

MCP2036

Inductive Sensor Analog Front End Device

Features

- · Complete Inductance Measurement System:
 - Low-Impedance Current Driver
 - Sensor/Reference Coil Multiplexer
 - High-Frequency Detector
- · Operating Voltage: 2.7 to 5.5V
- · Low-Power Standby Mode
- Gain and Frequency set by external passive components

Typical Applications

- · Harsh environment inductive keyboards
- · Inductive rotational sensor interface
- · Inductive displacement sensor interface
- · Inductive force sensor interface

Description

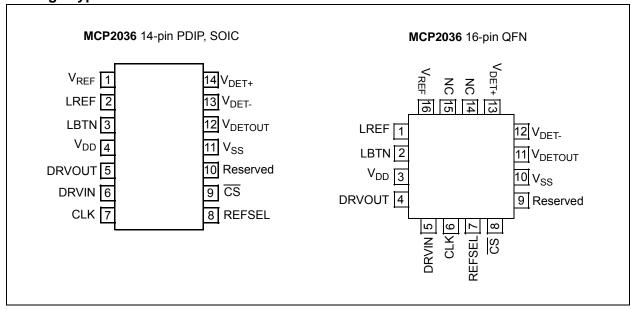
The MCP2036 Inductive Sensor Analog Front End (AFE) combines all the necessary analog functions for a complete inductance measurement system.

The device includes:

- High-frequency, current-mode coil driver for exciting the sensor coil.
- Synchronous detector for converting AC sense voltages into DC levels.
- Output amplifier/filter to improve resolution and limit noise.
- Virtual ground reference generator for single supply operation.

The device is available in 14-pin PDIP, SOIC and 16-pin QFN packages:

Package Types



1.0 FUNCTIONAL DESCRIPTION

The MCP2036 measures a sensor coil's impedance by exciting the coil with a pulsed DC current and measuring the amplitude of the resulting AC voltage waveform. The drive current is generated by the on-chip current amplifier/driver which takes the

high-frequency triangular waveform present on the DRVIN input, and amplifies it into the pulsed DC current for exciting the series combination of the sensor coils.

The AC voltages generated across the coils, are then capacitively coupled into the LBTN and LREF inputs. An input resistance of 2K between the inputs and the virtual ground offsets the AC input voltages up to the signal ground generated by the reference voltage generator, as shown in Figure 1-1.

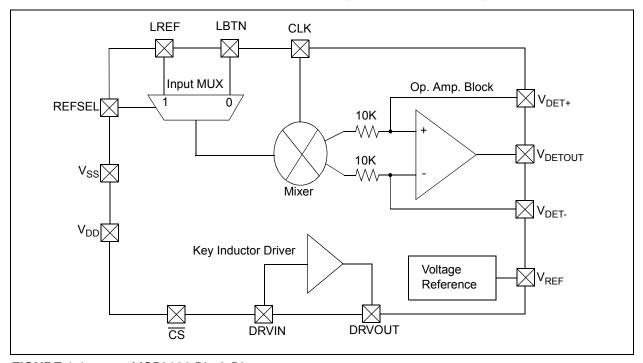


FIGURE 1-1: MCP2036 Block Diagram

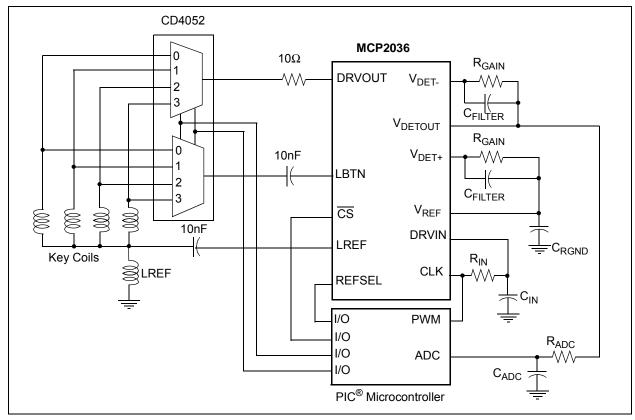


FIGURE 1-2: MCP2036 Typical Application

The coil voltages are then multiplexed into the Synchronous Detector section by the LBTN/LREF multiplexer. This allows the microcontroller to select which signal is sampled by the detector. The detector converts the coil voltages into a DC level using a frequency mixer, amplifier, and filter.

The mixer is composed of two switches driven by the clock present on the CLK signal input. The switches toggle the amplifier/filter between an inverting and non-inverting topology, at a rate equal to the clock input frequency. This inverts and amplifies the negative side of the signal, while amplifying the positive side. The result is a pulsed DC signal with a peak voltage, proportional to the amplitude of the AC coil voltage.

The gain of the detector is set by two pairs of resistors; one pair are the internal fixed series resistors between the frequency mixer and the amplifier. The second resistor pair are the two external gain set resistors (R_{GAIN}). The two capacitors (C_{FILTER}) in parallel with the external gain setting resistors form a low pass filter which converts the pulsed DC output signal into a smooth DC voltage which is proportional to the AC sensor voltage input. The output of the system is present on the V_{DETOUT} pin, which drives the microcontroller's ADC input for conversion into a digital value.

The virtual ground reference for the detector/amplifier is generated by a second internal op amp which produces a virtual ground equal to $\frac{1}{2}$ the supply voltage. The virtual ground is available externally at the V_{REF} output and used internally throughout the detector circuit, allowing single supply operation. A small external capacitance is required to stabilize this output and limit noise.

1.1 Coil Driver

The coil driver produces the excitation current for the sensor coils.

The coil driver input is derived from the digital clock supplied to the CLK input. The digital signal is first filtered through a low-pass filter, composed of R_{IN} and C_{IN} , and passed to the DRVIN input. The driver will create a triangular current in phase and proportional with the input voltage. Because the digital drive into the $R_{\text{IN}}\text{-}C_{\text{IN}}$ filter has a 50% duty cycle, the voltage on the DRVIN input will be centered at $V_{\text{DD}}/2$. The relationship between voltage, current, inductance and frequency is shown in Equation 1-1.

EQUATION 1-1:

$$\Delta V_{OUT} = (\Delta I_{DRV} \bullet L_{COIL} \bullet 2 \bullet F_{DRV})$$

 V_{OUT} = Pulsed Output Voltage

 ΔI_{DRV} = AC Drive Current Amplitude

 F_{DRV} AC Drive Current Frequency

 L_{COII} = Inductance of the Sensor Coil

Note: These equations assume a 50% duty cycle.

1.2 Synchronous Detector and Output Amplifier

The Synchronous Detector has two inputs, LREF and LBTN, selectable by REFSEL. This routes either signal into the frequency mixer of the detector. The frequency mixer then converts the AC waveform into a pulsed DC signal which is amplified and filtered.

The gain of the amplifier is user-settable, using an external resistor, R_{GAIN} (see Equation 1-2).

EQUATION 1-2:

$$Gain \sim R_{GAIN}/10$$
kOhm

An ADC plus firmware algorithm then digitizes the detector output voltage and uses the resulting data to detect a key press event...

Note: The output amplifier/filter uses a differential connection, so its output is centered to V_{REF} (V_{DD}/2). The amplitude of the detected signal should be calculated as the difference between voltages at the output of the detector and the reference voltage.

1.3 Virtual Ground Voltage Reference Circuit

To create both an inverting and non-inverting amplifier topology, a pseudo split supply design is required. To generate the dual supplies required, a rail splitter is included, which generates the virtual ground by creating a voltage output at $V_{DD}/2$. The output is used by the external passive network of the Detector/Amplifier section as a reference on the non-inverting input. A bypass capacitor of 0.1uF is required to ensure the stability of the output. For reference accuracy, no more than 3mA should be supplied to, or drawn from the reference output pin.

2.0 PIN DESCRIPTION

Descriptions of the pins are listed in Table 2-1.

TABLE 2-1: PIN FUNCTION TABLE

Pad Name	Pin No	Pin Number		Туре	Description
	14 Pins	16 Pins			
V _{REF}	1	16	OUT	AN	Voltage Reference
LREF	2	1	IN	AN	Reference Inductor Input
LBTN	3	2	IN	AN	Active Inductor Input
V _{DD}	4	3	PWR	AN	Power Supply
DRVOUT	5	4	OUT	AN	Current Driver Output for Inductors
DRVIN	6	5	IN	AN	Current Driver Input
CLK	7	6	IN	CMOS	Clock Signal
REFSEL	8	7	IN	CMOS	Detector Select Input
CS	9	8	IN	CMOS	Chip Select, Active low
Reserved	10	9	_	_	Must be tied to GND for proper operation.
V _{SS}	11	10	PWR	AN	Power Supply Return
V _{DETOUT}	12	11	OUT	AN	Detector Output Voltage
V _{DET-}	13	12	IN	AN	Negative Input for Output Detector
V _{DET+}	14	13	IN	AN	Positive Input for Output Detector
NC		14	_	_	No connect
NC		15	_	_	No connect

2.1 Chip Select (CS)

The circuit is fully enabled when a logic-low is applied to the \overline{CS} input. The circuit enters in Low-Power mode when a logic-high is applied to this input. During Low-Power mode, the detector output voltage falls to V_{RFF} and the supply current is reduced to 0.5 μ A (typ.).

This pin has an internal pull-up resistor to ensure proper selection of the circuit.

2.2 Voltage Reference (V_{REF})

 V_{REF} is a mid-scale reference output. It can source and sink small currents and has low output impedance. A load capacitor between 100nF and $1\mu F$ needs to be located close to this pin.

2.3 Power Supply (V_{DD}, V_{SS})

The V_{DD} pin is the power supply pin for the analog and digital circuitry within the MCP2036. This pin requires an appropriate bypass capacitor of 100nF. The voltage on this pin should be maintained in the 2.7V-5.5V range for specified operation.

The V_{SS} pin is the ground pin and the current return path for both analog and digital circuitry of the MCP2036. If an analog ground plane is available, it is recommended that this device be tied to the analog ground plane of the PCB.

2.4 Inductor Inputs (LREF, LBTN)

These pins are inputs for the external coils (reference and sensor). The inputs should be AC coupled to the coils by a 10nF ceramic capacitor.

2.5 Input Selection (REFSEL)

Digital input that is used to select between coil inputs (reference and sensor).

2.6 Clock (CLK)

The external clock input is used for synchronous detection of the AC waveforms on the coils. The clock signal is also used to generate a triangular waveform applied to coil driver input.

2.7 Inductor Driver Input (DRVIN)

The analog input to the coil driver. The triangular waveform applied to this input should be in phase with the clock signal for best performance.

2.8 Inductor Driver Output (DRVOUT)

Driver output used to excite the sensor coils. It is a current-mode output designed to drive small inductive loads.

2.9 Detector Output Voltage (V_{DETOUT})

The amplifier/filter output from the detector. This is a low-impedance analog output pin (V_{OUT}) for driving the microcontroller ADC. The detector output is rail-to-rail.

2.10 Inputs for Output Detector (V_{DET+} , V_{DET-})

The non-inverting and inverting inputs for the amplifier/filter op amp. The two inputs are connected to the output of the mixer circuit through two internal $10 \mathrm{K}\Omega$ resistors.

3.0 APPLICATIONS

The MCP2036 is an Analog Front End device that uses the electromagnetic interaction between a conductive target and a sensing coil to detect the pressure applied by the user on the surface of a touch panel. The device incorporates all analog blocks for a simple inductor impedance measurement circuit.

For an inductive touch system, two methods are used for switching the driver and measurement circuitry between the different sensor coils: analog multiplexers and GPIO grounding (see Figure 3-1 and Figure 3-2). The MCP2036 is designed to work with both configurations:

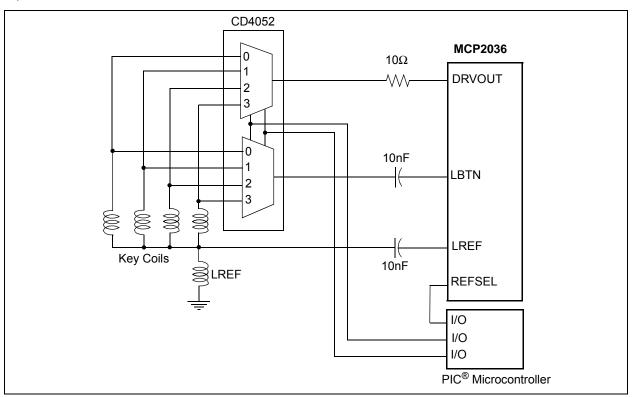


FIGURE 3-1: Using Analog-Multiplexer for Key Selection (Example)

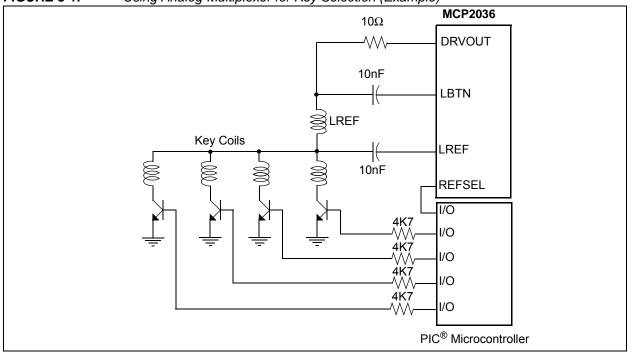


FIGURE 3-2: Using GPIO for Key Selection (Example)

3.1 Application example

Figure 3-3 shows an example for a 4-key Inductive Touch keyboard with key controlled by the IO pins of the PIC® MCU.

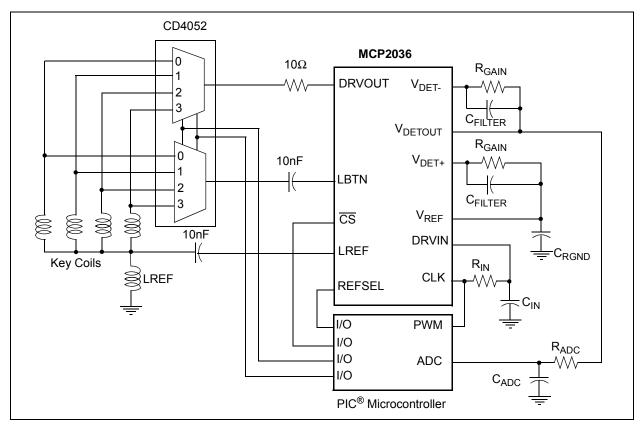


FIGURE 3-3: MCP2036 Typical Application

The PIC^{\circledR} microcontroller is used to generate a square wave signal and to do all the necessary operations for proper detection of the key press event.

Then, R_{IN}-C_{IN} filter converts the square wave output of the PWM into a quasi-triangular waveform.

To calculate the amplitude of the triangular signal, the standard charging time equation for an RC network will be used, as shown in Equation 3-1:

EQUATION 3-1:

$$V(t) = V_{step} \bullet [1 - \exp(-t/RC)]$$

For the first half of the square wave, the capacitor C_{IN} is charged through R_{IN} , for the second half, it is discharged through R_{IN} , and assuming that clock signal has a 50% duty cycle factor, we can consider:

EQUATION 3-2:

$$V_{start} = V_{DD}/2 - \Delta V$$

$$V_{stop} = V_{DD}/2 + \Delta V$$

When the PWM signal switches from low-to-high or from high-to-low, the step voltage applied to the capacitor C_{IN} will be:

EQUATION 3-3:

$$V_{step} = (V_{DD}/2 + \Delta V)$$

Substituting in the equation for an RC network:

EQUATION 3-4:

$$2\Delta V = (V_{DD}/2 + \Delta V) \bullet [1 - \exp(-t/RC)]$$

$$\Delta V = \frac{V_{DD}}{2} \bullet \frac{1 - \exp(\frac{-t}{R_{IN}C_{IN}})}{1 + \exp(\frac{-t}{R_{IN}C_{IN}})}$$

MCP2036

The peak to peak amplitude of the resulting triangular waveform, at the coil driver input, is shown in Equation 3-5:

EQUATION 3-5:

$$\begin{aligned} V_{PKPK} &= \ 2\Delta V \\ V_{PKPK} &= \ V_{DD} \bullet \frac{1 - \exp\left(\frac{-t}{R_{IN}C_{IN}}\right)}{1 + \exp\left(\frac{-t}{R_{IN}C_{IN}}\right)} \end{aligned}$$

Note: V_{PKPK} should not exceed specified value (600mV) for best performance.

From the previous equation, the designer should choose values for V_{PKPK} and R_{IN} . Using the equation above, the value of C_{IN} will be:

EQUATION 3-6:

$$C_{IN} = \frac{t}{R_{IN} \bullet \ln \left(\frac{V_{DD} - V_{PKPK}}{V_{DD} + V_{PKPK}} \right)} = \frac{1}{2 \bullet F \bullet R_{IN} \bullet \ln \left(\frac{V_{DD} - V_{PKPK}}{V_{DD} + V_{PKPK}} \right)}$$

Note: Assuming a power supply of 5V and V_{PKPK} =500mV, for R_{IN} =3.9KΩ, C_{IN} should have about 320pF. A 330pF capacitor will be used

The amplitude of the pulsed current applied to key inductors will be:

EQUATION 3-7:

$$\Delta I = V_{PKPK} ullet G_{DRV}$$
 G_{DRV} - Gain of Coil Driver

This current produces a pulsed voltage to key inductors ends. The amplitude of this voltage will be:

EQUATION 3-8:

$$\Delta U = L \bullet \frac{\Delta I}{\Delta t} = L \bullet V_{PKPK} \bullet G_{DRV} \bullet 2F$$

F - PWM Frequency

L - Inductance of Key Inductor

Note: For a PWM frequency of 2 MHz and inductor value of 2.7μH, the amplitude of pulsed voltage will be:

$$\Delta U = 10.8 mV$$

The total voltage across both the reference and sensor coils would be double (two series inductors). For a specific power supply voltage, half of this power supply, relative to the voltage reference, is available for output amplifier/detector. Assuming a 30% margin, the desired gain for the detector should be about:

EQUATION 3-9:

$$Gain = \frac{70\% \bullet \left(\frac{V_{DD}}{2}\right)}{2 \bullet \Delta U}$$

The gain of the amplifier is user-settable, using an external resistor, R_{GAIN} . The value of that resistor will be determined using the following equation:

EQUATION 3-10:

$$Gain \sim R_{GAIN}/10$$
kOhm

With a 10-bit ADC, using oversampling and averaging techniques, the effective resolution is close to 11 bits. As shown in AN1239, "Inductive Touch Sensor Design", the typical shift in sensor impedance is typically 3-4%, so the actual number of counts per press is typically between 20 and 40 counts. In this way, the microcontroller firmware could easily detect press event.

Note: For a power supply of 5V and ΔU = 10mV, the resulted gain is 81. To obtain this gain, R_{GAIN} = 820kOhm should be used.

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4.0 ELECTRICAL CHARACTERISTICS

4.1 Absolute Maximum Ratings

4.2 Specifications

TABLE 4-1: DC CHARACTERISTICS

Electrical Specifications: Unless	otherwise ind	icated, T _A = -	+25°C, V _{DD}	= +2.7V to	+5.5V, V _{SS} =	= GND.
Parameters	Sym.	Min.	Тур.	Max.	Units	Conditions
General Device Parameters						
Supply Voltage	V_{DD}	2.7	_	5.5	V	
Power Down Current	I _{PD}	_	12	_	nA	CS = 1, V _{DD} = +2.7V, (Note 1)
	I _{PD}	_	25	_	nA	CS = 1, V _{DD} = +5.5V, (Note 1)
Quiescent Current	I _{DD}	_	2	_	mA	V _{DD} = +2.7V, DRVIN=0V, CLK=Low
	I _{DD}	_	3.7	_	mA	V _{DD} = +5.5V DRVIN=0V, CLK=Low
Active Current	I _{DD}	_	3.4	_	mA	V _{DD} = +2.7V, CLK=2MHz
	I _{DD}	_	6.8	_	mA	V _{DD} = +5.5V CLK=2MHz
Digital IO Parameters						
Digital Input High Voltage	V _{IH}	0.7V _{DD}	_	_	V	
Digital Input Low Voltage	V_{IL}	_	_	0.3V _{DD}	V	
Input Pins Leakage Current	I _{LKG}	_	_	±100	nA	CS, CLK, REFSEL, LREF, LBTN
Output Amplifier/Filter Specific	Parameters					
System Parameters						
DC Open Loop Gain	A _{OL}	90	110	_	dB	
Power Supply Rejection Ratio	PSRR	_	86	_	dB	
Common Mode Rejection Ratio	CMMR	60	76	_	dB	
Amplifier Input Characteristics						
Input Offset Voltage	Vos	_	_	±7	mV	
Input Bias Current	Ι _Β	_	_	±20	pA	(Note 1)
	_	_	_	±1	nA	(Note 1)
Input Offset Current	I _{OS}	_	_	±1	pA	(Note 1)
Input Impedance	Z _{IN}	_	10 ¹³ 6	_	Ω pF	Common Mode Impedance
	_	_	10 ¹³ 6	_	Ω pF	Differential impedance
Amplifier Output Characteristic	s	1				•
Minimum Output Voltage	V _{OMIN}	V _{SS} +20	_	_	mV	
Maximum Output Voltage	V _{OMAX}	_	_	V _{DD} -20	mV	

TABLE 4-1: DC CHARACTERISTICS (CONTINUED)

Parameters	Sym.	Min.	Тур.	Max.	Units	Conditions
Short Circuit Current	I _{SC}	_	±6	_	mA	V _{DETOUT} , V _{DD} =3V
	_	_	±10	_	mA	V _{DETOUT} , V _{DD} =5V
Voltage Reference Specific Para	meters	•	•	•		
Output Voltage	V_{REF}	_	V _{DD} /2	_	mV	
Output Short Circuit Current	I _{SC}	_	6	_	mA	V _{DD} =3V
	_	_	10	_	mA	V _{DD} =5V
Maximum Output Capacitance	C _{OUT}	_	_	1	μF	(Note 1)
Series Output Resistance	R _{SER}	_	250	_	Ω	Internal resistor used to stabilize op amp output for pure capacitive loads
Coil Driver Specific Parameters		•				
System Parameters						
Amplifier Current Gain	A _{OL}	_	3	_	mA/V	V _{DD} =+2.7V
	A _{OL}	_	3.6	_	mA/V	V _{DD} =+5.5V
Power Supply Rejection Ratio	PSRR	60	_	_	dB	
Input Characteristics		•				
Input Voltage Range	V _{MAX}	V _{DD} /2 -300	_	V _{DD} /2 +300	mV	V _{DD} =5V
Input Bias/Leakage Current	Ι _Β	_	_	±20	pA	T=85°C (Note 1)
	I _B	_	_	±1	nA	T=125°C (Note 1)
Input Impedance	Z _{IN}	_	10 ¹³ 6	_	Ω pF	Common Mode Impedance
	_	_	10 ¹³ 6	_	Ω pF	Differential Impedance
Output Characteristics		•		•		
Minimum Output Voltage	V _{OMIN}	V _{SS} +20			mV	
Maximum Output Voltage	V _{OMAX}	_	_	V _{DD} -20	mV	
Short Circuit Current	I _{SC}	_	±6	_	mA	DRVOUT, V _{DD} =3V
	I _{SC}	_	±10	_	mA	DRVOUT, V _{DD} =5V
Resistor Specifications	•	•	•			
Resistance Value of R1	R1	_	8	_	ΚΩ	Resistor between pass gates and output amplifier input
Resistance Value of R2	R2	_	2	_	ΚΩ	Resistor between LBTN and LREF inputs and voltage reference

TABLE 4-2: AC CHARACTERISTICS

Parameters	Sym.	Min.	Тур.	Max.	Units	Conditions
rarameters	Sylli.	IVIIII.	iyp.	IVIAA.	Units	Conditions
Output Amplifier/Filter Spec	cific Paramete	ers				
Gain Bandwidth Product	GBWP	_	1	_	MHz	
Slew Rate	SR	_	0.6	_	V/µs	
Coil Driver Amplifier Param	eters					
Gain Bandwidth Product	GBWP	_	17.8	_	MHz	
Voltage Reference Specific	Parameters					
Gain Bandwidth Product	GBWP	_	1	_	MHz	
Slew Rate	SR	_	0.6	_	V/µs	

TABLE 4-3: TEMPERATURE SPECIFICATIONS

Electrical Characteristics: U	Electrical Characteristics: Unless otherwise indicated, V_{DD} = +2.7V to +5.5V,and V_{SS} = GND.					
Parameters	Sym.	Min.	Тур.	Max.	Units	Conditions
Temperature Ranges						
Industrial Temperature Range	T _A	-40	_	+85	°C	
Extended Temperature Range	T _A	-40	_	+125	°C	
Operating Temperature Range	T _A	-40	_	+125	°C	
Storage Temperature Range	T _A	-65	_	+150	°C	
Thermal Package Resistance	es	•	•	•		
Thermal Resistance, 14L-PDIP	θ_{JA}	_	70	_	°C/W	
Thermal Resistance, 14L-SOIC	θ_{JA}	_	120	_	°C/W	
Thermal Resistance, 16L-QFN	θ_{JA}	_	47	_	°C/W	

TABLE 4-4: TIMING DIAGRAM

Parameters	Sym.	Min.	Тур.	Max.	Units	Conditions
Input Clock Frequency	F _{CLK}	_	2	_	MHz	
Duty Factor	D	_	50	_	%	
Device Turn-On Time	t _{ON}	_	4	10	μs	Time from CS= 0 to valid V _{DETOUT} output (Note 1)
Device Power-Down Time	t _{OFF}	_	1—	_	μs	Time from \overline{CS} = 1 to High-Z outputs on all drivers (Note 1)

Note 1: Not tested in production but it is characterized.

5.0 TYPICAL PERFORMANCE CURVES

5.1 Performance Plots

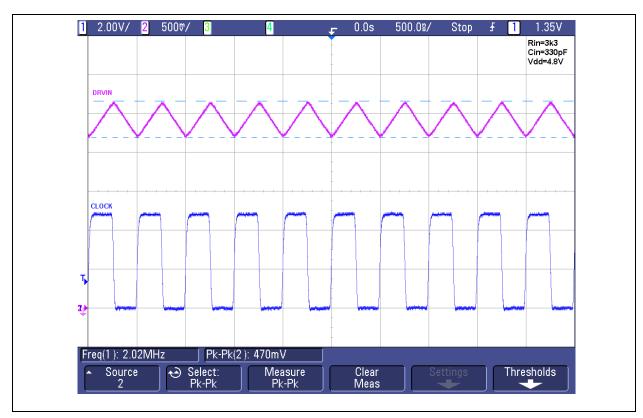


FIGURE 5-1: Driver Input Waveforms

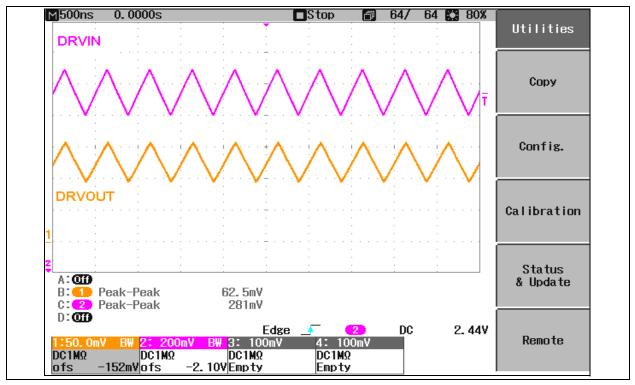


FIGURE 5-2: Inductor Driver Transfer Function (Rload = 1000hm)



FIGURE 5-3: Pulsed Voltage on Active Key Inductor (IO Configuration)



FIGURE 5-4: Pulsed voltage on Reference Inductor Series with Active Inductor

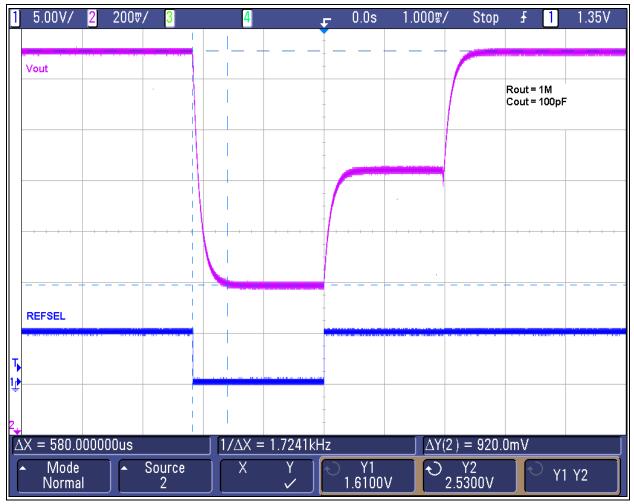


FIGURE 5-5: Output Detector Response Time

NOTES:	
110160.	

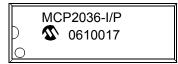
6.0 PACKAGING INFORMATION

6.1 Package Marking Information

14-Lead PDIP



Example



14-Lead SOIC (.150")



Example



16-Lead QFN



Example



Legend: XX...X Customer-specific information

Y Year code (last digit of calendar year)
YY Year code (last 2 digits of calendar year)
WW Week code (week of January 1 is week '01')

NNN Alphanumeric traceability code

e3 Pb-free JEDEC designator for Matte Tin (Sn)

This package is Pb-free. The Pb-free JEDEC designator (e3) can be found on the outer packaging for this package.

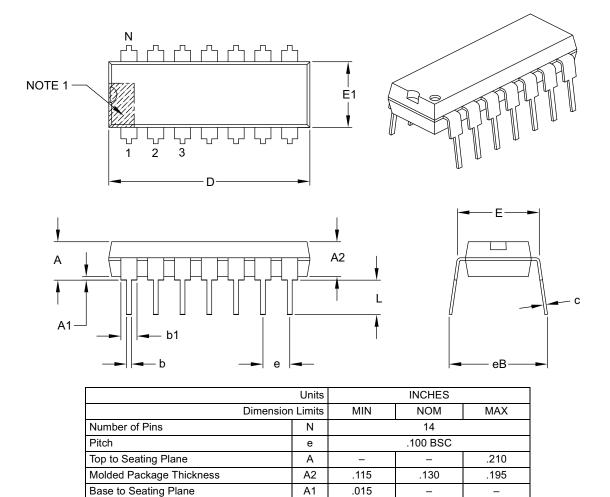
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

6.2 Package Details

The following sections give the technical details of the packages.

14-Lead Plastic Dual In-Line (P) - 300 mil Body [PDIP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Notes:

1. Pin 1 visual index feature may vary, but must be located with the hatched area.

Shoulder to Shoulder Width

Molded Package Width

Tip to Seating Plane

Overall Length

Lead Thickness

Upper Lead Width

Lower Lead Width

Overall Row Spacing §

- 2. § Significant Characteristic.
- 3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" per side.

Ε

E1

D

L

С

b1

b

eВ

.290

.240

.735

.115

.008

.045

.014

.310

.250

.750

.130

.010

.060

.018

.325

.280

.775

.150

.015

.070

.022

.430

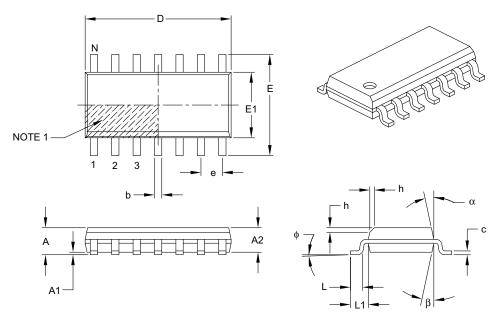
4. Dimensioning and tolerancing per ASME Y14.5M.

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-005B

14-Lead Plastic Small Outline (SL) - Narrow, 3.90 mm Body [SOIC]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



	Units)
D	imension Limits	MIN	NOM	MAX
Number of Pins	N		14	
Pitch	е		1.27 BSC	
Overall Height	A	_	_	1.75
Molded Package Thickness	A2	1.25	-	_
Standoff §	A1	0.10	_	0.25
Overall Width	E		6.00 BSC	
Molded Package Width	E1	3.90 BSC		
Overall Length	D	8.65 BSC		
Chamfer (optional)	h	0.25	_	0.50
Foot Length	L	0.40	_	1.27
Footprint	L1		1.04 REF	
Foot Angle	ф	0°	_	8°
Lead Thickness	С	0.17	_	0.25
Lead Width	b	0.31	_	0.51
Mold Draft Angle Top	α	5°	_	15°
Mold Draft Angle Bottom	β	5°	_	15°

Notes:

- 1. Pin 1 visual index feature may vary, but must be located within the hatched area.
- 2. § Significant Characteristic.
- 3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15 mm per side.
- 4. Dimensioning and tolerancing per ASME Y14.5M.

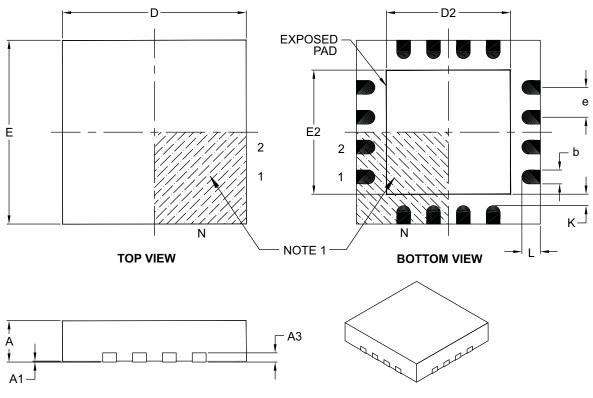
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-065B

16-Lead Plastic Quad Flat, No Lead Package (ML) – 4x4x0.9 mm Body [QFN]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



	Units		MILLIMETERS	3	
	Dimension Limits	MIN	NOM	MAX	
Number of Pins	N		16		
Pitch	е		0.65 BSC		
Overall Height	A	0.80	0.90	1.00	
Standoff	A1	0.00	0.02	0.05	
Contact Thickness	A3	0.20 REF			
Overall Width	E	4.00 BSC			
Exposed Pad Width	E2	2.50	2.65	2.80	
Overall Length	D	4.00 BSC			
Exposed Pad Length	D2	2.50	2.65	2.80	
Contact Width	b	0.25	0.30	0.35	
Contact Length	L	0.30	0.40	0.50	
Contact-to-Exposed Pad	K	0.20	-	_	

Notes:

- 1. Pin 1 visual index feature may vary, but must be located within the hatched area.
- 2. Package is saw singulated.
- 3. Dimensioning and tolerancing per ASME Y14.5M.
 - BSC: Basic Dimension. Theoretically exact value shown without tolerances.
 - REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-127B

MCP2036

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (05/2009)

Original release of the document.

MCP2036

NOTES:

PRODUCT IDENTIFICATION SYSTEM

 $\underline{\text{To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.}\\$

PART NO. Device	X /XX XXX Temperature Package Pattern Range	Examples: MCP2036 - I/P 301 = Industrial temp., PDIP package, QTP pattern #301.
Device:	MCP2036 VDD range 2.7V to 5.5V	
Temperature Range:	I = -40 °C to $+85$ °C (Industrial) E = -40 °C to $+125$ °C (Extended)	
Package:	ML = QFN SL = SOIC P = PDIP	
Pattern:	QTP, SQTP, Code or Special Requirements (blank otherwise)	

NOTES:

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
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