# 1A, 2A, 1.6MHz, Forced PWM, COT Synchronous Step-Down Converter

## Features

- **Low Quiescent Current at Light Load**
- **Efficiency Up to 95%**
- **$V_{IN}$ Range 2.55V to 6V**
- **$V_{REF}$ 0.6V with ±1% Accuracy**
- **Constant-On-Time Control Scheme Design for Fast Transient Response, Stability with MLCC Output Capacitor**
- **Fixed Soft-Start 0.5ms**
- **Cycle-by-Cycle Over Current Protection**
- **Input Under Voltage Lockout**
- **Output Under Voltage Protection (UVP Hiccup)**
- **Thermal Shutdown Protection**

## Applications

- **Portable and Mobile Devices**
- **Wireless and Networking Devices**
- **LCD TV Power Supply**

## General Description

The G2262C is a high efficiency synchronous step-down DC/DC converter. G2262C provides an adjustable regulated output voltage from 0.6V to VIN while delivering up to 2A of output current with input voltage from 2.55V to 6V.

The Constant-On-Time control scheme in G2262C provides fast transient response to be optimized over a wide range of loads and output capacitors. Thermal shutdown and cycle-by-cycle current limiting are used for protection.

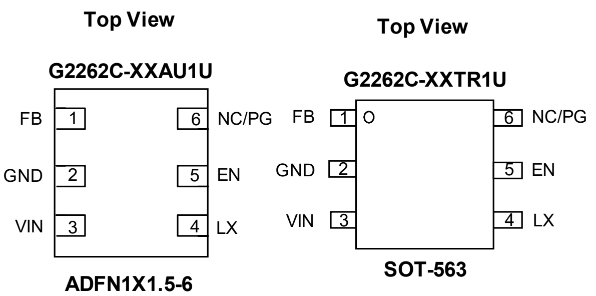
The G2262C is available in small ADFN1X1.5-6 and SOT-563 packages.

## Ordering Information

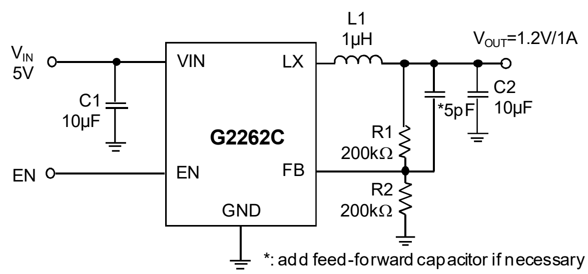
| ORDER NUMBER | MARKING | OUTPUT CURRENT | PG FUNCTION | TEMP. RANGE | PACKAGE (Green) |
|---|---|---|---|---|---|
| G2262C-1AAU1U | 2Hx | 1A | Yes | -40°C to +85°C | ADFN1X1.5-6 |
| G2262C-1BAU1U | 2Ix | 1A | No | -40°C to +85°C | ADFN1X1.5-6 |
| G2262C-2AAU1U | 2Jx | 2A | Yes | -40°C to +85°C | ADFN1X1.5-6 |
| G2262C-2BAU1U | 2Kx | 2A | No | -40°C to +85°C | ADFN1X1.5-6 |
| G2262C-1ATR1U | 2Hx | 1A | Yes | -40°C to +85°C | SOT-563 |
| G2262C-1BTR1U | 2Ix | 1A | No | -40°C to +85°C | SOT-563 |
| G2262C-2ATR1U | 2Jx | 2A | Yes | -40°C to +85°C | SOT-563 |
| G2262C-2BTR1U | 2Kx | 2A | No | -40°C to +85°C | SOT-563 |

Note: AU: ADFN1X1.5-6 TR: SOT-563
1: Bonding Code
U : Tape & Reel
Green: Lead Free / Halogen Free

## Pin Configuration




## Typical Application Circuit



## Absolute Maximum Ratings

VIN, LX, EN, FB, PG. . . . . . . . . . . . . . . . . -0.3V to 6V
LX (AC, less than 10nS) . . . . . . . . . . . . . . . . -3V to 10V
Thermal Resistance of Junction to Ambient, ($\theta_{JA}$)
ADFN1X1.5-6. . . . . . . . . . . . . . . . . . . . . . . . . 220°C/W
SOT-563 . . . . . . . . . . . . . . . . . . . . . . . . . . . . .130°C/W
Continuous Power Dissipation ($T_A$ = +25°C)
ADFN1X1.5-6. . . . . . . . . . . . . . . . . . . . . . . . . . 0.6W
SOT-563. . . . . . . . . . . . . . . . . . . . . . . . . . . . . .0.9W
Thermal Resistance of Junction to Ambient, ($\theta_{JC}$)
ADFN1X1.5-6. . . . . . . . . . . . . . . . . . . . . . . . .110°C/W
SOT-563. . . . . . . . . . . . . . . . . . . . . . . . . .60°C/W

Junction Temperature . . . . . . . . . . . . . . -40°C to150°C
Storage Temperature . . . . . . . . . . . . . . -65°C to 150°C
Reflow Temperature (soldering, 10sec) . . . . . . 260°C
ESD (HBM) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2KV

## Recommended Operating Conditions

Supply Input Voltage. . . . . . . . . . . . . . . . . . . .2.5V to 6V
Ambient Temperature Range. . . . . . . . .-40°C to 85°C
Junction Temperature Range. . . . . . . . -40°C to125°C

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

## Electrical Characteristics

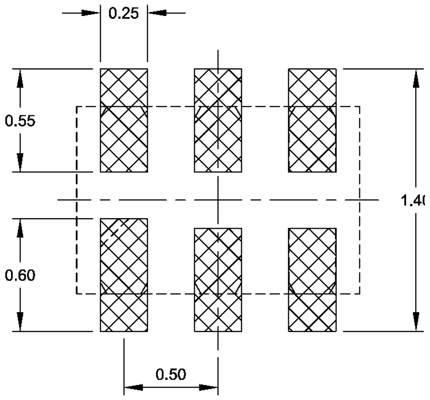
**($V_{IN}$=3.6V, $T_A$=25°C)**

The device is not guaranteed to function outside its operating conditions. Parameters with MIN and/or MAX limits are 100% tested at +25°C, unless otherwise specified.

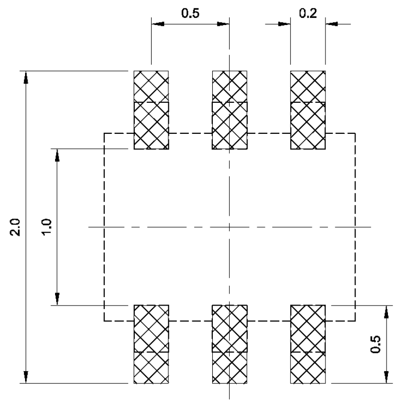
| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Input Voltage | $V_{IN}$ | | 2.55 | --- | 6 | V |
| Feedback Reference Voltage | $V_{REF}$ | | 0.594 | 0.6 | 0.606 | V |
| Feedback Leakage Current | $I_{FB}$ | $V_{FB}$ = 3.3V | --- | --- | 1 | µA |
| DC Bias Current | | $V_{EN}$=0V, shutdown | --- | --- | 0.5 | µA |
| Switching Leakage Current | | | --- | --- | 1 | µA |
| Switching Frequency | | | --- | 1.6 | --- | MHz |
| Switch On Resistance, High | $R_{PMOS}$ | $V_{IN}$ = 3.6V, $I_{LX}$ = 0.3A | --- | 95 | --- | mΩ |
| Switch On Resistance, Low | $R_{NMOS}$ | $V_{IN}$ = 3.6V, $I_{LX}$ = 0.3A | --- | 75 | --- | mΩ |
| PFET Switch Current Limit | $I_{LIM(P)}$ | Output current=2A version | --- | 3.4 | --- | A |
| | | Output current=1A version | --- | 2.4 | --- | A |
| NFET Switch Current Limit | $I_{LIM(N)}$ | Output current=2A version | 2 | 2.5 | --- | A |
| | | Output current=1A version | 1 | 1.5 | --- | A |
| VIN Under Voltage Lockout Threshold | $V_{UVLO}$ | $V_{IN}$ falling | --- | 2.4 | 2.45 | V |
| VIN Under Voltage Lockout Hysteresis | $V_{UVLO\_HYS}$ | $V_{IN}$ rising | --- | 100 | --- | mV |
| Over-Temperature Threshold | | | --- | 150 | --- | °C |
| Thermal Hysteresis | | | --- | 30 | --- | °C |
| EN Input Logic High Voltage | $V_{IH}$ | 2.6V≦$V_{IN}$≦5.5V | 1.2 | --- | --- | V |
| EN Input Logic Low Voltage | $V_{IL}$ | 2.6V≦$V_{IN}$≦5.5V | --- | --- | 0.4 | |
| EN Input Current | $I_{EN}$ | $V_{EN}$=5V | --- | --- | 0.1 | µA |
| Power Good Threshold | $V_{PG\_R}$ | $V_{OUT}$ rising, referenced to $V_{OUT}$ nominal | --- | 95 | --- | % |
| | $V_{PG\_HYST}$ | $V_{OUT}$ falling hysteresis, referenced to $V_{OUT}$ nominal | --- | 5 | --- | % |
| PG Low-Level Output Voltage | $V_{PG(OL)}$ | $I_{SINK}$=1mA, PG function version | --- | --- | 0.4 | V |
| PG Input Leakage Current | $I_{PG(LK)}$ | $V_{PG}$=5V, PG function version | --- | --- | 0.1 | µA |
| Power Good Delay | $t_{PG\_DLY}$ | $V_{FB}$ falling | --- | 40 | --- | µS |
| Soft-Start Time | $T_{SS}$ | VOUT rising from 10% to 90% | --- | 0.5 | --- | ms |
| Minimum Off Time | $T_{MIN-OFF}$ | | --- | 80 | --- | ns |

## Minimum Footprint PCB Layout Section

**ADFN1X1.5-6**



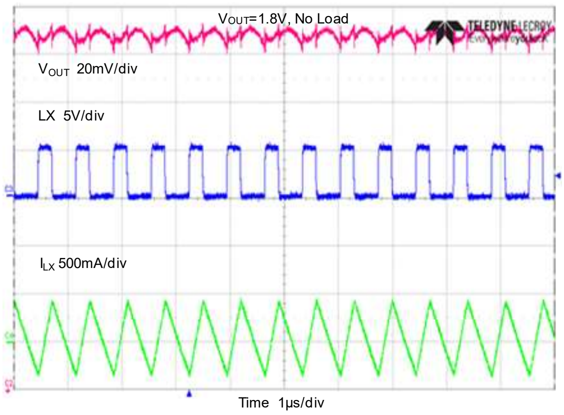

**SOT-563**



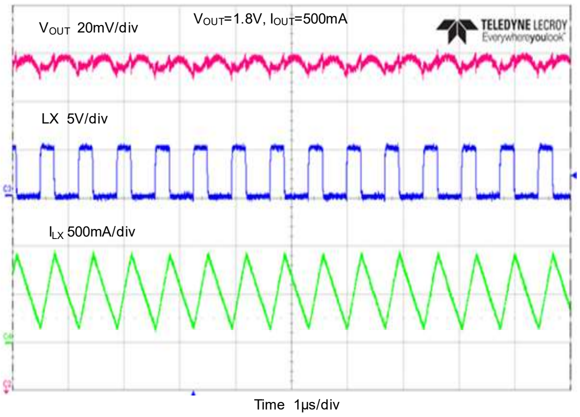
## Typical Performance Characteristics

**($V_{IN}$=5V, $V_{OUT}$=1.8V, $C_{IN}$=10µF, $C_{OUT}$=10µF, L=1µH, CFF=5pF, $T_A$=25°C)**

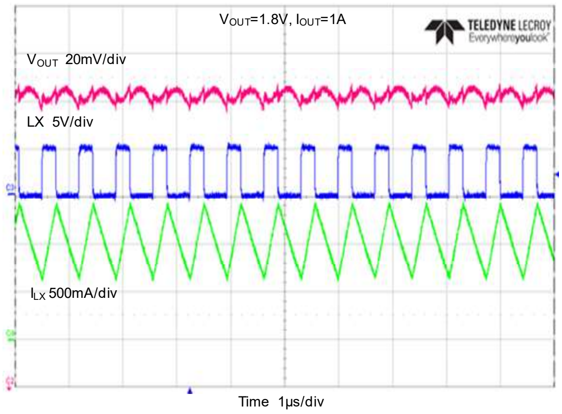
**Steady State Operation**



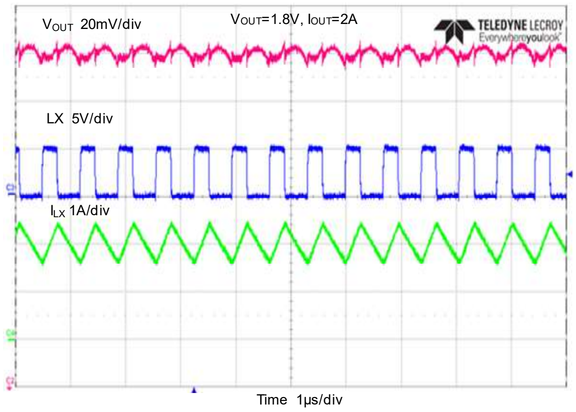

**Steady State Operation**



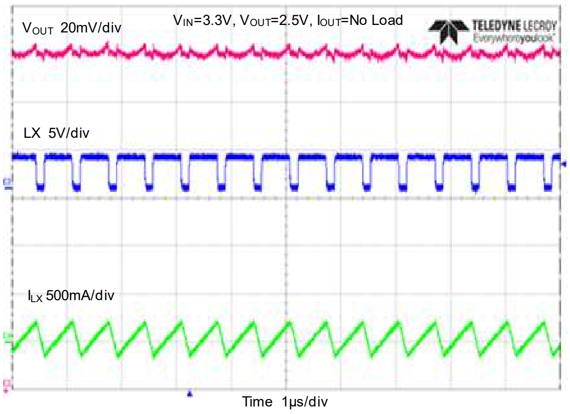

**Steady State Operation**



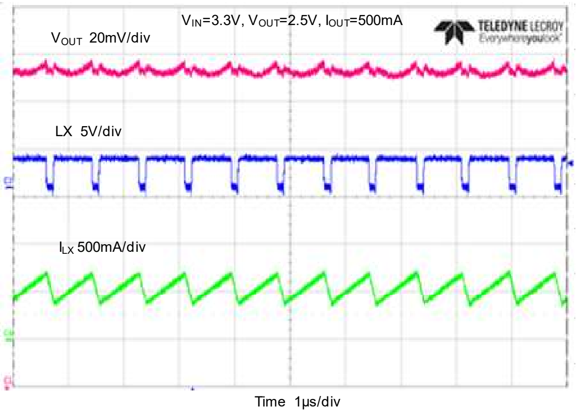

**Steady State Operation**




**Steady State Operation**

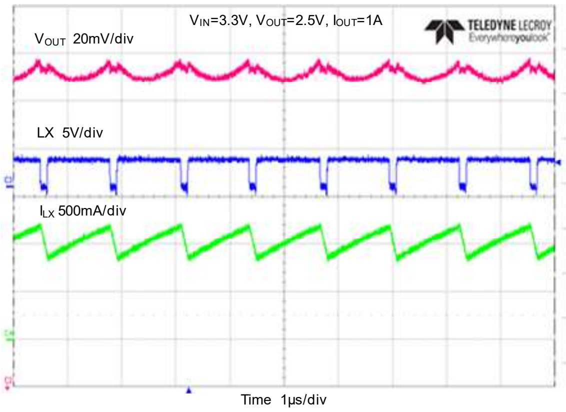



**Steady State Operation**

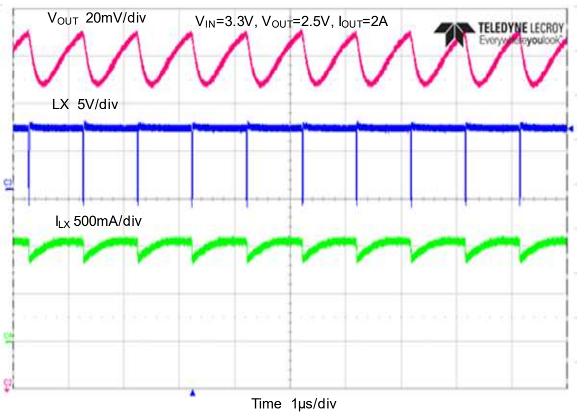


## Typical Performance Characteristics (continued)

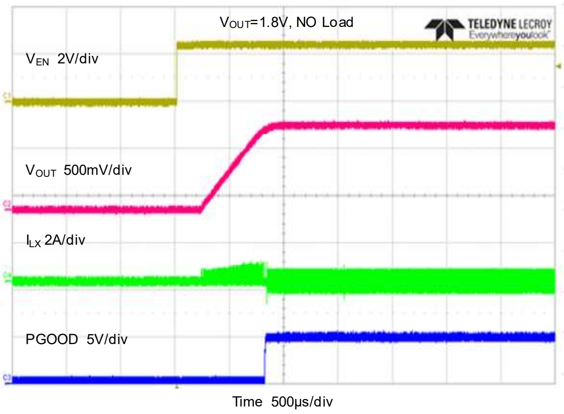
**Steady State Operation**



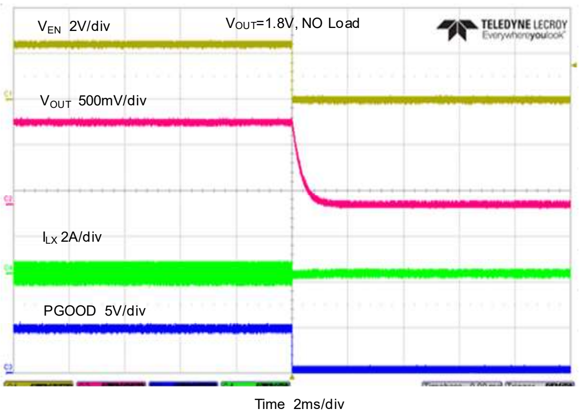

**Steady State Operation**



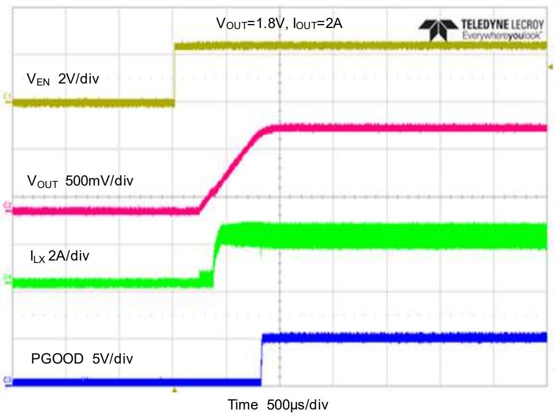

**Start-up Through Enable**



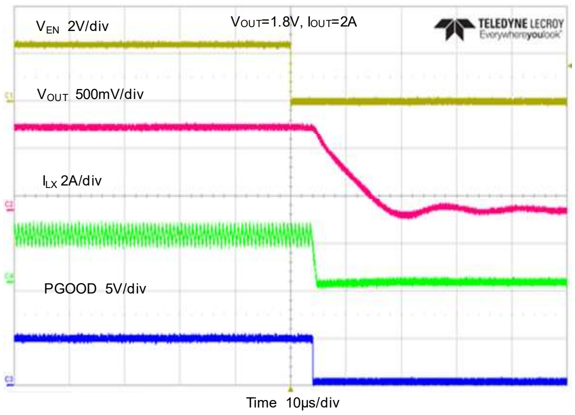

**Shut-down Through Enable**




**Start-up Through Enable**

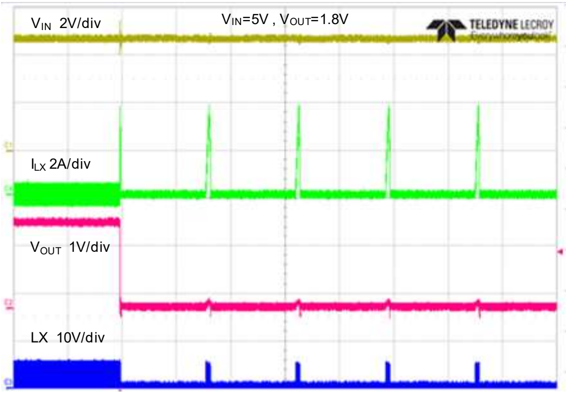



**Shut-down Through Enable**



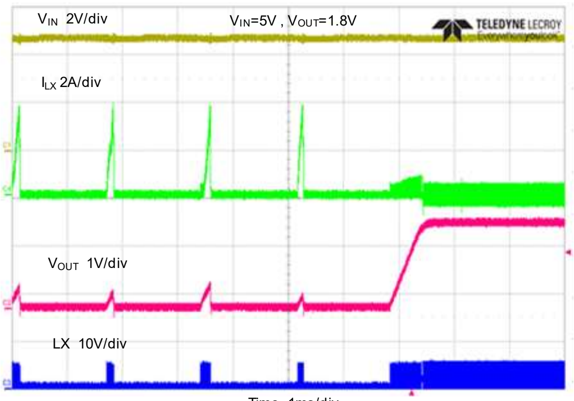
## Typical Performance Characteristics (continued)

Short Circuit



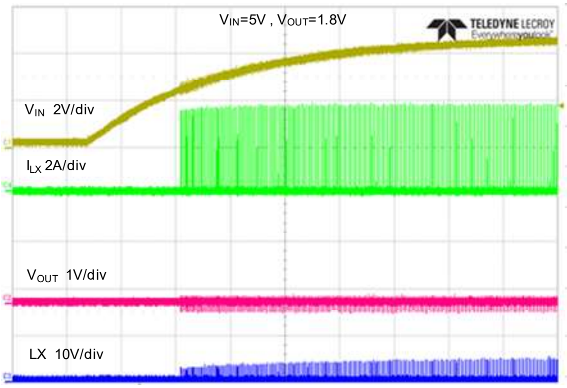

Time 1ms/div

Short Circuit Recovery



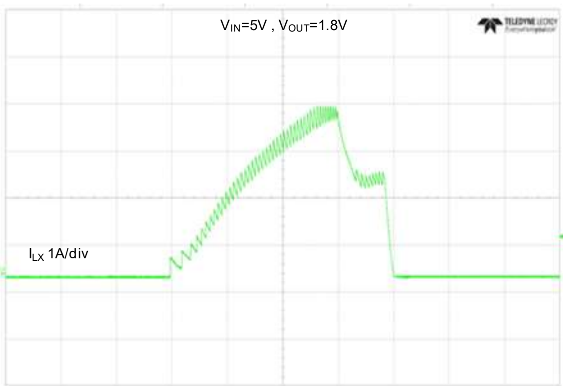

Time 1ms/div

Short Circuit



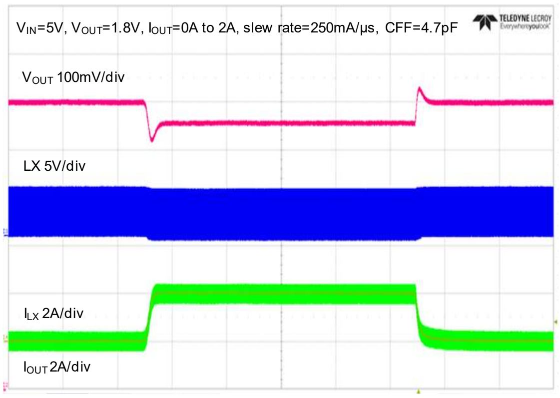

Time 50ms/div

Current Limit



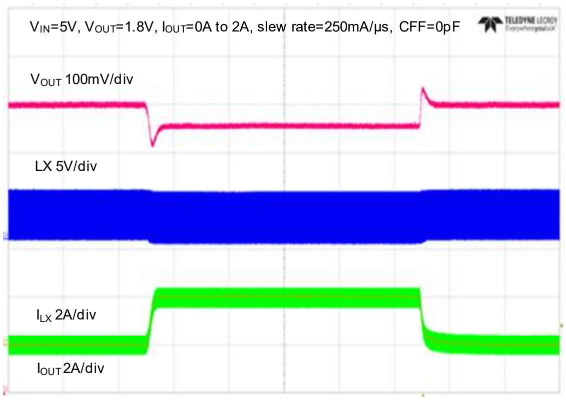

Time 20μs/div

Load Transient



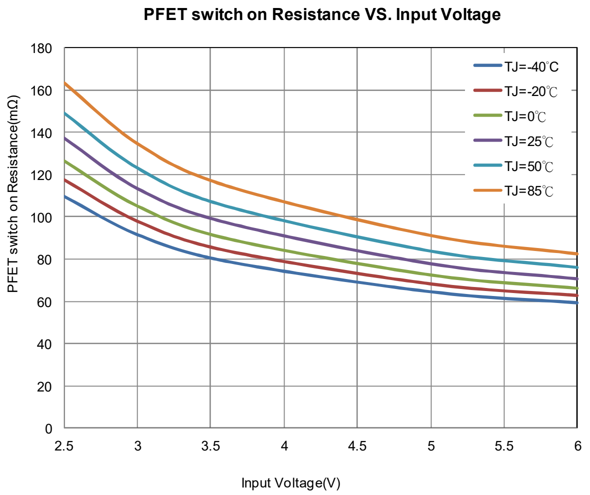

Time 100μs/div

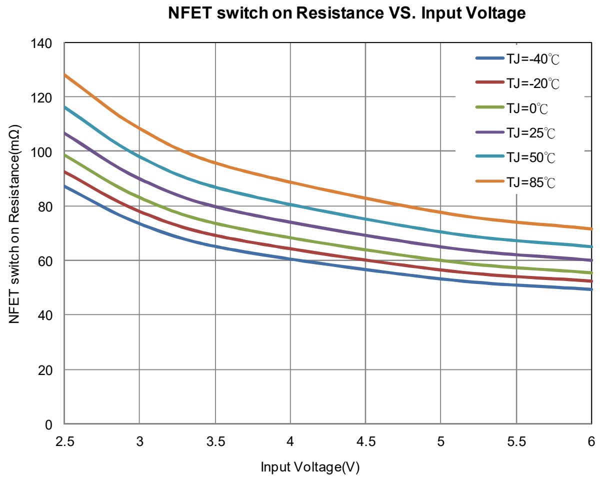
Load Transient

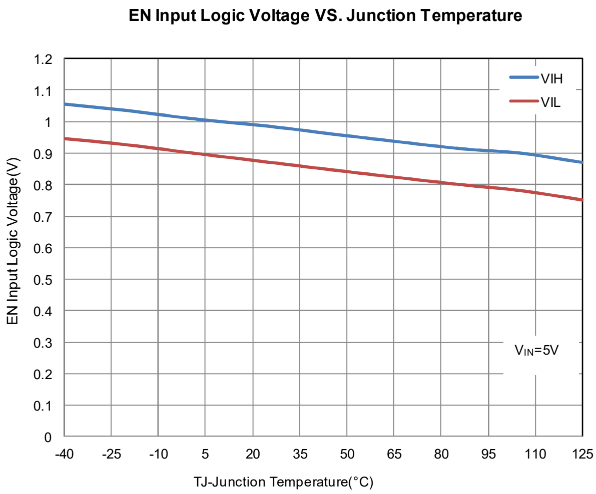


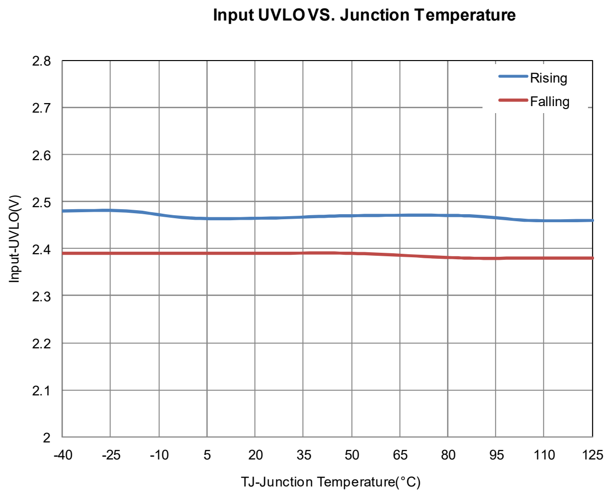

Time 100μs/div

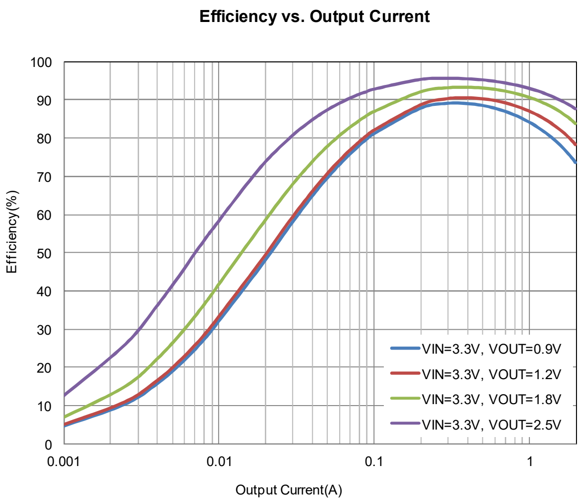
## Typical Performance Characteristics (continued)

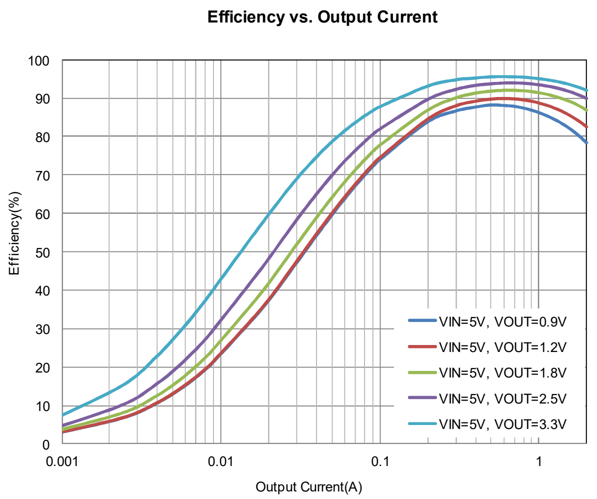


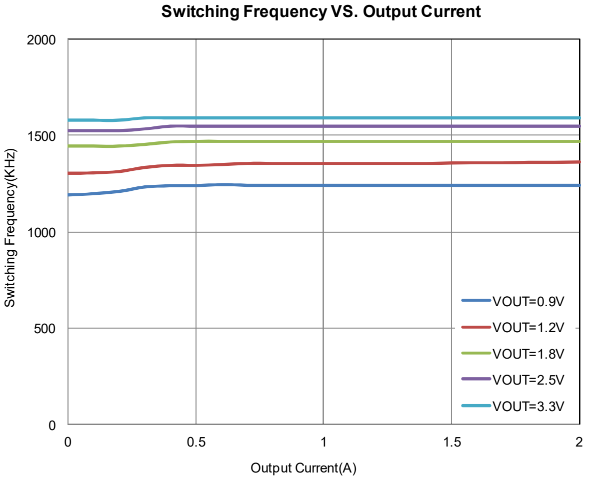



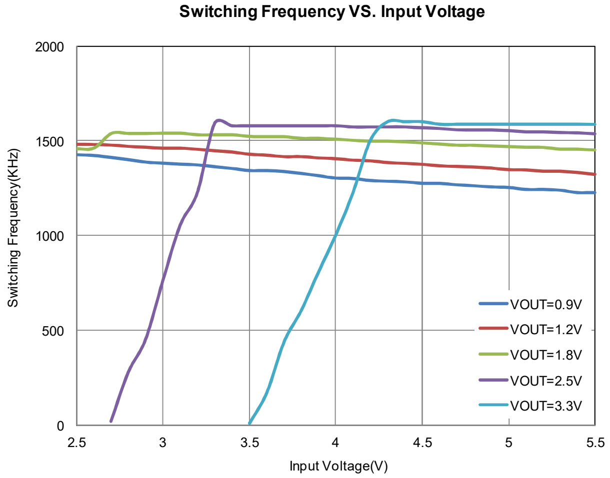



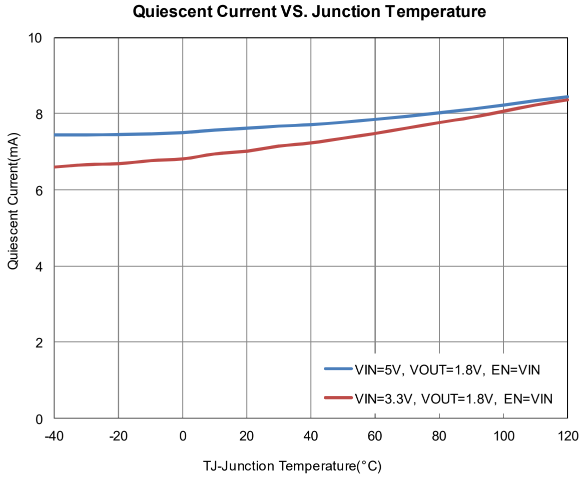



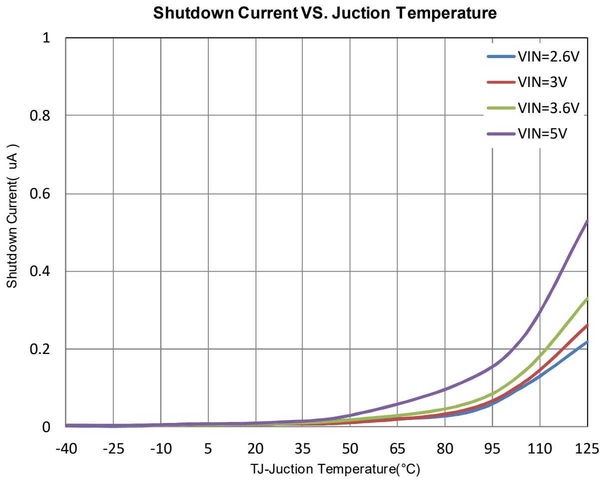



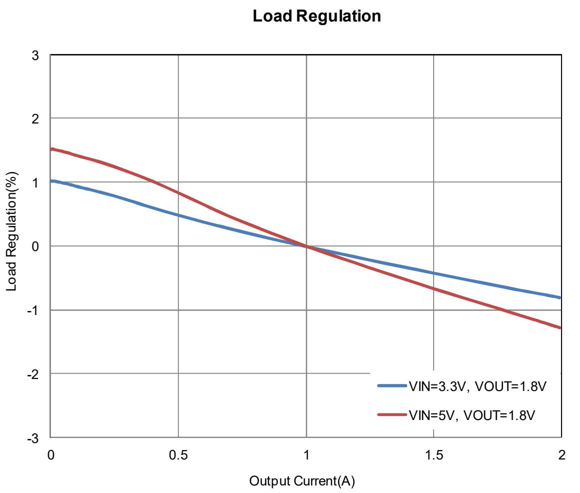
## Typical Performance Characteristics (continued)

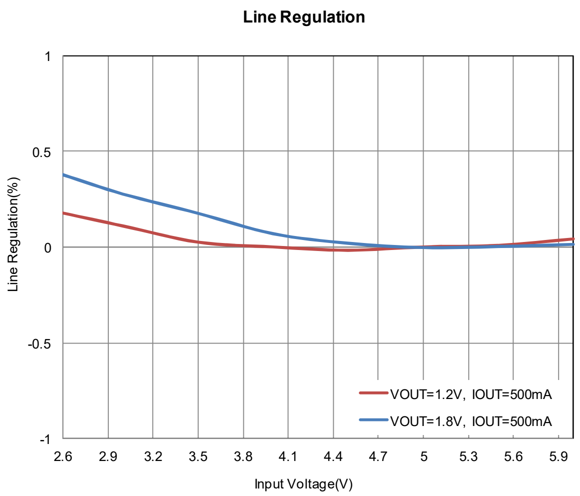


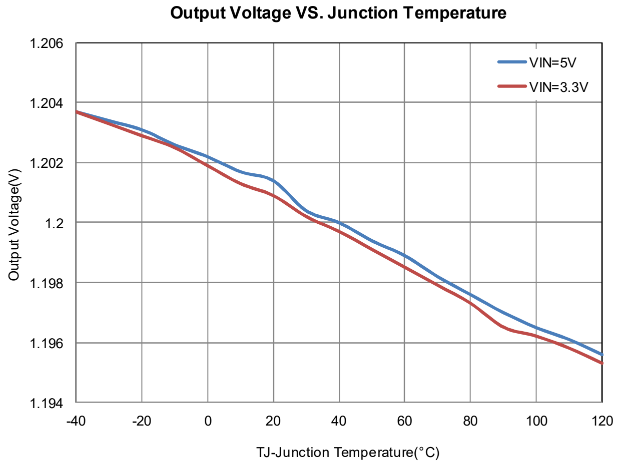



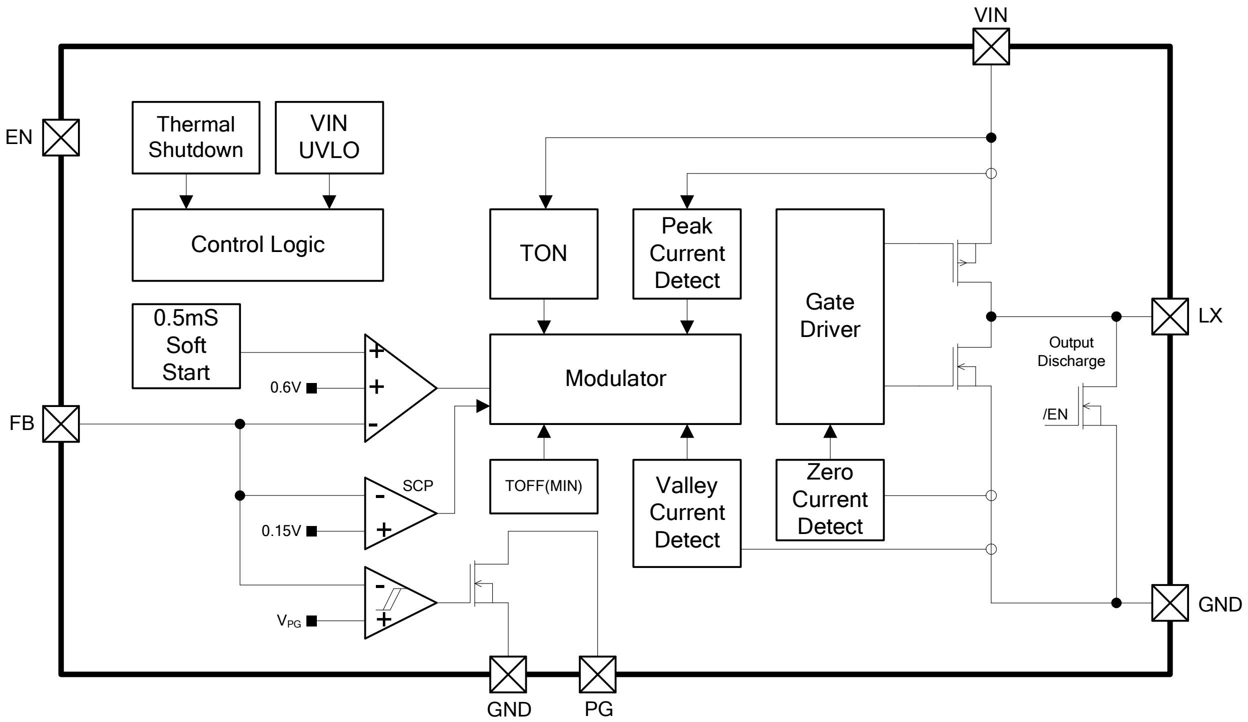
## Typical Performance Characteristics (continued)



## Pin Description

| PIN | NAME | FUNCTION |
|---|---|---|
| 1 | FB | An external resistor divider from the output to GND, tapped to the FB pin, sets the output voltage. |
| 2 | GND | Ground. |
| 3 | VIN | Supply voltage input. The G2262C operates from a 2.55V to 6V input. |
| 4 | LX | Switch node. |
| 5 | EN | Enable control input. Do not leave floating. |
| 6 | PG | Power good indicator. The output of this pin is an open drain output. Keep PG pulls up voltage is lower than Vin. |
| | NC | No connection pin. Leave this pin open or to the output. |

## Block Diagram



## Operation

The G2262C is a high efficiency synchronous step-down DC/DC converter. G2262C provides an adjustable regulated output voltage from 0.6V to VIN while delivering up to 2A of output current with input voltage from 2.55V to 6V.

The G2262C uses the constant on-time control scheme. The high side P-MOSFET is turned on and off by the Ton circuit block.

By comparing the feedback voltage ($V_{FB}$) from the output voltage with the internal 0.6V reference, COMP voltage of the error amplifier output is adjusted. When the load current increases, it causes a drop in the feedback voltage relative to 0.6V reference, then the COMP voltage rises to allow higher inductor current for the load current.

### Enable

When the input voltage is greater than the under voltage lockout threshold, a logic-high (>1.2V) enables the converter; a logic-low (<0.4V) or floating forces the IC into shutdown mode. There is an internal 1.6Meg Ohm resistor from EN pin to GND.
When the device is disabled, there is a 10 Ohm resistive discharge path from LX pin.

### Soft-Start (SS)

There is an internal built-in soft-start to ramp the output voltage at a fixed slew rate to avoid in-rush current. The typical soft-start time is 0.5ms. It is able to start into a pre-biased output capacitor. The converter starts with the biased voltage and ramps the output voltage to its nominal value.

### Over Current Protection (OCP)

The G2262C provides the over current protection by detecting the high side MOSFET peak inductor current (3.4A typ.) and the low-side MOSFET valley inductor current (2.5A typ.). If the inductor current is over the peak current limit threshold, the high-side MOSFET is turned off and the low-side MOSFET is turned on. Once the inductor current is larger than the valley current limit, the next switching cycle is not allowed. This avoids increasing the inductor current and protects the components.

### HICCUP Protection

When the inductor current limit is triggered 8 times, the inductor current limit is reduced to half for the next 8 cycles, and then the device stops switching to protect the components. After a delay of 1ms, G2262C automatically starts a new start-up procedure. Therefore, Hiccup protection is achieved and repeated until the high load condition is removed.

### Power Good

G2262C has an open drain and needs an external pull up resistor for the power good indicator. When $V_{FB}$ is high than 90% of regulated voltage, PG will be pulled high by the external pull up resistor. If $V_{FB}$ drops lower than 85% of regulated voltage, PG will be pulled low by the internal NMOS. Please keep PG pull up voltage is lower than $V_{IN}$.

### Thermal Shutdown (OTP)

When the junction temperature exceeds 150°C, the thermal shutdown protection is triggered to stop switching. Once the die temperature decreases below the hysteresis of 30°C, the device start the power up sequence again.

## Application Information

The G2262C is a single-phase buck converter. It provides single feedback loop, constant on-time control with fast transient response, and high efficiency. An internal 0.6V reference allows the low output voltage application. Over current protection, under voltage protection, and over temperature protection are all provided by G2262C.

### Output Voltage Setting

Connect a resistive voltage divider at the FB between $V_{OUT}$ and GND to adjust the output voltage. The output voltage is set by the following equation:

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R1}{R2}\right)$$

where $V_{REF}$ is the feedback reference voltage 0.6V (typ.).

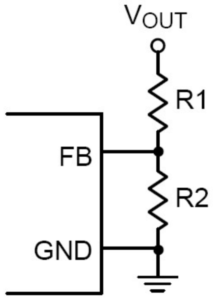



**Figure 1. Setting $V_{OUT}$ with a Voltage Divider**

**Inductor Selection**

For high efficiency application, an inductor with a DC resistance less than 15mOhm is recommended. Estimate the inductor value by the following equation :

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{f_{SW} \times LIR \times I_{LOAD(MAX)} \times V_{IN}}$$

where LIR is the ratio of the peak-to-peak ripple current to the average inductor current. Find a low loss inductor with the lowest possible DC resistance leading to high performance.

To avoid inductor saturation, the core must be large enough for the peak inductor current ($I_{PEAK}$) :

$$I_{PEAK} = I_{LOAD(MAX)} + \left(\frac{LIR}{2} \times I_{LOAD(MAX)}\right)$$

**Input Capacitor Selection**

High quality ceramic input decoupling capacitor, such as X5R or X7R, with values greater than 10uF are recommended for the input capacitor. Ceramic capacitors with X5R and X7R are highly recommended due to the low ESR, less capacitance variation, and more temperature stability.

Voltage rating and current rating are the key parameters when selecting an input capacitor. Generally, selecting an input capacitor with voltage rating 1.5 times greater than the maximum input voltage is a conservatively safe design.

The input capacitor is used to supply the input RMS current, which can be approximately calculated using the following equation :

$$I_{IN\_RMS} = I_{LOAD} \times \sqrt{\frac{V_{OUT}}{V_{IN}} X \left(1 - \frac{V_{OUT}}{V_{IN}}\right)}$$

The input capacitor requires an adequate ripple current rating due to the absorption of the input switching current. The input capacitance value determines the input ripple voltage of the regulator. The input voltage ripple caused by capacitor can be approximately calculated using the following equation:

$$\Delta V_{IN} = \frac{I_{OUT(MAX)}}{C_{IN} \times f_{SW}} X \frac{V_{OUT}}{V_{IN}} X \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

**Output Capacitor Selection**

The output voltage ripple (VP-P) can be calculated by the following equation:

$$V_{P\_P} = LIR \times I_{LOAD(MAX)} \times \left(ESR + \frac{1}{8 \times C_{OUT} \times f_{SW}}\right)$$

Selecting the low ESR capacitor is preferred to limit the output voltage ripple. Generally, a 10uF output ceramic capacitor will be sufficient in 1A output current application. For 2A output current application, a 20uF output capacitor is necessary for a more stable system, especially in the condition of a higher output voltage ($V_{OUT}$>2.5V).

During load transient, the output capacitor supplies the load current before the control loop can response. Therefore, the ESR will dominate the output voltage sag during load transient. The output voltage undershoot (VSAG) can be calculated by the following equation:

$$V_{SAG} = \Delta I_{LOAD} \times ESR$$

For a given output voltage sag specification, the ESR value can be determined.

The equivalent series inductance (ESL) also has influence on VSAG when the rapid change in load current results in di/dt during transient. Using a capacitor with low ESL can obtain better transient performance.

**Thermal Considerations**

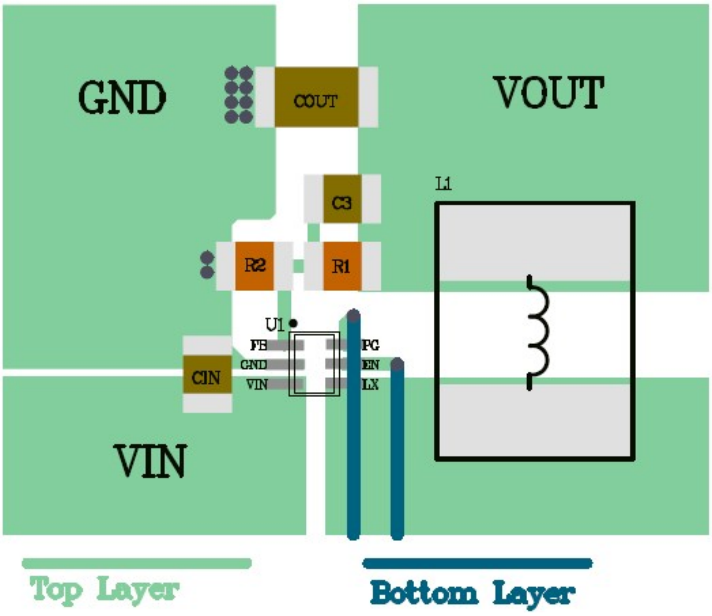
The maximum power dissipation depends on the thermal resistance of the IC package, PCB layout, rate of surrounding airflow, and difference between junction and ambient temperature. The maximum power dissipation can be calculated by the following equation:

$$P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$$

where $T_{J(MAX)}$ is the maximum junction temperature, $T_A$ is the ambient temperature, and $\theta_{JA}$ is the junction to ambient thermal resistance. $\theta_{JA}$, is layout dependent.

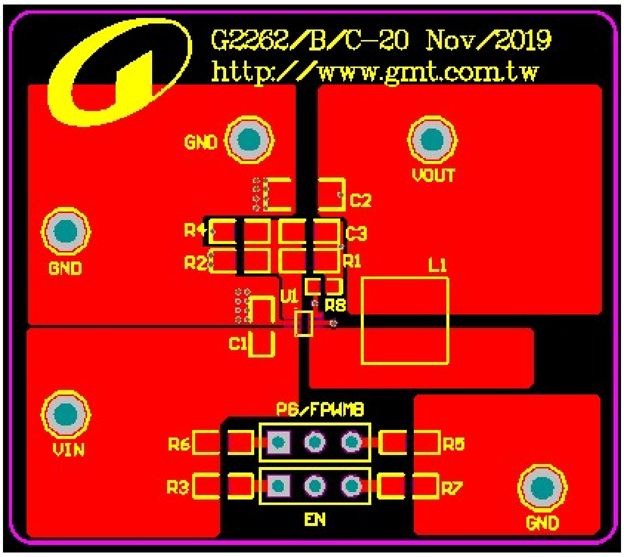
## PCB Layout guidelines

1. Place the CIN as close to the VIN pin as possible.
2. Minimize the copper area of LX trace to lower electrical and magnetic field radiation but make the trace wide enough to carry the output current.
3. Put the COUT near to the inductor and the IC. Tie the ground connection to the IC ground with GND plane.
4. Keep the trace for the FB away from the switching high current paths and first go through the regulator output capacitors.

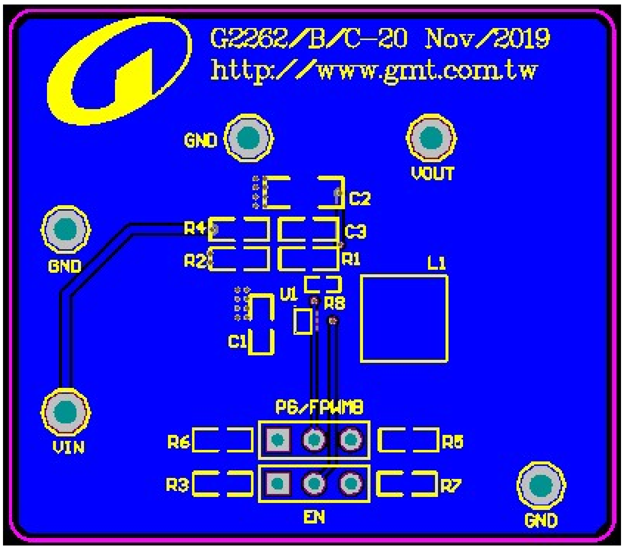



## EV Board PCB Layout Section

**Top Layer**

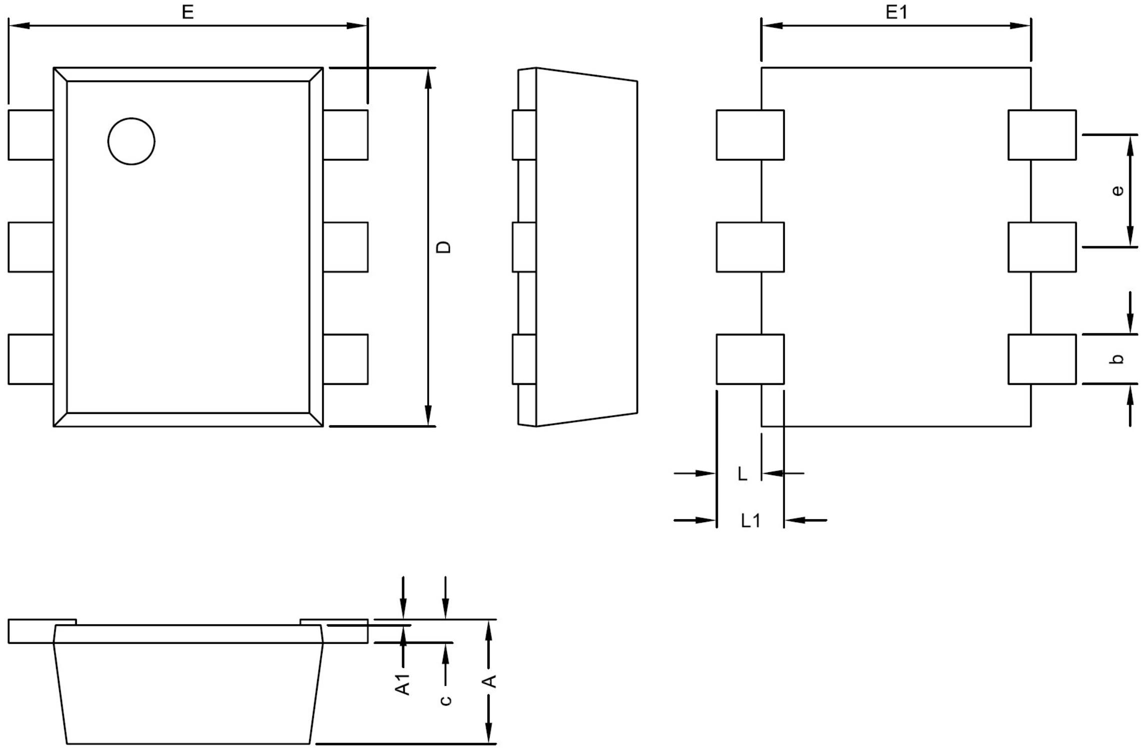



**Bottom Layer**




| EV2262C PCB | Information |
|---|---|
| Board Material | FR4 |
| Size | 36.83mm*41.93mm |
| Board Thickness | 1.6mm |
| Layers | 2 |
| Copper Thickness | 1oz |

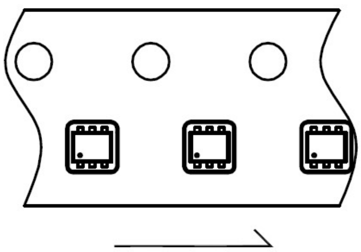
## Package Information




**SOT-563 Package**

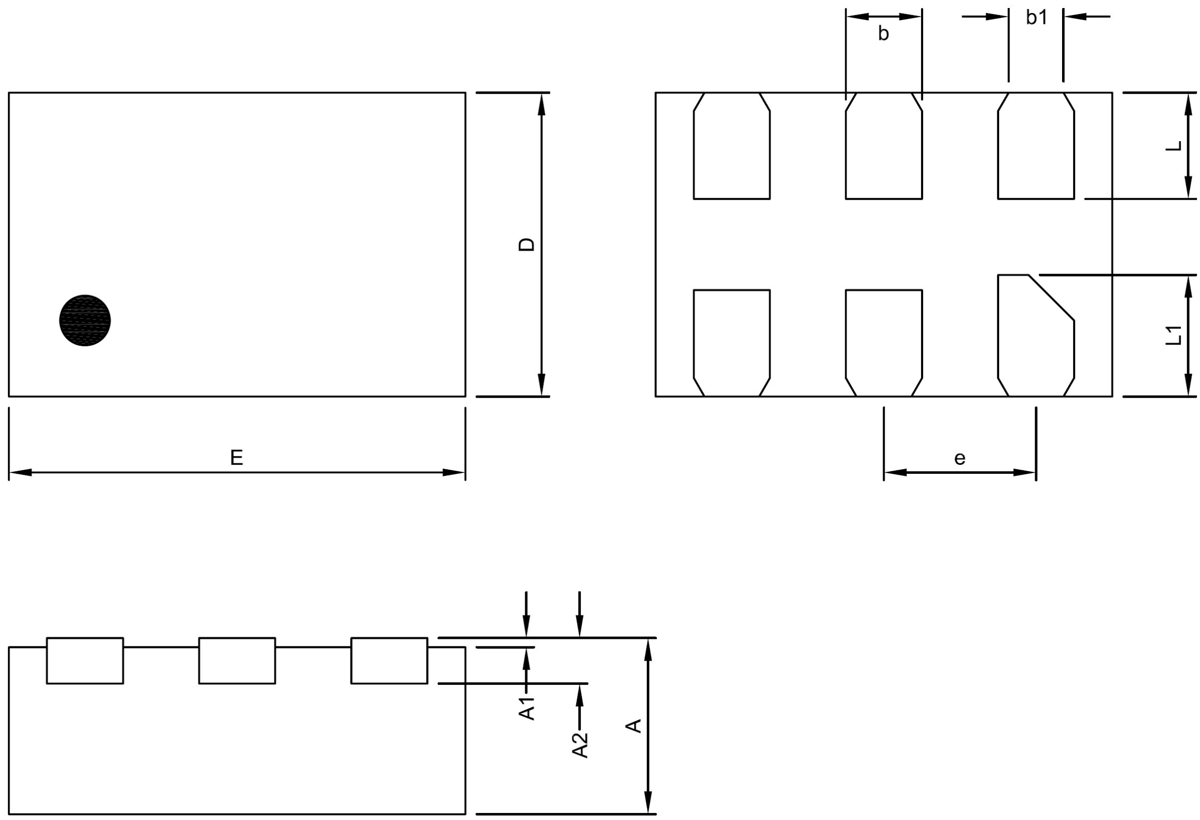
| Symbol | DIMENSION IN MM | | | DIMENSION IN INCH | | |
|---|---|---|---|---|---|---|
| | **MIN.** | **NOM.** | **MAX.** | **MIN.** | **NOM.** | **MAX.** |
| A | 0.525 | - - - | 0.600 | 0.021 | - - - | 0.024 |
| A1 | 0.00 | - - - | 0.05 | 0.000 | - - - | 0.002 |
| e | 0.500 BSC | | | 0.0197 BSC | | |
| c | 0.090 | - - - | 0.180 | 0.004 | - - - | 0.007 |
| D | 1.500 | 1.600 | 1.700 | 0.059 | 0.063 | 0.067 |
| b | 0.170 | 0.220 | 0.270 | 0.007 | 0.009 | 0.011 |
| E1 | 1.100 | 1.200 | 1.300 | 0.043 | 0.047 | 0.051 |
| E | 1.500 | 1.600 | 1.700 | 0.059 | 0.063 | 0.067 |
| L | 0.100 | 0.200 | 0.300 | 0.004 | 0.008 | 0.012 |
| L1 | 0.200 | 0.300 | 0.400 | 0.008 | 0.012 | 0.016 |

## Taping Specification



Feed Direction

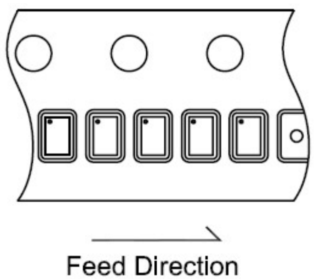
| PACKAGE | Q'TY/REEL |
|---|---|
| SOT-563 | 3,000ea |




**ADFN1X1.5-6 Package**

| Symbol | DIMENSION IN MM | | | DIMENSION IN INCH | | |
|---|---|---|---|---|---|---|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | 0.50 | 0.55 | 0.60 | 0.0197 | 0.0217 | 0.0236 |
| A1 | 0.00 | - - - | 0.05 | 0.0000 | - - - | 0.0020 |
| A2 | 0.152 REF | | | 0.0060 REF | | |
| D | 0.95 | 1.00 | 1.05 | 0.0374 | 0.0394 | 0.0413 |
| E | 1.45 | 1.50 | 1.55 | 0.0571 | 0.0591 | 0.0610 |
| b | 0.20 | 0.25 | 0.30 | 0.0079 | 0.0098 | 0.0118 |
| b1 | 0.18 REF | | | 0.0071 REF | | |
| e | 0.50 BSC | | | 0.0197 BSC | | |
| L | 0.30 | 0.35 | 0.40 | 0.0118 | 0.0138 | 0.0157 |
| L1 | 0.35 | 0.40 | 0.45 | 0.0138 | 0.0157 | 0.0177 |

## Taping Specification




| PACKAGE | Q'TY/REEL |
|---|---|
| ADFN1.0X1.5-6 | 5,000ea |