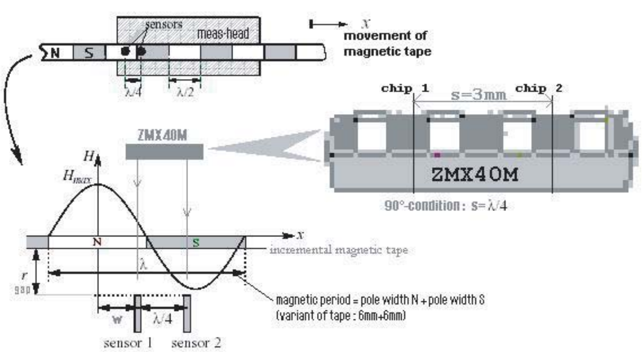
[*4] Parameter of TROMAFLEX 324 by company Max Baermann GmbH :
flexible plastic bonded ferrite material 3/24p according to DIN 17410 , isotropic Barium Ferrite ,
B_r = 127mT , $_{B}Hc$ = 91 kA/m , $_{I}Hc$ = 240 kA/m , $BH_{max.}$ = 3,0 kJ/m³ , density = 3,4 g/m³ , middle strain coefficient = $4{,}49 \cdot 10^{-5}$ m/K to 1m length ,
operating temperature range = -20°C to +70°C

PRINCIPLES – Length Measurement with Arc Tangent Interpolation for ZMX40M





picture :
magnetic field representation of magnetic tape (or strip)



picture :
mathematical principle

sensor output 1 (chip 1) : $V_1 = H_{max} \cdot \cos(w \cdot 2\Pi/\Lambda) = H_{max} \cdot \sin((w \cdot 2\Pi/\Lambda)+\Pi/2)$

sensor output 2 (chip 2) : $V_2 = H_{max} \cdot \sin(w \cdot 2\Pi/\Lambda)$

→ way of movement : $w = (\Lambda/2\Pi) \cdot \arctan(V_2/V_1)$

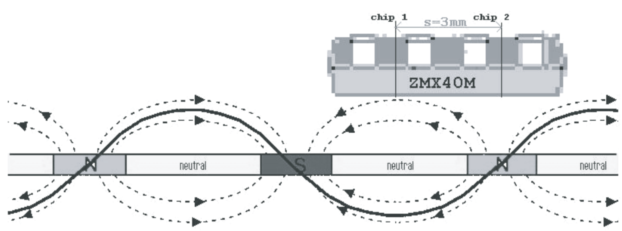
H_{max} = func (r , "magnetic structure")
r = gap between tape (or strip) and sensor

ZETEX SEMICONDUCTORS

PRINCIPLES – Magnetic Structures of Tape or Strip for ZMX40M

The basis of a length measuring system with ZMX40M is a flexible plastic band (tape or strip) filled with magnetic north-south-parts.
This magnetic band is moved along under a "ZMX40M - sensor head" or in reverse the head is mobile and the band is rigid.
The following variants of magnetic band are possible for use with the ZMX40M.

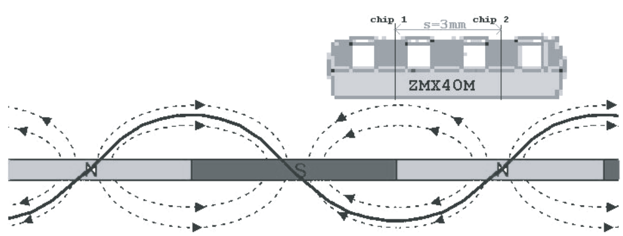
variant 1a :
: distance of magnetic period
 = 2•(b+a) = 12mm
: pole width N = b = 2mm
: pole width S = b = 2mm
: middle magnet distance
 = b+a = 6mm
: neutral zone width = a = 4mm
: 90°-condition → s = (b+a) / 2
: processing →
 tan (α) = sin (α) / cos (α)



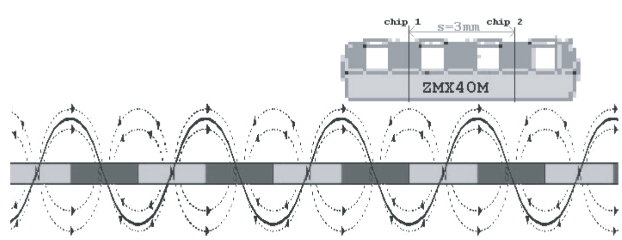
variant 1b :
: distance of magnetic period
 = 2•(b+a) = 12mm
: pole width N = b = 5mm
: pole width S = b = 5mm
: middle magnet distance
 = b+a = 6mm
: neutral zone width = a = 1mm
: 90°-condition → s = (b+a) / 2
: processing →
 tan (α) = sin (α) / cos (α)

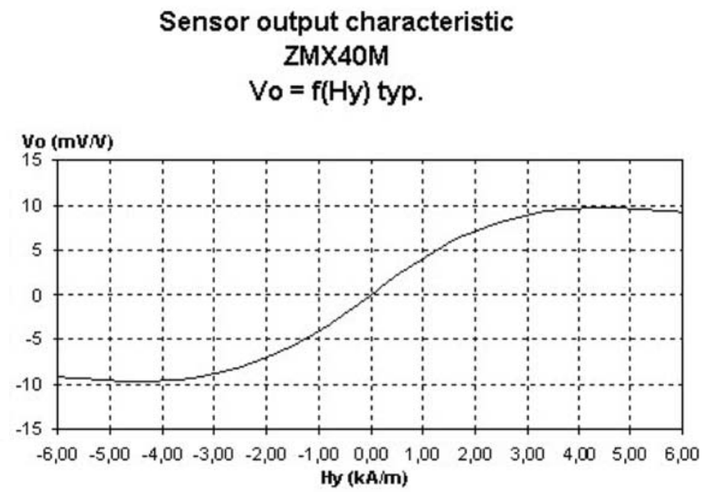
variant 1c ...... etc. ...... etc. (with different relations b to a)

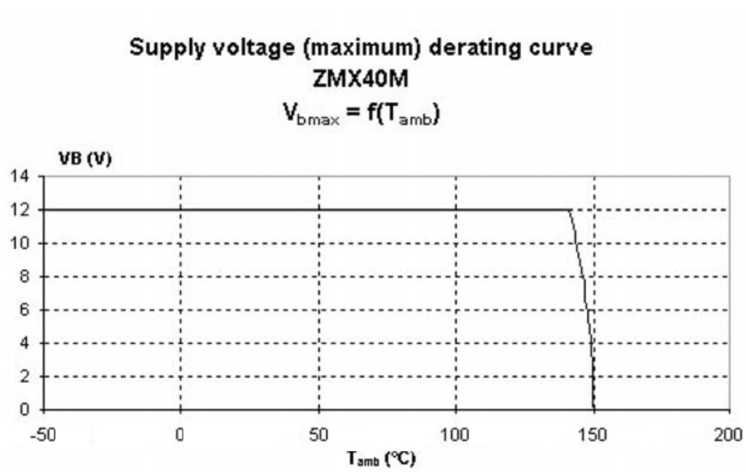
variant 2 :
: distance of magnetic period
 = 2•b = 12mm
: pole width N = b = 6mm
: pole width S = b = 6mm
: middle magnet distance
 = b = 6mm
: neutral zone width = a = 0
: 90°-condition → s = b / 2
: processing →
 tan (α) = sin (α) / cos (α)



variant 3 :
: distance of magnetic period
 = 2•b = 4mm
: pole width N = b = 2mm
: pole width S = b = 2mm
: middle magnet distance
 = b = 2mm
: neutral zone width = a = 0
: (90°+180°)-condition → s = (b / 2)+b
: processing →
 tan (α) = sin (α) / cos (α)
 = sin (α) / -cos (α+180°)



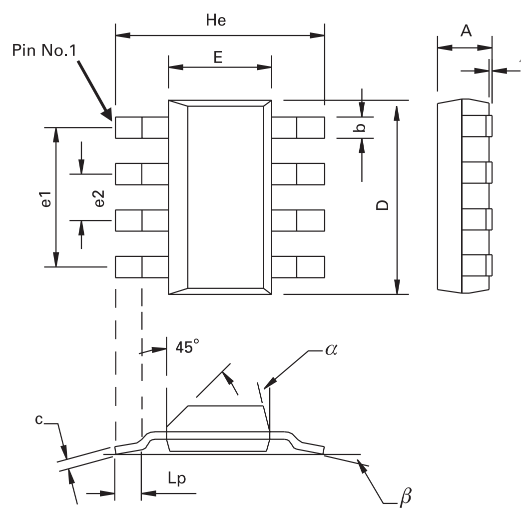




ZETEX SEMICONDUCTORS

ZMX40M

PACKAGE OUTLINE



PACKAGE DIMENSIONS

DIM	Millimeters			Inches			DIM	Millimeters			Inches		
	Min	Max	Typ.	Min	Max	Typ.		Min	Max	Typ.	Min	Max	Typ.
A	-	1.7	-	-	0.067	-	e1	-	-	4.59	-	-	0.1807
A1	0.02	0.1	-	0.008	0.004	-	e2	-	-	1.53	-	-	0.0602
b	-	-	0.7	-	-	0.0275	He	6.7	7.3	-	0.264	0.287	-
c	0.24	0.32	-	0.009	0.013	-	Lp	0.9	-	-	0.035	-	-
D	6.3	6.7	-	0.248	0.264	-	α	-	15°	-	-	15°	-

Europe

Zetex GmbH
Streitfeldstraße 19
D-81673 München
Germany

Telefon: (49) 89 45 49 49 0
Fax: (49) 89 45 49 49 49
europe.sales@zetex.com

Americas

Zetex Inc
700 Veterans Memorial Hwy
Hauppauge, NY 11788
USA

Telephone: (1) 631 360 2222
Fax: (1) 631 360 8222
usa.sales@zetex.com

Asia Pacific

Zetex (Asia) Ltd
3701-04 Metroplaza Tower 1
Hing Fong Road, Kwai Fong
Hong Kong

Telephone: (852) 26100 611
Fax: (852) 24250 494
asia.sales@zetex.com

Corporate Headquarters

Zetex Semiconductors plc
Zetex Technology Park
Chadderton, Oldham, OL9 9LL
United Kingdom

Telephone (44) 161 622 4444
Fax: (44) 161 622 4446
hq@zetex.com

ZETEX SEMICONDUCTORS

ISSUE 2 - JUNE 2005