

# LM2738 Step-Down Converter Evaluation Module User's Guide



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## Trademarks

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## 1 Introduction

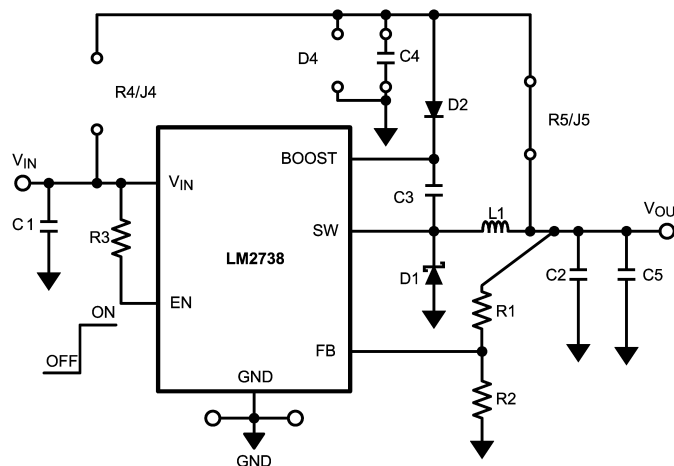
The LM2738 demo board is configured to convert 12-V input to 3.3-V output at 1.5-A load current using the LM2738X 1.6-MHz or the LM2738Y 550-kHz step down DC-DC regulator. The tiny low profile MSOP-PowerPAD-8 and WSON-8 packages allows the demo board to be manufactured using just over one square inch of a 4-layer printed circuit board.

The circuit is configured with the boost diode connected to  $V_{OUT}$ , and according to the data sheet,  $V_{OUT}$  must not exceed the maximum operating limit of  $5.5\text{ V} + V_{FD2}$  using this configuration. This makes sure that the voltage between the boost and SW pins,  $V_{BOOST} - V_{SW}$ , does not exceed 5.5 V for proper operation. Please see the [LM2738 550kHz/1.6MHz 1.5A Step-Down DC-DC Switching Regulator](#) data sheet for more information regarding this requirement.

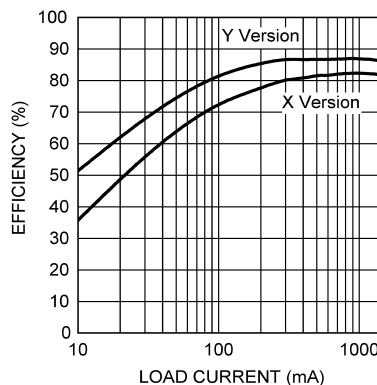
A bill of materials describes the parts used on this demo board. A schematic and layout have also been included along with measured performance characteristics. The schematics at the end of this document show how to re-configure this demo board for various input and output conditions as discussed in the [LM2738 550kHz/1.6MHz 1.5A Step-Down DC-DC Switching Regulator](#) data sheet. Short or leave open the indicated connection as indicated in the schematics. The above restrictions for the input voltage are valid only for the demo board as shipped with the demo board schematic (see [Figure 2-1](#)).

## 2 Operating Conditions

- $V_{IN} = 12\text{ V}$
- $V_O = 3.3\text{ V}$
- $I_O = 1.5\text{ A}$



**Figure 2-1. LM2738 Demo Board Schematic -  $V_{BOOST}$  Derived from  $V_{OUT} = 3.3\text{ V}$ ,  $V_{IN} = 12\text{ V}$**



**Figure 2-2. Efficiency vs Load Current -  $V_{IN} = 12\text{ V}$ ,  $V_{OUT} = 3.3\text{ V}$**

**Table 2-1. Bill of Materials X-Version (1.6 MHz)**

| Part ID            | Part Value                         | Manufacturer      | Part Number   | Package Type    |
|--------------------|------------------------------------|-------------------|---------------|-----------------|
| C1, Input Cap      | 10 $\mu$ F, 25 V, X7R              | TDK               | C3216X5R1E106 | 1206            |
| C2, C5, Output Cap | 22 $\mu$ F, 10 V, X5R              | TDK               | C3216X5R1A226 | 1206            |
| C3 (Boost Cap), C4 | 0.1 $\mu$ F                        | TDK               | C2012X7R1A104 | 0805            |
| D2, Boost Diode    | 1 $V_F$ at 100-mA Diode            | Diodes, Inc.      | BAT54WS-TP    | SOD-323         |
| R2, R3             | 10 k $\Omega$ , 1%                 | Vishay            | CRCW12061002F | 0805            |
| U1                 | 1.5-A Buck Regulator               | Texas Instruments | LM2738        | WSON-8          |
|                    |                                    |                   | LM2738        | MSOP-PowerPAD-8 |
| D1, Catch Diode    | 0.34- $V_F$ Schottky, 1.5 A, 30 VR | Toshiba           | CRS08         | -               |
| L1                 | 5.0 $\mu$ H, 2.9 A                 | Coilcraft         | MSS7341-502NL | -               |
| R1                 | 31.6 k $\Omega$ , 1%               | Vishay            | CRCW12063162F | 0805            |
| R5                 | 0 $\Omega$                         | Vishay            | CRCW12060R00F | 0805            |
| D4, R4             | Open or No Load                    |                   |               |                 |

**Table 2-2. Bill of Materials Y-Version (550 kHz)**

| Part ID            | Part Value                        | Manufacturer      | Part Number   | Package Type    |
|--------------------|-----------------------------------|-------------------|---------------|-----------------|
| C1, Input Cap      | 10 $\mu$ F, 25 V, X7R             | TDK               | C3216X5R1E106 | 1206            |
| C2, C5, Output Cap | 22 $\mu$ F, 10 V, X5R             | TDK               | C3216X5R1A226 | 1206            |
| C3 (Boost Cap), C4 | 0.1 $\mu$ F                       | TDK               | C2012X7R1A104 | 0805            |
| D2, Boost Diode    | 1 $V_F$ at 100 mA Diode           | Diodes, Inc.      | BAT54WS-TP    | SOD-323         |
| R2, R3             | 10 k $\Omega$ , 1%                | Vishay            | CRCW12061002F | 0805            |
| U1                 | 1.5-A Buck Regulator              | Texas Instruments | LM2738        | WSON-8          |
|                    |                                   |                   | LM2738        | MSOP-PowerPAD-8 |
| D1, Catch Diode    | 0.34 $V_F$ Schottky, 1.5 A, 30 VR | Toshiba           | CRS08         | -               |
| L1                 | 10.0 $\mu$ H, 2.0 A               | Coilcraft         | MSS7341-103NL | -               |
| R1                 | 31.6 k $\Omega$ , 1%              | Vishay            | CRCW12063162F | 0805            |
| R5                 | 0 $\Omega$                        | Vishay            | CRCW12060R00F | 0805            |
| D4, R4             | Open or No Load                   |                   |               |                 |

### 3 PCB Layout - WSON

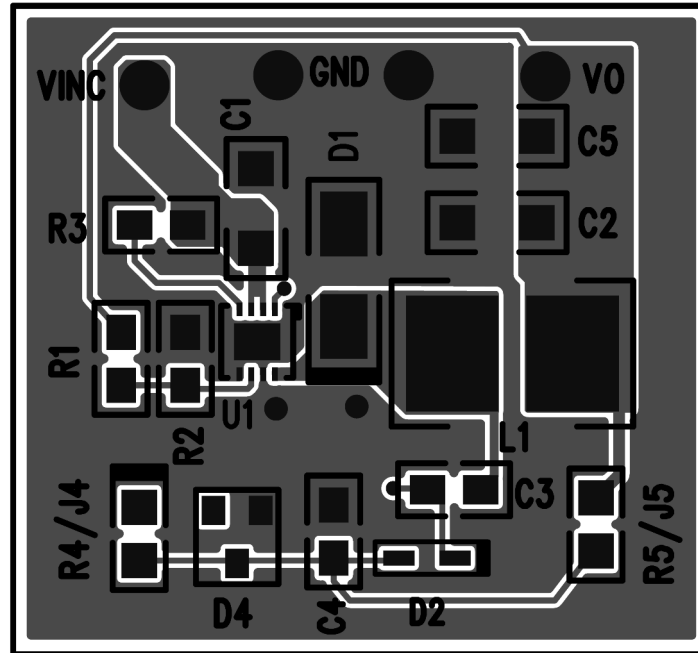


Figure 3-1. Top Layer

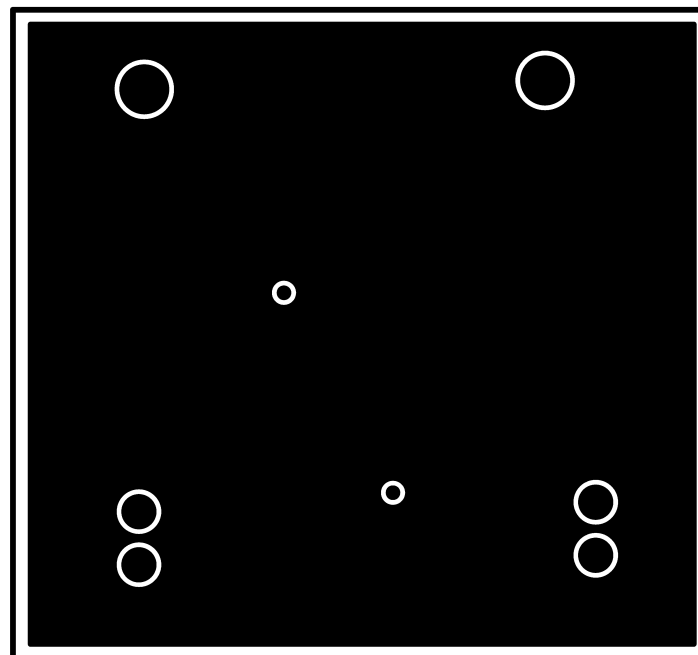


Figure 3-2. Internal Plane - Layer 2 (GND)

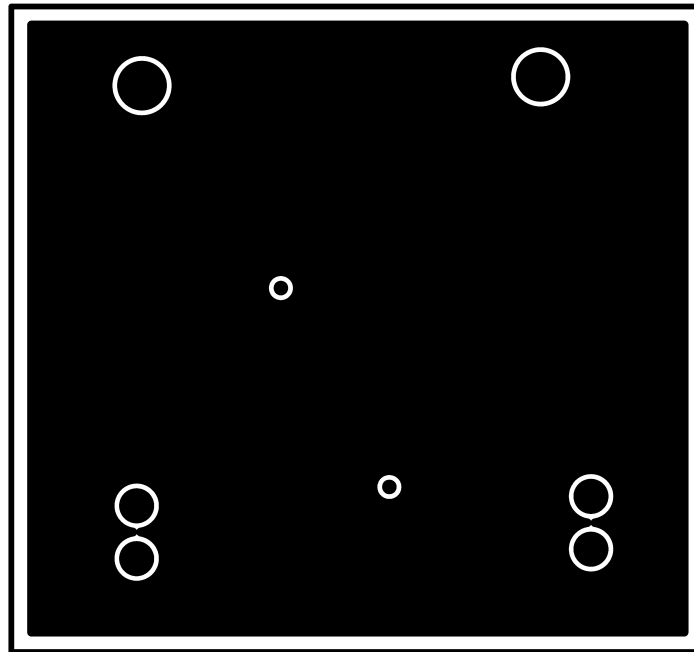


Figure 3-3. Internal Plane - Layer 3 (GND)

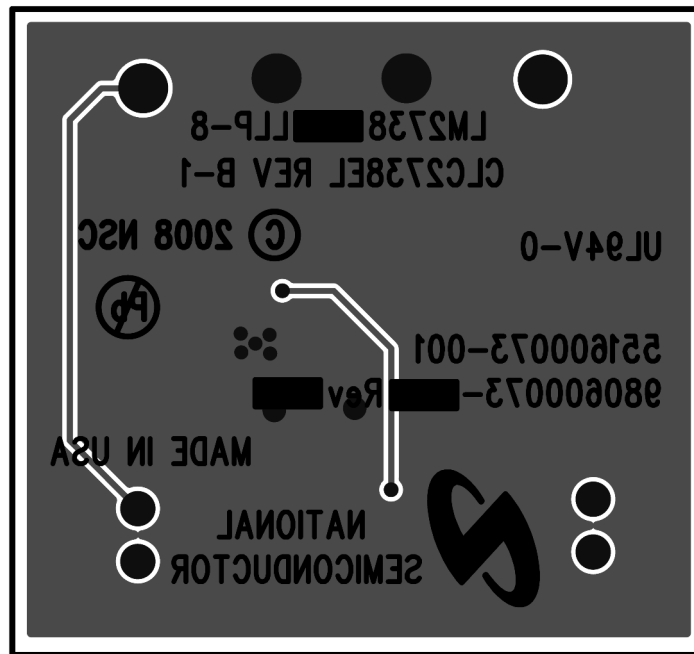


Figure 3-4. Bottom Layer

## 4 PCB Layout - MSOP-PowerPAD

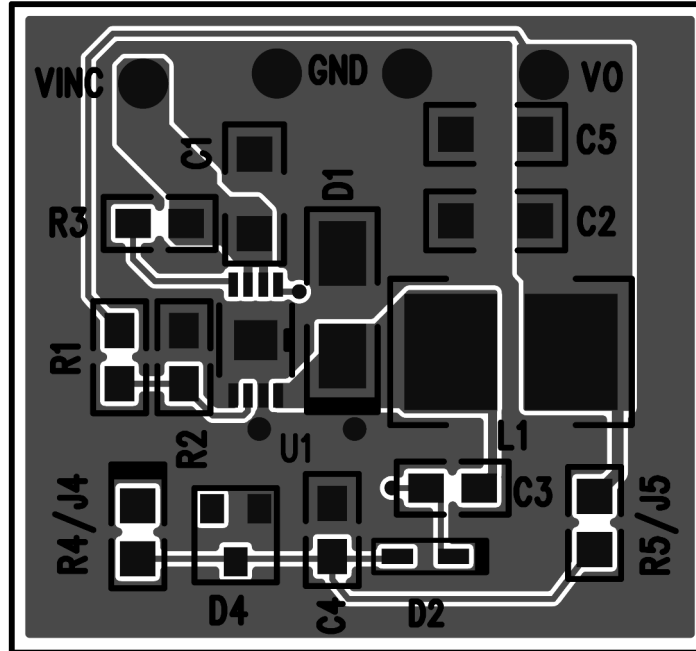


Figure 4-1. Top Layer

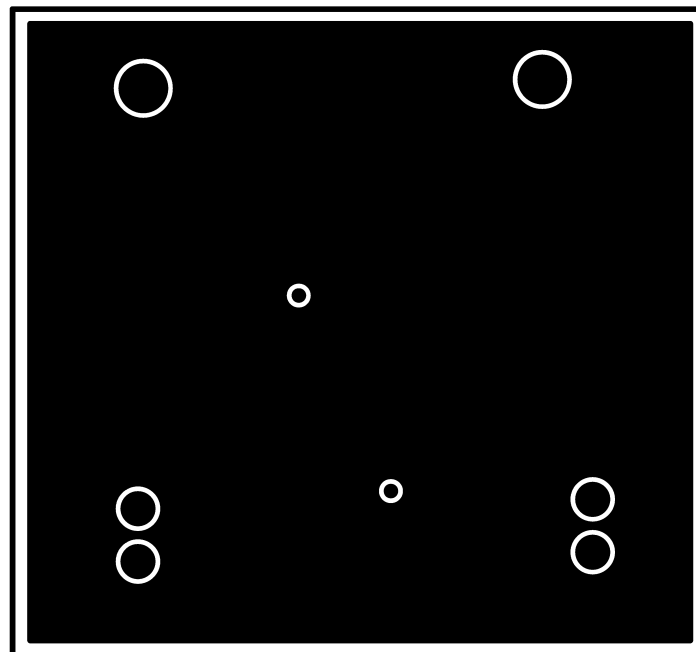


Figure 4-2. Internal Plane - Layer 2 (GND)

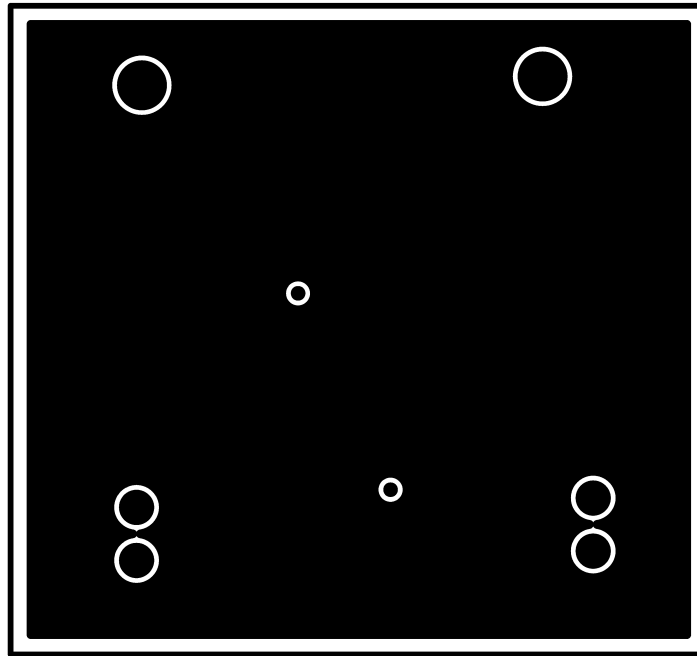


Figure 4-3. Internal Plane - Layer 3 (GND)

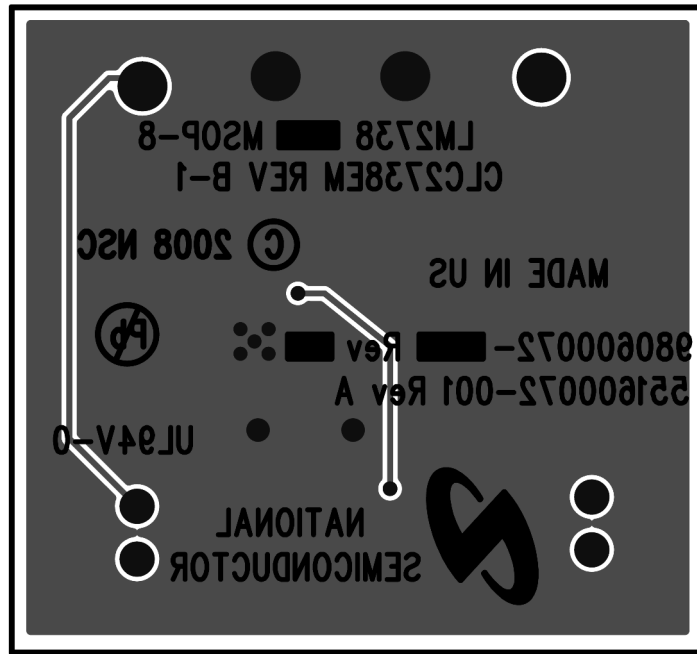


Figure 4-4. Bottom Layer

## 5 Additional Circuit Configuration Schematics

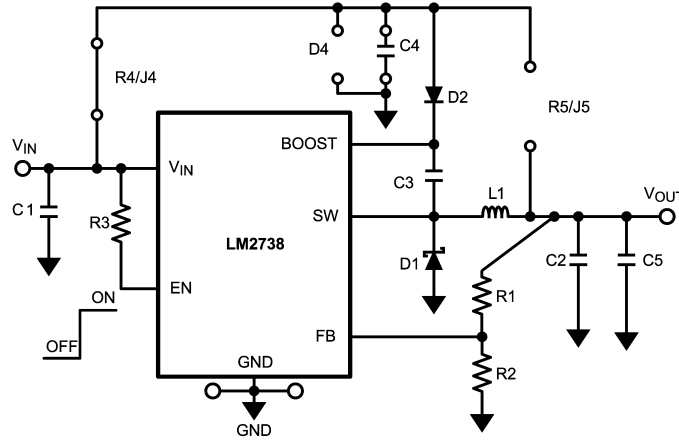


Figure 5-1.  $V_{BOOST}$  Derived from  $V_{IN} = 5\text{ V}$ , for  $V_{OUT} = 1.5\text{ V}$

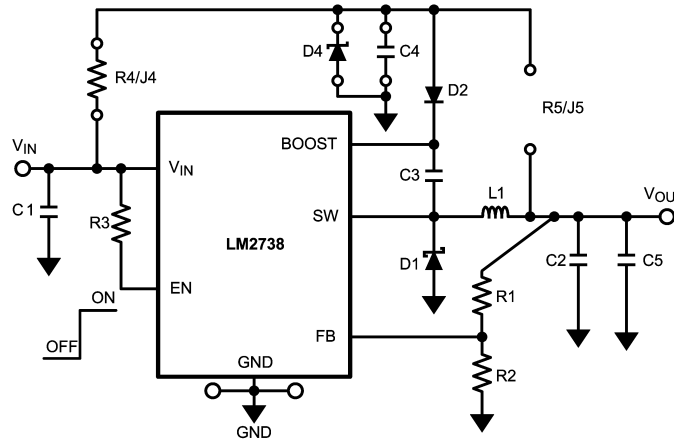
Table 5-1. Bill of Materials X-Version (1.6 MHz)

| Part ID            | Part Value                       | Manufacturer      | Part Number    | Package Type    |
|--------------------|----------------------------------|-------------------|----------------|-----------------|
| C1, Input Cap      | 10 $\mu\text{F}$ , 25 V, X7R     | TDK               | C3216X5R1E106  | 1206            |
| C2, Output Cap     | 22 $\mu\text{F}$ , 6.3 V, X5R    | TDK               | C3216X5R0J2266 | 1206            |
| C3 (Boost Cap), C4 | 0.1 $\mu\text{F}$                | TDK               | C2012X7R1A104  | 0805            |
| D2, Boost Diode    | 1 $V_F$ at 100-mA Diode          | Diodes, Inc.      | BAT54WS-TP     | SOD-323         |
| R2, R3             | 10 k $\Omega$ , 1%               | Vishay            | CRCW12061002F  | 0805            |
| U1                 | 1.5-A Buck Regulator             | Texas Instruments | LM2738         | WSO8-8          |
|                    |                                  |                   | LM2738         | MSOP-PowerPAD-8 |
| D1, Catch Diode    | 0.34 $V_F$ Schottky, 1.5 A, 30 V | Toshiba           | CRS08          | -               |
| L1                 | 2.2 $\mu\text{H}$ , 1.9A         | Coilcraft         | MSS5131-222ML  | -               |
| R1                 | 8.87 k $\Omega$ , 1%             | Vishay            | CRCW12068871F  | 0805            |
| R4                 | 0 $\Omega$                       | Vishay            | CRCW12060R00F  | 0805            |
| D4, R5, C5         | Open or No Load                  |                   |                |                 |

Table 5-2. Bill of Materials Y-Version (550 kHz)

| Part ID             | Part Value                       | Manufacturer      | Part Number   | Package Type    |
|---------------------|----------------------------------|-------------------|---------------|-----------------|
| C1, Input Cap       | 10 $\mu\text{F}$ , 25 V, X7R     | TDK               | C3216X5R1E106 | 1206            |
| C2, C5, Output Caps | 22 $\mu\text{F}$ , 6.3 V, X5R    | TDK               | C3216X5R0J226 | 1206            |
| C3 (Boost Cap), C4  | 0.1 $\mu\text{F}$                | TDK               | C2012X7R1A104 | 0805            |
| D2, Boost Diode     | 1 $V_F$ at 100-mA Diode          | Diodes, Inc.      | BAT54WS-TP    | SOD-323         |
| R2, R3              | 10 k $\Omega$ , 1%               | Vishay            | CRCW12061002F | 0805            |
| U1                  | 1.5-A Buck Regulator             | Texas Instruments | LM2738        | WSO8-8          |
|                     |                                  |                   | LM2738        | MSOP-PowerPAD-8 |
| D1, Catch Diode     | 0.34 $V_F$ Schottky, 1.5 A, 30 V | Toshiba           | CRS08         | -               |
| L1                  | 6.2 $\mu\text{H}$ , 2.5 A        | Coilcraft         | MSS7341-622NL | -               |
| R1                  | 8.87 k $\Omega$ , 1%             | Vishay            | CRCW12068871F | 0805            |
| R4                  | 0 $\Omega$                       | Vishay            | CRCW12060R00F | 0805            |
| D4, R5              | Open or No Load                  |                   |               |                 |





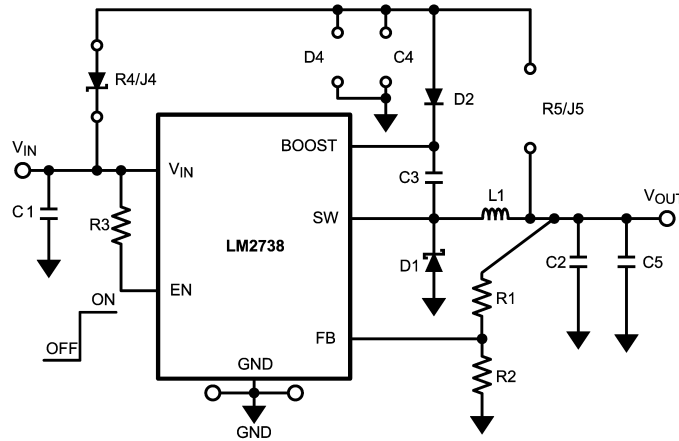
**Figure 5-2.  $V_{BOOST}$  Derived from  $V_{SHUNT}$  Coming from  $V_{IN} = 18\text{ V}$ ,  $V_{OUT} = 1.5\text{ V}$**

**Table 5-3. Bill of Materials X-Version (1.6 MHz)**

| Part ID             | Part Value                       | Manufacturer      | Part Number       | Package Type    |
|---------------------|----------------------------------|-------------------|-------------------|-----------------|
| C1, Input Cap       | 10 $\mu\text{F}$ , 25V, X7R      | TDK               | C3216X5R1E106     | 1206            |
| C2, C5, Output Caps | 22 $\mu\text{F}$ , 6.3V, X5R     | TDK               | C3216X5R0J226     | 1206            |
| C3 (Boost Cap), C4  | 0.1 $\mu\text{F}$                | TDK               | C2012X7R1A104     | 0805            |
| D2, Boost Diode     | 1 $V_F$ at 100-mA Diode          | Diodes, Inc.      | BAT54WS-TP        | SOD-323         |
| D4, Zener           | 5.1 V, 200 mW                    | Diodes, Inc.      | BZX84C5V1W        | SOT-323         |
| R2, R3              | 10 k $\Omega$ , 1%               | Vishay            | CRCW12061002F     | 0805            |
| U1                  | 1.5-A Buck Regulator             | Texas Instruments | LM2738            | WSO8-8          |
|                     |                                  |                   | LM2738            | MSOP-PowerPAD-8 |
| D1, Catch Diode     | 0.34 $V_F$ Schottky, 1.5 A, 30 V | Toshiba           | CRS08             | -               |
| L1                  | 2.7 $\mu\text{H}$ , 1.76 A       | TDK               | VLCF5020T-2R7N1R7 | -               |
| R1                  | 8.87 k $\Omega$ , 1%             | Vishay            | CRCW12068871F     | 0805            |
| R4                  | 4.12 k $\Omega$ , 1%             | Vishay            | CRCW12064121F     | 0805            |
| R5                  | Open or No Load                  |                   |                   |                 |

**Table 5-4. Bill of Materials Y-Version (550 kHz)**

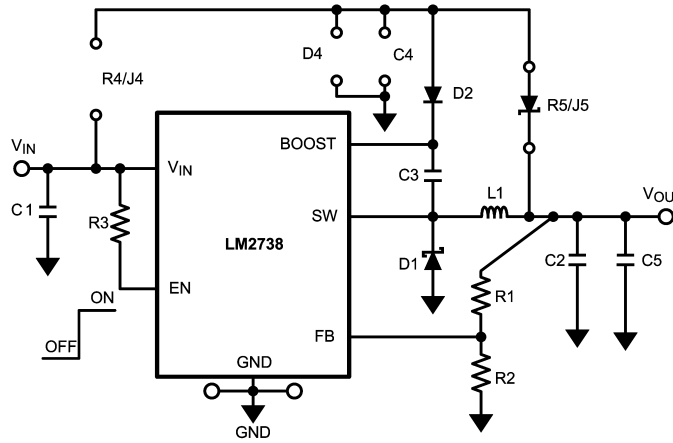
| Part ID             | Part Value                       | Manufacturer      | Part Number   | Package Type    |
|---------------------|----------------------------------|-------------------|---------------|-----------------|
| C1, Input Cap       | 10 $\mu\text{F}$ , 25 V, X7R     | TDK               | C3216X5R1E106 | 1206            |
| C2, C5, Output Caps | 47 $\mu\text{F}$ , 6.3 V, X5R    | TDK               | C3216X5R0J476 | 1206            |
| C3 (Boost Cap), C4  | 0.1 $\mu\text{F}$                | TDK               | C2012X7R1A104 | 0805            |
| D2, Boost Diode     | 1 $V_F$ at 100-mA Diode          | Diodes, Inc.      | BAT54WS-TP    | SOD-323         |
| D4, Zener           | 5.1 V, 200 mW                    | Diodes, Inc.      | BZX84C5V1W    | SOT-323         |
| R2, R3              | 10 k $\Omega$ , 1%               | Vishay            | CRCW12061002F | 0805            |
| U1                  | 1.5-A Buck Regulator             | Texas Instruments | LM2738        | WSO8-8          |
|                     |                                  |                   | LM2738        | MSOP-PowerPAD-8 |
| D1, Catch Diode     | 0.34 $V_F$ Schottky, 1.5 A, 30 V | Toshiba           | CRS08         | -               |
| L1                  | 8.7 $\mu\text{H}$ , 2.2 A        | Coilcraft         | MSS7341-872NL | -               |
| R1                  | 8.87 k $\Omega$ , 1%             | Vishay            | CRCW12068871F | 0805            |
| R4                  | 4.21 k $\Omega$ , 1%             | Vishay            | CRCW12064211F | 0805            |
| R5                  | Open or No Load                  |                   |               |                 |


**Figure 5-3.  $V_{BOOST}$  Derived from Series Zener Diode from  $V_{IN} = 15\text{ V}$ ,  $V_{OUT} = 1.5\text{ V}$** 
**Table 5-5. Bill of Materials X-Version (1.6 MHz)**

| Part ID             | Part Value                       | Manufacturer      | Part Number   | Package Type    |
|---------------------|----------------------------------|-------------------|---------------|-----------------|
| C1, Input Cap       | 10 $\mu\text{F}$ , 25 V, X7R     | TDK               | C3216X5R1E106 | 1206            |
| C2, C5, Output Caps | 22 $\mu\text{F}$ , 6.3 V, X5R    | TDK               | C3216X5R0J226 | 1206            |
| C3 (Boost Cap)      | 0.1 $\mu\text{F}$                | TDK               | C2012X7R1A104 | 0805            |
| D2, Boost Diode     | 1 $V_F$ at 100-mA Diode          | Diodes, Inc.      | BAT54WS-TP    | SOD-323         |
| R2, R3              | 10 k $\Omega$ , 1%               | Vishay            | CRCW12061002F | 0805            |
| U1                  | 1.5-A Buck Regulator             | Texas Instruments | LM2738        | WSO8-8          |
|                     |                                  |                   | LM2738        | MSOP-PowerPAD-8 |
| D1, Catch Diode     | 0.34 $V_F$ Schottky, 1.5 A, 30 V | Toshiba           | CRS08         | -               |
| L1                  | 3.3 $\mu\text{H}$ , 3.5 A        | Coilcraft         | MSS7341-332NL | -               |
| R1                  | 8.87 k $\Omega$ , 1%             | Vishay            | CRCW12068871F | 0805            |
| R4                  | 11 V, 200 mW, Zener              | Vishay            | BZX384C11-V   | SOD-323         |
| D4, R5, C4          | Open or No Load                  |                   |               |                 |

**Table 5-6. Bill of Materials Y-Version (550 kHz)**

| Part ID             | Part Value                       | Manufacturer      | Part Number   | Package Type    |
|---------------------|----------------------------------|-------------------|---------------|-----------------|
| C1, Input Cap       | 10 $\mu\text{F}$ , 25 V, X7R     | TDK               | C3216X5R1E106 | 1206            |
| C2, C5, Output Caps | 47 $\mu\text{F}$ , 6.3 V, X5R    | TDK               | C3216X5R0J476 | 1206            |
| C3 (Boost Cap)      | 0.1 $\mu\text{F}$                | TDK               | C2012X7R1A104 | 0805            |
| D2, Boost Diode     | 1 $V_F$ at 100-mA Diode          | Diodes, Inc.      | BAT54WS-TP    | SOD-323         |
| R2, R3              | 10 k $\Omega$ , 1%               | Vishay            | CRCW12061002F | 0805            |
| U1                  | 1.5-A Buck Regulator             | Texas Instruments | LM2738        | WSO8-8          |
|                     |                                  |                   | LM2738        | MSOP-PowerPAD-8 |
| D1, Catch Diode     | 0.34 $V_F$ Schottky, 1.5 A, 30 V | Toshiba           | CRS08         | -               |
| L1                  | 8.7 $\mu\text{H}$ , 2.2 A        | Coilcraft         | MSS7341-872NL | -               |
| R1                  | 8.87 k $\Omega$ , 1%             | Vishay            | CRCW12068871F | 0805            |
| R4                  | 11 V, 200 mW, Zener              | Vishay            | BZX384C11-V   | SOD-323         |
| D4, R5, C4          | Open or No Load                  |                   |               |                 |



**Figure 5-4.  $V_{BOOST}$  Derived from Series Zener Diode from  $V_{OUT} = 9\text{ V}$ ,  $V_{IN} = 15\text{ V}$**

**Table 5-7. Bill of Materials X-Version (1.6 MHz)**

| Part ID            | Part Value                       | Manufacturer      | Part Number   | Package Type    |
|--------------------|----------------------------------|-------------------|---------------|-----------------|
| C1, Input Cap      | 10 $\mu\text{F}$ , 25 V, X7R     | TDK               | C3216X5R1E106 | 1206            |
| C2, Output Cap     | 22 $\mu\text{F}$ , 10 V, X5R     | TDK               | C3216X5R1A226 | 1206            |
| C3 (Boost Cap), C4 | 0.1 $\mu\text{F}$                | TDK               | C2012X7R1A104 | 0805            |
| D2, Boost Diode    | 1 $V_F$ at 100-mA Diode          | Diodes, Inc.      | BAT54WS-TP    | SOD-323         |
| R2, R3             | 10 k $\Omega$ , 1%               | Vishay            | CRCW12061002F | 0805            |
| U1                 | 1.5-A Buck Regulator             | Texas Instruments | LM2738        | WSO8-8          |
|                    |                                  |                   | LM2738        | MSOP-PowerPAD-8 |
| D1, Catch Diode    | 0.34 $V_F$ Schottky, 1.5 A, 30 V | Toshiba           | CRS08         | -               |
| L1                 | 6.2 $\mu\text{H}$ , 2.5 A        | Coilcraft         | MSS7341-622NL | -               |
| R1                 | 102 k $\Omega$ , 1%              | Vishay            | CRCW1206123F  | 0805            |
| R5                 | 4.3 V, 200 mW, Zener             | Vishay            | BZX384C4V3-V  | SOD-323         |
| D4, R4             | Open or No Load                  |                   |               |                 |

**Table 5-8. Bill of Materials Y-Version (550 kHz)**

| Part ID            | Part Value                      | Manufacturer      | Part Number   | Package Type    |
|--------------------|---------------------------------|-------------------|---------------|-----------------|
| C1, Input Cap      | 10 $\mu\text{F}$ , 25 V, X7R    | TDK               | C3216X5R1E106 | 1206            |
| C2, Output Cap     | 22 $\mu\text{F}$ , 10 V, X5R    | TDK               | C3216X5R1A226 | 1206            |
| C3 (Boost Cap), C4 | 0.1 $\mu\text{F}$               | TDK               | C2012X7R1A104 | 0805            |
| D2, Boost Diode    | 1 $V_F$ at 100-mA Diode         | Diodes, Inc.      | BAT54WS-TP    | SOD-323         |
| R2, R3             | 10 k $\Omega$ , 1%              | Vishay            | CRCW12061002F | 0805            |
| U1                 | 1.5-A Buck Regulator            | Texas Instruments | LM2738        | WSO8-8          |
|                    |                                 |                   | LM2738        | MSOP-PowerPAD-8 |
| D1, Catch Diode    | 0.34 $V_F$ Schottky, 1.5 A, 30V | Toshiba           | CRS08         | -               |
| L1                 | 5.0 $\mu\text{H}$ , 2.9 A       | Coilcraft         | MSS7341-502NL | -               |
| R1                 | 102 k $\Omega$ , 1%             | Vishay            | CRCW12061023F | 0805            |
| R5                 | 4.3 V, 200 mW, Zener            | Vishay            | BZX384C4V3-V  | SOD-323         |
| D4, R4             | Open or No Load                 |                   |               |                 |

## 6 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

### Changes from Revision A (April 2013) to Revision B (December 2021)

Page

- Updated the numbering format for tables, figures, and cross-references throughout the document. ....2

*Revision History*

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- Updated the user's guide title..... 2
  - Edited user's guide for clarity..... 2
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