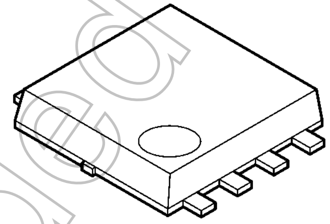
TOSHIBA CMOS Integrated Circuit Silicon Monolithic

# TCV7103F

## Buck DC-DC Converter IC

The TCV7103F is a single-chip buck DC-DC converter IC. The TCV7103F contains high-speed and low-on-resistance power MOSFETs to achieve synchronous rectification using an external low-side MOSFET, or rectification using an external diode, allowing for high efficiency.



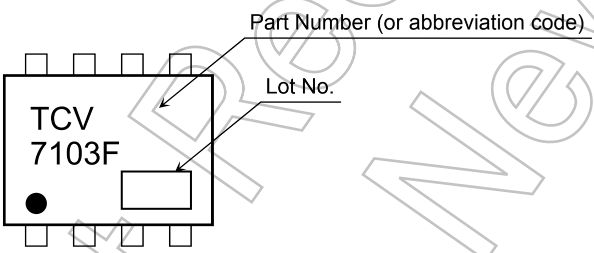
HSON8-P-0505-1.27

Weight: 0.068 g (typ.)

### Features

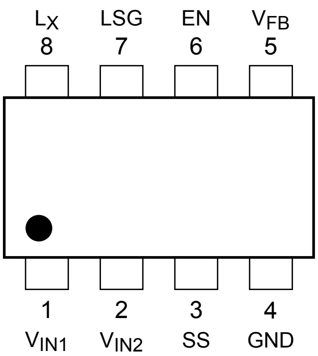
- Enables up to 5 A of load current ($I_{OUT}$) with a minimum of external components.
- High efficiency: η = 95% (typ.)
  (@$V_{IN}$ = 5 V, $V_{OUT}$ = 3.3 V, $I_{OUT}$ = 2 A)
  (when using the TPCP8001-H as a low-side MOSFET)
- Operating voltage range: $V_{IN}$ = 2.7 V to 5.5 V
- Low ON-resistance: $R_{DS\ (ON)}$ = 0.08 Ω (high-side) typical (@$V_{IN}$ = 5 V, Tj = 25°C)
- Oscillation frequency: $f_{OSC}$ = 1000 kHz (typ.)
- Feedback voltage: $V_{FB}$ = 0.8 V ± 1% (@ Tj = 25 °C)
- Incorporates an N-channel MOSFET driver for synchronous rectification
- Uses internal phase compensation to achieve high efficiency with a minimum of external components.
- Allows the use of a small surface-mount ceramic capacitor as an output filter capacitor.
- Housed in a small surface-mount package (SOP Advance) with a low thermal resistance.
- Soft-start time adjustable by an external capacitor
- Overcurret protection (OCP) with latch function

### Part Marking

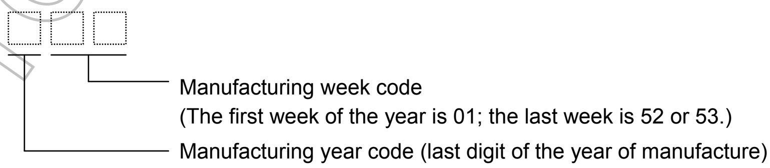



The dot (•) on the top surface indicates pin 1.

### Pin Assignment




*: The lot number consists of three digits. The first digit represents the last digit of the year of manufacture, and the following two digits indicates the week of manufacture between 01 and either 52 or 53.



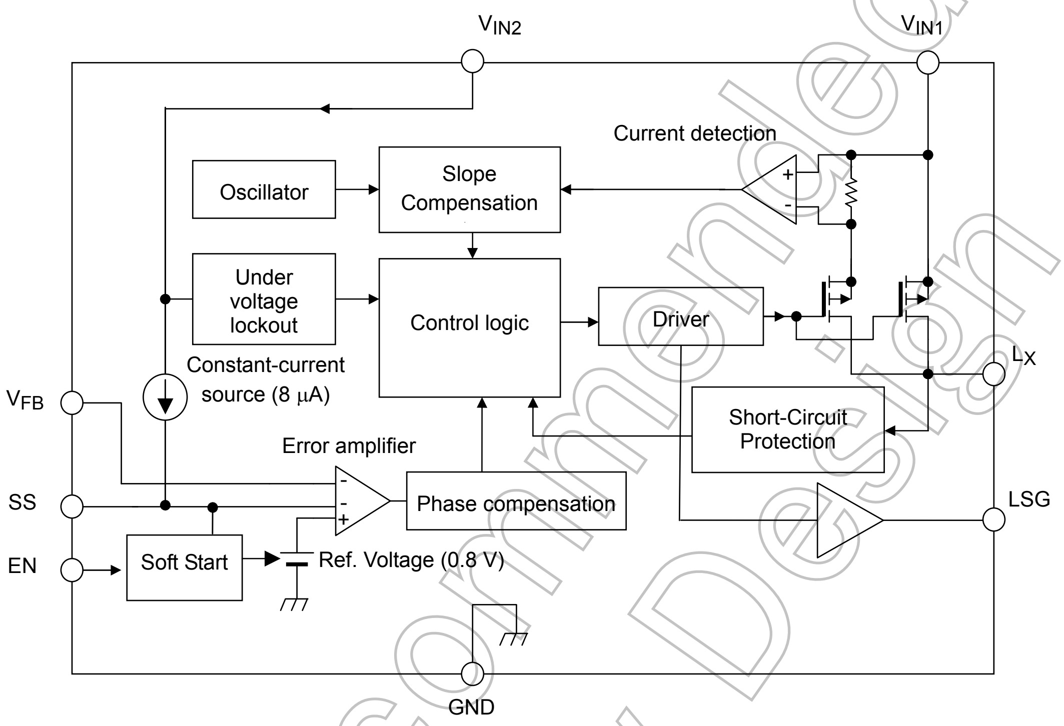

This product has a MOS structure and is sensitive to electrostatic discharge. Handle with care.

The product(s) in this document ("Product") contain functions intended to protect the Product from temporary small overloads such as minor short-term overcurrent, or overheating. The protective functions do not necessarily protect Product under all circumstances. When incorporating Product into your system, please design the system (1) to avoid such overloads upon the Product, and (2) to shut down or otherwise relieve the Product of such overload conditions immediately upon occurrence. For details, please refer to the notes appearing below in this document and other documents referenced in this document.

## Ordering Information

| Part Number | Shipping |
|---|---|
| TCV7103F (TE12L, Q) | Embossed tape (3000 units per reel) |

## Block Diagram






## Pin Description

| Pin No. | Symbol | Description |
|---|---|---|
| 1 | $V_{IN1}$ | Input pin for the output section<br>This pin is placed in the standby state if $V_{EN}$ = low. Standby current is 10 μA or less. |
| 2 | $V_{IN2}$ | Input pin for the control section<br>This pin is placed in the standby state if $V_{EN}$ = low. Standby current is 10 μA or less. |
| 3 | SS | Soft-start pin<br>When the SS input is left open, the soft-start time is 1 ms (typ.). The soft-start time can be adjusted with an external capacitor. The external capacitor is charged from a 8 μA (typ.) constant-current source, and the reference voltage of the error amplifier is regulated between 0 V and 0.8 V. The external capacitor is discharged when EN = low and in case of undervoltage lockout or thermal shutdown. |
| 4 | GND | Ground pin |
| 5 | $V_{FB}$ | Feedback pin<br>This input is fed into an internal error amplifier with a reference voltage of 0.8 V (typ.). |
| 6 | EN | Enable pin<br>When EN ≥ 1.5 V (@ $V_{IN}$ = 5 V), the internal circuitry is allowed to operate and thus enable the switching operation of the output section. When EN ≤ 0.5 V (@ $V_{IN}$ = 5 V), the internal circuitry is disabled, putting the TCV7103F in Standby mode. Standby current is 10 μA or less.<br>This pin has an internal pull-down resistor of approx. 500 kΩ. |
| 7 | LSG | Gate drive pin for the low-side switch |
| 8 | $L_X$ | Switch pin<br>This pin is connected to high-side P-channel MOSFET. |

## Absolute Maximum Ratings (Ta = 25°C)

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Input pin voltage for the output section | $V_{IN1}$ | −0.3 to 6 | V |
| Input pin voltage for the control section | $V_{IN2}$ | −0.3 to 6 | V |
| Soft-start pin voltage | $V_{SS}$ | −0.3 to 6 | V |
| Feedback pin voltage | $V_{FB}$ | −0.3 to 6 | V |
| Enable pin voltage | $V_{EN}$ | −0.3 to 6 | V |
| $V_{EN}$ – $V_{IN2}$ voltage difference | $V_{EN}$-$V_{IN2}$ | $V_{EN} - V_{IN2} < 0.3$ | V |
| LSG pin voltage | $V_{LSG}$ | −0.3 to 6 | V |
| Switch pin voltage (Note 1) | $V_{LX}$ | −0.3 to 6 | V |
| Switch pin current | $I_{LX}$ | −6.0 | A |
| Power dissipation (Note 2) | $P_D$ | 2.2 | W |
| Operating junction temperature | $T_{jopr}$ | −40 to125 | °C |
| Junction temperature (Note 3) | $T_j$ | 150 | °C |
| Storage temperature | $T_{stg}$ | −55 to150 | °C |

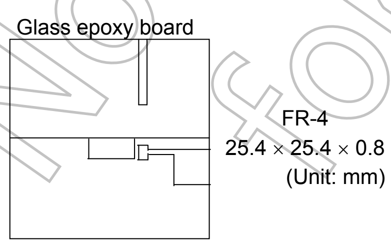
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc)

Note 1: The switch pin voltage ($V_{LX}$) doesn't include the peak voltage generated by TCV7103F's switching.
A negative voltage generated in dead time is permitted among the switch pin current ($I_{LX}$).

## Thermal Resistance Characteristics

| Characteristics | Symbol | Max | Unit |
|---|---|---|---|
| Thermal resistance, junction to ambient | $R_{th\ (j-a)}$ | 44.6 (Note 2) | °C/W |
| Thermal resistance, junction to case (Tc=25°C) | $R_{th\ (j-c)}$ | 4.17 | °C/W |

Note 2:




Single-pulse measurement: pulse width t=10(s)

Note 3: The TCV7103F may enter into thermal shutdown at the rated maximum junction temperature. Thermal design is required to ensure that the rated maximum operating junction temperature, $T_{jopr}$, will not be exceeded.

## Electrical Characteristics ($T_j$ = 25°C, $V_{IN1}$ = $V_{IN2}$ = 2.7 to 5.5 V, unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Operating input voltage | $V_{IN (OPR)}$ | — | 2.7 | — | 5.5 | V |
| Operating current | $I_{IN}$ | $V_{IN1} = V_{IN2} = V_{EN} = V_{FB}$ = 5 V | — | 530 | 680 | μA |
| Output voltage range | $V_{OUT (OPR)}$ | $V_{EN} = V_{IN1} = V_{IN2}$ | 0.8 | — | — | V |
| Standby current | $I_{IN (STBY) 1}$ | $V_{IN1} = V_{IN2}$ = 5 V, $V_{EN}$ = 0 V<br>$V_{FB}$ = 0.8 V | — | — | 10 | μA |
| Standby current | $I_{IN (STBY) 2}$ | $V_{IN1} = V_{IN2}$ = 3.3 V, $V_{EN}$ = 0 V<br>$V_{FB}$ = 0.8 V | — | — | 10 | μA |
| High-side switch leakage current | $I_{LEAK (H)}$ | $V_{IN1} = V_{IN2}$ = 5 V, $V_{EN}$ = 0 V<br>$V_{FB}$ = 0.8 V, $V_{LX}$ = 0 V | — | — | 10 | μA |
| EN threshold voltage | $V_{IH (EN) 1}$ | $V_{IN1} = V_{IN2}$ = 5 V | 1.5 | — | — | V |
| EN threshold voltage | $V_{IH (EN) 2}$ | $V_{IN1} = V_{IN2}$ = 3.3 V | 1.5 | — | — | V |
| EN threshold voltage | $V_{IL (EN) 1}$ | $V_{IN1} = V_{IN2}$ = 5 V | — | — | 0.5 | V |
| EN threshold voltage | $V_{IL (EN) 2}$ | $V_{IN1} = V_{IN2}$ = 3.3 V | — | — | 0.5 | V |
| EN input current | $I_{IH (EN) 1}$ | $V_{IN1} = V_{IN2}$ = 5 V, $V_{EN}$ = 5 V | 6 | — | 13 | μA |
| EN input current | $I_{IH (EN) 2}$ | $V_{IN1} = V_{IN2}$ = 3.3 V, $V_{EN}$ = 3.3 V | 4 | — | 9 | μA |
| $V_{FB}$ input voltage | $V_{FB1}$ | $V_{IN1} = V_{IN2}$ = 5 V, $V_{EN}$ = 5 V<br>Tj = 0 to 85°C | 0.792 | 0.8 | 0.808 | V |
| $V_{FB}$ input voltage | $V_{FB2}$ | $V_{IN1} = V_{IN2}$ = 3.3 V, $V_{EN}$ = 3.3 V<br>Tj = 0 to 85°C | 0.792 | 0.8 | 0.808 | V |
| $V_{FB}$ input current | $I_{FB}$ | $V_{IN1} = V_{IN2}$ = 2.7 to 5.5 V<br>$V_{FB} = V_{IN2}$ | –1 | — | 1 | μA |
| High-side switch on-state resistance | $R_{DS (ON) (H) 1}$ | $V_{IN1} = V_{IN2}$ = 5 V, $V_{EN}$ = 5 V<br>$I_{LX}$ = –1.5 A | — | 0.08 | — | Ω |
| High-side switch on-state resistance | $R_{DS (ON) (H) 2}$ | $V_{IN1} = V_{IN2}$ = 3.3 V, $V_{EN}$ = 3.3 V<br>$I_{LX}$ = –1.5 A | — | 0.1 | — | Ω |
| On-state resistance of high-side transistor connected to the LSG pin | $R_{LSG (ON) (H)}$ | $V_{IN1} = V_{IN2}$ = 5 V | — | 0.8 | — | Ω |
| On-state resistance of low-side transistor connected to the LSG pin | $R_{LSG (ON) (L)}$ | $V_{IN1} = V_{IN2}$ = 5 V | — | 0.4 | — | Ω |
| Oscillation frequency | $f_{OSC}$ | $V_{IN1} = V_{IN2} = V_{EN}$ = 5 V | 800 | 1000 | 1200 | kHz |
| Internal soft-start time | $t_{SS}$ | $V_{IN1} = V_{IN2}$ = 5 V, $I_{OUT}$ = 0 A,<br>Measured between 0% and 90% points at $V_{OUT}$. | 0.5 | 1 | 1.5 | ms |
| External soft-start charge current | $I_{SS}$ | $V_{IN1} = V_{IN2}$ = 5 V, $V_{EN}$ = 5 V | –5 | –8 | –11 | μA |
| High-side switch duty cycle | Dmax | $V_{IN1} = V_{IN2}$ = 2.7 to 5.5 V | — | — | 100 | % |
| Thermal shutdown (TSD): Detection temperature | $T_{SD}$ | $V_{IN1} = V_{IN2}$ = 5 V | — | 150 | — | °C |
| Thermal shutdown (TSD): Hysteresis | $\Delta T_{SD}$ | $V_{IN1} = V_{IN2}$ = 5 V | — | 15 | — | °C |
| Undervoltage lockout (UVLO): Detection voltage | $V_{UV}$ | $V_{EN} = V_{IN1} = V_{IN2}$ | 2.35 | 2.45 | 2.6 | V |
| Undervoltage lockout (UVLO): Recovery voltage | $V_{UVR}$ | $V_{EN} = V_{IN1} = V_{IN2}$ | 2.45 | 2.55 | 2.7 | V |
| Undervoltage lockout (UVLO): Hysteresis | $\Delta V_{UV}$ | $V_{EN} = V_{IN1} = V_{IN2}$ | — | 0.1 | — | V |
| $L_X$ current limit | $I_{LIM}$ | $V_{IN1} = V_{IN2}$ = 5 V, $V_{OUT}$ = 2 V | 5.75 | 7.0 | — | A |
| Overcurrent protection (OCP): Latch detection voltage | $V_{LOC}$ | $V_{IN1} = V_{IN2}$ = 5V | — | 0.3 | — | V |
| Overcurrent protection (OCP): Latch detection time | $t_{LOC}$ | $V_{IN1} = V_{IN2}$ = 5 V, $V_{FB}$ = 0.2 V | — | 2 | — | ms |



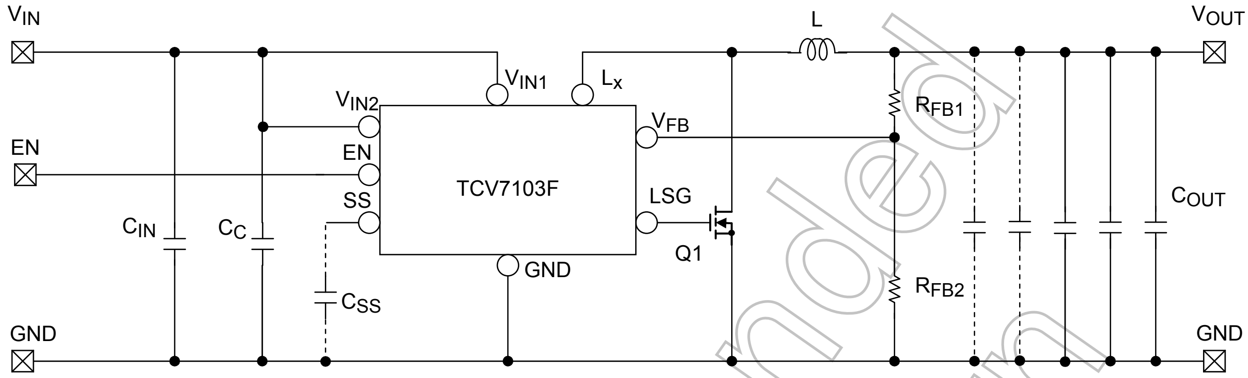
## Note on Electrical Characteristics

The test condition $T_j$ = 25°C means a state where any drifts in electrical characteristics incurred by an increase in the chip's junction temperature can be ignored during pulse testing.

## Application Circuit Examples

Figure 1 shows a typical application circuit using a low-ESR electrolytic or ceramic capacitor for $C_{OUT}$.

### When Using the TCV7103F with an External Low-Side MOSFET:




### When Using the TCV7103F with an External Schottky Barrier Diode:

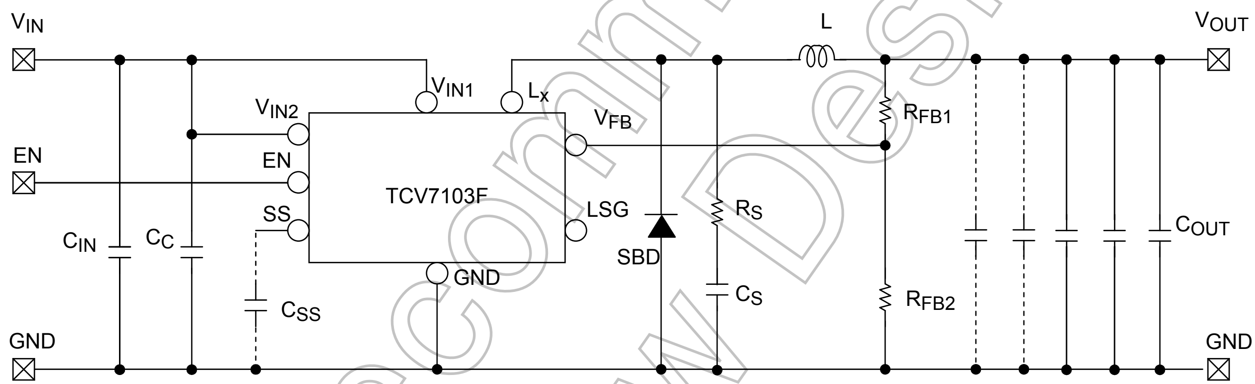



**Figure 1 TCV7103F Typical Application Circuit Examples**

Component values (reference value@ $V_{IN}$ = 5 V, $V_{OUT}$ = 3.3 V, Ta = 25°C)

Q1: Low-side FET (N-channel MOSFET: TPCP8001-H or TPC6012 (T5LS,F) manufactured by Toshiba Corporation)

SBD: Low-side Schottky barrier diode (Schottky barrier diode: CLS01 manufactured by Toshiba Corporation)

$C_{IN}$: Input filter capacitor = 10 μF
(ceramic capacitor: GRM21BB30J106K manufactured by Murata Manufacturing Co., Ltd.)

$C_{OUT}$: Output filter capacitor = 10 μF
(ceramic capacitor: GRM21BB30J106K manufactured by Murata Manufacturing Co., Ltd.)

$C_C$: Decoupling capacitor = 1 μF
(ceramic capacitor: GRM155B30J105K manufactured by Murata Manufacturing Co., Ltd.)

$R_{FB1}$: Output voltage setting resistor = 7.5 kΩ

$R_{FB2}$: Output voltage setting resistor = 2.4 kΩ

$R_S$: Snubber resistor = 4.7 Ω

$C_S$: Snubber capacitor = 220 pF
(ceramic capacitor: GRM1552C1H221J manufactured by Murata Manufacturing Co., Ltd.)

L: Inductor = 1 μH
(VLF10040T-1R0N9R7 or SLF7055-1R0N5R0-5PF manufactured by TDK-EPC Corporation, B1135AS-1R0N manufactured by TOKO, INC)

$C_{SS}$ is a capacitor for adjusting the soft-start time.

Examples of Component Values (For Reference Only)

| Output Voltage Setting $V_{OUT}$ | Inductance L | Input Capacitance $C_{IN}$ | Output Capacitance $C_{OUT}$ | Feedback Resistor $R_{FB1}$ | Feedback Resistor $R_{FB2}$ |
|---|---|---|---|---|---|
| 1.0 V | 1 μH | 10 μF | 50 μF | 7.5 kΩ | 30 kΩ |
| 1.2 V | 1 μH | 10 μF | 30 μF | 7.5 kΩ | 15 kΩ |
| 1.51 V | 1 μH | 10 μF | 30 μF | 16 kΩ | 18 kΩ |
| 1.8 V | 1 μH | 10 μF | 30 μF | 15 kΩ | 12 kΩ |
| 2.5 V | 1 μH | 10 μF | 30 μF | 5.1 kΩ | 2.4 kΩ |
| 3.3 V | 1 μH | 10 μF | 30 μF | 7.5 kΩ | 2.4 kΩ |

Component values need to be adjusted, depending on the TCV7103F's I/O conditions and the board layout.

## Application Notes

### Inductor Selection

The inductance required for inductor L can be calculated as follows:

$$L = \frac{V_{IN} - V_{OUT}}{f_{osc} \cdot \Delta I_L} \cdot \frac{V_{OUT}}{V_{IN}} \quad \cdots\cdots\cdots\cdots (1)$$

$V_{IN}$: Input voltage (V)
$V_{OUT}$: Output voltage (V)
$f_{osc}$: Oscillation frequency = 1000 kHz (typ.)
$\Delta I_L$: Inductor ripple current (A)

*: Generally, $\Delta I_L$ should be set to approximately 30% of the maximum output current. Since the maximum output current of the TCV7103F is 5.0 A, $\Delta I_L$ should be 1.5 A or so. The inductor should have a current rating greater than the peak output current of 5.75 A. If the inductor current rating is exceeded, the inductor becomes saturated, leading to an unstable DC-DC converter operation.

When $V_{IN}$ = 5 V and $V_{OUT}$ = 3.3 V, the required inductance can be calculated as follows. Be sure to select an appropriate inductor, taking the input voltage range into account.

$$L = \frac{V_{IN} - V_{OUT}}{f_{osc} \cdot \Delta I_L} \cdot \frac{V_{OUT}}{V_{IN}}$$

$$= \frac{5\ \text{V} - 3.3\ \text{V}}{1000\text{kHz} \cdot 1.5\text{A}} \cdot \frac{3.3\ \text{V}}{5\ \text{V}}$$

$$= 0.75\ \mu\text{H} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (2)$$

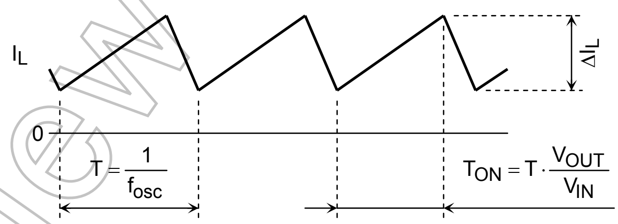



**Figure 2 Inductor Current Waveform**

### Setting the Output Voltage

A resistive voltage divider is connected as shown in Figure 3 to set the output voltage; it is given by Equation 3 based on the reference voltage of the error amplifier (0.8 V typ.), which is connected to the Feedback pin, $V_{FB}$. $R_{FB1}$ should be up to 30 kΩ or so, because an extremely large-value $R_{FB1}$ incurs a delay due to parasitic capacitance at the $V_{FB}$ pin. It is recommended that resistors with a precision of ±1% or higher be used for $R_{FB1}$ and $R_{FB2}$.

$$V_{OUT} = V_{FB} \cdot \left(1 + \frac{R_{FB1}}{R_{FB2}}\right)$$

$$= 0.8\ \text{V} \cdot \left(1 + \frac{R_{FB1}}{R_{FB2}}\right) \quad \cdots\cdots (3)$$

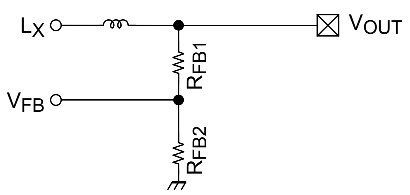



**Figure 3 Output Voltage Setting Resistors**

## Output Filter Capacitor Selection

Use a low-ESR electrolytic or ceramic capacitor as the output filter capacitor. Since a capacitor is generally sensitive to temperature, choose one with excellent temperature characteristics. As a rule of thumb, its capacitance should be 30 μF or greater for applications. The capacitance should be set to an optimal value that meets the system's ripple voltage requirement and transient load response characteristics. The phase margin tends to decrease as the output voltage is getting low. Enlarge a capacitance for output flatness when phase margin is insufficient, or the transient load response characteristics cannot be satisfied. Since the ceramic capacitor has a very low ESR value, it helps reduce the output ripple voltage; however, because the ceramic capacitor provides less phase margin, it should be thoroughly evaluated.

## Rectifier Selection

A low-side switch or Schottky barrier diode should be externally connected to the TCV7103F.

It is recommended that an N-channel MOSFET TPCP8001-H, TPC6012 (T5LS,F) or equivalent be on as a low-side switch. The TPCP8001-H enables fast switching with its low gate charge (Qg), resulting in higher efficiency under light load current conditions. An N-channel MOSFET of a different type can also be used. However, if the switching speed of the external MOSFET is low, a shoot-through current may flow due to the simultaneous conduction of high-side and low-side switches, leading to device failure. Thus, observe the waveform at the $L_X$ pin while operating the TCV7103F with a current close to the rated value to make sure that there is a dead time (the period between the time when the low-side switch is turned off and the high-side switch is turned on) of more than 10 ns. Thorough evaluation is required to ensure that the TCV7103F provides an appropriate dead time even when in the end-product environment.

As for the Schottky barrier diode, the CLS01 is recommended to be used. Using a Schottky barrier diode tends to lead to a large voltage overshoot on the $L_X$ pin. Thus, a series RC filter consisting of a resistor of $R_S$ = 4.7 Ω and a capacitor of $C_S$ = 220 pF should be connected in parallel with the Schottky barrier diode. Power loss of a Schottky barrier diode tends to increase due to an increased reverse current caused by the rise in ambient temperature and self-heating due to a supplied current. The rated current should therefore be derated to allow for such conditions in selecting an appropriate diode.

## Soft-Start Feature

The TCV7103F has a soft-start feature.

If the SS pin is left open, the soft-start time, $t_{SS}$, for $V_{OUT}$ defaults to 1 ms (typ.) internally.

The soft-start time can be extended by adding an external capacitor ($C_{SS}$) between the SS and GND pins. The soft-start time can be calculated as follows:

$$t_{SS2} = 0.1 \cdot C_{SS} \quad \cdots\cdots(4)$$

$t_{SS2}$: Soft-start time (in seconds) when an external capacitor is connected between SS and GND.

$C_{SS}$: Capacitor value (μF)

The soft-start feature is activated when the TCV7103F exits the undervoltage lockout (UVLO) state after power-up and when the voltage at the EN pin has changed from logic low to logic high.

### Overcurrent Protection（OCP）

TCV7103F has an overcurrent protection with latch function. When a peak current of $L_X$ pin exceeds a $I_{LIM}$=7.0A (typ.), ON time of high-side switch (internal) is limited. When OCP is in operation, and $V_{FB}$ input voltage drops below latch detection voltage $V_{LOC}$=0.3V (typ.) for more than latch detection time $t_{LOC}$=2ms (typ.), TCV7103F will halt the output voltage and this state is latched. When the EN pin level changes from high to low, or the input voltage becomes under $V_{UV}$=2.45V (typ.), releases the latch. While soft-start feature is in operation, OCP does not operate.

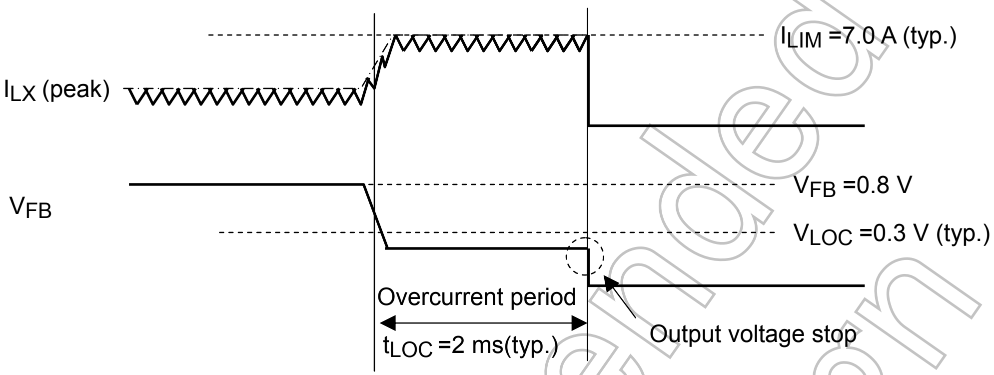



**Figure 4 Overcurrent Protection Operation**

### Undervoltage Lockout (UVLO)

The TCV7103F has undervoltage lockout (UVLO) protection circuitry. The TCV7103F does not provide output voltage ($V_{OUT}$) until the input voltage ($V_{IN2}$) has reached $V_{UVR}$ (2.55 V typ.). UVLO has hysteresis of 0.1 V (typ.). After the switch turns on, if $V_{IN2}$ drops below $V_{UV}$ (2.45 V typ.), UVLO shuts off the switch at $V_{OUT}$.

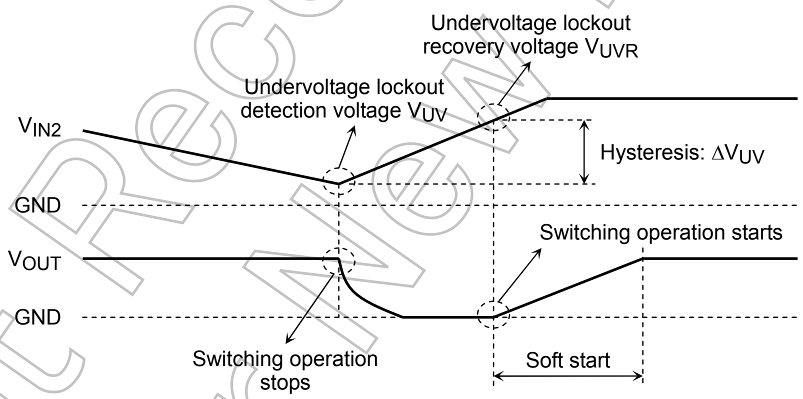



**Figure 5 Undervoltage Lockout Operation**

### Thermal Shutdown (TSD)

The TCV7103F provides thermal shutdown. When the junction temperature continues to rise and reaches $T_{SD}$ (150°C typ.), the TCV7103F goes into thermal shutdown and shuts off the power supply. TSD has a hysteresis of about 15°C (typ.). The device is enabled again when the junction temperature has dropped by approximately 15°C from the TSD trip point. The device resumes the power supply when the soft-start circuit is activated upon recovery from TSD state.

Thermal shutdown is intended to protect the device against abnormal system conditions. It should be ensured that the TSD circuit will not be activated during normal operation of the system.

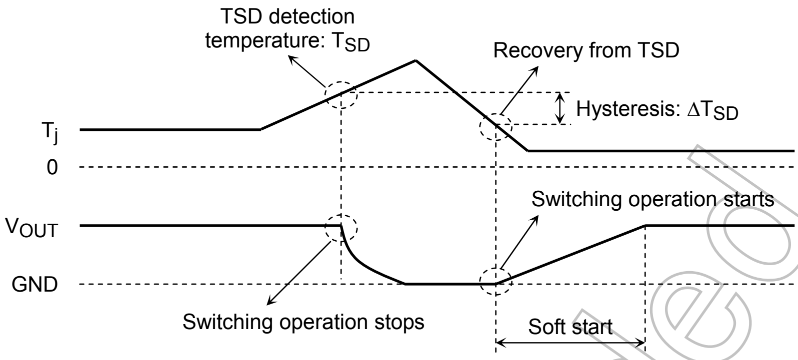
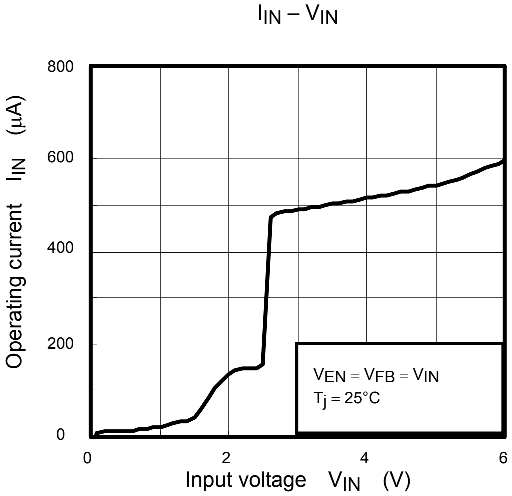


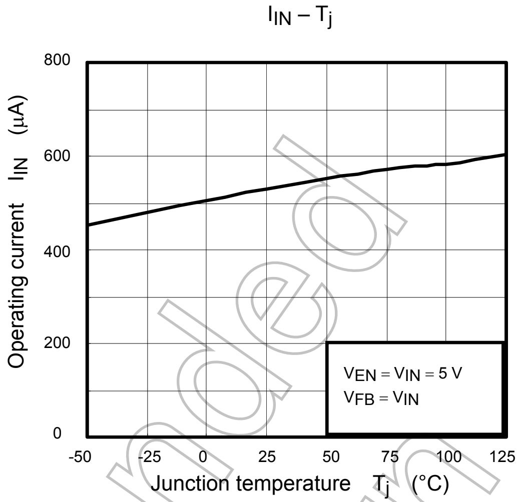

**Figure 6 Thermal Shutdown Operation**

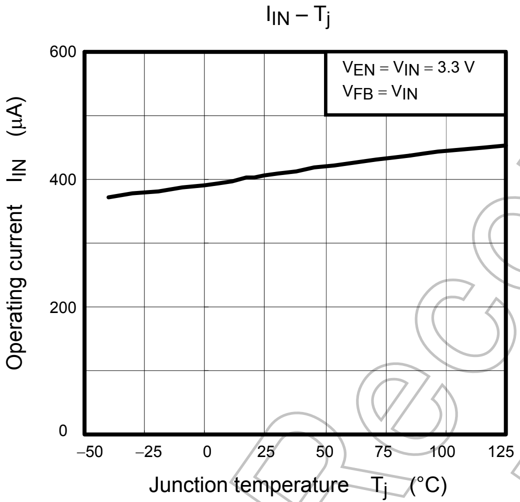
## Usage Precautions

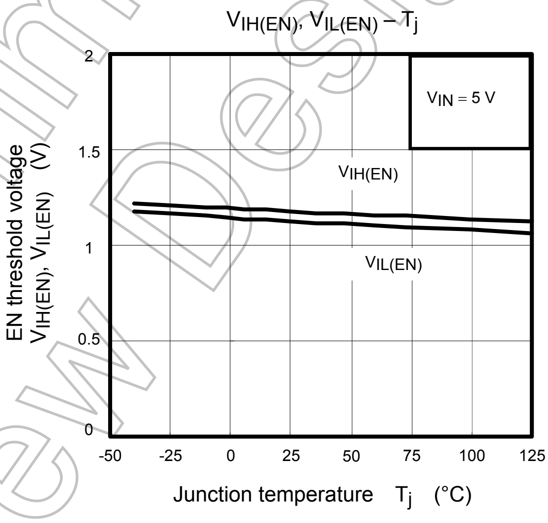
- The input voltage, output voltage, output current and temperature conditions should be considered when selecting capacitors, inductors and resistors. These components should be evaluated on an actual system prototype for best selection.
- External components such as capacitors, inductors and resistors should be placed as close to the TCV7103F as possible.
- The TCV7103F has an ESD diode between the EN and $V_{IN2}$ pins. The voltage between these pins should satisfy $V_{EN} - V_{IN2} < 0.3$ V.
- Add a decoupling capacitor ($C_C$) of 0.1 μF to 1 μF between the GND and $V_{IN2}$ pins. To achieve stable operation, also insert a resistor of about 100 Ω between the $V_{IN2}$ and $V_{IN1}$ pins to reduce the ripple voltage at the $V_{IN2}$ pin.
- The minimum programmable output voltage is 0.8 V (typ.). If the difference between the input and output voltages is small, the output voltage might not be regulated accurately and fluctuate significantly.
- GND pin is connected with the back of IC chip and serves as the heat radiation pin. Secure the area of a GND pattern as large as possible for greater of heat radiation.
- The overcurrent protection circuits in the Product are designed to temporarily protect Product from minor overcurrent of brief duration. When the overcurrent protective function in the Product activates, immediately cease application of overcurrent to Product. Improper usage of Product, such as application of current to Product exceeding the absolute maximum ratings, could cause the overcurrent protection circuit not to operate properly and/or damage Product permanently even before the protection circuit starts to operate.
- The thermal shutdown circuits in the Product are designed to temporarily protect Product from minor overheating of brief duration. When the overheating protective function in the Product activates, immediately correct the overheating situation. Improper usage of Product, such as the application of heat to Product exceeding the absolute maximum ratings, could cause the overheating protection circuit not to operate properly and/or damage Product permanently even before the protection circuit starts to operate.

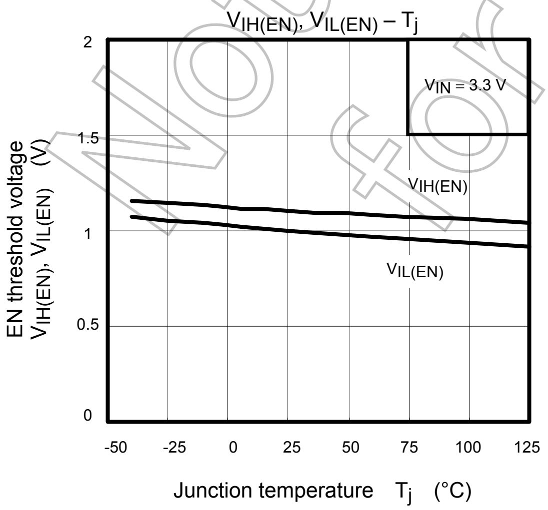
## Typical Performance Characteristics

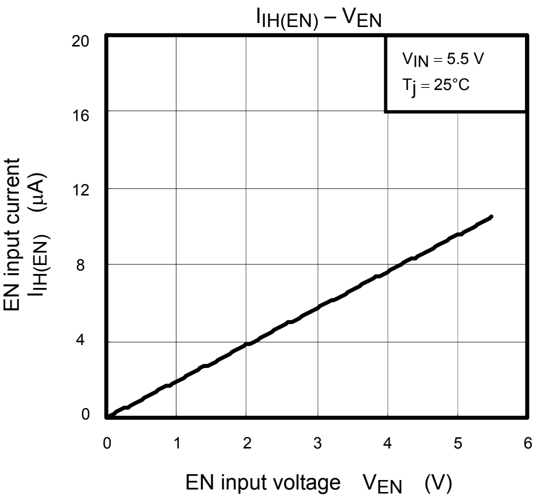


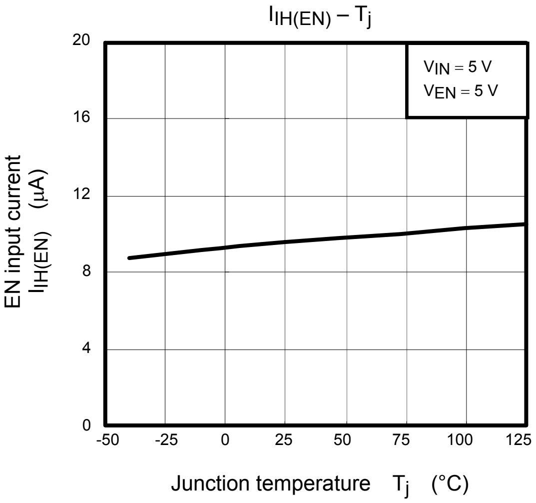



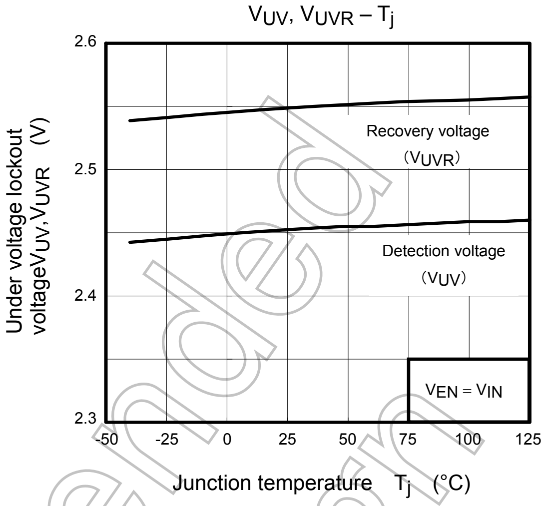



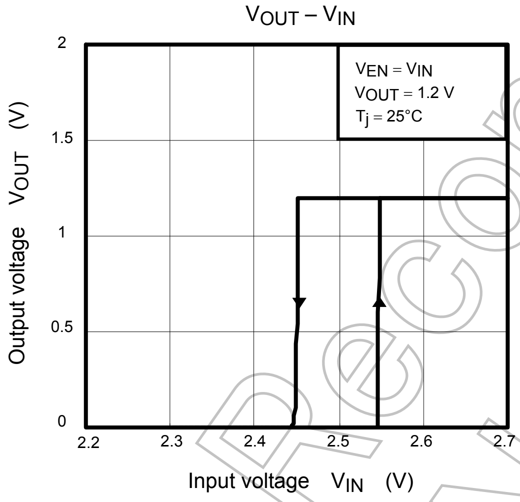



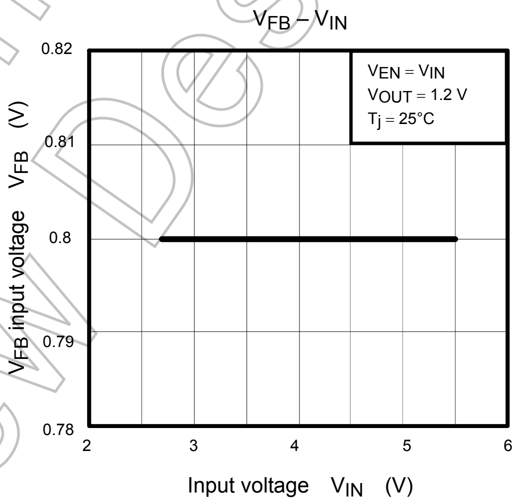



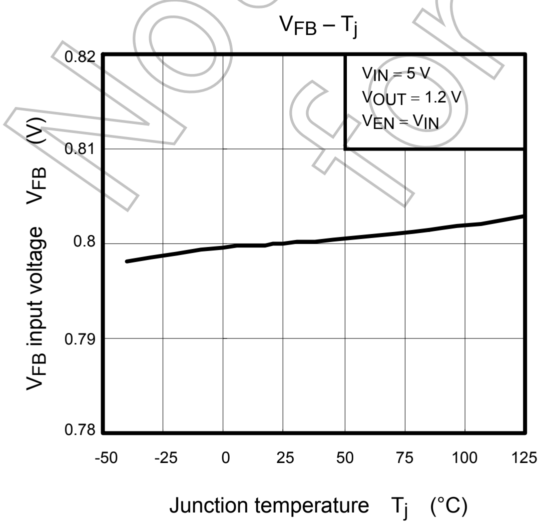



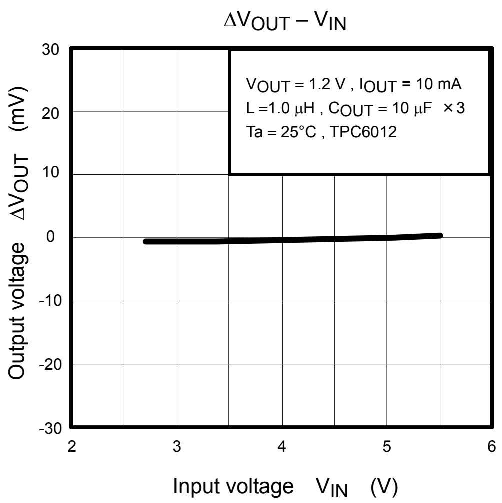

$I_{IH(EN)}$ – $T_j$
$V_{IN}$ = 5 V
$V_{EN}$ = 5 V
EN input current $I_{IH(EN)}$ (μA)
Junction temperature $T_j$ (°C)

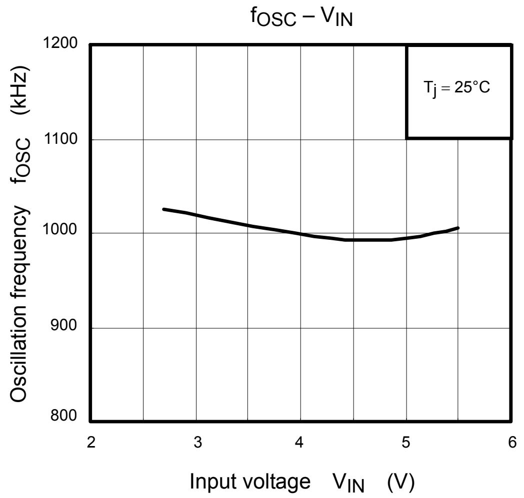

$V_{UV}$, $V_{UVR}$ – $T_j$
Recovery voltage ($V_{UVR}$)
Detection voltage ($V_{UV}$)
$V_{EN}$ = $V_{IN}$
Under voltage lockout voltage $V_{UV}$, $V_{UVR}$ (V)
Junction temperature $T_j$ (°C)

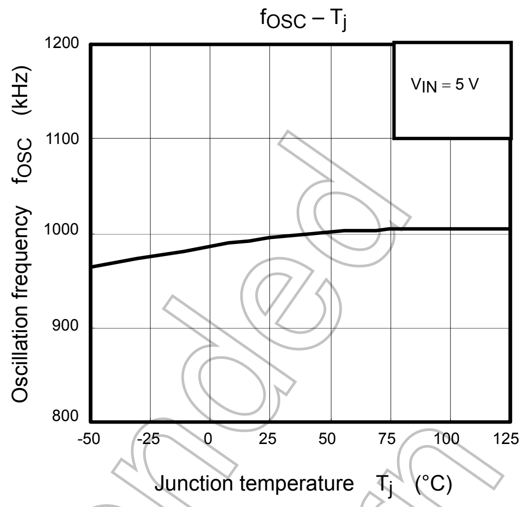

$V_{OUT}$ – $V_{IN}$
$V_{EN}$ = $V_{IN}$
$V_{OUT}$ = 1.2 V
$T_j$ = 25°C
Output voltage $V_{OUT}$ (V)
Input voltage $V_{IN}$ (V)

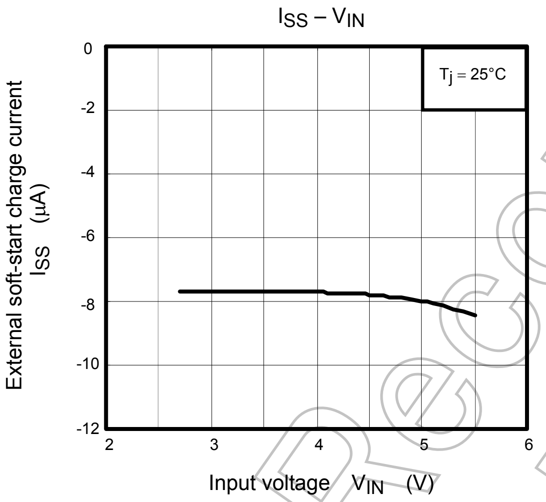

$V_{FB}$ – $V_{IN}$
$V_{EN}$ = $V_{IN}$
$V_{OUT}$ = 1.2 V
$T_j$ = 25°C
$V_{FB}$ input voltage $V_{FB}$ (V)
Input voltage $V_{IN}$ (V)

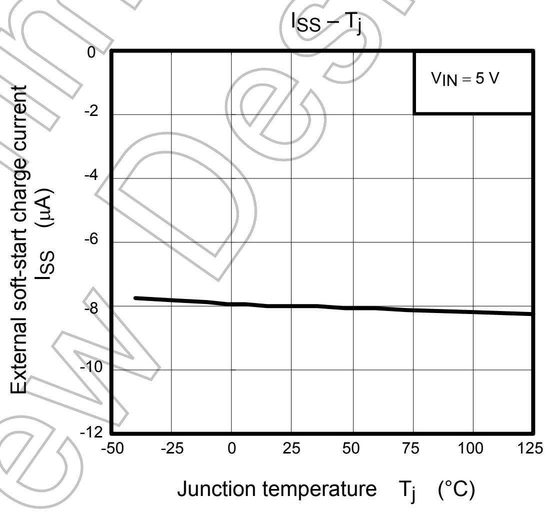

$V_{FB}$ – $T_j$
$V_{IN}$ = 5 V
$V_{OUT}$ = 1.2 V
$V_{EN}$ = $V_{IN}$
$V_{FB}$ input voltage $V_{FB}$ (V)
Junction temperature $T_j$ (°C)

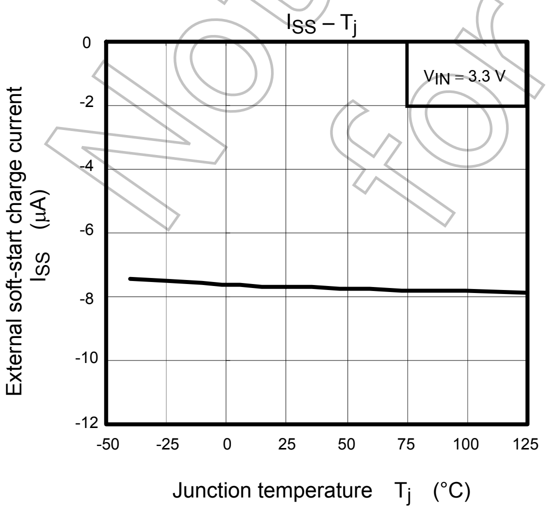

$\Delta V_{OUT}$ – $V_{IN}$
$V_{OUT}$ = 1.2 V , $I_{OUT}$ = 10 mA
L =1.0 μH , $C_{OUT}$ = 10 μF ×3
Ta = 25°C , TPC6012
Output voltage $\Delta V_{OUT}$ (mV)
Input voltage $V_{IN}$ (V)

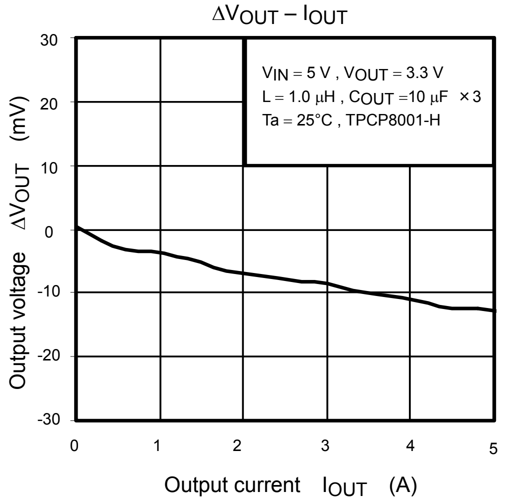

fOSC – VIN
Tj = 25°C
Oscillation frequency fOSC (kHz)
1200
1100
1000
900
800
2
3
4
5
6
Input voltage VIN (V)

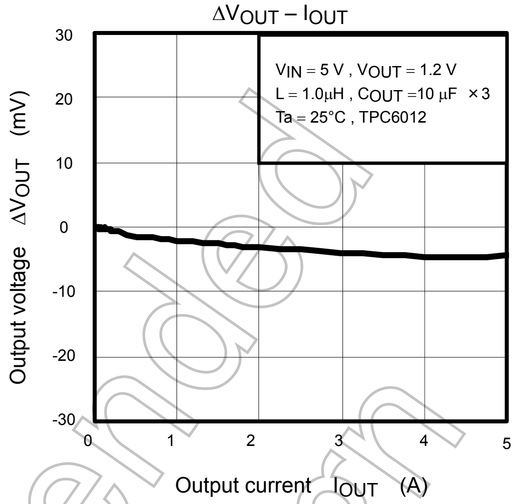

fOSC – Tj
VIN = 5 V
Oscillation frequency fOSC (kHz)
1200
1100
1000
900
800
-50
-25
0
25
50
75
100
125
Junction temperature Tj (°C)

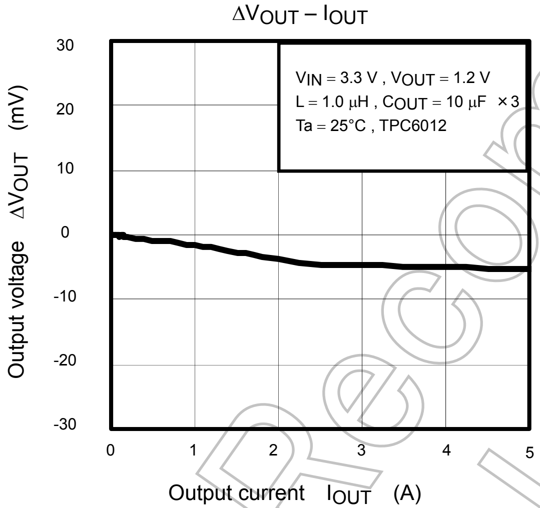

ISS – VIN
Tj = 25°C
External soft-start charge current ISS (μA)
0
-2
-4
-6
-8
-10
-12
2
3
4
5
6
Input voltage VIN (V)

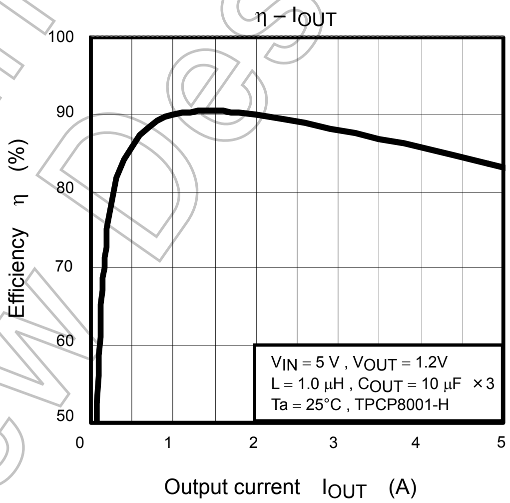

ISS – Tj
VIN = 5 V
External soft-start charge current ISS (μA)
0
-2
-4
-6
-8
-10
-12
-50
-25
0
25
50
75
100
125
Junction temperature Tj (°C)

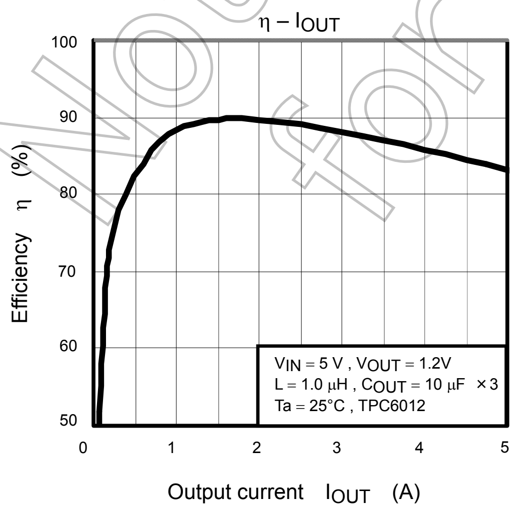

ISS – Tj
VIN = 3.3 V
External soft-start charge current ISS (μA)
0
-2
-4
-6
-8
-10
-12
-50
-25
0
25
50
75
100
125
Junction temperature Tj (°C)

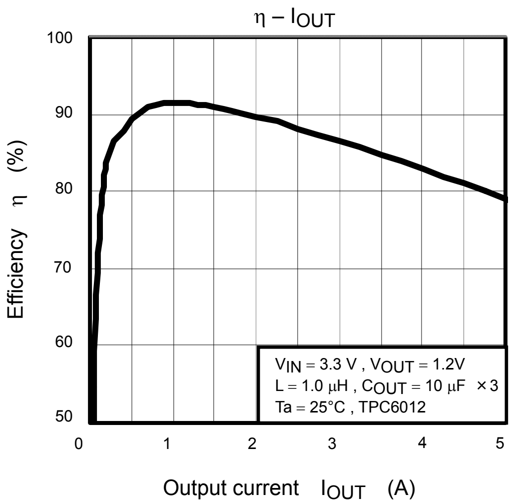

ΔVOUT – IOUT
VIN = 5 V , VOUT = 3.3 V
L = 1.0 μH , COUT =10 μF ×3
Ta = 25°C , TPCP8001-H
Output voltage ΔVOUT (mV)
Output current IOUT (A)

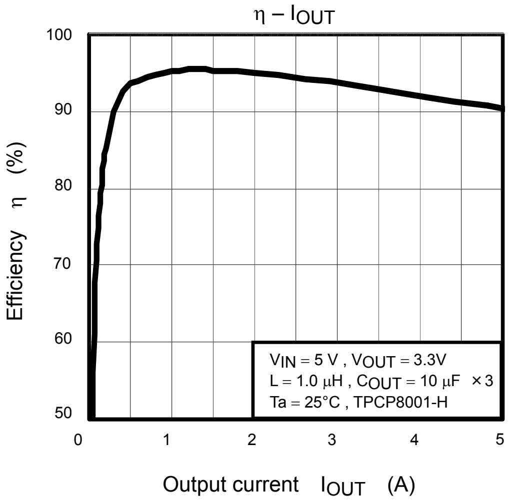

ΔVOUT – IOUT
VIN = 5 V , VOUT = 1.2 V
L = 1.0μH , COUT =10 μF ×3
Ta = 25°C , TPC6012
Output voltage ΔVOUT (mV)
Output current IOUT (A)

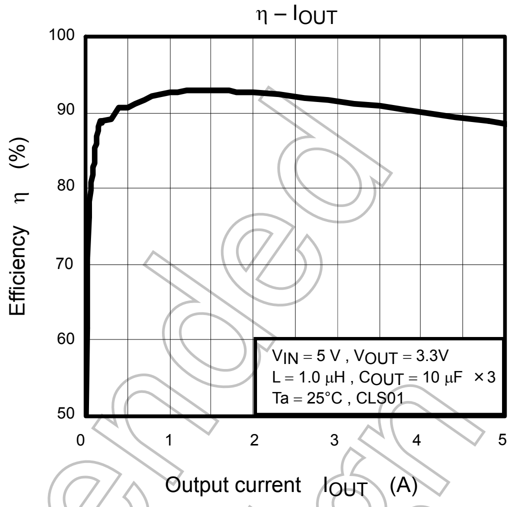

ΔVOUT – IOUT
VIN = 3.3 V , VOUT = 1.2 V
L = 1.0 μH , COUT = 10 μF ×3
Ta = 25°C , TPC6012
Output voltage ΔVOUT (mV)
Output current IOUT (A)

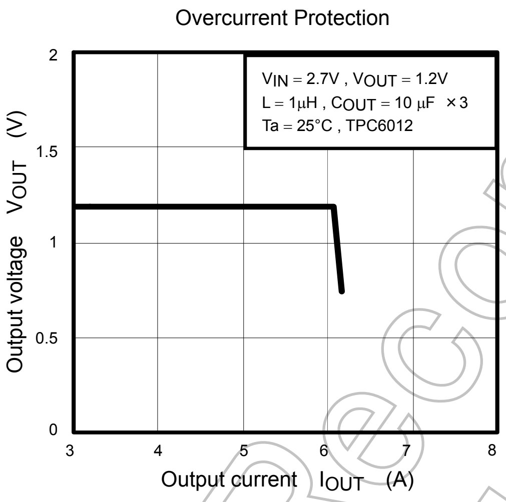

η – IOUT
VIN = 5 V , VOUT = 1.2V
L = 1.0 μH , COUT = 10 μF ×3
Ta = 25°C , TPCP8001-H
Efficiency η (%)
Output current IOUT (A)

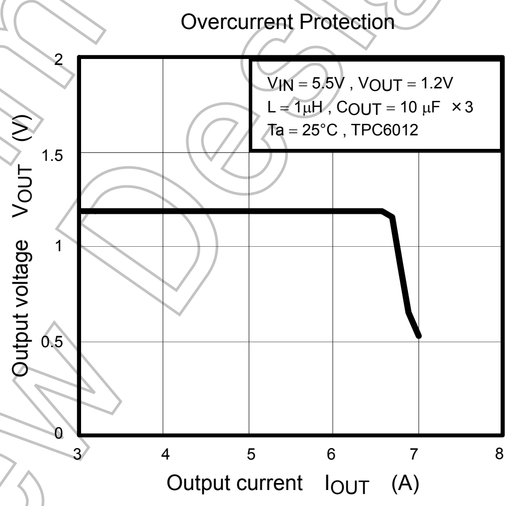

η – IOUT
VIN = 5 V , VOUT = 1.2V
L = 1.0 μH , COUT = 10 μF ×3
Ta = 25°C , TPC6012
Efficiency η (%)
Output current IOUT (A)

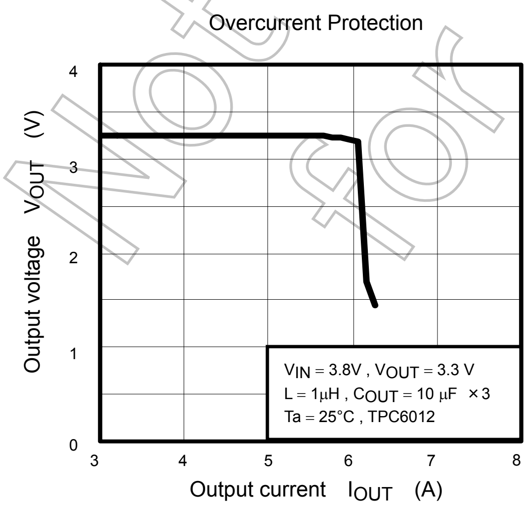

η – IOUT
VIN = 3.3 V , VOUT = 1.2V
L = 1.0 μH , COUT = 10 μF ×3
Ta = 25°C , TPC6012
Efficiency η (%)
Output current IOUT (A)

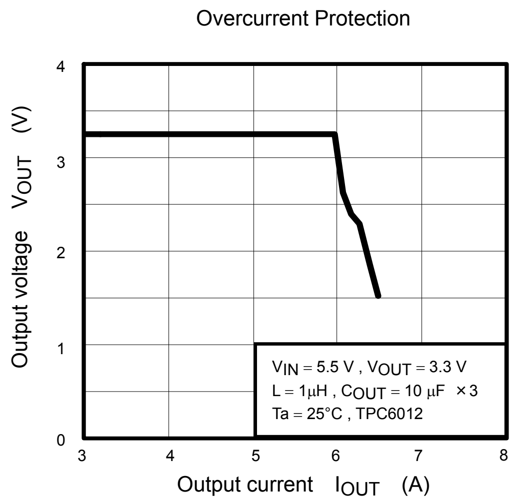

η – IOUT
Efficiency η (%)
Output current IOUT (A)
VIN = 5 V , VOUT = 3.3V
L = 1.0 μH , COUT = 10 μF ×3
Ta = 25°C , TPCP8001-H


η – IOUT
Efficiency η (%)
Output current IOUT (A)
VIN = 5 V , VOUT = 3.3V
L = 1.0 μH , COUT = 10 μF ×3
Ta = 25°C , CLS01

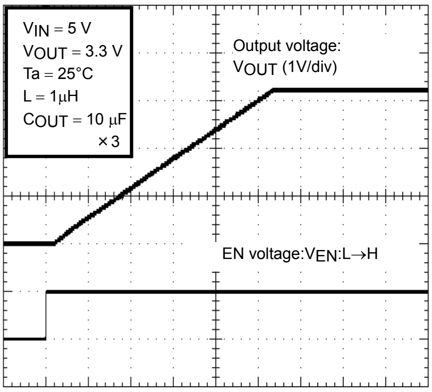

Overcurrent Protection
Output voltage VOUT (V)
Output current IOUT (A)
VIN = 2.7V , VOUT = 1.2V
L = 1μH , COUT = 10 μF ×3
Ta = 25°C , TPC6012


Overcurrent Protection
Output voltage VOUT (V)
Output current IOUT (A)
VIN = 5.5V , VOUT = 1.2V
L = 1μH , COUT = 10 μF ×3
Ta = 25°C , TPC6012


Overcurrent Protection
Output voltage VOUT (V)
Output current IOUT (A)
VIN = 3.8V , VOUT = 3.3 V
L = 1μH , COUT = 10 μF ×3
Ta = 25°C , TPC6012

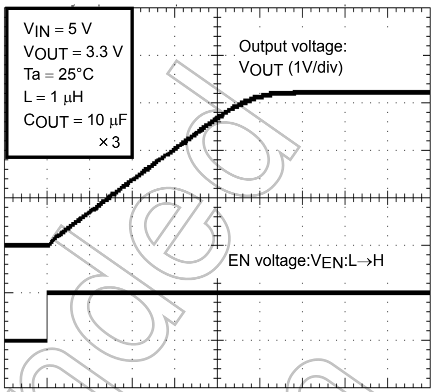

Overcurrent Protection
Output voltage VOUT (V)
Output current IOUT (A)
VIN = 5.5 V , VOUT = 3.3 V
L = 1μH , COUT = 10 μF ×3
Ta = 25°C , TPC6012

Startup Characteristics
(Interanal Soft-Start Time)



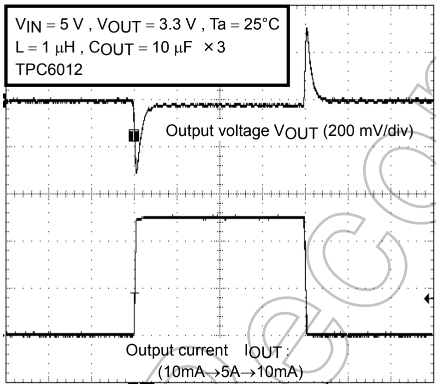

200 μs/div

Startup Characteristics
($C_{SS}$ = 0.1 μF)



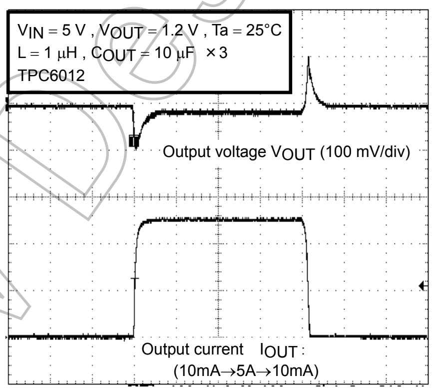

2 ms/div

Load Response Characteristics




100 μs/div

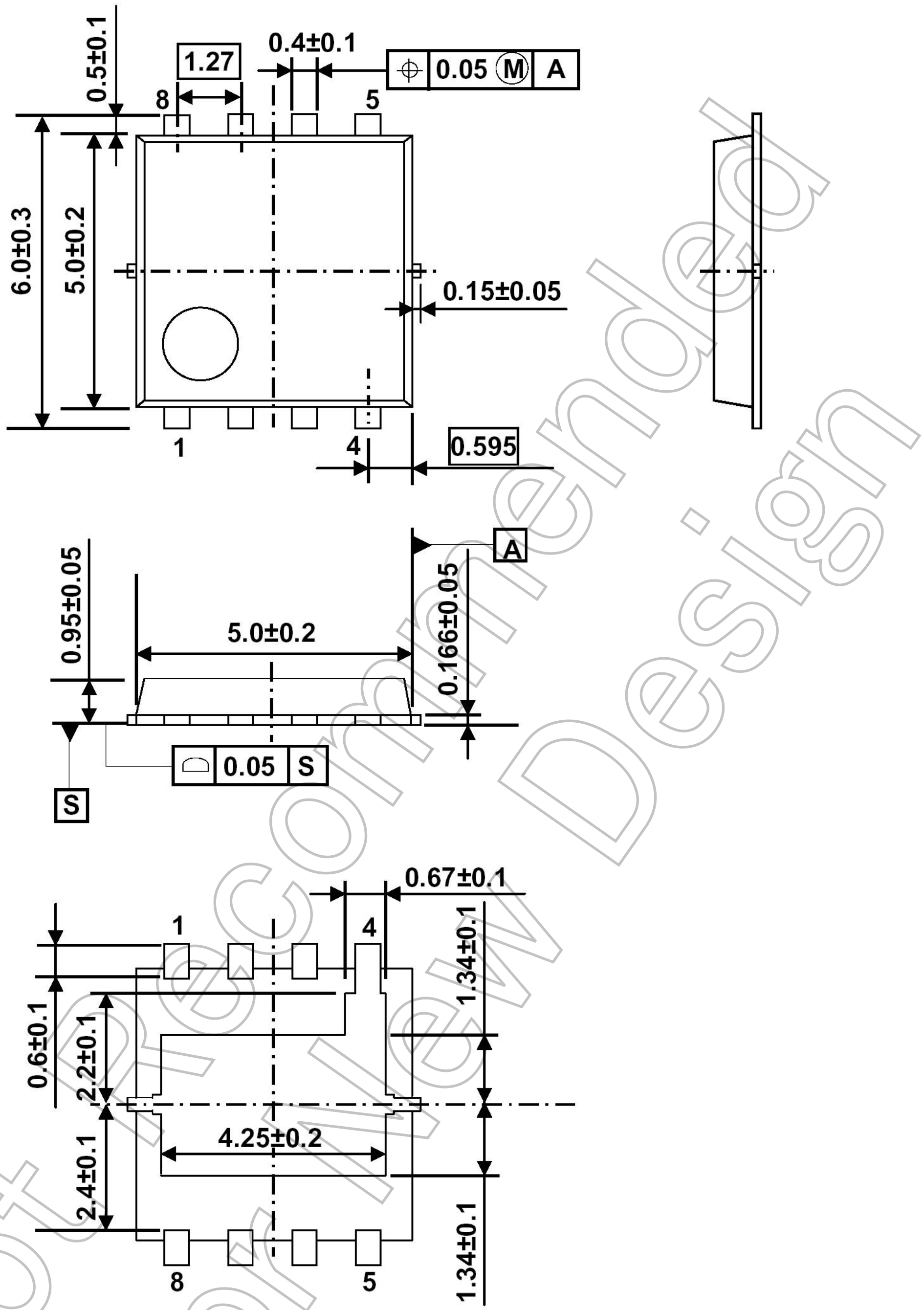
Load Response Characteristics




100 μs/div

## Package Dimensions

HSON8-P-0505-1.27 Unit: mm




Weight: 0.068 g (typ.)

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