

# LM2853

*LM2853 3A 550 kHz Synchronous SIMPLE SWITCHER® Buck Regulator*



Literature Number: SNVS459

## LM2853

# 3A 550 kHz Synchronous SIMPLE SWITCHER® Buck Regulator

## General Description

The LM2853 synchronous SIMPLE SWITCHER® buck regulator is a 550 kHz step-down switching voltage regulator capable of driving up to a 3A load with excellent line and load regulation. The LM2853 accepts an input voltage between 3.0V and 5.5V and delivers a customizable output voltage that is factory programmable from 0.8V to 3.3V in 100mV increments. Internal type-three compensation enables a low component count solution and greatly simplifies external component selection. The exposed-pad TSSOP-14 package enhances the thermal performance of the LM2853.

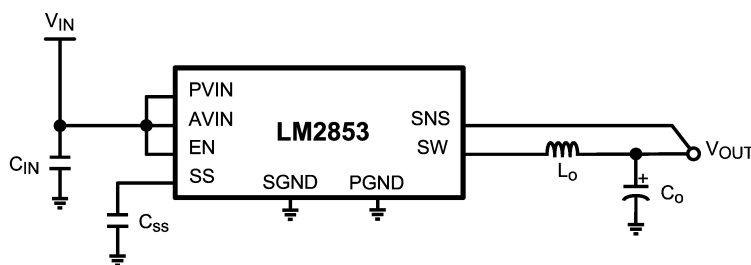
## Features

- Input voltage range of 3.0V to 5.5V
- Factory EEPROM set output voltages from 0.8V to 3.3V in 100 mV increments
- Maximum load current of 3A
- Voltage Mode Control
- Internal type-three compensation
- Switching frequency of 550 kHz
- Low standby current of 12  $\mu$ A
- Internal 40 m $\Omega$  MOSFET switches
- Standard voltage options  
0.8/1.0/1.2/1.5/1.8/2.5/3.0/3.3 volts
- Exposed pad TSSOP-14 package

## Applications

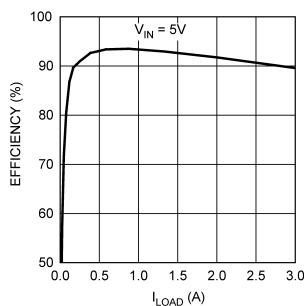
- Low voltage point of load regulation
- Local solution for FPGA/DSP/ASIC core power
- Broadband networking and communications infrastructure

## Typical Application Circuit



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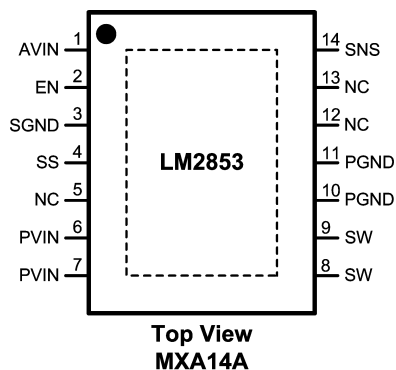
Efficiency vs Load Current ( $V_{OUT} = 3.3V$ )



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## Connection Diagram



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## Ordering Information

| Order Number  | Voltage Option | Package Marking | Package Type         | Package Drawing | Supplied As               |
|---------------|----------------|-----------------|----------------------|-----------------|---------------------------|
| LM2853MH-0.8  | 0.8            | LM2853-0.8      | TSSOP-14 exposed pad | MXA14A          | 94 Units, Rail            |
| LM2853MHX-0.8 |                |                 |                      |                 | 2500 Units, Tape and Reel |
| LM2853MH-1.0  | 1.0            | LM2853-1.0      |                      |                 | 94 Units, Rail            |
| LM2853MHX-1.0 |                |                 |                      |                 | 2500 Units, Tape and Reel |
| LM2853MH-1.2  | 1.2            | LM2853-1.2      |                      |                 | 94 Units, Rail            |
| LM2853MHX-1.2 |                |                 |                      |                 | 2500 Units, Tape and Reel |
| LM2853MH-1.5  | 1.5            | LM2853-1.5      |                      |                 | 94 Units, Rail            |
| LM2853MHX-1.5 |                |                 |                      |                 | 2500 Units, Tape and Reel |
| LM2853MH-1.8  | 1.8            | LM2853-1.8      |                      |                 | 94 Units, Rail            |
| LM2853MHX-1.8 |                |                 |                      |                 | 2500 Units, Tape and Reel |
| LM2853MH-2.5  | 2.5            | LM2853-2.5      |                      |                 | 94 Units, Rail            |
| LM2853MHX-2.5 |                |                 |                      |                 | 2500 Units, Tape and Reel |
| LM2853MH-3.0  | 3.0            | LM2853-3.0      |                      |                 | 94 Units, Rail            |
| LM2853MHX-3.0 |                |                 |                      |                 | 2500 Units, Tape and Reel |
| LM2853MH-3.3  | 3.3            | LM2853-3.3      |                      |                 | 94 Units, Rail            |
| LM2853MHX-3.3 |                |                 |                      |                 | 2500 Units, Tape and Reel |

**Note:** Contact factory for other voltage options.

## Pin Descriptions

| Pin #       | Name | Function                                                                                                                                                          |
|-------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1           | AVIN | Input Voltage for Control Circuitry.                                                                                                                              |
| 2           | EN   | Enable.                                                                                                                                                           |
| 3           | SGND | Low noise ground.                                                                                                                                                 |
| 4           | SS   | Soft-Start Pin.                                                                                                                                                   |
| 5           | NC   | No Connect. This pin must be tied to ground.                                                                                                                      |
| 6,7         | PVIN | Input Voltage for Power Circuitry.                                                                                                                                |
| 8,9         | SW   | Switch Pin.                                                                                                                                                       |
| 10,11       | PGND | Power Ground.                                                                                                                                                     |
| 12,13       | NC   | No-Connect. These pins must be tied to ground.                                                                                                                    |
| 14          | SNS  | Output Voltage Sense Pin.                                                                                                                                         |
| Exposed Pad | EP   | The exposed pad is internally connected to GND, but it cannot be used as the primary GND connection. The exposed pad should be soldered to an external GND plane. |

**Absolute Maximum Ratings** (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

|                             |                    |
|-----------------------------|--------------------|
| AVIN, PVIN, EN, SNS, SW, SS | –0.3V to 6.0V      |
| ESD Susceptibility (Note 2) | 2kV                |
| Power Dissipation           | Internally Limited |
| Storage Temperature Range   | –65°C to +150°C    |
| Maximum Junction Temp.      | 150°C              |

14-Pin Exposed Pad TSSOP Package

|                      |       |
|----------------------|-------|
| Infrared (15 sec)    | 220°C |
| Vapor Phase (60 sec) | 215°C |
| Soldering (10 sec)   | 260°C |

**Operating Ratings** (Note 1)

|                      |                 |
|----------------------|-----------------|
| PVIN to GND          | 1.5V to 5.5V    |
| AVIN to GND          | 3.0V to 5.5V    |
| Junction Temperature | –40°C to +125°C |

**Electrical Characteristics**

Specifications with standard typeface are for  $T_J = 25^\circ\text{C}$ , and those in bold face type apply over the full Junction Temperature Range (–40°C to 125°C). Minimum and Maximum limits are guaranteed through test, design or statistical correlation. Typical values represent the most likely parametric norm at  $T_J = 25^\circ\text{C}$  and are provided for reference purposes only. Unless otherwise specified AVIN = PVIN = 5V.

| Symbol                         | Parameter                    | Conditions                                                                                                                               | Min           | Typ  | Max           | Units         |
|--------------------------------|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|---------------|------|---------------|---------------|
| <b>SYSTEM PARAMETERS</b>       |                              |                                                                                                                                          |               |      |               |               |
| $V_{OUT}$                      | Voltage Tolerance (Note 3)   | $V_{OUT} = 0.8\text{V}$ option                                                                                                           | <b>0.782</b>  | 0.8  | <b>0.818</b>  | V             |
|                                |                              | $V_{OUT} = 1.0\text{V}$ option                                                                                                           | <b>0.9775</b> | 1.0  | <b>1.0225</b> |               |
|                                |                              | $V_{OUT} = 1.2\text{V}$ option                                                                                                           | <b>1.1730</b> | 1.2  | <b>1.227</b>  |               |
|                                |                              | $V_{OUT} = 1.5\text{V}$ option                                                                                                           | <b>1.4663</b> | 1.5  | <b>1.5337</b> |               |
|                                |                              | $V_{OUT} = 1.8\text{V}$ option                                                                                                           | <b>1.7595</b> | 1.8  | <b>1.8405</b> |               |
|                                |                              | $V_{OUT} = 2.5\text{V}$ option                                                                                                           | <b>2.4437</b> | 2.5  | <b>2.5563</b> |               |
|                                |                              | $V_{OUT} = 3.0\text{V}$ option                                                                                                           | <b>2.9325</b> | 3.0  | <b>3.0675</b> |               |
|                                |                              | $V_{OUT} = 3.3\text{V}$ option                                                                                                           | <b>3.2257</b> | 3.3  | <b>3.3743</b> |               |
| $\Delta V_{OUT}/\Delta V_{IN}$ | Line Regulation (Note 3)     | $V_{OUT} = 0.8\text{V}, 1.0\text{V}, 1.2\text{V}, 1.5\text{V}, 1.8\text{V}$ or $2.5\text{V}$<br>$3.0\text{V} \leq AVIN \leq 5.5\text{V}$ |               | 0.2  | <b>1.1</b>    | %             |
|                                |                              | $V_{OUT} = 3.0\text{V}$ or $3.3\text{V}$<br>$3.5\text{V} \leq AVIN \leq 5.5\text{V}$                                                     |               | 0.2  | <b>1.1</b>    | %             |
| $\Delta V_{OUT}/\Delta I_O$    | Load Regulation              | Normal operation                                                                                                                         |               | 2    |               | mV/A          |
| $V_{ON}$                       | UVLO Threshold (AVIN)        | Rising                                                                                                                                   |               | 2.47 | <b>3.0</b>    | V             |
|                                |                              | Falling Hysteresis                                                                                                                       | <b>50</b>     | 155  | <b>260</b>    | mV            |
| $R_{DS(ON)-P}$                 | PFET On Resistance           | $I_{sw} = 3\text{A}$                                                                                                                     |               | 40   | <b>120</b>    | m $\Omega$    |
| $R_{DS(ON)-N}$                 | NFET On Resistance           | $I_{sw} = 3\text{A}$                                                                                                                     |               | 32   | <b>100</b>    | m $\Omega$    |
| $R_{SS}$                       | Soft-Start Resistance        |                                                                                                                                          |               | 450  |               | k $\Omega$    |
| $I_{CL}$                       | Peak Current Limit Threshold |                                                                                                                                          | <b>3.6</b>    | 5    |               | A             |
| $I_Q$                          | Operating Current            | Non-switching                                                                                                                            |               | 0.85 | <b>2</b>      | mA            |
| $I_{SD}$                       | Shutdown Quiescent Current   | $EN = 0\text{V}$                                                                                                                         |               | 12   | <b>50</b>     | $\mu\text{A}$ |
| $R_{SNS}$                      | Sense Pin Resistance         |                                                                                                                                          |               | 432  |               | k $\Omega$    |
| <b>PWM</b>                     |                              |                                                                                                                                          |               |      |               |               |
| $f_{osc}$                      | Switching Frequency          | .                                                                                                                                        | <b>325</b>    | 550  | <b>725</b>    | kHz           |
| $D_{range}$                    | Duty Cycle Range             |                                                                                                                                          | <b>0</b>      |      | <b>100</b>    | %             |
| <b>ENABLE CONTROL</b> (Note 4) |                              |                                                                                                                                          |               |      |               |               |
| $V_{IH}$                       | EN Pin Minimum High Input    |                                                                                                                                          | <b>75</b>     |      |               | % of AVIN     |
| $V_{IL}$                       | EN Pin Maximum Low Input     |                                                                                                                                          |               |      | <b>25</b>     | % of AVIN     |
| $I_{EN}$                       | EN Pin Pullup Current        | $EN = 0\text{V}$                                                                                                                         |               | 1.5  |               | $\mu\text{A}$ |

**Electrical Characteristics** Specifications with standard typeface are for  $T_J = 25^\circ\text{C}$ , and those in bold face type apply over the full Junction Temperature Range ( $-40^\circ\text{C}$  to  $125^\circ\text{C}$ ). Minimum and Maximum limits are guaranteed through test, design or statistical correlation. Typical values represent the most likely parametric norm at  $T_J = 25^\circ\text{C}$  and are provided for reference purposes only. Unless otherwise specified  $AVIN = PVIN = 5V$ . (Continued)

| Symbol                    | Parameter                       | Conditions | Min | Typ | Max | Units              |
|---------------------------|---------------------------------|------------|-----|-----|-----|--------------------|
| <b>THERMAL CONTROLS</b>   |                                 |            |     |     |     |                    |
| $T_{SD}$                  | Thermal Shutdown Threshold      |            |     | 165 |     | $^\circ\text{C}$   |
| $T_{SD-HYS}$              | Hysteresis for Thermal Shutdown |            |     | 10  |     | $^\circ\text{C}$   |
| <b>THERMAL RESISTANCE</b> |                                 |            |     |     |     |                    |
| $\theta_{JA}$             | Junction to Ambient             | MXA14A     |     | 38  |     | $^\circ\text{C/W}$ |

**Note 1:** Absolute maximum ratings indicate limits beyond which damage to the device may occur. Operating Range indicates conditions for which the device is intended to be functional, but does not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics.

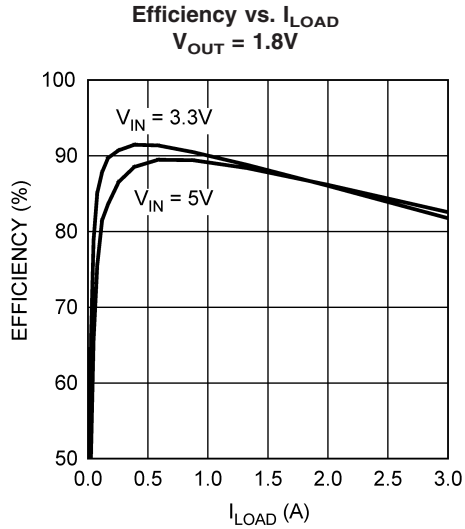
**Note 2:** The human body model is a 100 pF capacitor discharged through a 1.5 k $\Omega$  resistor into each pin. Test Method is per JESD22-A114.

**Note 3:**  $V_{OUT}$  measured in a non-switching, closed-loop configuration at the SNS pin.

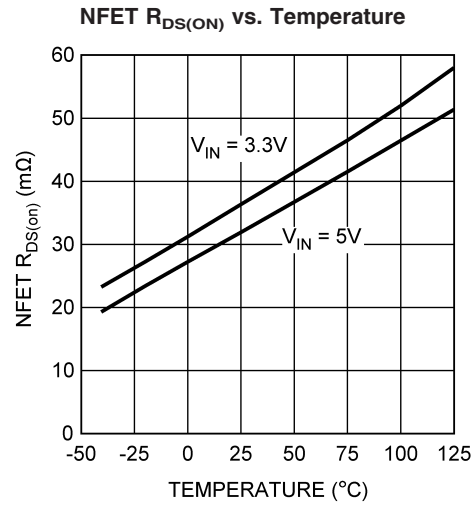
**Note 4:** The enable pin is internally pulled up, so the LM2853 is automatically enabled unless an external enable voltage is applied.

## Typical Performance Characteristics

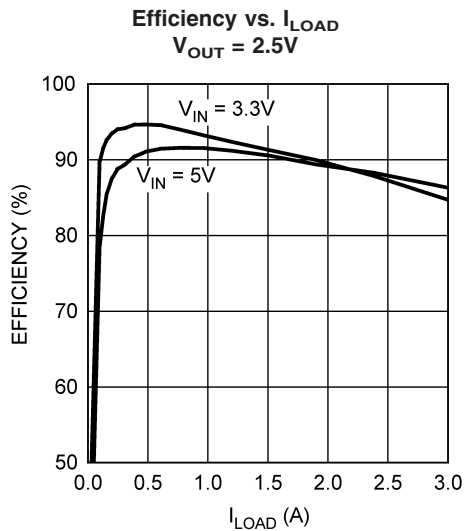
Unless otherwise specified, the following conditions apply:  $V_{IN} = AV_{IN} = PV_{IN} = 5V$ ,  $T_J = 25^\circ\text{C}$ .



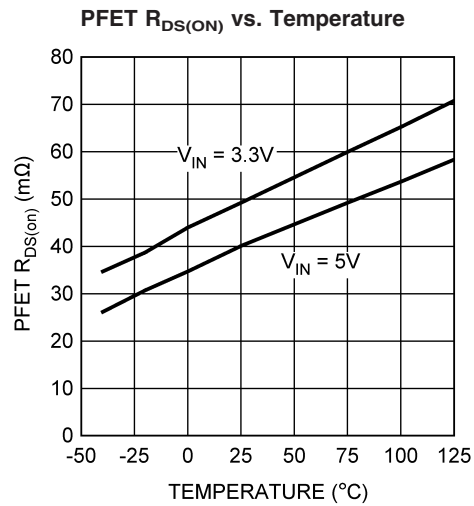
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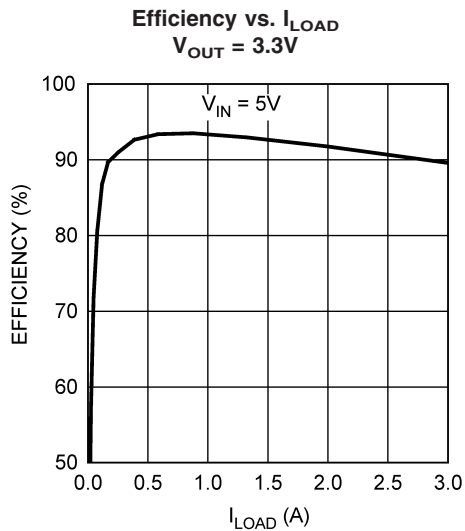
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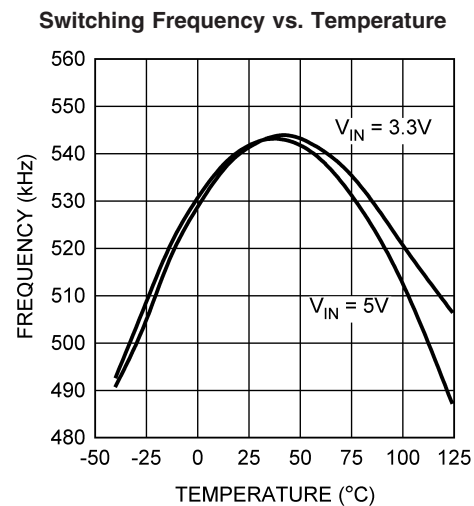
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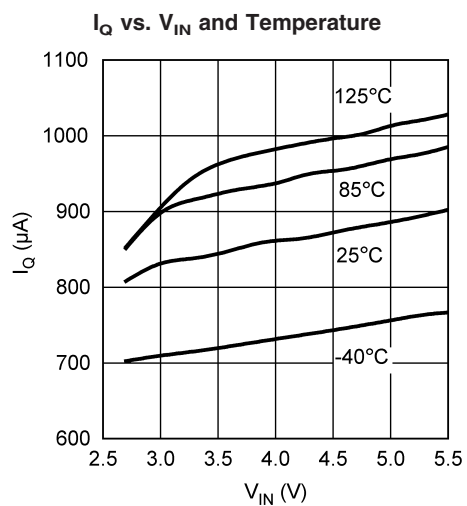
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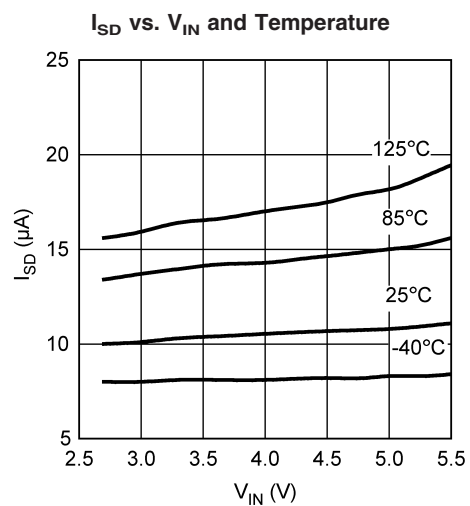
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## Typical Performance Characteristics

Unless otherwise specified, the following conditions apply:  $V_{IN} = AV_{IN} = PV_{IN} = 5V$ ,  $T_J = 25^\circ C$ . (Continued)

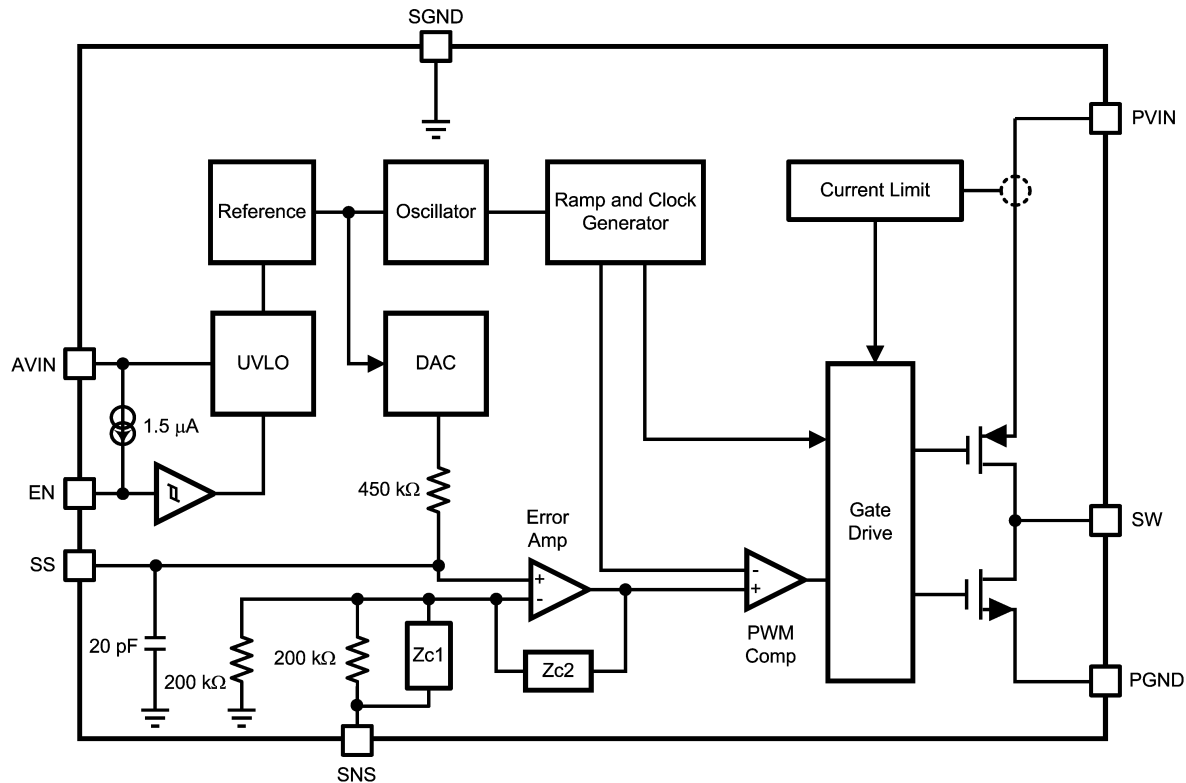


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## Block Diagram



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## Applications Information

The LM2853 is a DC-DC buck regulator belonging to National Semiconductor's synchronous SIMPLE SWITCHER® family. Integration of the PWM controller, power switches and compensation network greatly reduces the component count required to implement a switching power supply. A typical application requires only four components: an input capacitor, a soft-start capacitor, an output filter capacitor and an output filter inductor.

### INPUT CAPACITOR ( $C_{IN}$ )

Fast switching of large currents in the buck converter places a heavy demand on the voltage source supplying PVIN. The input capacitor,  $C_{IN}$ , supplies extra charge when the switcher needs to draw a burst of current from the supply. The RMS current rating and the voltage rating of the  $C_{IN}$  capacitor are therefore important in the selection of  $C_{IN}$ . The RMS current specification can be approximated by:

$$I_{RMS} = I_{LOAD} \sqrt{D(1-D)}$$

where  $D$  is the duty cycle,  $V_{OUT}/V_{IN}$ .  $C_{IN}$  also provides filtering of the supply. Trace resistance and inductance degrade the benefits of the input capacitor, so  $C_{IN}$  should be placed very close to PVIN in the layout. A 22  $\mu$ F or 47  $\mu$ F ceramic capacitor is typically sufficient for  $C_{IN}$ . In parallel with the large input capacitance a smaller capacitor should be added such as a 1  $\mu$ F ceramic for higher frequency filtering. Ceramic capacitors with high quality dielectrics such as X5R or X7R should be used to provide a constant capacitance across temperature and line variations. For improved

load regulation and transient performance, the use of a small 1  $\mu$ F ceramic capacitor is also recommended as a local bypass for the AVIN pin.

### SOFT-START CAPACITOR ( $C_{SS}$ )

The DAC that sets the reference voltage of the error amplifier sources a current through a resistor to set the reference voltage. The reference voltage is one half of the output voltage of the switcher due to the 200 k $\Omega$  divider connected to the SNS pin. Upon start-up, the output voltage of the switcher tracks the reference voltage with a two to one ratio as the DAC current charges the capacitance connected to the reference voltage node. Internal capacitance of 20 pF is permanently attached to the reference voltage node which is also connected to the soft start pin, SS. Adding a soft-start capacitor externally increases the time it takes for the output voltage to reach its final level. The charging time required for the reference voltage can be estimated using the RC time constant of the DAC resistor and the capacitance connected to the SS pin. Three RC time constant periods are needed for the reference voltage to reach 95% of its final value. The actual start up time will vary with differences in the DAC resistance and higher-order effects.

If little or no soft-start capacitance is connected, then the start up time may be determined by the time required for the current limit current to charge the output filter capacitance. The capacitor charging equation  $I = C\Delta V/\Delta t$  can be used to estimate the start-up time in this case. For example, a part with a 3V output, a 100  $\mu$ F output capacitance and a 5A current limit threshold would require a time of 60  $\mu$ s:

## Applications Information (Continued)

$$\Delta t = C \frac{\Delta V}{I} = 100 \mu\text{F} \frac{3\text{V}}{5\text{A}} = 60 \mu\text{s}$$

Since it is undesirable for the power supply to start up in current limit, a soft-start capacitor must be chosen to force the LM2853 to start up in a more controlled fashion based on the charging of the soft-start capacitance. In this example, suppose a 3 ms start time is desired. Three time constants are required for charging the soft-start capacitor to 95% of the final reference voltage. So in this case  $RC = 1 \text{ ms}$ . The DAC resistor,  $R$ , is 450 k $\Omega$  so  $C$  can be calculated to be 2.2 nF. A 2.2 nF ceramic capacitor can be chosen to yield approximately a 3 ms start-up time.

### SOFT-START CAPACITOR ( $C_{SS}$ ) AND FAULT CONDITIONS

Various fault conditions such as short circuit and UVLO of the LM2853 activate internal circuitry designed to control the voltage on the soft-start capacitor. For example, during a short circuit current limit event, the output voltage typically falls to a low voltage. During this time, the soft-start voltage is forced to track the output so that once the short is removed, the LM2853 can restart gracefully from whatever

voltage the output reached during the short circuit event. The range of soft-start capacitors is therefore restricted to values 1 nF to 50 nF.

### COMPENSATION

The LM2853 provides a highly integrated solution to power supply design. The compensation of the LM2853, which is type-three, is included on-chip. The benefit of integrated compensation is straight-forward, simple power supply design. Since the output filter capacitor and inductor values impact the compensation of the control loop, the range of  $L_O$ ,  $C_O$  and  $C_{ESR}$  values is restricted in order to ensure stability.

### OUTPUT FILTER VALUES

Table 1 details the recommended inductor and capacitor ranges for the LM2853 that are suggested for various typical output voltages. Values slightly different than those recommended may be used, however the phase margin of the power supply may be degraded. For best performance when output voltage ripple is a concern, ESR values near the minimum of the recommended range should be paired with capacitance values near the maximum. If a minimum output voltage ripple solution from a 5V input voltage is desired, a 6.8  $\mu\text{H}$  inductor can be paired with a 220  $\mu\text{F}$  (50 m $\Omega$ ) capacitor without degraded phase margin.

TABLE 1. Recommended  $L_O$  and  $C_O$  Values

| $V_{OUT}$ (V) | $V_{IN}$ (V) | $L_O$ ( $\mu\text{H}$ ) |     | $C_O$ ( $\mu\text{F}$ ) |     | $C_{ESR}$ (m $\Omega$ ) |     |
|---------------|--------------|-------------------------|-----|-------------------------|-----|-------------------------|-----|
|               |              | Min                     | Max | Min                     | Max | Min                     | Max |
| 0.8           | 5            | 4.7                     | 6.8 | 120                     | 220 | 70                      | 100 |
| 0.8           | 3.3          | 4.7                     | 4.7 | 150                     | 220 | 50                      | 100 |
|               |              |                         |     |                         |     |                         |     |
| 1             | 5            | 4.7                     | 6.8 | 120                     | 220 | 70                      | 100 |
| 1             | 3.3          | 4.7                     | 4.7 | 150                     | 220 | 50                      | 100 |
|               |              |                         |     |                         |     |                         |     |
| 1.2           | 5            | 4.7                     | 6.8 | 120                     | 220 | 70                      | 100 |
| 1.2           | 3.3          | 4.7                     | 4.7 | 120                     | 220 | 60                      | 100 |
|               |              |                         |     |                         |     |                         |     |
| 1.5           | 5            | 4.7                     | 6.8 | 120                     | 220 | 70                      | 100 |
| 1.5           | 3.3          | 4.7                     | 4.7 | 120                     | 220 | 60                      | 100 |
|               |              |                         |     |                         |     |                         |     |
| 1.8           | 5            | 4.7                     | 6.8 | 120                     | 220 | 70                      | 120 |
| 1.8           | 3.3          | 4.7                     | 4.7 | 100                     | 220 | 70                      | 120 |
|               |              |                         |     |                         |     |                         |     |
| 2.5           | 5            | 4.7                     | 6.8 | 120                     | 220 | 70                      | 150 |
| 2.5           | 3.3          | 4.7                     | 4.7 | 100                     | 220 | 80                      | 150 |
|               |              |                         |     |                         |     |                         |     |
| 3.0           | 5            | 4.7                     | 6.8 | 120                     | 220 | 70                      | 150 |
| 3.0           | 3.3          | 4.7                     | 4.7 | 100                     | 220 | 80                      | 150 |
|               |              |                         |     |                         |     |                         |     |
| 3.3           | 5            | 4.7                     | 6.8 | 120                     | 220 | 70                      | 150 |

## Applications Information (Continued)

### CHOOSING AN INDUCTANCE VALUE

The current ripple present in the output filter inductor is determined by the input voltage, output voltage, switching frequency and inductance according to the following equation:

$$\Delta I_L = \frac{D \times (V_{IN} - V_{OUT})}{f \times L_O}$$

where  $\Delta I_L$  is the peak to peak current ripple, D is the duty cycle  $V_{OUT}/V_{IN}$ ,  $V_{IN}$  is the input voltage applied to the output stage,  $V_{OUT}$  is the output voltage of the switcher, f is the switching frequency and  $L_O$  is the inductance of the output filter inductor. Knowing the current ripple is important for inductor selection since the peak current through the inductor is the load current plus one half the ripple current. Care must be taken to ensure the peak inductor current does not reach a level high enough to trip the current limit circuitry of the LM2853. As an example, consider a 5V to 1.2V conversion and a 550 kHz switching frequency. According to *Table 1*, a 4.7  $\mu$ H inductor may be used. Calculating the expected peak-to-peak ripple,

$$\Delta I_L = \frac{\frac{1.2V}{5V} \times (5V - 1.2V)}{550 \text{ kHz} \times 4.7 \mu\text{F}} = 353 \text{ mA}$$

The maximum inductor current for a 3A load would therefore be 3A plus 177 mA, 3.177A. As shown in the ripple equation, the current ripple is inversely proportional to inductance.

### OUTPUT FILTER INDUCTORS

Once the inductance value is chosen, the key parameter for selecting the output filter inductor is its saturation current ( $I_{SAT}$ ) specification. Typically  $I_{SAT}$  is given by the manufacturer as the current at which the inductance of the coil falls to a certain percentage of the nominal inductance. The  $I_{SAT}$  of an inductor used in an application should be greater than the maximum expected inductor current to avoid saturation. Below is a table of inductors that are suitable in LM2853 applications.

**TABLE 2. Recommended Inductors**

| Inductance  | Part Number   | Vendor    |
|-------------|---------------|-----------|
| 4.7 $\mu$ F | DO3308P-472ML | Coilcraft |
| 4.7 $\mu$ F | DO3316P-472ML | Coilcraft |
| 4.7 $\mu$ F | MSS1260-472ML | Coilcraft |
| 5.2 $\mu$ F | MSS1038-522NL | Coilcraft |
| 5.6 $\mu$ F | MSS1260-562ML | Coilcraft |
| 6.8 $\mu$ F | DO3316P-682ML | Coilcraft |
| 6.8 $\mu$ F | MSS1260-682ML | Coilcraft |

### OUTPUT FILTER CAPACITORS

The recommended capacitors that may be used in the output filter with the LM2853 are limited in value and ESR range according to *Table 1*.

Below are some examples of capacitors that can typically be used in an LM2853 application.

**TABLE 3. Recommended Capacitors**

| Capacitance ( $\mu$ F) | Part Number        | Chemistry     | Vendor         |
|------------------------|--------------------|---------------|----------------|
| 100                    | 594D107X_010C2T    | Tantalum      | Vishay-Sprague |
| 100                    | 593D107X_010D2_E3  | Tantalum      | Vishay-Sprague |
| 100                    | TPSC107M006#0075   | Tantalum      | AVX            |
| 100                    | NOSD107M006#0080   | Niobium Oxide | AVX            |
| 100                    | NOSC107M004#0070   | Niobium Oxide | AVX            |
| 120                    | 594D127X_6R3C2T    | Tantalum      | Vishay-Sprague |
| 150                    | 594D157X_010C2T    | Tantalum      | Vishay-Sprague |
| 150                    | 595D157X_010D2T    | Tantalum      | Vishay-Sprague |
| 150                    | 591D157X_6R3C2_20H | Tantalum      | Vishay-Sprague |
| 150                    | TPSD157M006#0050   | Tantalum      | AVX            |
| 150                    | TPSC157M004#0070   | Tantalum      | AVX            |
| 150                    | NOSD157M006#0070   | Niobium Oxide | AVX            |
| 220                    | 594D227X_6R3D2T    | Tantalum      | Vishay-Sprague |
| 220                    | 591D227X_6R3D2_20H | Tantalum      | Vishay-Sprague |
| 220                    | 591D227X_010D2_20H | Tantalum      | Vishay-Sprague |
| 220                    | 593D227X_6R3D2_E3  | Tantalum      | Vishay-Sprague |

## Applications Information (Continued)

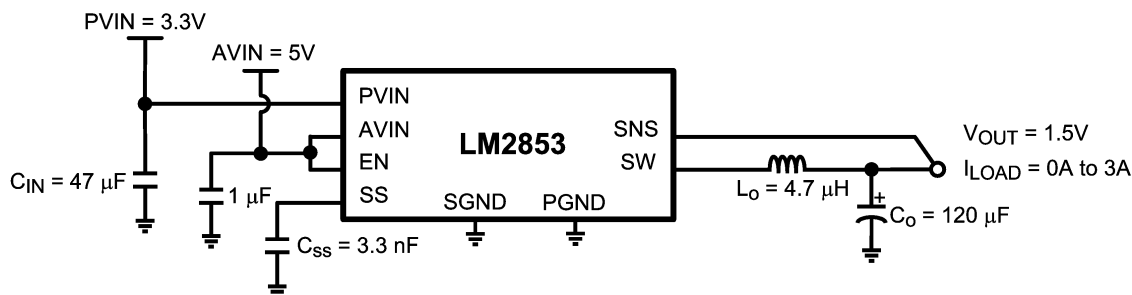
TABLE 3. Recommended Capacitors (Continued)

| Capacitance ( $\mu\text{F}$ ) | Part Number      | Chemistry     | Vendor |
|-------------------------------|------------------|---------------|--------|
| 220                           | TPSD227M006#0050 | Tantalum      | AVX    |
| 220                           | NOSD227M0040060  | Niobium Oxide | AVX    |

### SPLIT-RAIL OPERATION

The LM2853 can be powered using two separate voltages for AVIN and PVIN. AVIN is the supply for the control logic; PVIN is the supply for the power FETs. The output filter

components need to be chosen based on the value of PVIN. For PVIN levels lower than 3.3V, use output filter component values recommended for 3.3V. PVIN must always be equal to or less than AVIN.



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### SWITCH NODE PROTECTION

The LM2853 includes protection circuitry that monitors the voltage on the switch pin. Under certain fault conditions, switching is disabled in order to protect the switching devices. One side effect of the protection circuitry may be observed when power to the LM2853 is applied with no or light load on the output. The output will regulate to the rated voltage, but no switching may be observed. As soon as the output is loaded, the LM2853 will begin normal switching operation.

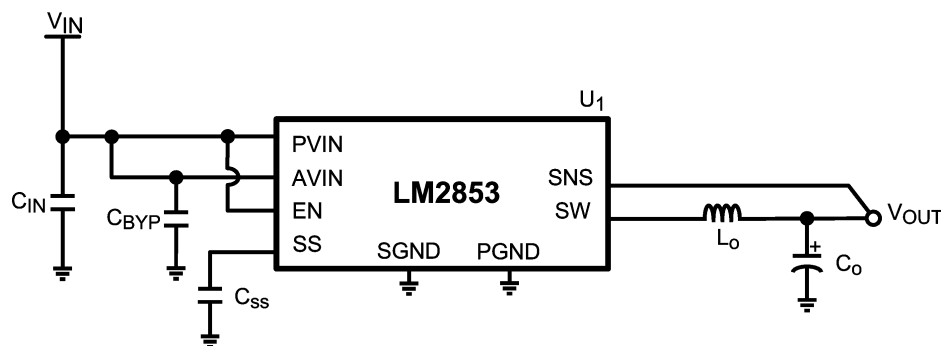
### LAYOUT GUIDELINES

These are several guidelines to follow while designing the PCB layout for an LM2853 application.

1. The input bulk capacitor,  $C_{IN}$ , should be placed very close to the PVIN pin to keep the resistance as low as possible between the capacitor and the pin. High current levels will be present in this connection.
2. All ground connections must be tied together. Use a broad ground plane, for example a completely filled back plane, to establish the lowest resistance possible between all ground connections.

3. The sense pin connection should be made as close to the load as possible so that the voltage at the load is the expected regulated value. The sense line should not run too close to nodes with high  $dV/dt$  or  $dI/dt$  (such as the switch node) to minimize interference.
4. The switch node connections should be low resistance to reduce power losses. Low resistance means the trace between the switch pin and the inductor should be wide. However, the area of the switch node should not be too large since EMI increases with greater area. So connect the inductor to the switch pin with a short, but wide trace. Other high current connections in the application such as PVIN and  $V_{OUT}$  assume the same trade off between low resistance and EMI.
5. Allow area under the chip to solder the entire exposed die attach pad to ground for improved thermal performance. Lab measurements also show improved regulation performance when the exposed pad is well grounded.

### LM2853 Example Circuit Schematic



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FIGURE 1.

## LM2853 Example Circuit Schematic (Continued)

**Bill of Materials for 5V to 3.3V Conversion**

| ID               | Part Number       | Type      | Size      | Parameters                     | Qty | Vendor          |
|------------------|-------------------|-----------|-----------|--------------------------------|-----|-----------------|
| U <sub>1</sub>   | LM2853MH-3.3      | 3A Buck   | ETSSOP-14 | 3.3V                           | 1   | NSC             |
| C <sub>IN</sub>  | GRM31CR60J476ME19 | Capacitor | 1206      | 47 $\mu$ F                     | 1   | Murata          |
| C <sub>BYP</sub> | GRM21BR71C105KA01 | Capacitor | 0805      | 1 $\mu$ F                      | 1   | Murata          |
| C <sub>SS</sub>  | VJ0805Y222KXXA    | Capacitor | 0603      | 2.2 nF                         | 1   | Vishay-Vitramon |
| L <sub>O</sub>   | DO3316P-682       | Inductor  | DO3316P   | 6.8 $\mu$ H                    | 1   | Coilcraft       |
| C <sub>O</sub>   | 594D127X06R3C2T   | Capacitor | C Case    | 120 $\mu$ F<br>(85m $\Omega$ ) | 1   | Vishay-Sprague  |

**Bill of Materials for 3.3V to 1.2V Conversion**

| ID               | Part Number       | Type      | Size      | Parameters                      | Qty | Vendor          |
|------------------|-------------------|-----------|-----------|---------------------------------|-----|-----------------|
| U <sub>1</sub>   | LM2853MH-1.2      | 3A Buck   | ETSSOP-14 | 1.2V                            | 1   | NSC             |
| C <sub>IN</sub>  | GRM31CR60J476ME19 | Capacitor | 1206      | 47 $\mu$ F                      | 1   | Murata          |
| C <sub>BYP</sub> | GRM21BR71C105KA01 | Capacitor | 0805      | 1 $\mu$ F                       | 1   | Murata          |
| C <sub>SS</sub>  | VJ0805Y222KXXA    | Capacitor | 0603      | 2.2 nF                          | 1   | Vishay-Vitramon |
| L <sub>O</sub>   | DO3316P-472       | Inductor  | DO3316P   | 4.7 $\mu$ H                     | 1   | Coilcraft       |
| C <sub>O</sub>   | NOSD157M006R0070  | Capacitor | D Case    | 150 $\mu$ F<br>(70 m $\Omega$ ) | 1   | AVX             |

**PACKAGING INFORMATION**

| Orderable Device  | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|-------------------|---------------|--------------|--------------------|------|----------------|----------------------------|------------------|----------------------|--------------|-------------------------|-------------------------|
| LM2853MH-0.8      | ACTIVE        | HTSSOP       | PWP                | 14   |                | TBD                        | Call TI          | Call TI              | -40 to 125   | LM2853<br>-0.8          | <a href="#">Samples</a> |
| LM2853MH-0.8/NOPB | ACTIVE        | HTSSOP       | PWP                | 14   | 94             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | LM2853<br>-0.8          | <a href="#">Samples</a> |
| LM2853MH-1.0      | ACTIVE        | HTSSOP       | PWP                | 14   |                | TBD                        | Call TI          | Call TI              | -40 to 125   | LM2853<br>-1.0          | <a href="#">Samples</a> |
| LM2853MH-1.0/NOPB | ACTIVE        | HTSSOP       | PWP                | 14   | 94             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | LM2853<br>-1.0          | <a href="#">Samples</a> |
| LM2853MH-1.2      | ACTIVE        | HTSSOP       | PWP                | 14   |                | TBD                        | Call TI          | Call TI              | -40 to 125   | LM2853<br>-1.2          | <a href="#">Samples</a> |
| LM2853MH-1.2/NOPB | ACTIVE        | HTSSOP       | PWP                | 14   | 94             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | LM2853<br>-1.2          | <a href="#">Samples</a> |
| LM2853MH-1.5      | ACTIVE        | HTSSOP       | PWP                | 14   |                | TBD                        | Call TI          | Call TI              | -40 to 125   | LM2853<br>-1.5          | <a href="#">Samples</a> |
| LM2853MH-1.5/NOPB | ACTIVE        | HTSSOP       | PWP                | 14   | 94             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | LM2853<br>-1.5          | <a href="#">Samples</a> |
| LM2853MH-1.8      | ACTIVE        | HTSSOP       | PWP                | 14   | 94             | TBD                        | Call TI          | Call TI              | -40 to 125   | LM2853<br>-1.8          | <a href="#">Samples</a> |
| LM2853MH-1.8/NOPB | ACTIVE        | HTSSOP       | PWP                | 14   | 94             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | LM2853<br>-1.8          | <a href="#">Samples</a> |
| LM2853MH-2.5      | ACTIVE        | HTSSOP       | PWP                | 14   |                | TBD                        | Call TI          | Call TI              | -40 to 125   | LM2853<br>-2.5          | <a href="#">Samples</a> |
| LM2853MH-2.5/NOPB | ACTIVE        | HTSSOP       | PWP                | 14   | 94             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | LM2853<br>-2.5          | <a href="#">Samples</a> |
| LM2853MH-3.0      | ACTIVE        | HTSSOP       | PWP                | 14   |                | TBD                        | Call TI          | Call TI              | -40 to 125   | LM2853<br>-3.0          | <a href="#">Samples</a> |
| LM2853MH-3.0/NOPB | ACTIVE        | HTSSOP       | PWP                | 14   | 94             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | LM2853<br>-3.0          | <a href="#">Samples</a> |
| LM2853MH-3.3      | ACTIVE        | HTSSOP       | PWP                | 14   | 94             | TBD                        | Call TI          | Call TI              | -40 to 125   | LM2853<br>-3.3          | <a href="#">Samples</a> |
| LM2853MH-3.3/NOPB | ACTIVE        | HTSSOP       | PWP                | 14   | 94             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | LM2853<br>-3.3          | <a href="#">Samples</a> |
| LM2853MHX-0.8     | ACTIVE        | HTSSOP       | PWP                | 14   |                | TBD                        | Call TI          | Call TI              | -40 to 125   | LM2853<br>-0.8          | <a href="#">Samples</a> |

| Orderable Device   | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|--------------------|---------------|--------------|--------------------|------|----------------|----------------------------|------------------|----------------------|--------------|-------------------------|-------------------------|
| LM2853MHX-0.8/NOPB | ACTIVE        | HTSSOP       | PWP                | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | LM2853<br>-0.8          | <a href="#">Samples</a> |
| LM2853MHX-1.0      | ACTIVE        | HTSSOP       | PWP                | 14   |                | TBD                        | Call TI          | Call TI              | -40 to 125   | LM2853<br>-1.0          | <a href="#">Samples</a> |
| LM2853MHX-1.0/NOPB | ACTIVE        | HTSSOP       | PWP                | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | LM2853<br>-1.0          | <a href="#">Samples</a> |
| LM2853MHX-1.2      | ACTIVE        | HTSSOP       | PWP                | 14   |                | TBD                        | Call TI          | Call TI              | -40 to 125   | LM2853<br>-1.2          | <a href="#">Samples</a> |
| LM2853MHX-1.2/NOPB | ACTIVE        | HTSSOP       | PWP                | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | LM2853<br>-1.2          | <a href="#">Samples</a> |
| LM2853MHX-1.5      | ACTIVE        | HTSSOP       | PWP                | 14   |                | TBD                        | Call TI          | Call TI              | -40 to 125   | LM2853<br>-1.5          | <a href="#">Samples</a> |
| LM2853MHX-1.5/NOPB | ACTIVE        | HTSSOP       | PWP                | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | LM2853<br>-1.5          | <a href="#">Samples</a> |
| LM2853MHX-1.8      | ACTIVE        | HTSSOP       | PWP                | 14   |                | TBD                        | Call TI          | Call TI              | -40 to 125   | LM2853<br>-1.8          | <a href="#">Samples</a> |
| LM2853MHX-1.8/NOPB | ACTIVE        | HTSSOP       | PWP                | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | LM2853<br>-1.8          | <a href="#">Samples</a> |
| LM2853MHX-2.5      | ACTIVE        | HTSSOP       | PWP                | 14   |                | TBD                        | Call TI          | Call TI              | -40 to 125   | LM2853<br>-2.5          | <a href="#">Samples</a> |
| LM2853MHX-2.5/NOPB | ACTIVE        | HTSSOP       | PWP                | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | LM2853<br>-2.5          | <a href="#">Samples</a> |
| LM2853MHX-3.0      | ACTIVE        | HTSSOP       | PWP                | 14   |                | TBD                        | Call TI          | Call TI              | -40 to 125   | LM2853<br>-3.0          | <a href="#">Samples</a> |
| LM2853MHX-3.0/NOPB | ACTIVE        | HTSSOP       | PWP                | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | LM2853<br>-3.0          | <a href="#">Samples</a> |
| LM2853MHX-3.3      | ACTIVE        | HTSSOP       | PWP                | 14   |                | TBD                        | Call TI          | Call TI              | -40 to 125   | LM2853<br>-3.3          | <a href="#">Samples</a> |
| LM2853MHX-3.3/NOPB | ACTIVE        | HTSSOP       | PWP                | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | LM2853<br>-3.3          | <a href="#">Samples</a> |

(1) The marketing status values are defined as follows:

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**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.

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**TBD:** The Pb-Free/Green conversion plan has not been defined.

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**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)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

<sup>(4)</sup> There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

<sup>(5)</sup> Multiple Device Markings will be inside parentheses. Only one Device 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 Device Marking for that device.

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**TAPE AND REEL INFORMATION**


\*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 |
|--------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM2853MHX-0.8/NOPB | HTSSOP       | PWP             | 14   | 2500 | 330.0              | 12.4               | 6.95    | 8.3     | 1.6     | 8.0     | 12.0   | Q1            |
| LM2853MHX-1.0/NOPB | HTSSOP       | PWP             | 14   | 2500 | 330.0              | 12.4               | 6.95    | 8.3     | 1.6     | 8.0     | 12.0   | Q1            |
| LM2853MHX-1.2/NOPB | HTSSOP       | PWP             | 14   | 2500 | 330.0              | 12.4               | 6.95    | 8.3     | 1.6     | 8.0     | 12.0   | Q1            |
| LM2853MHX-1.5/NOPB | HTSSOP       | PWP             | 14   | 2500 | 330.0              | 12.4               | 6.95    | 8.3     | 1.6     | 8.0     | 12.0   | Q1            |
| LM2853MHX-1.8/NOPB | HTSSOP       | PWP             | 14   | 2500 | 330.0              | 12.4               | 6.95    | 8.3     | 1.6     | 8.0     | 12.0   | Q1            |
| LM2853MHX-2.5/NOPB | HTSSOP       | PWP             | 14   | 2500 | 330.0              | 12.4               | 6.95    | 8.3     | 1.6     | 8.0     | 12.0   | Q1            |
| LM2853MHX-3.0/NOPB | HTSSOP       | PWP             | 14   | 2500 | 330.0              | 12.4               | 6.95    | 8.3     | 1.6     | 8.0     | 12.0   | Q1            |
| LM2853MHX-3.3/NOPB | HTSSOP       | PWP             | 14   | 2500 | 330.0              | 12.4               | 6.95    | 8.3     | 1.6     | 8.0     | 12.0   | Q1            |

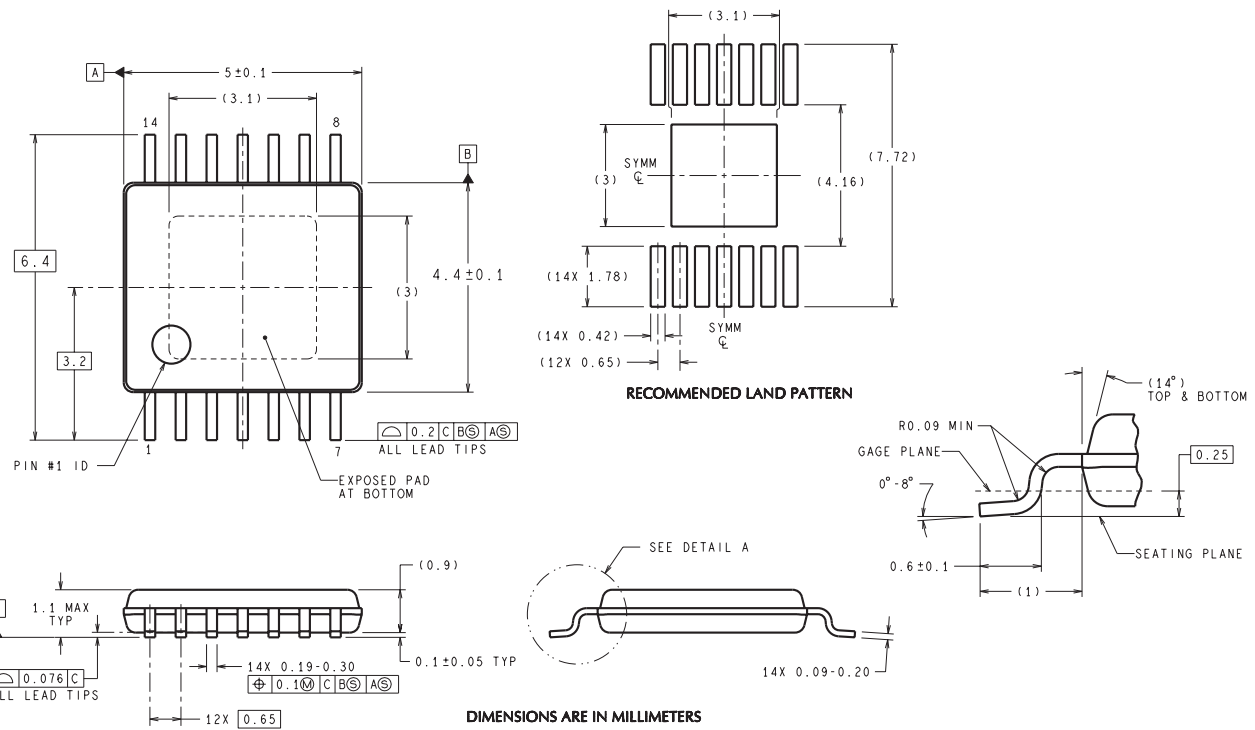
## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device             | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM2853MHX-0.8/NOPB | HTSSOP       | PWP             | 14   | 2500 | 367.0       | 367.0      | 35.0        |
| LM2853MHX-1.0/NOPB | HTSSOP       | PWP             | 14   | 2500 | 367.0       | 367.0      | 35.0        |
| LM2853MHX-1.2/NOPB | HTSSOP       | PWP             | 14   | 2500 | 367.0       | 367.0      | 35.0        |
| LM2853MHX-1.5/NOPB | HTSSOP       | PWP             | 14   | 2500 | 367.0       | 367.0      | 35.0        |
| LM2853MHX-1.8/NOPB | HTSSOP       | PWP             | 14   | 2500 | 367.0       | 367.0      | 35.0        |
| LM2853MHX-2.5/NOPB | HTSSOP       | PWP             | 14   | 2500 | 367.0       | 367.0      | 35.0        |
| LM2853MHX-3.0/NOPB | HTSSOP       | PWP             | 14   | 2500 | 367.0       | 367.0      | 35.0        |
| LM2853MHX-3.3/NOPB | HTSSOP       | PWP             | 14   | 2500 | 367.0       | 367.0      | 35.0        |

PWP0014A



MXA14A (Rev A)

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| DSP                          | <a href="http://dsp.ti.com">dsp.ti.com</a>                                           |
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| RFID                         | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>                                 |
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### Applications

|                               |                                                                                          |
|-------------------------------|------------------------------------------------------------------------------------------|
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| Computers and Peripherals     | <a href="http://www.ti.com/computers">www.ti.com/computers</a>                           |
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| Energy and Lighting           | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
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