LP3974

PRODUCT BRIEF High Performance Power Management Unit for Application Processors

Check for Samples: LP3974

FEATURES

- **Linear Charger with Single Input**
  - **USB or AC Adapter Input**
  - **28V OVP on the Charger Input**
- **Four High-Efficiency Synchronous Magnetic Buck Regulators:**
  - **2 x 1A, 2 x 800 mA**
  - **2 Regulators Have DVS Support**
  - **High-Efficiency ECO Mode @ low I_{OUT}**
  - **Can Be Used with Inductors as Low as 1µH @ 4MHz Clock**
  - **Buck1, Buck2 and Buck4 Have Ramp Control to Change Rate of Change of Output**
- **11 General-Type Low Noise LDOs**
  - **7 x 300 mA**
  - **2 x 450 mA**
  - **2 x 150 mA**
- **5 Wide-Input Low-Output (WILO) LDOs**
  - **2 x 10 mA**
  - **1 x 50 mA**
  - **2 x 150 mA**
- **All LDOs S/W Configurable**
- **Two Over-Voltage Protected Outputs for USB Transceivers**
- **Real Time Clock with Two Alarms**
- **Back-Up Battery Charger**
- **Momentary Power Loss Detection**
- **Interrupt Request to Reduce S/W Polling**
- **I^2C-Compatible Serial Interface**
- **100-Bump 0.4 mm Pitch Micro SMDxt Package**

APPLICATIONS

- **Smartphones**
- **GSM, GPRS, EDGE, CDMA & WCDMA Handsets**

DESCRIPTION

The LP3974 is designed to meet the power management requirements of the latest cellular phones. The LP3974 PMU contains a single-input Li-Ion battery charger, 16 low-dropout voltage regulators (including 5 wide input low-output regulators, 2 over-voltage protected voltage regulators, and 4 buck regulators), dual DPDT analog switches, real time clock, and backup battery charger. Programming is handled via an I^2C-compatible high-speed Serial Interface allowing control of program on/off conditions and the output voltages of individual regulators, and to read status information of the PMU. It can charge and maintain a single cell Li-Ion battery operating from an AC adapter or USB power source.

The Li-Ion charger requires few external components and integrates the power FET. Charging is thermally regulated to obtain the most efficient charging rate for a given ambient temperature. Over-Voltage Protection (OVP) circuit at the charger input protects the PMU from input voltages up to +28V, eliminating the need for any external protection circuitry. Buck regulators have an automatic switch to ECO mode at low load conditions providing very good efficiency at low output currents. General-type LDO regulators provide excellent PSRR and ULTRA LOW NOISE, 45 µV typ., ideally suited for supplying voltage to RF section. The real-time clock/calendar provides time interval information as well as two programmable alarms.

To accommodate different processor requirements, the LP3974 PMU can have three different default voltage settings and startup sequences selected by external pin.

Note: This document is not a full datasheet. For more information regarding this product or to order samples please contact your local National Semiconductor sales office or visit http://www.national.com/support/dir.html

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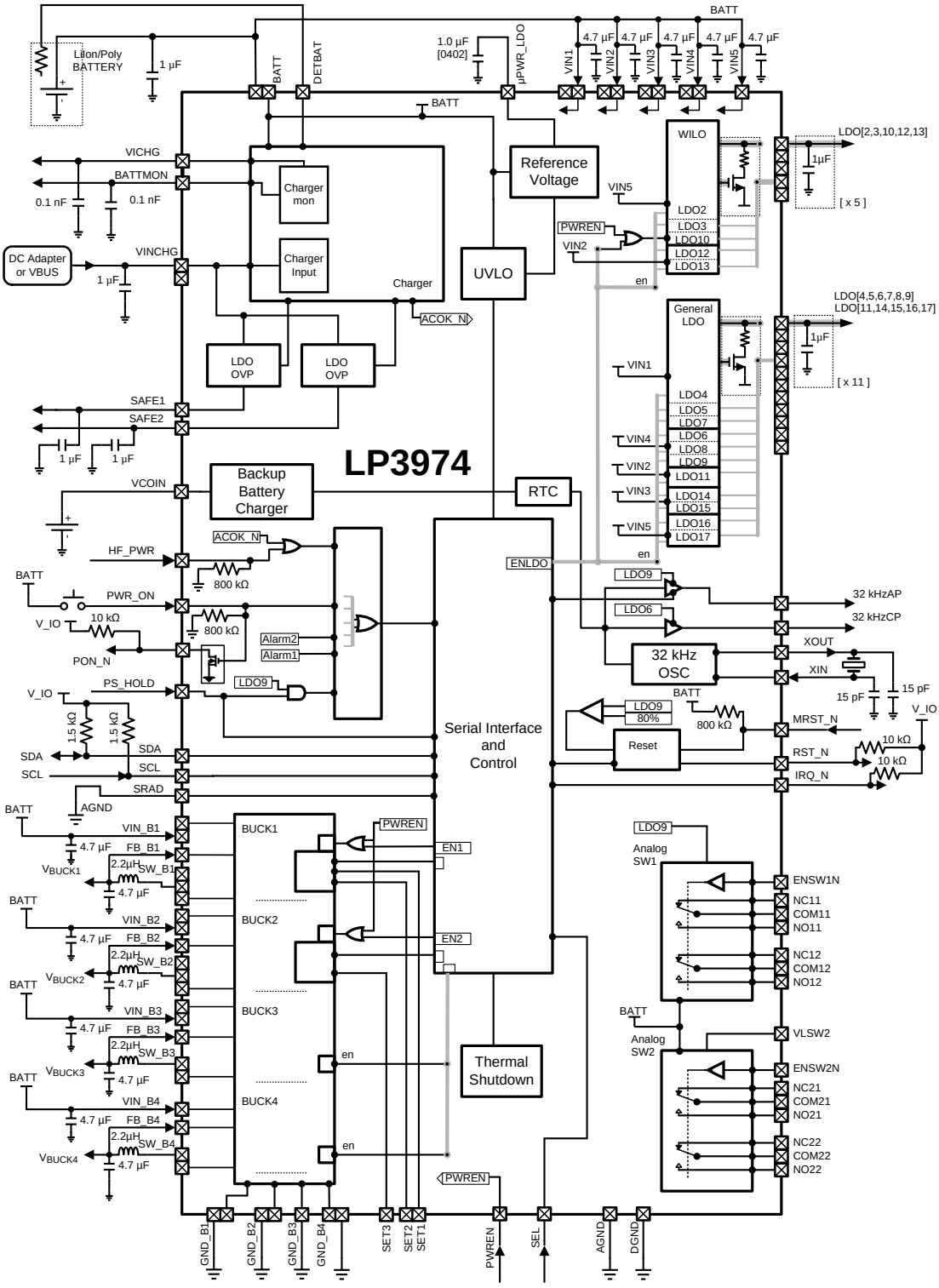
These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

TYPICAL APPLICATION DIAGRAM



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DEVICE PIN DIAGRAM

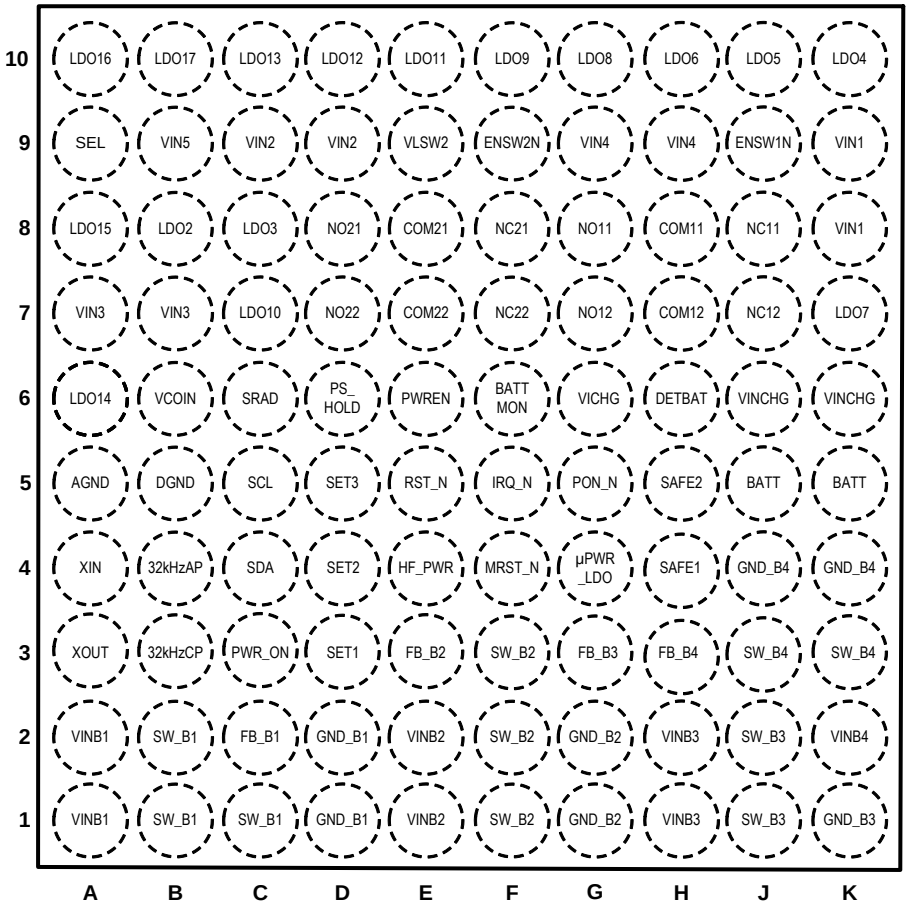

Figure 1. TOP VIEW
100–Bump (0.4 mm pitch) micro SMDxt Package

PACKAGE MARKING INFORMATION

XY = 2-Digit Date Code
TT = 2-Digit Die Run Trace Code
LP3974 = Product Identification

◇ = Pin A1

Operational Description

The LP3974 is designed for the charging and voltage rail requirements within mobile handsets. The linear charger accepts DC voltages to provide the correct charging and charge maintenance profile for LI-Ion batteries. The charger outputs are programmable to meet the varying needs of these types of batteries. Powered from the Battery input to the device, 4 switching regulators and 16 LDO type linear regulators provide for distributed power within the handset.

APPLICATION INFORMATION

Buck Information

The LP3974 has four integrated high-efficiency step-down DC-DC switching buck converters that deliver a constant voltage from a single cell battery to portable devices. Using voltage mode architecture with synchronous rectification, Bucks 1 and 2 have the ability to deliver up to 1A, Bucks 3 and 4 up to 800 mA, depending on the input voltage and output voltage, ambient temperature, and the inductor chosen. There are two modes of operation depending on the current required – PWM (Pulse Width Modulation), ECO (ECOnomy) mode. The device operates in PWM mode at load currents of approximately 50 mA (typ.) or higher. Lighter output current loads cause the device to automatically switch into ECO mode for reduced current consumption and a longer battery life. Buck1 has DVS capability using external SET1, SET2 inputs while Buck2 has DVS capability via SET3 input. Additional features include soft-start, under voltage protection, current overload protection, and thermal shutdown protection. Only three external power components per buck are required for implementation.

LDO Information

All LDOs can be programmed through serial interface for different output voltage values which are summarized in the output voltage selection tables below.

At the PMU power on, LDOs start up according to the selected startup sequence and the default voltages.

For stability all LDOs need to have external capacitors with recommended value of 1µF connected to the output . It is important to select the type of capacitor whose capacitance will in no case (voltage, temperature, etc) be outside of limits specified in the LDO electrical characteristics.

General-Type LDOs

The general LDOs are optimized to supply both analog and digital loads having LOW NOISE (45 μV_{RMS} for I_{OUT} > 5mA) and excellent PSRR (65 dB at 10 kHz) performance. They can be programmed through the serial interface for different output voltage values.

In sleep mode quiescent current is lowered to 30 µA for energy saving; in this mode these LDOs should not be loaded by more than 3-5mA of output current.

The innovative design of these general type LDOs reduces the sensitivity to the placement of the output capacitor. These general purpose LDOs do not need the output capacitor to be placed close to the PMU as is the case for normal LDOs. If a (1uF or more) capacitor is attached to a circuit load there is no need to place an output capacitor at the PMU.

WILO-Type LDOs

Wide Input Low Output LDOs are designed to enable a lowered output voltage range with voltages down to 0.8V.

Single Input Linear Charger

LP3974 has a built-in Li-Ion/Li-Poly battery management system. Its main features are:

- One input - AC adapter or USB
- Integrated PMOS power routing switch
- CC/CV linear charging
- Selectable battery regulation voltage
- Flexible charging cycle control
- Wide array of charging current options

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- Safety timer with time doubling

Charger Function

A charge management system allowing safe charge and maintenance of a Li-Ion battery is implemented on the LP3974.

Following the correct detection of a voltage at the charger input, the charger enters pre-charge mode. In this mode the battery is charged with a small constant current. Settings for the battery current in pre-charge mode, full-rate voltage level, and maximum pre-charge time are pre-set during factory test.

In full charging mode full rate constant current is applied to the battery to raise the voltage to the termination level. The charging current is programmable. When termination voltage is reached, the charger is in constant voltage mode and a constant voltage is maintained. After reaching the end-of-charge condition, the charge management isolates the battery and enters the maintenance mode. A maintenance mode enables the battery voltage to be maintained at the correct level. If restart conditions have been met, then the charge cycle is re-initiated to re-establish the termination voltage level.

Backup Battery Charger

Backup battery charger (BBC) is intended for charging an external coin battery. It consists of Voltage Limited Current Source with 1kΩ output resistor. By default it is always on and the output will be active when the supply voltage is above the UVLO threshold typically 2.7V. The output voltage is programmable to 5 voltages from 2.9V to 3.3V. The default output is set to 3.0V.

It is possible to turn backup battery charger off via registers. BBC has a reverse current protection.

Momentary Power Loss

When power is removed from the PMU and MPL function is enabled (RTC register 0x1B) then the Momentary Power Loss (MPL) timer starts as unexpected powerdown has occurred. This timer is set to the maximum duration allowed for a momentary power loss (RTC register 0x1B). If power is restored before the timer expires, the MPL block will inform the LP3974 control logic about the MPL event.

The MPL circuit is powered from VCOIN pin. MPL timer uses 32.786 kHz RTC crystal oscillator for time base. Host processor needs to enable the MPL function every time the device is powered up.

Analog Switches

Two double pole – double throw switches are integrated on the device and are powered from the VBATT domain. Separate supplies are used for the logic control; LDO9 supplies the power for SW1, and an external supply at VLSW2 supplies the logic on SW2. This arrangement allows some control over the logic thresholds for each switch. These switches are designed for break before make switching, with high speed switching for rail to rail signals.

These devices operate over the entire supply range with a flat response for On-Resistance. The switches are bi-directional and hence the pins NC, NO, and COM can be used as inputs or outputs. An input voltage supply of 1.5V to VBATT may be applied at VLSW2 pin to enable SW2 to operate at lower input logic thresholds.

Overvoltage-Protected LDO Outputs (SAFE1/2)

SAFE1/2 provide a regulated output of 4.7V from the charger DC input. In this way high voltage protection can be provided for low rated USB devices within the system. As it is derived from the CHGIN pin the operational voltage range for this applies, i.e., 4.5V to 7.5V.

RTC Operational Description

This Real Time Clock (RTC) has following features:

- Accurate time counting with fine-grained correction for inaccuracies caused by environment
- Calendar for years 2000-2099 with leap year compensation and automatic day of week calculation
- Two highly customizable alarms

All RTC data is presented in Binary Coded Decimal format. RTC time and alarm registers are user-writable.

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Alarms registers are used to set periodical or one-time events. The result of an alarm event depends on the PMU state. If the PMU is in standby, then the alarm causes the PMU to start up. If the PMU is in working mode, then the alarm creates an interrupt.

Interrupts

The LP3974 has 4 main interrupt registers, IRQ1-4. It also has 4 main interrupt masking registers such that if asserted, the particular interrupt that causes an event will be ignored. These interrupts are generated from normal start up / shutdown events, charger events, timed events and warning conditions.

Device Status

The LP3974 has 2 status registers and 2 status masking registers.

Master Reset

The LP3974 has a master reset input which, when brought low, will power down the device for a preset time, then allow the device to power back up. The device will power up with all supplies reset to their default values.

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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)	Op Temp (°C)	Top-Side Markings (4)	Samples
LP3974RME/NOPB	ACTIVE	DSBGA	YQB	100	250	Green (RoHS & no Sb/Br)	SNAG	Level-1-260C-UNLIM	-25 to 85	3974	Samples
LP3974RMX/NOPB	ACTIVE	DSBGA	YQB	100	1000	Green (RoHS & no Sb/Br)	SNAG	Level-1-260C-UNLIM	-25 to 85	3974	Samples

(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.
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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.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

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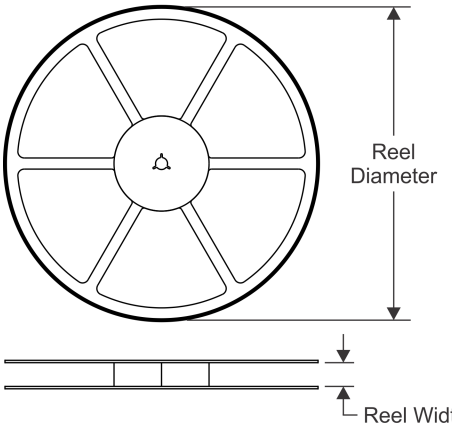
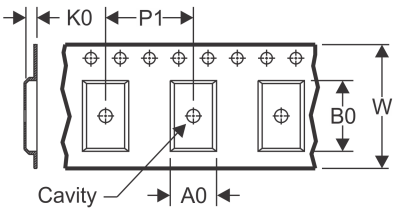
REEL DIMENSIONS

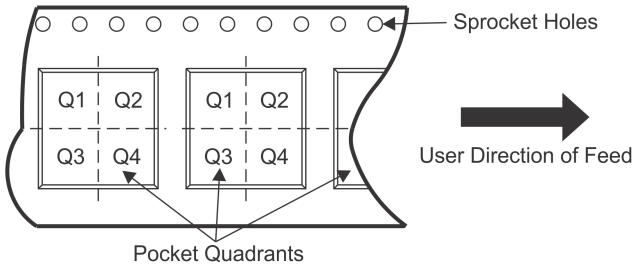


TAPE DIMENSIONS



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

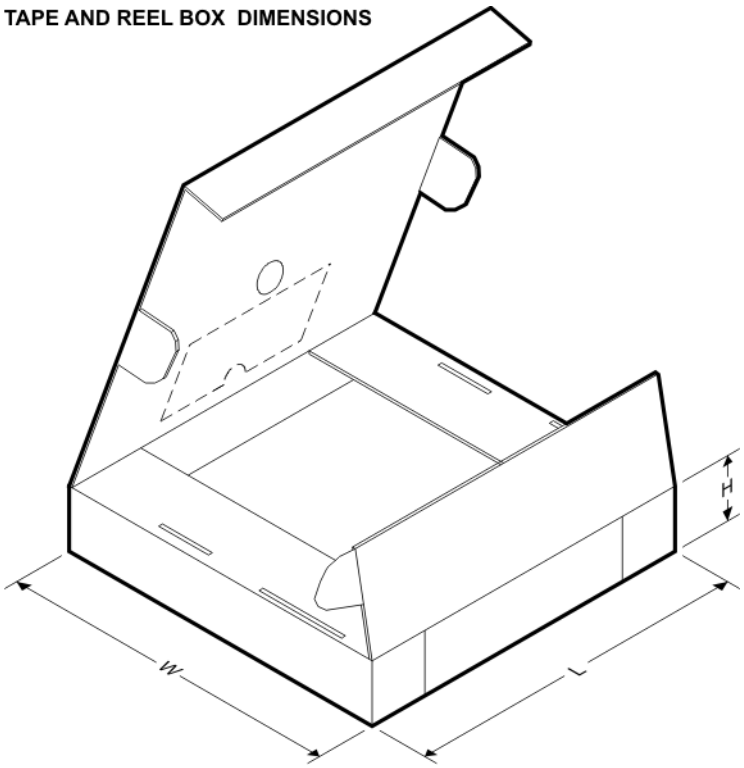
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LP3974RME/NOPB	DSBGA	YQB	100	250	178.0	12.4	4.19	4.19	0.76	8.0	12.0	Q1
LP3974RMX/NOPB	DSBGA	YQB	100	1000	178.0	12.4	4.19	4.19	0.76	8.0	12.0	Q1

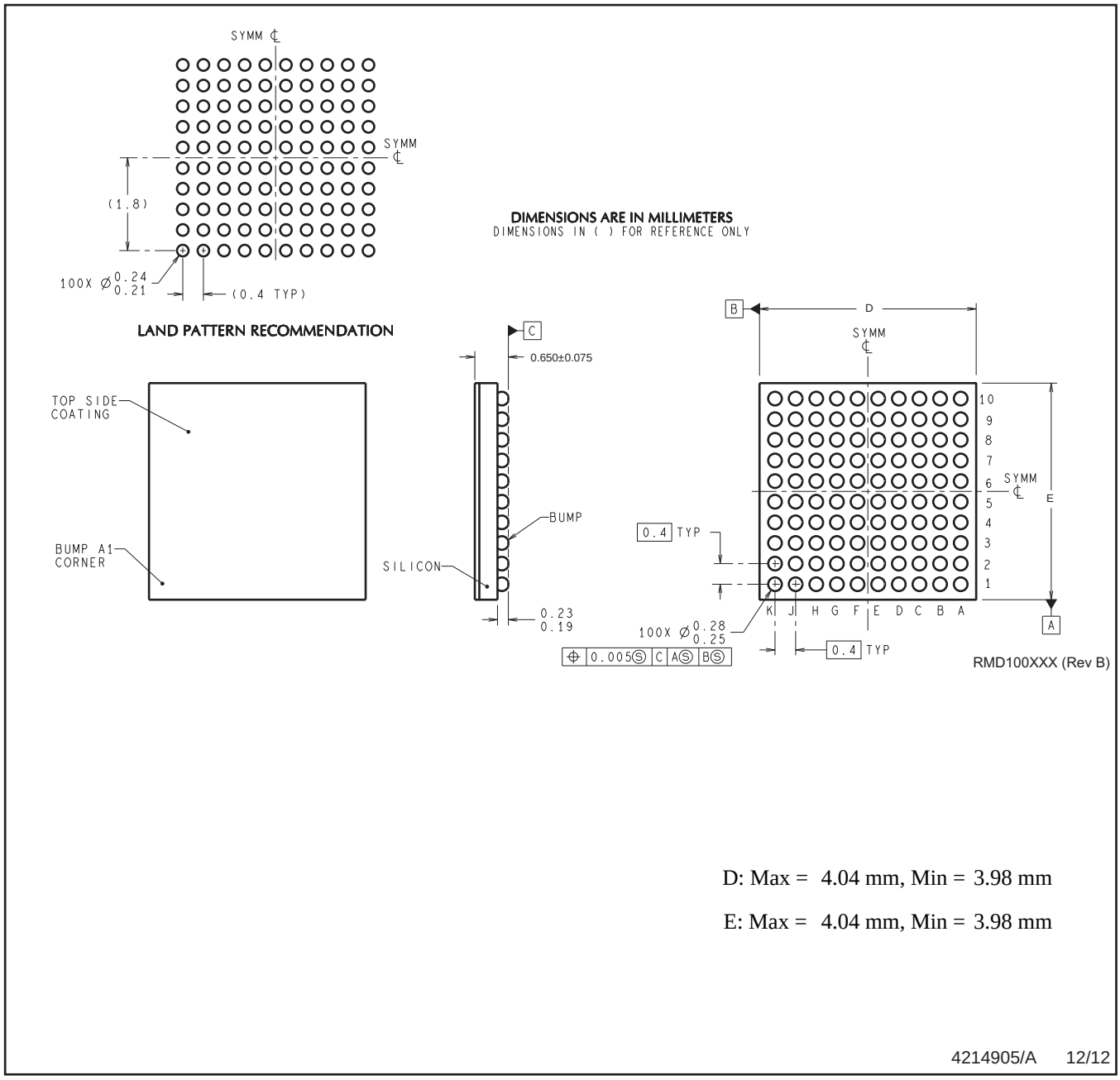
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LP3974RME/NOPB	DSBGA	YQB	100	250	210.0	185.0	35.0
LP3974RMX/NOPB	DSBGA	YQB	100	1000	210.0	185.0	35.0

YQB0100



D: Max = 4.04 mm, Min = 3.98 mm

E: Max = 4.04 mm, Min = 3.98 mm

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NOTES: A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
B. This drawing is subject to change without notice.

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