# Dual High-Efficiency PWM Step-Down DC/DC Converter

## FEATURES FOR EACH CHANNEL

- 700mA Output Current
- High Efficiency up to 95%
- 2.5V to 5.5V Input Range
- Low Quiescent Current 130uA
- Adjustable Output from 0.6V to VIN
- No Schottky Diode Required
- 1.5MHz Constant Frequency Operation
- Low Dropout Operation: 100% Duty Cycle
- Small 12-Lead WDFN Package
- RoHS Compliant and 100% Lead(Pb)-Free

## APPLICATIONS

- Personal Information Appliances
- Mobile Phones
- Wireless and DSL Modems
- Portable Instruments

## GENERAL DESCRIPTION

The TS2122 is a dual high-efficiency PWM step-down DC-DC converter. It is capable of delivering 700mA output each channel over a wide input voltage from 2.5V to 5.5V, the TS2122 is ideally suited for portable electronic devices that are powered from 1- cell Li-ion battery or from other power sources within the range such as cellular phones, PDAs and other handheld devices. The switching ripple is easily smoothed-out by small package filtering elements due to a fixed operation frequency of 1.5MHz. This along with small WDFN-12L 3X3 package provides small PCB area application. Other features include soft start, lower internal reference voltage with 2% accuracy, over temperature protection, and over current protection.

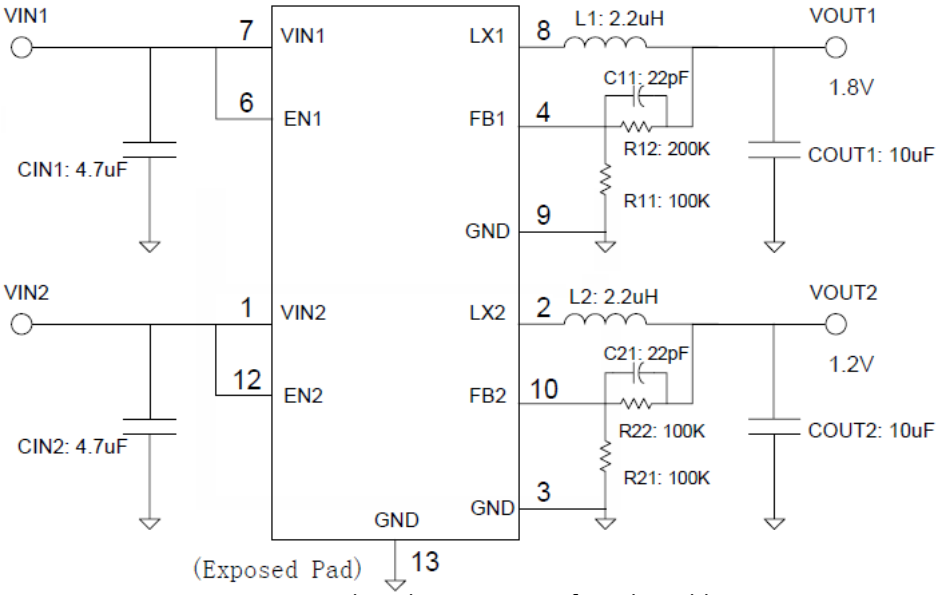



Figure 1 Typical Application Circuit for Adjustable Version

# ORDERING INFORMATION

| PART NUMBER | TEMP RANGE | SWICHING FREQUENCY | OUTPUT VOLTAGE (V) | OUTPUT CURRENT (A) | PACKAGE | PINS |
|---|---|---|---|---|---|---|
| TS2122AA | -40°C to 85°C | 1.5MHz | Adjustable | 0.7 | DFN | 12 |

# PIN CONFIGURATION

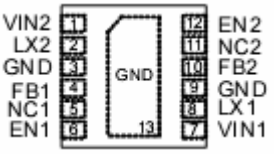



**Figure 2. PIN Configuration**

# PIN DESCRIPTION

| PIN NUMBER | PIN NAME | PIN DESCRIPTION |
|---|---|---|
| 1 | VIN2 | Power Input of Channel 2. |
| 2 | LX2 | Pin for Switching of Channel 2. |
| 3,9, 13(Exposed-Pad) | GND | Ground. The exposed pad must be soldered to a large PCB and connected to GND for maximum power dissipation. |
| 4 | FB1 | Feedback of Channel 1. |
| 5,11 | NC1,NC2 | No Connection |
| 6 | EN1 | Enable of Channel 1(Active High). |
| 7 | VIN1 | Power Input of Channel 1. |
| 8 | LX1 | Pin for Switch of Channel 1. |
| 10 | FB2 | Feedback of Channel 2 |
| 12 | EN2 | Enable of Channel 2(Active High). |

# ABSOLUTE MAXIMUM RATINGS

**(Note: Do not exceed these limits to prevent damage to the device. Exposure to absolute maximum rating conditions for long periods may affect device reliability.)**

| PARAMETER | VALUE | UNIT |
|---|---|---|
| Supply Voltage VIN1 | -0.3 to 6.0 | V |
| FB, EN Voltage | -0.3 to VIN+0.3 | V |
| LX Voltage | -0.3 to VIN+0.3 | V |
| Operating Ambient Temperature | -40 to 85 | °C |
| Maximum Junction Temperature | 125 | °C |
| Storage Temperature | -65 to 150 | °C |
| Lead Temperature (Soldering, 10 sec) | 300 | °C |
| Power Dissipation | 1.667 | W |

# ELECTRICAL CHARACTERISTICS

**(For each output channel, $V_{IN}$ = 3.6V, $V_{REF}$ =0.6V, L=2.2uH, $C_{IN}$ = 2.2uH, $V_{OUT}$ =10uF, $T_A$= 25°C unless otherwise specified)**

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| CHANNEL 1 AND CHANNEL 2 | | | | | | |
| Input Voltage Range | $V_{IN}$ | | 2.5 | | 5.5 | V |
| UVLO Threshold | $V_{UVLO}$ | $V_{HYSTERESIS}$ =100mV | 2.3 | 2.45 | 2.5 | V |
| Operating Supply Current | $I_{SUPPLY}$ | $V_{FB}$ =0.5V or $V_{OUT}$ =90%, $I_{Load}$ =0 | | 130 | 170 | µA |
| Shutdown Supply Current | | $V_{EN}$ =0V, $V_{IN}$ =4.2V | | 0.1 | 1 | |
| Regulated Feedback Voltage | $V_{FB}$ | $T_a$ =25°C | 0.588 | 0.6 | 0.612 | V |
| | | 0< $T_a$ <85°C | 0.5865 | 0.6 | 0.6135 | |
| | | -40°C < $T_a$ <85°C | 0.585 | 0.6 | 0.615 | |
| Reference Voltage Line Regulation | | $V_{IN}$ =2.7V to 5.5V | | 0.04 | 0.4 | % |
| Regulated Output Voltage | $V_{OUT}$ | $V_{OUT}$ =1.8V; $I_{OUT}$ =100mA | 1.746 | 1.8 | 1.854 | V |
| Peak Inductor Current | $I_{PEAK}$ | VIN =3V, VFB =0.5V or VOUT =90%,Duty Cycle<35% | | 1 | | A |
| Oscillator Frequency | $F_{OSC}$ | $V_{FB}$=0.6V or $V_{OUT}$ =100% | 1.2 | 1.5 | 1.8 | MHz |
| | | $V_{FB}$=0 or $V_{OUT}$ =0 | | 220 | | KHz |
| Rds(ON) of P-channel FET | | $I_{SW}$ =100mA | | 0.15 | 0.3 | Ohm |
| Rds(ON) of N-channel FET | | $I_{SW}$ =-100mA | | 0.15 | 0.3 | Ohm |
| Enable Threshold | | $V_{IN}$ = 2.5V to 5.5V | 0.3 | 1 | 1.5 | V |
| Enable Leakage Current | | | -0.1 | | 0.1 | µA |
| LX Leakage Current | | $V_{EN}$ = 0V, $V_{SW}$ = 0V or 5V, $V_{IN}$ = 5V | -1 | | 1 | uA |
| Maximum Duty Cycle | | | 100 | | | % |

# FUNCTION BLOCK DIAGRAM

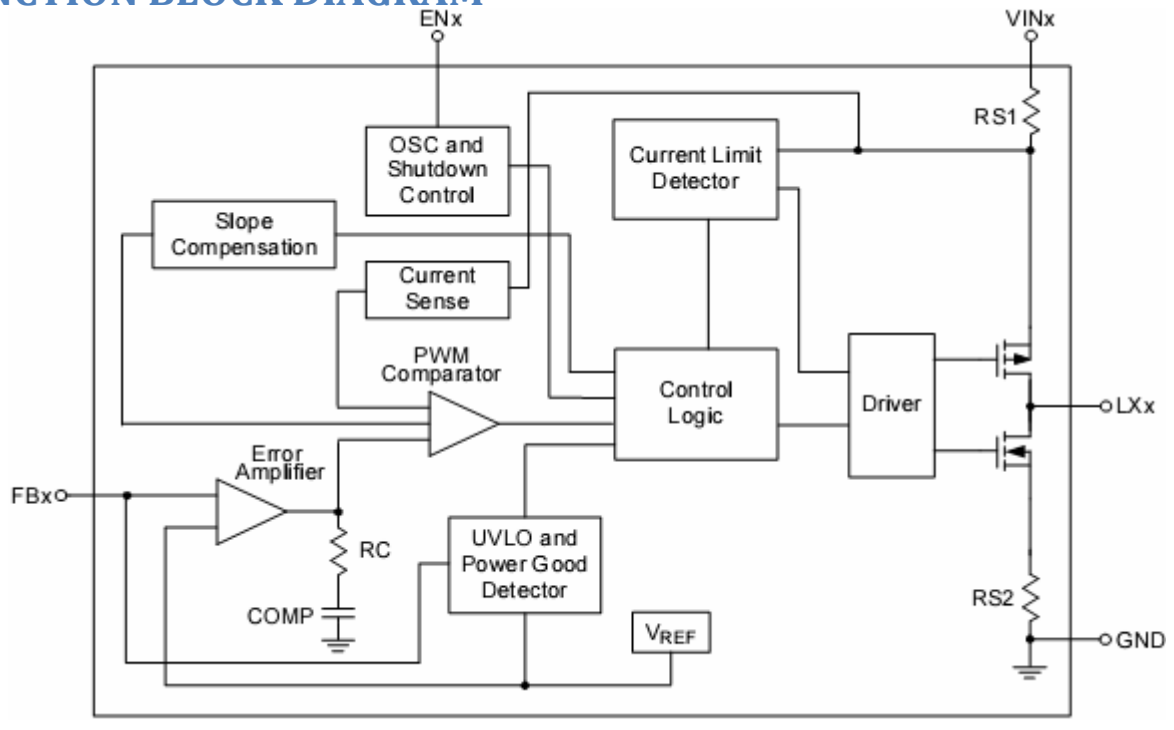



Figure 3 Functional Block Diagram

# APPLICATION INFORMATION

## INDUCTOR SELECTION

In normal operation, the inductor maintains continuous current to the output. The inductor current has a ripple that is dependent on the inductance value. The high inductance reduces the ripple current. In general, select the inductance by the following equation:

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \cdot f \cdot VI}$$

Where OUT V is the output voltage, IN V is the input voltage, f is the switch frequency, and VI is the peak-to-peak inductor ripple current. Typically, choose VI as the 30% of the maximum output current.

| Manufacturer | Part Number | Inductance( uH) | DRC max (Ohms) | Dimensions L*W*H(mm3) |
|---|---|---|---|---|
| Murata | LQH32PN | 2.2 | 0.09 | 3.2*2.5*1.7 |
| | | 4.7 | 0.15 | |
| Sumida | CDRH3D16 | 2.2 | 0.07 | 4*4*1.8 |
| | | 4.7 | 0.16 | |

Table 1 Recommend Surface Mount Inductors

## INPUT CAPACITOR SELECTION

The input capacitor reduces input voltage ripple to the converter, low ESR ceramic capacitor is highly recommended. For most applications, a 4.7uF capacitor is used. The input capacitor should be placed as close as possible to VIN and GND.

## OUTPUT CAPACITOR SELECTION

A low ESR output capacitor is required in order to maintain low output voltage ripple. In the case of ceramic output capacitors, capacitor ESR is very small and does not contribute to the ripple, so a lower capacitance value is acceptable when ceramic capacitors are used. A 10uF ceramic output capacitor is suitable for most applications.

## OUTPUT VOLTAGE PROGRAMMING

In the adjustable version, the output voltage is set by a resistive divider according to the following equation:

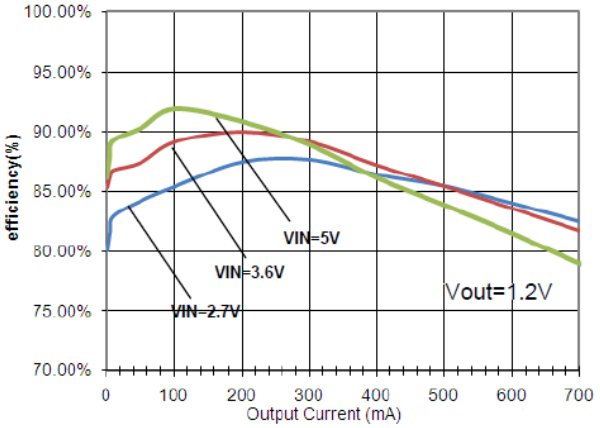
$$R_2 = R_1 \times \left( \frac{V_{OUT}}{0.6} - 1 \right)$$

Typically choose R1=100K and determine R2 from the following equation: Connect a small capacitor across R1 feed forward capacitance at the FB pin for better performance.

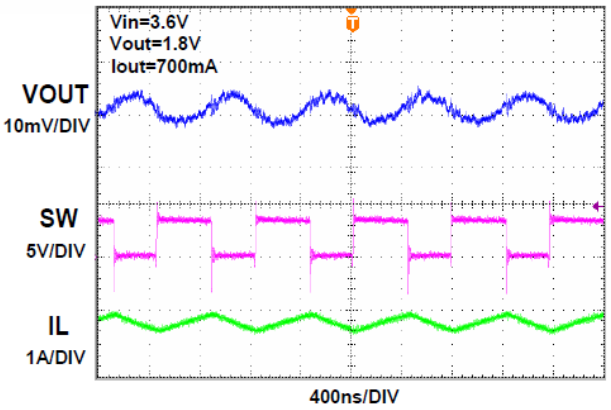
# TYPICAL PERFORMANCE CHARACTERISTICS

**(VIN=VEN=3.6V, L=2.2uH, CIN=4.7uF, COUT=10uF)**

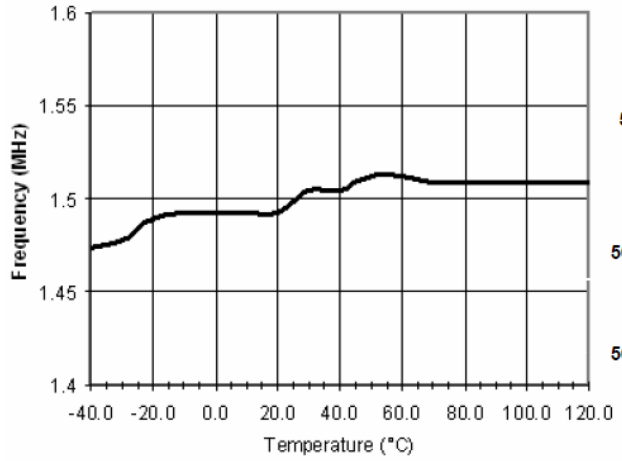
Efficiency vs. Output Current



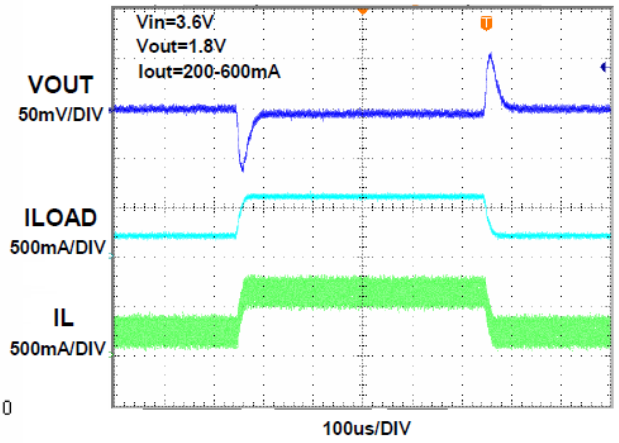

Steady State Waveform



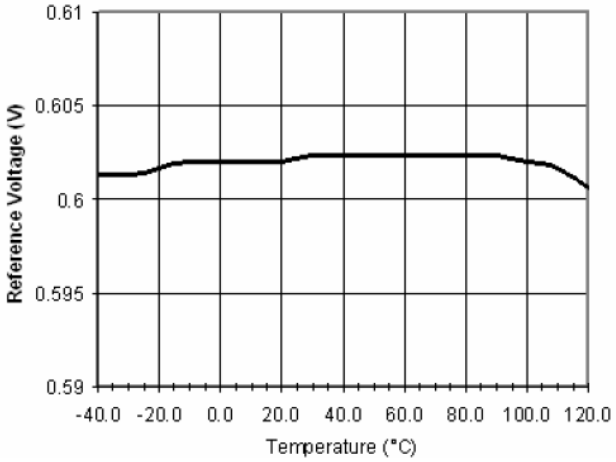

Oscillator Frequency vs. Temperature



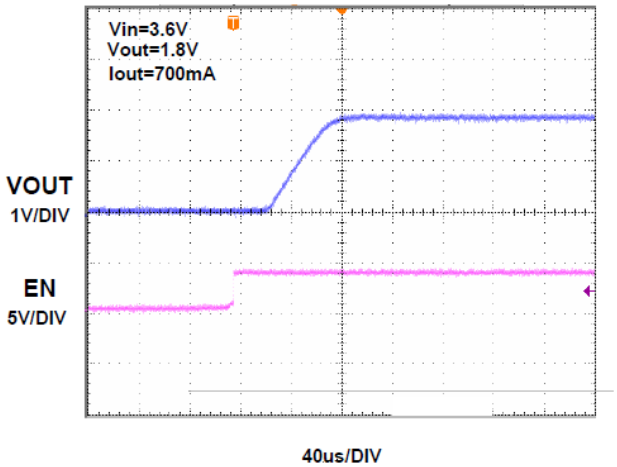

Load Transient Waveform




Reference Voltage vs. Temperature

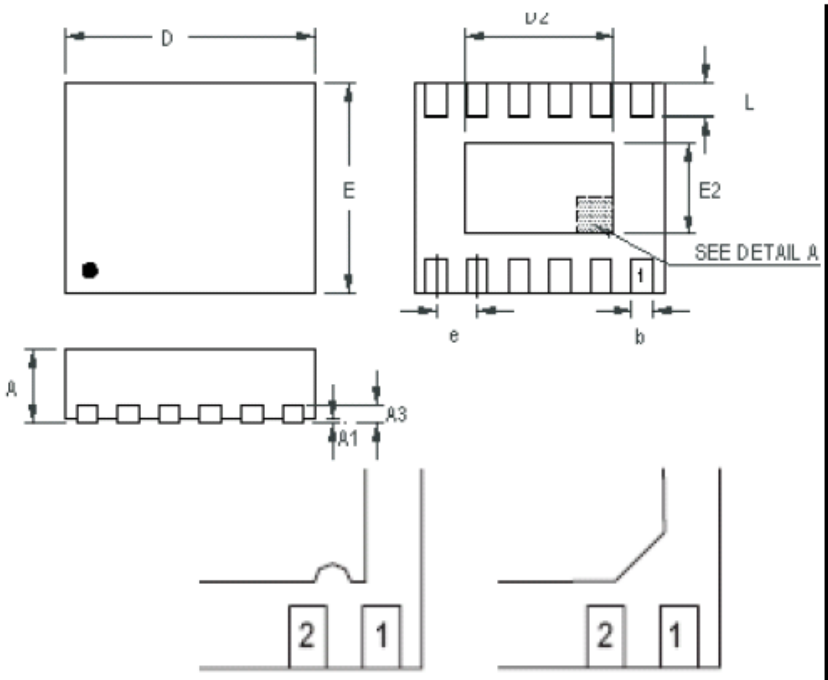



Startup through Enable Waveform



# PACKAGE OUTLINE

## DFN12 3MM X 3MM PACKAGE OUTLINE AND DIMENSIONS




**DETAIL A**

**PIN #1 ID and Tie Bar Mark Options**

| SYMBOL | DIMENSION IN MILIMETERS | | DIMENSION IN INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.700 | 0.800 | 0.028 | 0.031 |
| A1 | 0.000 | 0.050 | 0.000 | 0.002 |
| A3 | 0.175 | 0.250 | 0.007 | 0.010 |
| b | 0.150 | 0.250 | 0.006 | 0.010 |
| D | 2.950 | 3.050 | 0.116 | 0.120 |
| D2 | 2.300 | 2.650 | 0.091 | 0.104 |
| E | 2.950 | 3.050 | 0.116 | 0.120 |
| E2 | 1.400 | 1.750 | 0.055 | 0.069 |
| e | 0.450 | | 0.018 | |
| L | 0.035 | 0.450 | 0.014 | 0.018 |