



# Single-Chip Global Positioning System Receiver Front-End

## General Description

The MAX2742 complete single-chip global positioning system (GPS) RF front-end utilizes many innovative and leading-edge RF CMOS design techniques. This high-performance, state-of-the-art device consumes extremely low power and eliminates the need for costly SAW and bulky discrete IF filters. The MAX2742 incorporates a fully integrated low-noise amplifier (LNA) and mixer, IF section, digital sampler, and local oscillator synthesizer.

The intended input signal for the MAX2742 is the L1 GPS signal 1.57542GHz. This device supports high-accuracy output quantization, which delivers the best performance obtainable for the GPS receiver. The power consumption of the MAX2742 is as low as 32mW at a +2.4V supply.

The MAX2742 is available in a space-saving 48-pin TQFP package and is specified for the extended (-40°C to +85°C) temperature range.

## Applications

In-Vehicle Navigation Systems (IVNS)  
Location-Based Services (PDAs and Accessories)  
Recreational Handheld/Walkie Talkies  
Geographical Information Systems (GISs)  
Telematics (Vehicle, Asset Tracking, and Inventory Management)  
Emergency Roadside Assistance  
Emergency Response Systems  
Digital Cameras/Camcorders  
Consumer Electronics

## Features

- ◆ Complete Single-Chip GPS Front-End Receiver
- ◆ Single-Ended or Differential Outputs at 1.023MHz
- ◆ Low 4.5dB Typical Noise Figure
- ◆ No External IF SAW or Discrete Filters Required
- ◆ Very Low 32mW Power Consumption at +2.4V
- ◆ Wide +2.4V to +3.6V Operational Supply Voltage Range
- ◆ Extended -40°C to +85°C Temperature Range

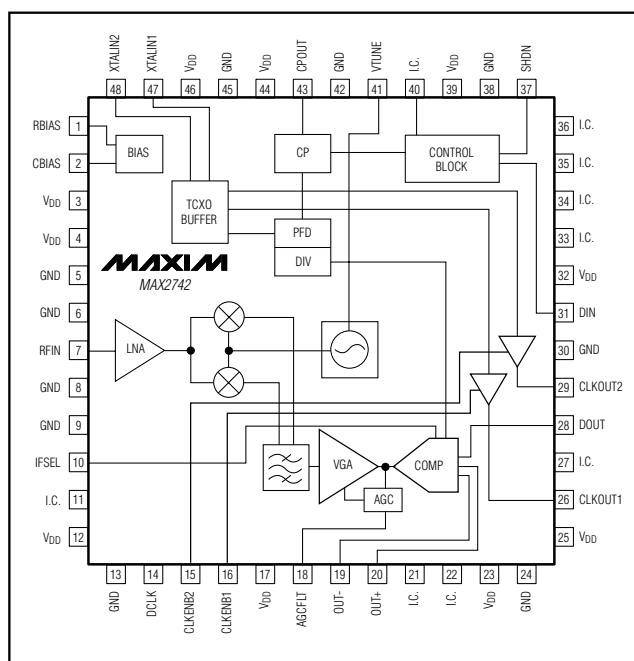
MAX2742

## Ordering Information

| PART       | TEMP RANGE     | PIN-PACKAGE |
|------------|----------------|-------------|
| MAX2742ECM | -40°C to +85°C | 48 TQFP-EP* |

\*EP = Exposed paddle.

## Block Diagram/ Pin Configuration



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## ABSOLUTE MAXIMUM RATINGS

V<sub>DD</sub> to GND .....-0.3V to +3.7V  
 All Other Pins to GND .....-0.3V to (V<sub>DD</sub> + 0.3V)  
 RF LNA Input Power .....+10dBm  
 Continuous Power Dissipation (T<sub>A</sub> = +70°C)  
 48-Pin TQFP-EP (derate 12.5mW/°C above +70°C) ....100mW

Operating Temperature Range .....-40°C to +85°C  
 Junction Temperature .....+150°C  
 Storage Temperature Range .....-65°C to +150°C  
 Soldering Temperature (10s) .....+300°C



**CAUTION!** ESD SENSITIVE DEVICE

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## DC ELECTRICAL CHARACTERISTICS

(MAX2742 EV kit, V<sub>DD</sub> = +2.4V to +3.6V, SHDN = V<sub>DD</sub>, T<sub>A</sub> = -40°C to +85°C. Typical values are at V<sub>DD</sub> = +3V and T<sub>A</sub> = +25°C, unless otherwise noted.)

| PARAMETER                | CONDITIONS                                               | MIN                   | TYP | MAX | UNITS |
|--------------------------|----------------------------------------------------------|-----------------------|-----|-----|-------|
| Supply Voltage           |                                                          | 2.4                   |     | 3.6 | V     |
| Supply Current           | V <sub>DD</sub> = +3.0V, T <sub>A</sub> = +25°C (Note 1) |                       | 14  | 20  | mA    |
|                          | Shutdown mode                                            |                       | 10  |     | μA    |
| Logic-Input High Voltage |                                                          | V <sub>DD</sub> - 0.5 |     |     | V     |
| Logic-Input Low Voltage  |                                                          |                       |     | 0.5 | V     |
| Logic-Input Bias Current |                                                          | -40                   |     | +40 | μA    |

## AC ELECTRICAL CHARACTERISTICS

(MAX2742 EV kit, V<sub>DD</sub> = +2.4V to +3.6V, SHDN = V<sub>DD</sub>, T<sub>A</sub> = -40°C to +85°C. Typical values are at V<sub>DD</sub> = +3V and T<sub>A</sub> = +25°C, unless otherwise noted.)

| PARAMETER                  | CONDITIONS                                                                  | MIN | TYP                   | MAX | UNITS |
|----------------------------|-----------------------------------------------------------------------------|-----|-----------------------|-----|-------|
| <b>GENERAL PERFORMANCE</b> |                                                                             |     |                       |     |       |
| Maximum Conversion Gain    | (Notes 2, 3)                                                                |     | 102                   | 117 | dB    |
| Input Frequency            |                                                                             |     | 1575.42               |     | MHz   |
| Noise Figure               | Measured at quantizer input                                                 |     | 4.5                   |     | dB    |
| Return Loss (S11)          |                                                                             |     | -15                   |     | dB    |
| LNA/Mixer Input IP3        | f <sub>1</sub> = 1.5MHz and f <sub>2</sub> = 2.0MHz above carrier frequency |     | -32                   |     | dBm   |
| Output IF Frequency        |                                                                             |     | 1.023                 |     | MHz   |
| <b>OUTPUT STAGE</b>        |                                                                             |     |                       |     |       |
| Output Rise/Fall Time      | Differential (VOUT+, VOUT-), C <sub>L</sub> < 20pF                          |     | 25                    |     | ns    |
|                            | Single ended (DOUT), C <sub>L</sub> < 20pF                                  |     | 5                     |     |       |
| Output-Voltage-Level Low   | Differential                                                                |     | V <sub>DD</sub> - 0.9 |     | V     |
|                            | Single ended                                                                |     | 0                     |     |       |
| Output-Voltage-Level High  | Differential                                                                |     | V <sub>DD</sub>       |     | V     |
|                            | Single ended                                                                |     |                       |     |       |

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## AC ELECTRICAL CHARACTERISTICS (continued)

(MAX2742 EV kit,  $V_{DD} = +2.4V$  to  $+3.6V$ ,  $SHDN = V_{DD}$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ . Typical values are at  $V_{DD} = +3V$  and  $T_A = +25^{\circ}C$ , unless otherwise noted.)

| PARAMETER                                | CONDITIONS                                       | MIN | TYP    | MAX | UNITS  |
|------------------------------------------|--------------------------------------------------|-----|--------|-----|--------|
| <b>SYNTHESIZER</b>                       |                                                  |     |        |     |        |
| TCXO Input Frequency                     | Fundamental frequency crystal                    |     | 18.414 |     | MHz    |
| Charge-Pump Current                      |                                                  |     | 0.4    |     | mA     |
| Phase Noise                              | $f_{OFFSET} = 10kHz$ offset, $BW_{LOOP} = 70kHz$ |     | -71    |     | dBc/Hz |
|                                          | $f_{OFFSET} = 1MHz$ offset, $BW_{LOOP} = 70kHz$  |     | -106   |     |        |
| Comparison Frequency Spur                | $BW_{LOOP} = 70kHz$                              |     | -66    |     | dBc    |
| VCO Turning Range                        | (Notes 2, 3)                                     | 148 | 210    | 277 | MHz    |
| VCO Tuning Gain                          | (Notes 2, 3)                                     | 139 | 200    | 305 | MHz/V  |
| <b>IF STAGE</b>                          |                                                  |     |        |     |        |
| IF Stage Gain                            | VGA set at maximum gain                          |     | 77     |     | dB     |
| Dynamic Range IF Stage Gain              |                                                  |     | 50     |     | dB     |
| Bandpass Filter 1dB Corner Frequency     | Low-frequency corner                             |     | 0.1    |     | MHz    |
|                                          | High-frequency corner                            |     | 3.2    |     |        |
| Bandpass Filter 60dB High-Side Rejection |                                                  |     | 5.0    |     | MHz    |
| Image Rejection                          |                                                  |     | 18     |     | dB     |
| In-Band Ripple                           |                                                  |     | 1      |     | dB     |
| AGC Loop Lock Time                       |                                                  |     | 1      |     | ms     |

**Note 1:** At  $T_A = +25^{\circ}C$ , min/max limits are guaranteed by production test.

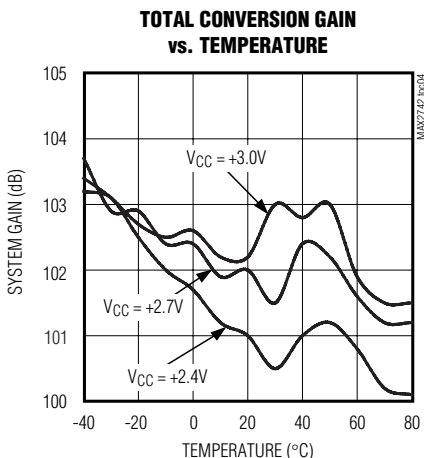
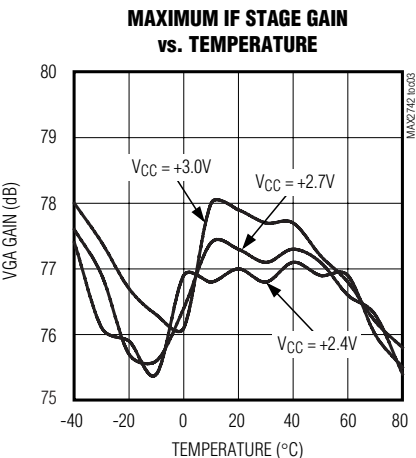
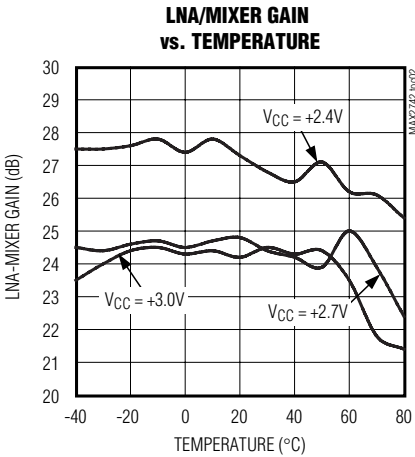
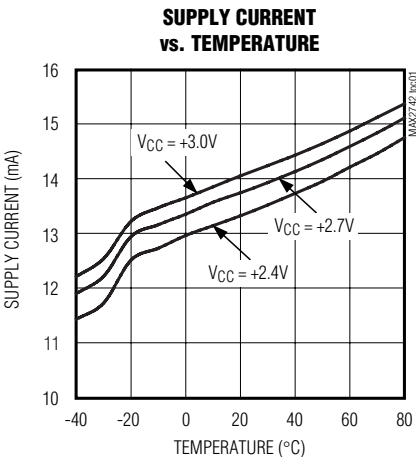
**Note 2:** At  $T_A = -40^{\circ}C$ , min/max limits are guaranteed by design and characterization.

**Note 3:** At  $T_A = +25^{\circ}C$  and  $+85^{\circ}C$ , min/max limits are guaranteed by production test.

# Single-Chip Global Positioning System Receiver Front-End

## Typical Operating Characteristics

(MAX2742 EV kit,  $V_{DD} = +3V$ , and  $T_A = +25^{\circ}C$ , unless otherwise noted.)



# Single-Chip Global Positioning System Receiver Front-End

## Pin Description

**MAX2742**

| PIN                                  | NAME             | FUNCTION                                                                                                                                                  |
|--------------------------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                                    | RBIAS            | External Bias Resistor. Connect a 100k $\Omega$ $\pm$ 1% resistor in parallel with a 0.1 $\mu$ F capacitor in series with a 71k $\Omega$ resistor to GND. |
| 2                                    | CBIAS            | External Bias Capacitor. Connect a 0.1 $\mu$ F capacitor to GND.                                                                                          |
| 3, 4, 12, 17, 23, 25, 32, 39, 44, 46 | VDD              | Supply Voltage. Bypass to GND with a capacitor as close to the pin as possible.                                                                           |
| 5, 6, 8, 9, 13, 24, 30, 38, 42, 45   | GND              | Ground. Connect to PC board ground plane.                                                                                                                 |
| 7                                    | RFIN             | LNA Input. Requires external matching network.                                                                                                            |
| 10                                   | IFSEL            | IF Output Select. Selects output type. Drive high for single-ended output, drive low for differential output.                                             |
| 11, 21, 22, 27, 33–36, 40            | I.C.             | Internally Connected. Leave unconnected.                                                                                                                  |
| 14                                   | DCLK             | Digital Control Clock                                                                                                                                     |
| 15                                   | CLKENB2          | Clock Output Enable 2. Drive high to enable limited-swing clock output.                                                                                   |
| 16                                   | CLKENB1          | Clock Output Enable 1. Drive high to enable full-swing clock output.                                                                                      |
| 18                                   | AGCFLT           | AGC External Filter                                                                                                                                       |
| 19, 20                               | OUT-, OUT+       | Differential Comparator Outputs                                                                                                                           |
| 26                                   | CLKOUT1          | Full-Swing Clock Output                                                                                                                                   |
| 28                                   | DOUT             | Digital Output                                                                                                                                            |
| 29                                   | CLKOUT2          | Limited-Swing Clock Output                                                                                                                                |
| 31                                   | DIN              | Digital-Control Data Input                                                                                                                                |
| 37                                   | SHDN             | Shutdown. Drive SHDN high to disable all device functions. Drive SHDN low for normal operation.                                                           |
| 41                                   | VTUNE            | VCO Tuning Input                                                                                                                                          |
| 43                                   | CPOUT            | Charge-Pump Output. Connect directly to loop filter.                                                                                                      |
| 47, 48                               | XTALIN1, XTALIN2 | Connect XTALIN1 and XTALIN2 together and to the TCXO output through a coupling capacitor.                                                                 |
| EP                                   | GND              | Exposed Paddle. Connect to PC board ground plane for optimal performance.                                                                                 |

# Single-Chip Global Positioning System Receiver Front-End

## Detailed Description

### LNA/Mixer

The RF input from the GPS antenna is fed through an LNA with a 24dB gain. The amplified signal is then fed to a mixer that downconverts the signal (1575.42MHz) to a quadrature differential IF of 1.023MHz.

### IF Stage

The quadrature IF signals pass through the IF filter, which rejects the out-of-band spurs by more than 60dB and the image noise by 18dB (typ). After the image reject filter, the signal is converted from quadrature to differential. The filtered IF signal is then amplified by the AGC block, which sets the VGA output signal level to a predetermined value through the application using 50dB of dynamic range. The internal offset-cancellation mechanism generates a highpass characteristic for the IF section with a 1dB corner frequency of about 100kHz.

### IF Output Selection

The sampled outputs of the GPS signal are available in a single-ended or differential format. The IFSEL pin controls the output format.

### Synthesizer

An on-chip VCO provides quadrature differential LO signals to the downconverting mixer and controls the frequency. An on-board TCXO generates the reference frequency. The integrated synthesizer includes the

VCO, TCXO buffer, main frequency divider, phase-frequency detector, and charge pump. It uses an off-chip PLL loop filter and TCXO. Connect the output of the TCXO to XTALIN1 and XTALIN2 through a coupling capacitor.

The main division ratio for the synthesizer is 684. With this division ratio, a low-side injection LO can be synthesized with an 18.414MHz TXCO.

## Applications Information

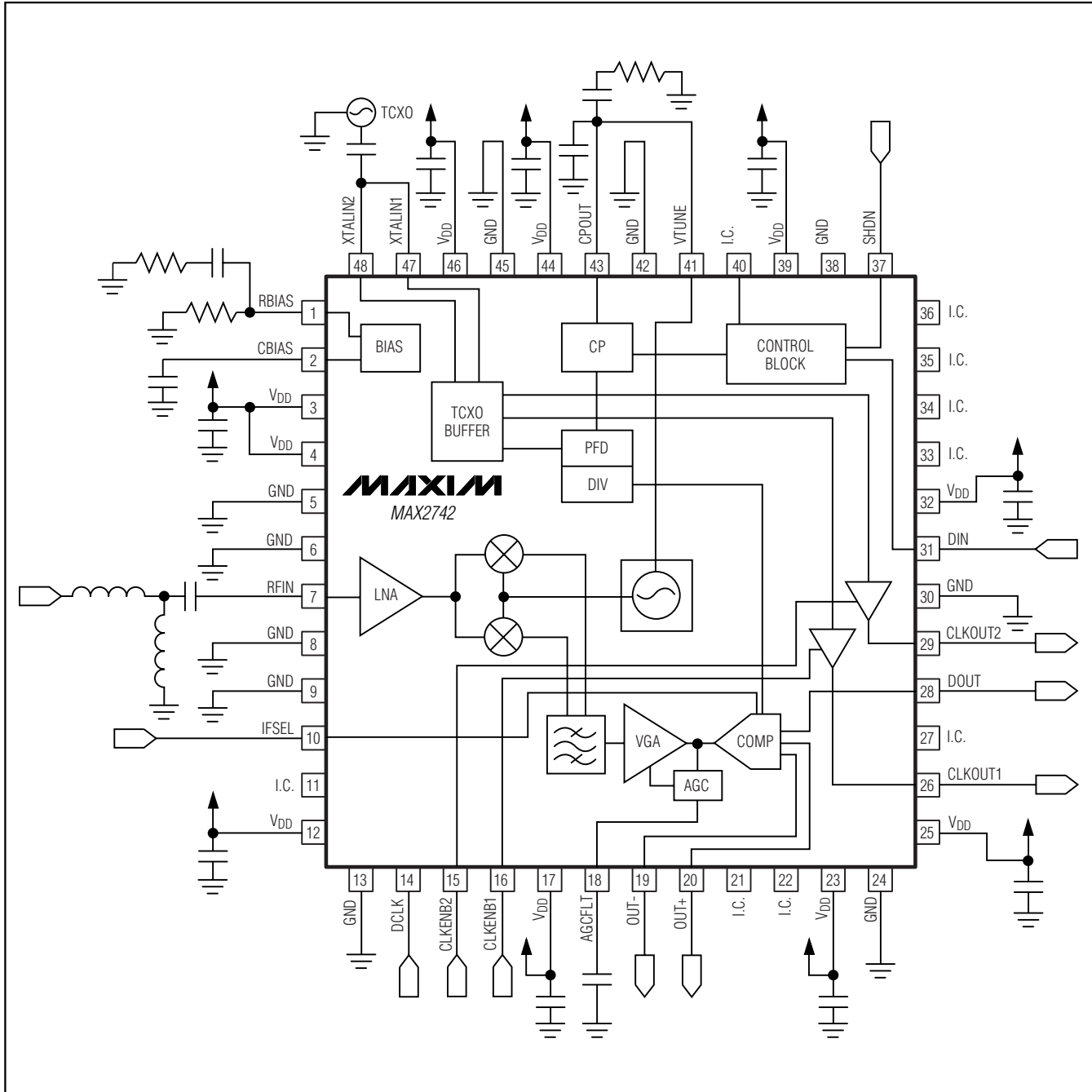
### Layout Issues

A properly designed PC board is an essential part of any RF/microwave circuit. On all high-frequency inputs and outputs, use controlled impedance lines and keep them as short as possible to minimize losses and radiation. Keeping the traces short also reduces parasitic inductance. To further reduce the parasitic inductance, use wider traces and a solid ground or power plane below the signal traces. Also, place decoupling capacitors as close to the supply pins as possible. For proper power dissipation and operation, connect the metal exposed paddle solidly to the ground plane of the PC board.

# Single-Chip Global Positioning System Receiver Front-End

## Typical Application Circuit

**MAX2742**



## Chip Information

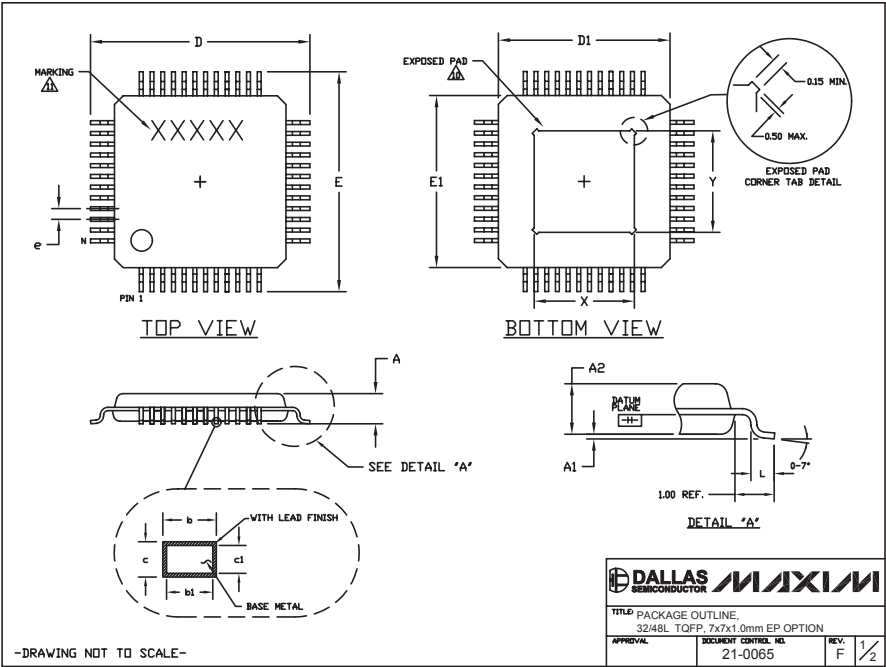
PROCESS: CMOS

TRANSISTOR COUNT: 18443

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## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)



- NOTES:
1. ALL DIMENSIONS AND TOLERANCING CONFORM TO ANSI Y14.5-1982.
  2. DATUM PLANE  $\square$  IS LOCATED AT MOLD PARTING LINE AND COINCIDENT WITH LEAD, WHERE LEAD EXITS PLASTIC BODY AT BOTTOM OF PARTING LINE.
  3. DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE MOLD PROTRUSION IS 0.25 MM ON D1 AND E1 DIMENSIONS.
  4. THE TOP OF PACKAGE IS SMALLER THAN THE BOTTOM OF PACKAGE BY 0.15 MILLIMETERS.
  5. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 MM TOTAL IN EXCESS OF THE b DIMENSION AT MAXIMUM MATERIAL CONDITION.
  6. ALL DIMENSIONS ARE IN MILLIMETERS.
  7. THIS OUTLINE CONFORMS TO JEDEC PUBLICATION 95 REGISTRATION MS-026, VARIATIONS ABA-HD AND ABC-HD.
  8. LEADS SHALL BE COPLANAR WITHIN .004 INCH.
  9. EXPOSED DIE PAD SHALL BE COPLANAR WITH BOTTOM OF PACKAGE WITHIN 2 MILS (.05 MM).
  10. DIMENSIONS X & Y APPLY TO EXPOSED PAD (EP) VERSIONS ONLY. SEE INDIVIDUAL PRODUCT DATASHEET TO DETERMINE IF A PRODUCT USES EXPOSED PAD PACKAGE.
  11. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
  12. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.

| SYMBOL | JEDEC VARIATION<br>ALL DIMENSIONS IN MILLIMETERS |      |      |           |      |      |
|--------|--------------------------------------------------|------|------|-----------|------|------|
|        | ABA-HD                                           |      |      | ABC-HD    |      |      |
|        | MIN.                                             | NOM. | MAX. | MIN.      | NOM. | MAX. |
| A      | 0.05                                             | 0.10 | 0.15 | 0.05      | 0.10 | 0.15 |
| A1     | 0.05                                             | 0.10 | 0.15 | 0.05      | 0.10 | 0.15 |
| A2     | 0.95                                             | 1.00 | 1.05 | 0.95      | 1.00 | 1.05 |
| D      | 8.90                                             | 9.00 | 9.10 | 8.90      | 9.00 | 9.10 |
| D1     | 6.90                                             | 7.00 | 7.10 | 6.90      | 7.00 | 7.10 |
| E      | 8.90                                             | 9.00 | 9.10 | 8.90      | 9.00 | 9.10 |
| E1     | 6.90                                             | 7.00 | 7.10 | 6.90      | 7.00 | 7.10 |
| L      | 0.45                                             | 0.60 | 0.75 | 0.45      | 0.60 | 0.75 |
| N      | 32                                               |      |      | 48        |      |      |
| e      | 0.80 BSC.                                        |      |      | 0.50 BSC. |      |      |
| b      | 0.30                                             | 0.37 | 0.45 | 0.17      | 0.22 | 0.27 |
| b1     | 0.30                                             | 0.35 | 0.40 | 0.17      | 0.20 | 0.23 |
| c      | 0.09                                             | --   | 0.20 | 0.09      | --   | 0.20 |
| c1     | 0.09                                             | --   | 0.16 | 0.09      | --   | 0.16 |
| X      | 3.20                                             | 3.50 | 3.80 | 3.70      | 4.00 | 4.30 |
| Y      | 3.20                                             | 3.50 | 3.80 | 3.70      | 4.00 | 4.30 |

-DRAWING NOT TO SCALE-



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