

## 1.5MHz, 1.5A, High Efficiency PWM Step-Down DC/DC Converter

### General Description

The ID8215 is a high-efficiency, DC-to-DC step-down switching regulator, capable of delivering up to 1.5A of output current. The devices operate from an input voltage range of 2.6V to 5.5V and provide output voltages from 0.6V to VIN, making the iD8215 ideal for low voltage power conversions. Running at a fixed frequency of 1.5MHz allows the use of small inductance value and low DCR inductors, thereby achieving higher efficiencies. Other external components, such as ceramic input and output caps, can also be small due to higher switching frequency, while maintaining exceptional low noise output voltages. Built-in EMI reduction circuitry makes this converter ideal power supply for RF applications. Internal soft-start control circuitry reduces inrush current. Short-circuit and thermal-overload protection improves design reliability.

iD8215 is housed in a tiny SOT-23-5 and TDFN-6L package.

### Ordering Information

iD8215 -

Package:  
A50: SOT-23-5  
FF6: TDFN- 6L(2X2), Pitch=0.65  
FF7: TDFN- 6L(2X2), Pitch=0.65

Taping  
R: Tape and Reel

| Output Voltage | Voltage Code |
|----------------|--------------|
| Adjustable     | AD           |

### Applications

- USB ports/Hubs
- Hot Swaps
- Cellphones
- Tablet PC
- Set Top Boxes

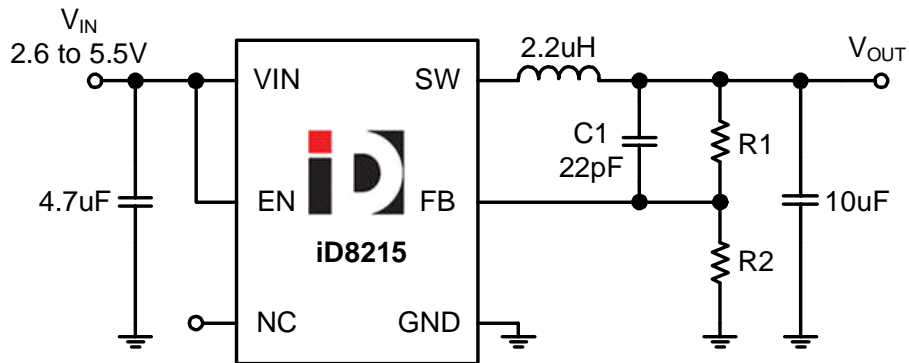
### Features

- Up to 1.5A Max Output Current
- 1.5MHz Frequency
- Light Load operation
- Internal Compensation
- Tiny SOT-23-5 and TDFN-6L Package

### Marking Information

For marking information, please contact our sales representative directly or through distributor around your location.

**Typical Application Circuit  
(Adjustable Operation)**



**Absolute Maximum Ratings** (Note 1)

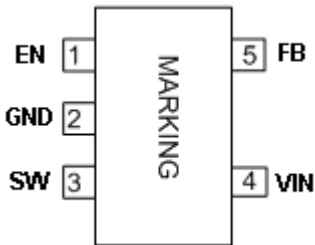
|  |                |
|--|----------------|
| IN, SW, FB, EN Voltage                                   | -0.3V to 6 V   |
| Power Dissipation, P <sub>D</sub> @ T <sub>A</sub> =25°C |                |
| SOT-23-5   | 600mW          |
| TDFN-6L  | 1282mW         |
| Thermal Resistance, θ <sub>ja</sub>                      |                |
| SOT-23-5   | 167°C/W        |
| TDFN-6L  | 78°C/W         |
| Lead Temperature   | 260°C          |
| Storage Temperature                                      | -65°C to 150°C |
| ESD Susceptibility                                       |                |
| HBM (Human Body Mode)                                    | 2kV            |
| MM (Machine Mode)  | 200V           |

**Recommended Operating Conditions**

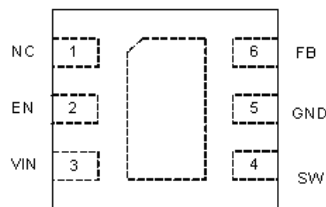
|                               |                       |
|-------------------------------|-----------------------|
| Input Voltage V <sub>IN</sub> | 2.6V to 5.5V          |
| EN Input Voltage              | 0V to V <sub>IN</sub> |
| Junction Temperature          | -40°C to 125°C        |
| Ambient Operating Temperature | -40°C to 85°C         |

**Pin Configurations**

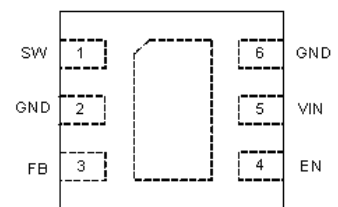
(Top View)



**SOT-23-5**



**TDFN-6L (FF6)**



**TDFN-6L (FF7)**

## Pin Description

| SOT-23-5 | TDFN-6L (FF6) | TDFN-6L (FF7) | Name | Description   |
|----------|---------------|---------------|------|---|
| 1        | 2             | 4             | EN   | Chip Enable (Active High).                              |
| 4        | 3             | 5             | VIN  | Power Input.  |
| 3        | 4             | 1             | SW   | Pin for Switching.                                      |
| 2        | 5             | 2, 6          | GND  | Ground.   |
| 5        | 6             | 3             | FB   | Feedback  |
| -        | 1             |               | NC   | No Internal Connection (Floating or Connecting to GND). |

## Electrical Characteristics ( $V_{IN} = 3.6V$ , unless otherwise specified. Typical values are at $T_A = 25^{\circ}C$ )

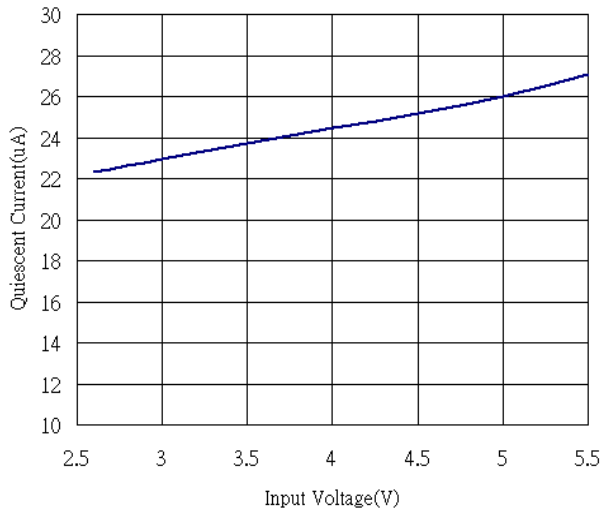
| Parameters                | Condition                               | Min   | Typ  | Max   | Units      |
|---------------------------|---|-------|------|-------|------------|
| Input Voltage Range       |   | 2.6   |      | 5.5   | V          |
| Input UVLO                | Rising, Hysteresis=90mV                 |       | 2.5  |       | V          |
| Input Supply Current      | VFB =0.65V                              |       | 38   |       | $\mu A$    |
| Input Shutdown Current    |   |       |      | 1     | $\mu A$    |
| FB Feedback Voltage       | VIN=2.5 to 5V                           | 0.582 | 0.6  | 0.618 | V          |
| FB Input Current          |   |       | 0.01 |       | $\mu A$    |
| Output Voltage Range      |   | 0.6   |      | VIN   | V          |
| Load Regulation           |   |       | 0.1  |       | %          |
| Line Regulation           | $V_{IN}=2.6$ to 5.5V                    |       | 0.04 |       | %/V        |
| Switching Frequency       |   |       | 1.5  |       | MHz        |
| NMOS Switch On Resistance | $I_{SW}=200mA$                          |       | 280  |       | m $\Omega$ |
| PMOS Switch On Resistance | $I_{SW}=200mA$                          |       | 200  |       | m $\Omega$ |
| PMOS Switch Current Limit |   | 1.5   |      |       | A          |
| SW Leakage Current        | $V_{IN}=5.5V, V_{SW}=0$ or 5.5V, EN=GND |       |      | 10    | $\mu A$    |
| EN Input Current          |   |       |      | 1     | $\mu A$    |
| EN Input Low Voltage      |   | 0.4   |      |       | V          |
| EN Input High Voltage     |   |       |      | 1.5   | V          |

**Note 1:** Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. 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 remain possibility to affect device reliability.

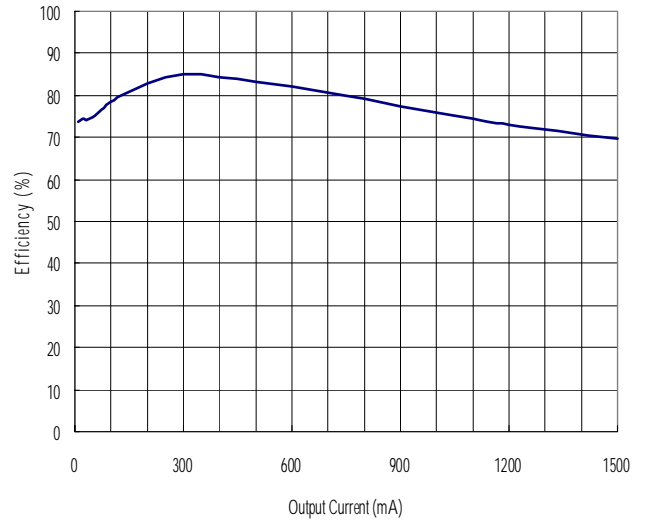
# Typical Operating Characteristics

(Vin=5V Vout=1.2V)

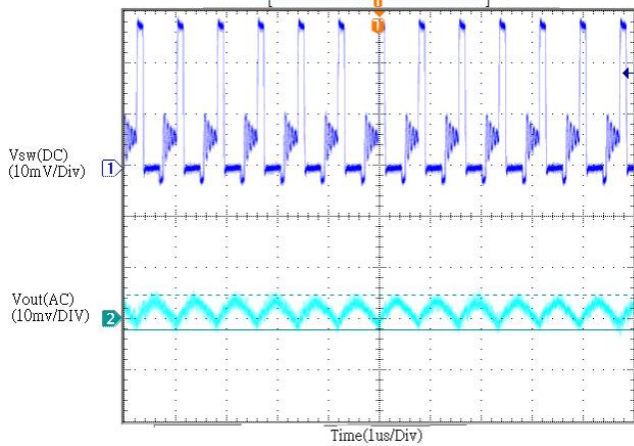
Quiescent Current vs. Input Voltage



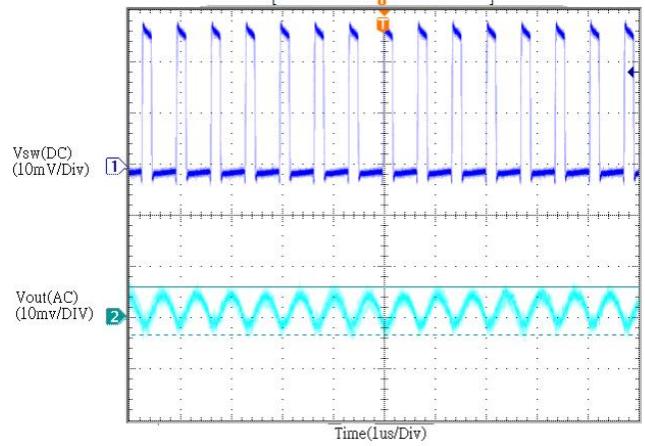
Efficiency VS. Output Current



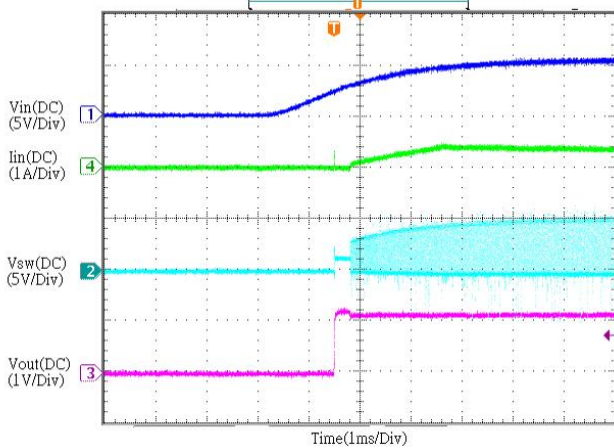
Light Load Operation



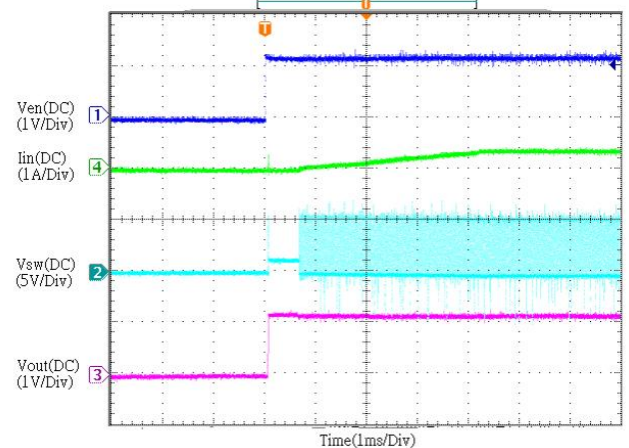
Heavy Load Operation

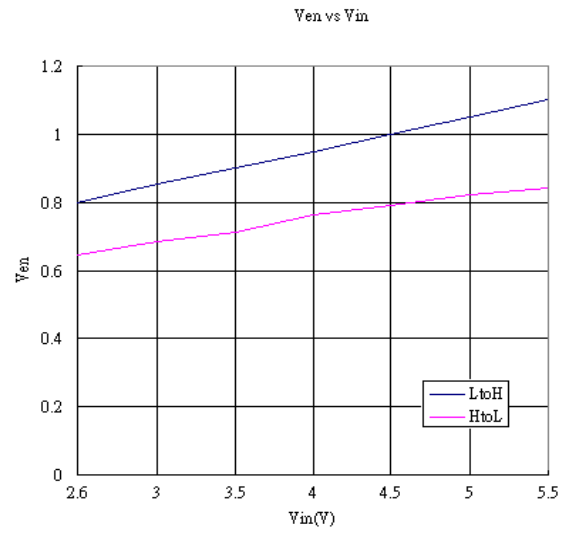
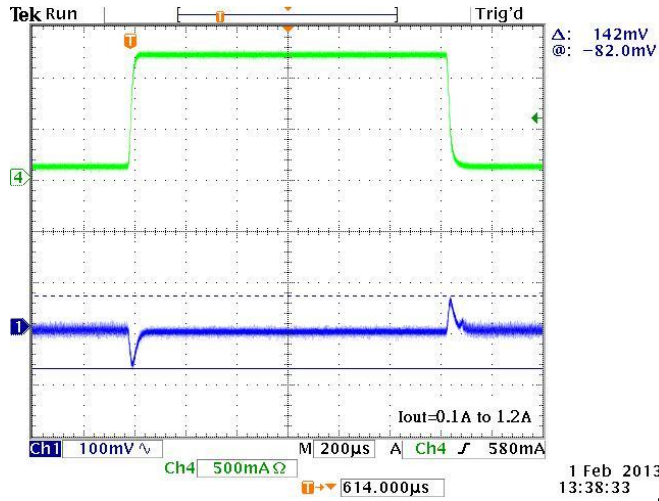


Power On from Vin



Power On from EN





## Applications Information

### FUNCTION DESCRIPTION

The iD8215 high efficiency switching regulator is a small, simple, DC-to-DC step-down converter capable of delivering up to 1.5A of output current. The device operates in pulse-width modulation (PWM) at 1.5MHz from a 2.6V to 5.5V input voltage and provides an output voltage from 0.6V to  $V_{IN}$ , making the iD8215 ideal for on-board post-regulation applications. An internal synchronous rectifier improves efficiency and eliminates the typical Schottky free-wheeling diode. Using the on resistance of the internal high-side MOSFET to sense switching currents eliminates current-sense resistors, further improving efficiency and cost.

### Loop Operation

iD8215 uses a PWM current-mode control scheme. An open-loop comparator compares the integrated voltage-feedback signal against the sum of the amplified current-sense signal and the slope compensation ramp. At each rising edge of the internal clock, the internal high-side MOSFET turns on until the PWM comparator terminates the on cycle. During this on-time, current ramps up through the inductor, sourcing current to the output and storing energy in the inductor. The current mode feedback system regulates the peak inductor current as a function of the output voltage error signal. During the off cycle, the internal high-side P-channel MOSFET turns off, and the internal low-side N-channel MOSFET turns on. The inductor releases the stored energy as its current ramps down while still providing current to the output.

### Current Sense

An internal current-sense amplifier senses the current through the high-side MOSFET during on time and produces a proportional current signal, which is used to sum with the slope compensation signal. The summed signal then is compared with the error

amplifier output by the PWM comparator to terminate the on cycle.

### Current Limit

There is a cycle-by-cycle current limit on the high-side MOSFET. When the current flowing out of SW exceeds this limit, the high-side MOSFET turns off and the synchronous rectifier turns on. iD8215 utilizes a frequency fold-back mode to prevent overheating during short-circuit output conditions. The device enters frequency fold-back mode when the FB voltage drops below 200mV, limiting the current to  $I_{PEAK}$  and reducing power dissipation. Normal operation resumes upon removal of the short-circuit condition.

### Soft-start

iD8215 has an internal soft-start circuitry to reduce supply inrush current during startup conditions. When the device exits under-voltage lockout (UVLO), shutdown mode, or restarts following a thermal-overload event, the I soft-start circuitry slowly ramps up current available at SW.

### UVLO and Thermal Shutdown

If  $V_{IN}$  drops below 2.5V, the UVLO circuit inhibits switching. Once  $V_{IN}$  rises above 2.6V, the UVLO clears, and the soft-start sequence activates. Thermal-overload protection limits total power dissipation in the device. When the junction temperature exceeds  $T_J = +160^{\circ}\text{C}$ , a thermal sensor forces the device into shutdown, allowing the die to cool. The thermal sensor turns the device on again after the junction temperature cools by  $15^{\circ}\text{C}$ , resulting in a pulsed output during continuous overload conditions. Following a thermal-shutdown condition, the soft-start sequence begins.

## DESIGN PROCEDURE

### Setting Output Voltages

Output voltages are set by external resistors. The FB threshold is 0.6V.

$$R_{TOP} = R_{BOTTOM} \times [(V_{OUT} / 0.6) - 1]$$

### Input Capacitor and Output Capacitor Selection

The input capacitor in a DC-to-DC converter reduces current peaks drawn from the battery or other input power source and reduces switching noise in the controller. The impedance of the input capacitor at the switching frequency should be less than that of the input source so high-frequency switching currents do not pass through the input source.

The out ripple with a ceramic capacitor is approximately as follows:

$$V_{RIPPLE} = I_{L(PEAK)} [1 / (2\pi \times f_{OSC} \times C_{OUT})]$$

If the capacitor has significant ESR, the output ripple component due to capacitor ESR is as follows:

$$V_{RIPPLE(ESR)} = I_{L(PEAK)} \times ESR$$

The output capacitor keeps output ripple small and ensures control-loop stability. The output capacitor must also have low impedance at the switching frequency. Ceramic, polymer, and tantalum capacitors are suitable, with ceramic exhibiting the lowest ESR and high-frequency impedance.

### Inductor Selection

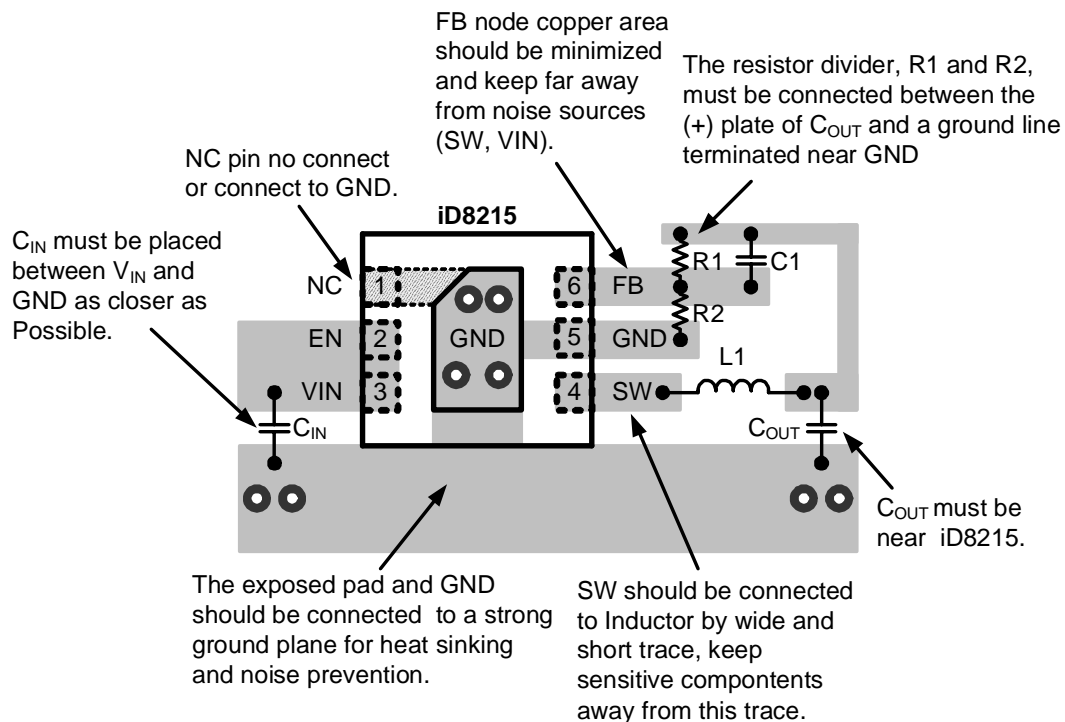
A reasonable inductor value ( $L_{IDEAL}$ ) can be derived from the following:

$$L_{IDEAL} = [2(V_{IN}) \times D(1 - D)] / I_{OUT} \times f_{OSC}$$

## Layout Considerations

Follow the PCB layout guidelines for optimal performance of iD8215.

- For the main current paths as indicated in bold lines in Figure 3, keep their traces short and wide.
- Keep  $C_{IN}$  must be near  $V_{IN}$  pin,  $C_{IN}$  capacitor provides the AC current to the internal power MOSFET.
- SW node is with high frequency voltage swing and should be kept small area. Keep analog components away from SW node to prevent stray capacitive noise pick-up.
- Keep the switching node SW, away from the sensitive FB node.
- Connect all analog grounds to a command node and then connect the command node to the power ground behind the output capacitors.

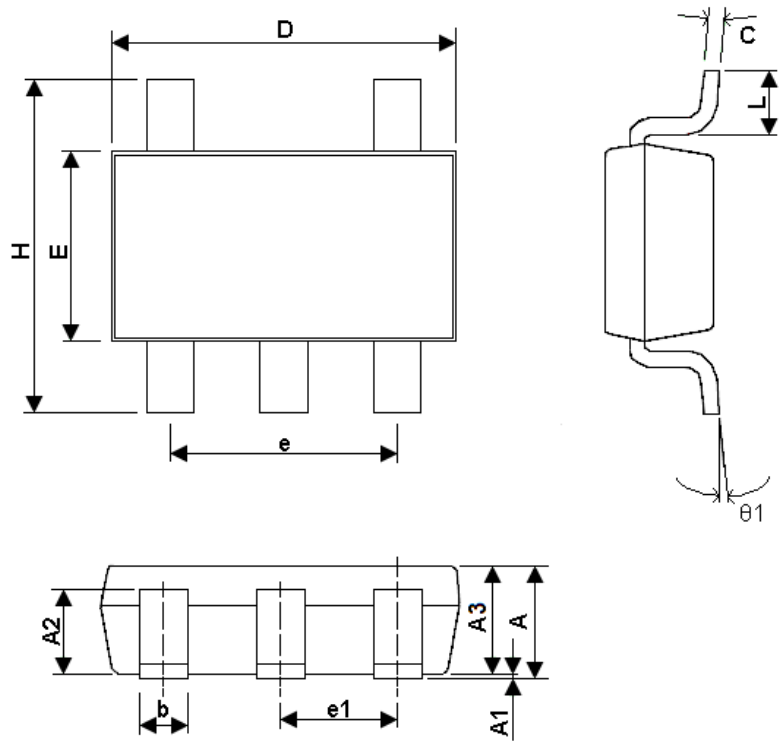


**Figure 3. Layout Guide**



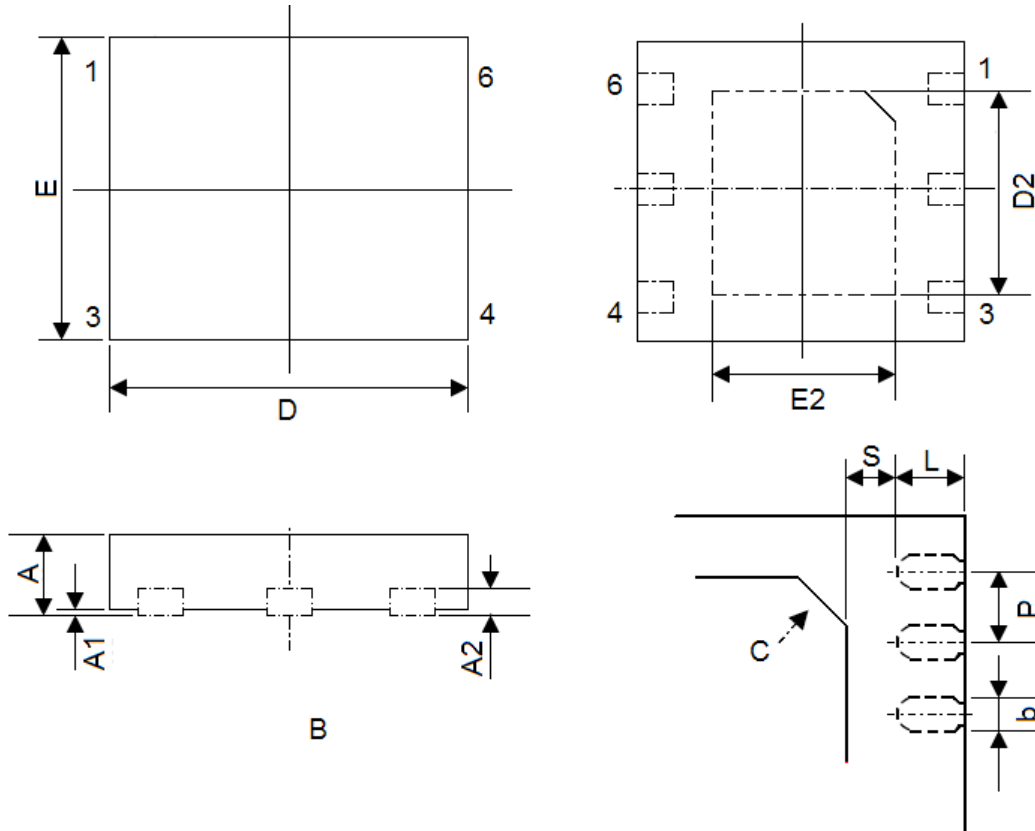
## Packaging

### SOT-23-5



| SYMBOLS | DIMENSIONS IN MILLIMETERS |           |      | DIMENSIONS IN INCH |       |       |
|---------|---------------------------|-----------|------|--------------------|-------|-------|
|         | MIN                       | NOM       | MAX  | MIN                | NOM   | MAX   |
| A       | 1.00                      | 1.10      | 1.30 | 0.039              | 0.043 | 0.051 |
| A1      | 0.00                      | ---       | 0.10 | 0.000              | ---   | 0.004 |
| A2      | 0.70                      | 0.80      | 0.90 | 0.027              | 0.031 | 0.035 |
| b       | 0.35                      | 0.40      | 0.50 | 0.013              | 0.016 | 0.020 |
| C       | 0.10                      | 0.15      | 0.25 | 0.004              | 0.006 | 0.001 |
| D       | 2.70                      | 2.90      | 3.10 | 0.106              | 0.114 | 0.122 |
| E       | 1.50                      | 1.60      | 1.80 | 0.059              | 0.063 | 0.071 |
| e       | ---                       | 1.90(TYP) | ---  | ---                | 0.075 | ---   |
| H       | 2.60                      | 2.80      | 3.00 | 0.102              | 0.110 | 0.118 |
| L       | 0.370                     | ---       | ---  | 0.015              | ---   | ---   |
| Θ1      | 1°                        | 5°        | 9°   | 1°                 | 5°    | 9°    |
| e1      | ---                       | 0.95(TYP) | ---  | ---                | 0.037 | ---   |

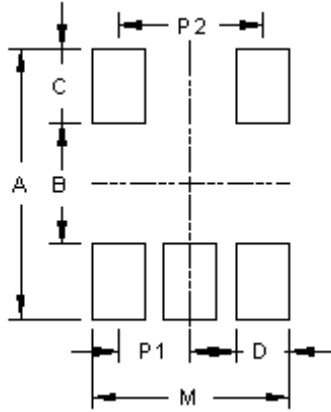
**TDFN-6L (2mm x 2mm)  
Pitch=0.65**



| SYMBOLS | DIMENSIONS IN MILLIMETERS |         |       | DIMENSIONS IN INCH |         |        |
|---------|---------------------------|---------|-------|--------------------|---------|--------|
|         | MIN                       | NOM     | MAX   | MIN                | NOM     | MAX    |
| A       | 0.70                      | 0.75    | 0.80  | 0.028              | 0.030   | 0.031  |
| A1      | 0.005                     | 0.030   | 0.060 | 0.0002             | 0.0011  | 0.0024 |
| A2      | 0.150                     | 0.20    | 0.25  | 0.006              | 0.008   | 0.010  |
| b       | 0.18                      | 0.265   | 0.35  | 0.007              | 0.01    | 0.138  |
| C       | ---                       | 0.25REF | ---   | ---                | 0.01REF | ---    |
| D       | 1.9                       | 2.00    | 2.1   | 0.075              | 0.079   | 0.083  |
| E       | 1.9                       | 2.00    | 2.1   | 0.075              | 0.079   | 0.083  |
| E2      | 0.5                       | 0.7     | 0.8   | 0.02               | 0.028   | 0.031  |
| D2      | 1.1                       | 1.27    | 1.45  | 0.043              | 0.05    | 0.057  |
| L       | 0.25                      | 0.35    | 0.45  | 0.01               | 0.014   | 0.018  |
| P       | 0.60                      | 0.65    | 0.70  | 0.024              | 0.026   | 0.028  |
| S       | 0.2                       | ---     | ---   | 0.008              | ---     | ---    |

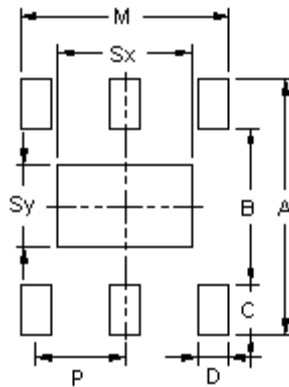
## Footprints

### SOT-23-5



| Package  | Number of PIN | Footprint Dimension (mm) |      |      |      |      |      |      | Tolerance |
|----------|---------------|--------------------------|------|------|------|------|------|------|-----------|
|          |               | P1                       | P2   | A    | B    | C    | D    | M    |           |
| SOT-23-5 | 5             | 0.95                     | 1.90 | 3.60 | 1.60 | 1.00 | 0.70 | 2.60 | ±0.10     |

### TDFN-6L (2mm x 2mm) Pitch=0.65



| Package     | Number of PIN | Footprint Dimension (mm) |      |      |      |      |      |      |      | Tolerance |
|-------------|---------------|--------------------------|------|------|------|------|------|------|------|-----------|
|             |               | P                        | A    | B    | C    | D    | Sx   | Sy   | M    |           |
| TDFN-6L 2x2 | 6             | 0.65                     | 2.80 | 1.20 | 0.80 | 0.35 | 1.40 | 0.70 | 1.65 | ±0.050    |