XC6193 Series

Push Button Smart Load Switch with 140mΩ internal high-side switch and external Pch MOSFET control pin (GATE pin).

**FEATURES**

- **Input Voltage Range**: 1.6V – 6.0V
- **Stand-by Current**: 0.001μA (TYP.) / Turn-Off state
- **Quiescent Current**: 0.13μA (TYP.) / Turn-On state
- **Output Current**: Only Internal FET - 1000mA (VIN=2.0V) / External FET - Dependent on FET
- **Turn-On Delay Time**: 0.2s, 1.0s, 3.0s or 5.0s
- **Turn-Off Method**: Type A - By inputting "H" voltage to the SHDN pin.
  - By inputting "L" voltage during the T_{OFFD} to the SW pin.
  - Type B - By inputting "H" voltage to the SHDN pin.
- **Turn-Off Delay Time**: 3s, 5s, 10s or 15s
- **Added function**: External MOSFET Control function (The GATE pin)
  - Shutdown function (the SHDN pin)
- **Protective function**: Output capacitor inrush current limit soft-start
  - Output capacitor discharge
  - Output short circuit protection
  - Thermal shutdown
- **Operating Ambient Temperature**: -40deg ~ +85deg
- **Package**: USP-8B06 (2.0 x 2.0 x h0.33mm)

**APPLICATIONS**

- Wearable devices
- Smart card devices
- Wireless headphones / Earphones
- IoT devices
- Applications with ON/OFF switch function
- Various applications equipped with buttons
- Various applications equipped with mechanical switches
- The devices with waterproof function.

**GENERAL DESCRIPTION**

The XC6193 series are the Push Button load switch with functions best suitable for battery operated devices.

The built-in high side switch is turned on by the Push Button (Turning off is also possible on the type.) and turned off by the "L" level signal into the SHDN pin from the MCU or the like.

The high side switch is turned on and latched by inputting "L" signal from the Push Button of the device to the SW pin. It is possible to shut down (OFF) by inputting a 1-pulse signal of "H" level from the MCU or the like to the SHDN pin. This realizes a main switch of battery operated devices easily. (*1) (The XC6193 series are possible to control not only the built-in high side switch but also the external Pch MOSFET.)

The leak current at shutdown is so small, which is 10nA (TYP.), that this IC will contribute to reducing the discharge of the battery and making shelf life longer of the devices after shipping as well as functioning as a main switch.

For the A type, it is possible to turn off forcibly in case of emergency by Push Button signal. This enables a freeze device to be turned off. For the B type, turn-off is available only with SHDN pin.

In addition to the built-in high side switch, the XC6193 series has the GATE pin for driving an external Pch MOSFET.

In addition to these functions, this IC is equipped with output capacitor inrush current limiting function and short-circuit protection function, realizing an intelligent load switch.

(*1) Please be sure to complete the preparation for shutting down safely before inputting the signal to SHDN pin from the MCU or the likes.

**TYPICAL APPLICATION CIRCUIT**

![TYPICAL APPLICATION CIRCUIT Diagram](image-url)
Diodes inside the circuit are an ESD protection diodes and a parasitic diodes.
## PRODUCT CLASSIFICATION

### Ordering Information

**XC6193①②③④⑤⑥-⑦**

<table>
<thead>
<tr>
<th>DESIGNATOR</th>
<th>DESCRIPTION</th>
<th>SYMBOL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
</table>
| ① TYPE | | A | Turn-on: By the SW pin  
Shut-down: By the SW pin or the SHDN pin |
| | | B | Turn-on: By the SW pin  
Shut-down: By the SHDN pin |
| ② Turn-On delay time | | A | 0.2s. |
| | | 1 | 1s. option \(^{(2)}\) |
| | | 3 | 3s. option \(^{(2)}\) |
| | | 5 | 5s. option \(^{(2)}\) |
| ③④ Turn-Off delay time | | NN | It does not have “Turn-Off function by the SW pin”  
Applies to XC6193B only. |
| | | 03 | 3s. option \(^{(2)}\) |
| | | 05 | 5s. |
| | | 10 | 10s. |
| | | 15 | 15s. option \(^{(2)}\) |
| ⑤⑥~⑦ Package and Taping Type | | ER-G | USP-8B06 (5,000pcs/Reel) |

\(^{(1)}\) The “-G” suffix denotes Halogen and Antimony free as well as being fully EU RoHS compliant.

\(^{(2)}\) For option products, please contact your local Torex sales office or representative.

### Selection Guide

<table>
<thead>
<tr>
<th>Parts No.</th>
<th>Turn-On Delay Time</th>
<th>Turn-Off Delay Time</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>XC6193AA05ER-G</td>
<td>0.2s</td>
<td>5s</td>
<td>USP-8B06</td>
</tr>
<tr>
<td>XC6193AA10ER-G</td>
<td>0.2s</td>
<td>10s</td>
<td></td>
</tr>
<tr>
<td>XC6193BANNER-G</td>
<td>Not applicable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**PIN CONFIGURATION**

![PIN CONFIGURATION Diagram](image)

*The dissipation pad for the USP-8B06 package should be solder-plated in recommended mount pattern and metal masking so as to enhance mounting strength and heat release. When taking out a potential of the heat-sink, connect with Vss pin (#5 pin).*

**PIN ASSIGNMENT**

<table>
<thead>
<tr>
<th>PIN NUMBER</th>
<th>PIN NAME</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VIN</td>
<td>Power Supply Input</td>
</tr>
<tr>
<td>2</td>
<td>NC</td>
<td>No connection pin (The NC pin should be connected the Vss pin or be floated.)</td>
</tr>
<tr>
<td>3</td>
<td>SW</td>
<td>Push Button Signal input pin</td>
</tr>
<tr>
<td>4</td>
<td>GATE</td>
<td>External Pch MOSFET Control pin</td>
</tr>
<tr>
<td>5</td>
<td>VSS</td>
<td>Ground Pin</td>
</tr>
<tr>
<td>6</td>
<td>TEST</td>
<td>The TEST pin must be connected the Vss pin.</td>
</tr>
<tr>
<td>7</td>
<td>SHDN</td>
<td>Forced Shutdown pin</td>
</tr>
<tr>
<td>8</td>
<td>VOUT</td>
<td>Output pin</td>
</tr>
</tbody>
</table>

**PIN FUNCTION ASSIGNMENT**

<table>
<thead>
<tr>
<th>PIN NAME</th>
<th>SIGNAL</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW</td>
<td>L</td>
<td>Active</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>Keep the current state</td>
</tr>
<tr>
<td></td>
<td>OPEN</td>
<td>Undefined State (*)</td>
</tr>
<tr>
<td>SHDN</td>
<td>L</td>
<td>Keep the current state</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>Shut down</td>
</tr>
<tr>
<td></td>
<td>OPEN</td>
<td>Undefined State (*)</td>
</tr>
<tr>
<td>GATE</td>
<td>Low impedance</td>
<td>VOUT=&quot;H&quot; Level</td>
</tr>
<tr>
<td></td>
<td>High impedance</td>
<td>VOUT=&quot;L&quot; Level</td>
</tr>
</tbody>
</table>

(*) Please do not leave the SW pin and the SHDN pin open. Each should have a certain voltage.
# ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>RATINGS</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>V\text{IN} Pin Voltage</td>
<td>V\text{IN}</td>
<td>-0.3 \sim +6.6</td>
<td>V</td>
</tr>
<tr>
<td>V\text{OUT} Pin Voltage</td>
<td>V\text{OUT}</td>
<td>-0.3 \sim \text{VIN}+0.3 or +6.6\textsuperscript{(1)}</td>
<td>V</td>
</tr>
<tr>
<td>V\text{OUT} Pin Output Current</td>
<td>I\text{OUT}</td>
<td>1500</td>
<td>mA</td>
</tr>
<tr>
<td>SW Pin Voltage</td>
<td>V\text{SW}</td>
<td>-0.3 \sim +6.6</td>
<td>V</td>
</tr>
<tr>
<td>SHDN Pin Voltage</td>
<td>V\text{SHDN}</td>
<td>-0.3 \sim +6.6</td>
<td>V</td>
</tr>
<tr>
<td>GATE Pin Voltage</td>
<td>V\text{GATE}</td>
<td>-0.3 \sim +6.6</td>
<td>V</td>
</tr>
<tr>
<td>TEST Pin Voltage</td>
<td>V\text{TEST}</td>
<td>-0.3 \sim \text{VIN}+0.3 or +6.6\textsuperscript{(1)}</td>
<td>V</td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>USP-8B06</td>
<td>Pd 1240 (JESD51-7 board)	extsuperscript{(2)}</td>
<td>mW</td>
</tr>
<tr>
<td>Operating Ambient Temperature</td>
<td>Topr</td>
<td>-40 \sim +85</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>Tstg</td>
<td>-55 \sim +125</td>
<td>°C</td>
</tr>
</tbody>
</table>

Each rating voltage is based on the $V_{\text{SS}}$

\textsuperscript{(1)} Either of lower one, $\text{VIN}+0.3$ or +6.6, is applicable.

\textsuperscript{(2)} The power dissipation figure shown is PCB mounted and is for reference only.

Please refer to PACKAGING INFORMATION for the mounting condition.
## ELECTRICAL CHARACTERISTICS

### XC6193 Series

**Ta=25°C**

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
<th>CIRCUIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage Range</td>
<td>$V_{IN}$</td>
<td>$V_{IN}=6.0V, V_{SW}=V_{IN}$</td>
<td>1.8</td>
<td>-</td>
<td>6.0</td>
<td>V</td>
<td>(1)</td>
</tr>
<tr>
<td>Stand-by Current$^1$</td>
<td>$I_{STB}$</td>
<td>$V_{IN}=6.0V, V_{SW}=V_{IN}$</td>
<td>-0.10</td>
<td>0.001</td>
<td>0.10</td>
<td>μA</td>
<td>(1)</td>
</tr>
<tr>
<td>Operation Current$^2$</td>
<td>$I_{OP}$</td>
<td>Turn-Off states, $V_{IN}=6.0V, V_{SW}=0V$</td>
<td>-</td>
<td>48</td>
<td>91</td>
<td>μA</td>
<td>(1)</td>
</tr>
<tr>
<td>Quiescent Current$^3$</td>
<td>$I_{Q}$</td>
<td>Turn-On keeps, $V_{IN}=6.0V, V_{SW}=V_{IN}$</td>
<td>-</td>
<td>0.13</td>
<td>0.42</td>
<td>μA</td>
<td>(1)</td>
</tr>
<tr>
<td>UVLO Detect Voltage</td>
<td>$V_{UVLO}$</td>
<td>Turn-On States, $V_{IN}$ condition</td>
<td>1.1</td>
<td>1.2</td>
<td>1.37</td>
<td>V</td>
<td>(1)</td>
</tr>
<tr>
<td>UVLO Detect Delay Time</td>
<td>$t_{UVLO}$</td>
<td>After UVLO detected</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>μs</td>
<td>(1)</td>
</tr>
<tr>
<td>Turn-On Delay Time$^4$</td>
<td>$t_{OND}$</td>
<td>XC6193xAxx Change the $V_{SW}$ from $V_{IN}$ to 0V.</td>
<td>0.18</td>
<td>0.20</td>
<td>0.22</td>
<td>s</td>
<td>(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>XC6193x1xx Change the $V_{SW}$ from $V_{IN}$ to 0V.</td>
<td>0.90</td>
<td>1.00</td>
<td>1.10</td>
<td>s</td>
<td>(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>XC6193x3xx Change the $V_{SW}$ from $V_{IN}$ to 0V.</td>
<td>2.70</td>
<td>3.00</td>
<td>3.30</td>
<td>s</td>
<td>(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>XC6193x5xx Change the $V_{SW}$ from $V_{IN}$ to 0V.</td>
<td>4.50</td>
<td>5.00</td>
<td>5.50</td>
<td>s</td>
<td>(1)</td>
</tr>
<tr>
<td>Turn-Off Delay Time$^5,6,7$</td>
<td>$t_{OFFD}$</td>
<td>XC6193Ax03 Change the $V_{SW}$ from $V_{IN}$ to 0V.</td>
<td>2.70</td>
<td>3.00</td>
<td>3.30</td>
<td>s</td>
<td>(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>XC6193Ax05 Change the $V_{SW}$ from $V_{IN}$ to 0V.</td>
<td>4.50</td>
<td>5.00</td>
<td>5.50</td>
<td>s</td>
<td>(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>XC6193Ax10 Change the $V_{SW}$ from $V_{IN}$ to 0V.</td>
<td>9.0</td>
<td>10.0</td>
<td>11.0</td>
<td>s</td>
<td>(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>XC6193Ax15 Change the $V_{SW}$ from $V_{IN}$ to 0V.</td>
<td>13.5</td>
<td>15.0</td>
<td>16.5</td>
<td>s</td>
<td>(1)</td>
</tr>
<tr>
<td>Thermal shutdown Detect Temperature</td>
<td>$T_{TSD}$</td>
<td>After detected the voltage drop due to the ON resistance of the driver transistor.</td>
<td>-</td>
<td>125</td>
<td>-</td>
<td>°C</td>
<td>(1)</td>
</tr>
<tr>
<td>Thermal shutdown Release Temperature</td>
<td>$T_{TSDR}$</td>
<td>-</td>
<td>105</td>
<td>-</td>
<td>°C</td>
<td>(1)</td>
<td></td>
</tr>
<tr>
<td>Short Circuit Detect Voltage</td>
<td>$V_{SHORT}$</td>
<td>$V_{OUT}$ Condition</td>
<td>$V_{IN}-0.85$</td>
<td>$V_{IN}-0.55$</td>
<td>$V_{IN}-0.25$</td>
<td>V</td>
<td>(1)</td>
</tr>
<tr>
<td>Short Circuit Detect Delay Time</td>
<td>$t_{SHORT}$</td>
<td>After short detected, $V_{SW}=V_{IN}$</td>
<td>80</td>
<td>-</td>
<td>-</td>
<td>μs</td>
<td>(1)</td>
</tr>
</tbody>
</table>

Unless otherwise stated, $V_{SS}$ common, $V_{IN}=6.0V, V_{SW}=6.0V, V_{BID}=0V, V_{PG}=Open, I_{OUT}=0mA, C_{IN}=0.1μF, C_{L}=0.1μF$

$^1$ Self-supply current when $V_{OUT}$ is in the Turn-off state and $V_{IN}$ level is input into the $V_{SW}$ pin.

$^2$ Self-supply current when $V_{OUT}$ is in the Turn-off state and "L" level is input into the $V_{SW}$ pin.

$^3$ Self-supply current when $V_{OUT}$ is in the Turn-on state and $V_{IN}$ level is input into the $V_{SW}$ pin.

$^4$ Time from SW pin "L" level until $V_{OUT}$ pin "H" level$^7$ pin in the Turn-off state.

$^5$ Time from SW pin "L" level until $V_{OUT}$ pin "L" level$^8$ pin in the Turn-on state.

$^6$ Type B does not have this function.

---

![SW Pin Voltage Diagram](image1)

$0V$ $V_{OUT}$ Pin "H" Voltage : $V_{IN} \times 0.9$

![VOUT Pin Voltage Diagram](image2)

$0V$ $V_{OUT}$ Pin Voltage

(*7) $V_{OUT}$ Pin "H" Voltage : $V_{IN} \times 0.9$

![VOUT Pin Voltage Diagram](image3)

$0V$ $V_{OUT}$ Pin Voltage

(*8) $V_{OUT}$ Pin "L" Voltage : $V_{IN} \times 0.1$
### ELECTRICAL CHARACTERISTICS (Continued)

**XC6193 Series**

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
<th>CIRCUIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Driver On Resistor</td>
<td>$R_{ON}$</td>
<td>Turn-On states, $V_{IN}=1.8V$</td>
<td>0.145</td>
<td>0.19</td>
<td>0.46</td>
<td>$\Omega$</td>
<td>(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Turn-On states, $V_{IN}=2.0V$</td>
<td>0.135</td>
<td>0.18</td>
<td>0.40</td>
<td>$\Omega$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Turn-On states, $V_{IN}=3.0V$</td>
<td>0.110</td>
<td>0.14</td>
<td>0.26</td>
<td>$\Omega$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Turn-On states, $V_{IN}=6.0V$</td>
<td>0.085</td>
<td>0.11</td>
<td>0.20</td>
<td>$\Omega$</td>
<td></td>
</tr>
<tr>
<td>SW pin &quot;H&quot; Voltage</td>
<td>$V_{SWH}$</td>
<td>Turn-On states, $V_{SW}=6.0V$</td>
<td>1.1</td>
<td>-</td>
<td>6.0</td>
<td>$V$</td>
<td>(1)</td>
</tr>
<tr>
<td>SW pin &quot;L&quot; Voltage</td>
<td>$V_{SWL}$</td>
<td>Turn-On states, $V_{SW}=0V$</td>
<td>0</td>
<td>-</td>
<td>0.4</td>
<td>$V$</td>
<td>(1)</td>
</tr>
<tr>
<td>SW pin &quot;H&quot; Current</td>
<td>$I_{SWH}$</td>
<td>$V_{SW}=6.0V$</td>
<td>-0.10</td>
<td>0.01</td>
<td>0.10</td>
<td>$\mu A$</td>
<td>(1)</td>
</tr>
<tr>
<td>SW pin &quot;L&quot; Current</td>
<td>$I_{SWL}$</td>
<td>$V_{SW}=0V$</td>
<td>-0.10</td>
<td>0.01</td>
<td>0.10</td>
<td>$\mu A$</td>
<td>(1)</td>
</tr>
<tr>
<td>SHDN pin &quot;H&quot; Voltage</td>
<td>$V_{SHDNH}$</td>
<td>$V_{SHDN}=6.0V$</td>
<td>1.1</td>
<td>-</td>
<td>6.0</td>
<td>$V$</td>
<td>(1)</td>
</tr>
<tr>
<td>SHDN pin &quot;L&quot; Voltage</td>
<td>$V_{SHDNL}$</td>
<td>$V_{SHDN}=0V$</td>
<td>0</td>
<td>-</td>
<td>0.4</td>
<td>$V$</td>
<td>(1)</td>
</tr>
<tr>
<td>SHDN pin &quot;H&quot; Current</td>
<td>$I_{SHDNH}$</td>
<td>$V_{SHDN}=6.0V$</td>
<td>-0.10</td>
<td>0.01</td>
<td>0.10</td>
<td>$\mu A$</td>
<td>(1)</td>
</tr>
<tr>
<td>SHDN pin &quot;L&quot; Current</td>
<td>$I_{SHDNL}$</td>
<td>$V_{SHDN}=0V$</td>
<td>-0.10</td>
<td>0.01</td>
<td>0.10</td>
<td>$\mu A$</td>
<td>(1)</td>
</tr>
<tr>
<td>GATE pin On Resistor1</td>
<td>$R_{GATE1}$</td>
<td>Turn-On states, $V_{IN}=6.0V$, $V_{GATE}=0.3V$</td>
<td>95</td>
<td>-</td>
<td>-</td>
<td>$\Omega$</td>
<td>(1)</td>
</tr>
<tr>
<td>GATE pin On Resistor2</td>
<td>$R_{GATE2}$</td>
<td>Turn-On states, $V_{IN}=1.8V$, $V_{GATE}=0.3V$</td>
<td>-</td>
<td>-</td>
<td>300</td>
<td>$\Omega$</td>
<td>(1)</td>
</tr>
<tr>
<td>GATE pin Leak Current</td>
<td>$I_{GATEL}$</td>
<td>Turn-Off states, $V_{IN}=6.0V$, $V_{GATE}=6.0V$</td>
<td>-0.10</td>
<td>0.01</td>
<td>0.10</td>
<td>$\mu A$</td>
<td>(1)</td>
</tr>
<tr>
<td>CL Discharge Current</td>
<td>$I_{CCL}$</td>
<td>Turn-Off states, $V_{IN}=1.8V$, $V_{OUT}=0.3V$</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>$mA$</td>
<td>(1)</td>
</tr>
</tbody>
</table>

Unless otherwise stated, $V_{SS}$ common, $V_{IN}=6.0V$, $V_{SW}=6.0V$, $V_{SHDN}=0V$, $V_{PBG}=Open$, $I_{OUT}=0mA$, $C_{IN}=0.1\mu F$, $C_{L}=0.1\mu F$
XC6193 Series

■ TEST CIRCUITS

Test Circuit (1)

[Diagram of XC6193 Series test circuit with labels for VIN, SW, VSS, GATE, SHDN, and TEST.]
TYPICAL APPLICATION CIRCUIT

Example of R2’s value selection

(1) Consideration of voltage drop due to the GATE pin leakage current at turn-off states.
   1) GATE pin Leak Current = 0.1μA (MAX.)
   2) Cut-off threshold of the Q1 (VGS_cut of) = 0.3 V. (Please check the actual Q1’s data-sheet.)
      R2 x 0.1μA < VGS_cut off

   R2 < 3MΩ

(2) Consideration of VGS of the Q1 at turn-on states.
   1) GATE pin On Resistor2 (RGATE2) = 300Ω (MAX.)
   2) Turn-on threshold of the Q1 (VGS) = -1.5V (VG = VIN + VGS = 0.3V), (Please check the actual Q1’s data-sheet.)
   3) VIN = 1.8V
      R2 > (VIN – VG) / VG x RGATE2

   R2 > 1.5kΩ

(3) Consideration of current flowing between R2 and Vss at turn-on states.
   1) GATE pin On Resistor1 (RGATE1) = 95Ω (MIN.)
   2) The current flowing through to R2 = IR2

   IR2 = VIN / (R2 + RGATE1)

【Typical Examples】

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<thead>
<tr>
<th>VALUE</th>
<th>MANUFACTURER</th>
<th>PRODUCT NUMBER</th>
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<tr>
<td>SBD*1) VF = 0.37V</td>
<td>Panjit</td>
<td>RB751S40</td>
</tr>
<tr>
<td>CIN 0.1μF / 10V (Ceramic)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CL 0.1μF / 10V (Ceramic)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1 Set it as necessary. (Example: 0.1μF~1μF)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R1 200kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2 1.5kΩ~3MΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R3 5kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R4 47kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1 Rds=112mΩ@VGS=-1.8V</td>
<td>ON Semiconductor</td>
<td>FDZ375P</td>
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</table>

*1) Please select freely according to the threshold of the MCU’s I/O.
The XC6193 series type-A fixes VOUT at "H" voltage (same level as the VIN pin voltage) when "L" voltage is input for the required time into the SW pin, and shuts down VOUT (same level as GND) when "L" voltage is subsequently input for the required time into the SW pin, thereby realizing alternating ON/OFF control(*). Two shutdown methods are available: inputting "H" voltage into the SHDN pin, and inputting "L" voltage the required time into the SW pin.

* Alternating ON/OFF control on this IC is a system that alternates between VOUT "H" voltage and shutdown each time "L" voltage is input for the required time into the SW pin.

The type-B fixes VOUT at "H" voltage when "L" voltage is input for the required time into the SW pin. After VOUT is fixed at "H" voltage, the signal is not accepted if "L" voltage is subsequently input into the SW pin. The shutdown method is inputting "H" voltage into the SHDN pin.

The XC6193 series have been equipped the GATE pin, so it can handle an output current of 1A or more by connecting a Pch MOSFET (Q1) as shown in the typical application circuit.

As protective functions, the XC6193 series are equipped with the inrush current limiting soft-start circuit, the output short protection circuit and the thermal shutdown circuit.

---

**Fig.1 XC6193A Block diagram**

**Fig.2 Typical application circuit**
[Operational Explanation (Continued)]

[Turn-On sequence: Fig.3]

If Voltage "Low" is input over the duration of $T_{OND}$ to the SW pin while $V_{OUT}$ is fixed at Voltage "Low", $V_{OUT}$ will begin to rise while the output current is being suppressed by the inrush current limit soft-start function, which will gradually turn on the Pch driver transistor PM1 (refer to Fig.1).

Even if the SW pin voltage changes to the Voltage "High" while $V_{OUT}$ is rising, $V_{OUT}$ will ultimately be fixed at Voltage "High".

When the gate voltage of the PM1 has dropped sufficiently, the Nch transistor: NM1 (refer to Fig.1) connected to the GATE pin will turn on, and the GATE pin will have a low-impedance.

---

**Fig.3 Turn-On sequence**
OPERATIONAL EXPLANATION (Continued)

[Shutdown sequence: Fig.4]
In the XC6193 series, when one pulse of "H" voltage (at least 100μs as a guideline) is input into the SHDN pin with VOUT fixed at "H" voltage, VOUT changes to the shutdown state and the IC enters the standby state.

[Turn-Off sequence: Fig.5]
On the A type, when "L" voltage is input into the SW pin for the duration t\text{OFFD} with VOUT fixed at "H" voltage, VOUT shuts down. After shutdown, returning the SW pin to "H" voltage reduces the supply current to the standby current while holding the IC’s logic. The B type does not have this function.
OPERATIONAL EXPLANATION (Continued)

[Operation after Turn-On: Fig.6]
On the A type, when “L” voltage is input into the SW pin for the duration $t_{OND}$ and $V_{OUT}$ is fixed at “H” voltage, and then “L” voltage is input into the SW pin for the duration $t_{OFFD}$, the Turn-Off sequence cannot be initiated.

To initiate the Turn-Off sequence, “H” voltage must be input into the SW pin, and then “L” voltage must again be input for the duration $t_{OFFD}$.

The B type does not have a Turn-Off sequence by SW pin.

[Operation after Turn-Off: Fig.7]
On the A type, when “L” voltage is input into the SW pin for the duration $t_{OFFD}$ and $V_{OUT}$ is shut down, and then “L” voltage is input into the SW pin for the duration $t_{OND}$, the Turn-On sequence cannot be initiated.

To initiate the Turn-On sequence, “H” voltage must be input into the SW pin, and then “L” voltage must again be input for the duration $t_{OND}$.

The B type does not have a Turn-Off sequence by SW pin.
In the XC6193 series, in order to initiate the Turn-On sequence after "H" voltage is input into the SHDN pin and V\text{OUT} is shut down, "H" voltage must be input into the SW pin and then "L" voltage must again be input for the duration \( t_{\text{OND}} \).

---

**Fig.8 Operation after shutdown**

- **SHDN pin Voltage**
- **SW Pin Voltage**
- **V\text{OUT} Pin Voltage**
- **GATE Pin Voltage**
OPERATIONAL EXPLANATION (Continued)

[Thermal shutdown function: Fig.9]

The XC6193 series are equipped with thermal shutdown functions.

If a load current causes the V_{OUT} pin voltage to drop by roughly 50mV (TYP.) compared to the V_{IN} pin voltage, the overheat protection circuit will be activated and begin monitoring the IC heat generation.

If the IC temperature is equal to or greater than the Thermal Shutdown Detect Temperature (T_{TSDD} : refer to Electrical Characteristics), the function will turn PM1 OFF and stop the supply of load current.

Also, if the discontinuation of the load current supply causes the IC temperature is equal to or less than the Thermal Shutdown Release Temperature (T_{TSDR}: refer to Electrical Characteristics), the IC operation will automatically be restored. The inrush current limit soft start function also operates during automatic restoration.

However, if the V_{OUT} pin voltage is equal to or less than the Short Circuit Detect Voltage (V_{SHORT}: refer to Electrical Characteristics) before the IC temperature is equal to or less than T_{TSDR}, the IC will shut down.

Then, by performing turn-on sequence (refer to Fig.3: Turn-On Sequence), V_{OUT} is turned on again.

![Fig.9 Thermal shutdown function](image_url)
**OPERATIONAL EXPLANATION (Continued)**

**[Inrush current limit and output short circuit protection: Fig.10]**

The XC6193 series are equipped with the inrush current limiting soft-start function and the function of shutting down the output when output short circuit is detected.

After the Turn-On sequence (refer to Fig.3: Turn-On Sequence), if the V\textsubscript{OUT} pin voltage is equal to or less than the Short Circuit Detect Voltage (V\textsubscript{SHORT}: refer to Electrical Characteristics) for a duration equal to or longer than the Short Circuit Detect Delay Time (T\textsubscript{SHORT}: refer to Electrical Characteristics), it will be identified as output short. And the PM1 is latched off-state, causes V\textsubscript{OUT} to shut down.

The relation between the output current (I\textsubscript{SHORT}) and V\textsubscript{SHORT} when output short is given by the equation below.

\[
I_{\text{SHORT}} = \frac{V_{\text{IN}} - V_{\text{SHORT}}}{R_{\text{ON}}} \quad \text{(A)}
\]

* R\textsubscript{ON_min} is interlocked with V\textsubscript{SHORT_max}, and R\textsubscript{ON_max} is interlocked with R\textsubscript{ON_min}

* It is limited to the case of using IC alone.

During the Turn-On sequence, if the V\textsubscript{OUT} pin voltage is equal to or less than the V\textsubscript{SHORT} voltage, the output short-circuit protection function will not operate.

Once the V\textsubscript{OUT} pin voltage is greater than the V\textsubscript{SHORT} voltage, the output short-circuit protection function will begin to operate.

The equation for the maximum output current is as follows.

\[
I_{\text{OUT (Min.)}} = \frac{V_{\text{IN}} - V_{\text{SHORT_{max}}}}{R_{\text{ON_{min}}}} \quad \text{(A)}
\]

* It is limited to the case of using IC alone.
OPERATIONAL EXPLANATION (Continued)

[SW pin]
When "L" voltage is input into the SW pin for the duration tOND with the IC in the standby state, the pin fixes VOUT at "H" voltage. On the A type, when VOUT is fixed at "H" voltage, "L" voltage can be input for the duration toFFD to shut down VOUT.

[SHDN pin]
This pin shuts down VOUT when one pulse of "H" voltage (100μs or more as a guideline) is input into the SHDN pin with VOUT fixed at "H" voltage.

[GATE pin]
GATE pin are connected with NM1 and R2(Fig.1). Since NM1 is the N-ch MOSFET and it is synchronized with the GATE signal of PM1, if PM1 turns ON at the GATE pin, NM1 will turn ON, and if PM1 turns OFF, NM1 will turn OFF.

[VOUT pin]
VOUT pin is connected with PM1, R1 (Fig.1) and CL discharge transistor NM2 (Fig.1). PM1 is a Pch MOSFET and functions as the main driver. NM2 is an Nch MOSFET, and is synchronized with the GATE signal of PM1. Therefore, when PM1 turns ON, NM2 turns OFF.

[SW Circuit]
This circuit transmits the signal input into the SW pin to the internal circuitry.

[SHDN Circuit]
This circuit transmits the signal input into the SHDN pin to the internal circuitry.

[VREF & POR]
This circuit supplies the internal circuit with reference voltage as well as a reset signal to the logic circuitry.

[Type Select]
This circuit selects the product type.

[Turn-On Delay Counter]
This circuit count-controls the time until VOUT is fixed at "H" voltage after "L" voltage is input into the SW pin. During the time until the count is completed, the counter circuit can be returned to the initial state by inputting "H" voltage into the SW pin.

[Turn-Off Delay Counter]
This circuit only operates on the A type. When VOUT is fixed at "H" voltage, this circuit count-controls the time from input of "L" voltage into the SW pin until VOUT shuts down. During the time until the count is completed, the counter circuit can be returned to the initial state by inputting "H" voltage into the SW pin.

[UVLO]
It is Under Voltage Lock Out circuit. VOUT will shut down if the input voltage is less than VUVLO.

[IREF]
It is internal circuit reference current source.

[Soft Start (Inrush Current Limit)]
A circuit which slowly switches the PM1 gate voltage from Voltage "High" to Voltage "Low", and limits the inrush current.

[Short Circuit Protect]
This circuit outputs a signal to shut down if the VOUT pin voltage reaches VSHORT. Also, this function will stop until VOUT turns ON and reaches VSHORT. Until then, only the Thermal Shutdown circuit will operate as a protection function.

[Thermal Shutdown]
If a load current causes the VOUT pin voltage to drop by roughly 50mV (TYP.) compared to the VIN pin voltage, this function will begin monitoring the IC heat generation. If the IC temperature is equal to or greater than TSHDN, it will turn off the PM1 and stop the supply of load current.
NOTES ON USE

1) For temporary, transitional voltage drop or voltage rising phenomenon, the IC is liable to malfunction should the ratings be exceeded.

2) Please use this IC within the specified operating ranges.

3) In some cases, power supply noise may cause malfunctioning of the internal counter circuit. Sufficiently reinforce the VIN, VOUT, and GND lines, and connect 0.1μF or higher capacitors near the IC between VIN and GND (VSS), and between VOUT and GND (VSS).

4) When using the capacitor larger than 100μF for CL, it is possible that Inrush Current becomes large. Please sufficiently test actual operation before use.

5) When “L” level is input into the SW pin, Operation Current flows. Sufficiently test actual operation before designing peripheral circuits.

6) The SW pin and SHDN pin are connected to the gate of a CMOS inverter. If a voltage lower than the VIN pin voltage or a voltage higher than the VSS pin voltage is input into each pin, the flow-through current of the CMOS inverter may appear as supply current.

7) If an intermediate voltage between “L” voltage and “H” voltage is input into the SW pin or SHDN pin, starting and stopping of the IC may become unstable. Sufficiently test peripheral components and other parts to ensure that an intermediate voltage between “L” voltage and “H” voltage is not continuously input for an excessive time into the SW pin and the SHDN pin.

8) Since electromagnetic wave may cause unexpected malfunction, please reinforce the shielding of the equipment and connect a filter to each terminal as necessary and fully check with actual equipment before using.

9) The TEST pin must be connected to GND (Vss).

10) When transiently varying the input voltage, please make sure to set the slew rate under 1V/us.

11) When using for an application other than a push-button application, please design the timing to include deviations and test sufficiently with the actual device before use.

12) Torex places an importance on improving our products and their reliability. We request that users incorporate fail-safe designs and post-aging protection treatment when using Torex products in their systems.
TYPICAL PERFORMANCE CHARACTERISTICS

(1) Standby Current vs. Input Voltage

XC6193 Series

Turn-Off State, $V_{SW}=V_{IN}$
$C_{IN}=0.1\mu F, C_{L}=0.1\mu F$

(2) Standby Current vs. Ambient Temperature

XC6193 Series

Turn-Off State, $V_{SW}=V_{IN}$
$C_{IN}=0.1\mu F, C_{L}=0.1\mu F$

(3) Quiescent Current vs. Input Voltage

XC6193 Series

Turn-On State, $V_{SW}=V_{IN}$
$C_{IN}=0.1\mu F, C_{L}=0.1\mu F$

(4) Quiescent Current vs. Ambient Temperature

XC6193 Series

Turn-On State, $V_{SW}=V_{IN}$
$C_{IN}=0.1\mu F, C_{L}=0.1\mu F$

(5) Operation Current vs. Input Voltage

XC6193 Series

Turn-Off State, $V_{SW}=0V$
$C_{IN}=0.1\mu F, C_{L}=0.1\mu F$

(6) Operation Current vs. Ambient Temperature

XC6193 Series

Turn-Off State, $V_{SW}=0V$
$C_{IN}=0.1\mu F, C_{L}=0.1\mu F$
XC6193 Series

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(7) Turn-On Delay Time vs. Ambient Temperature

**XC6193xAxx**

- $V_{IN}=3.0V, V_{SW}=V_{IN}>0V$
- $C_{IN}=0.1\mu F, C_{L}=0.1\mu F$

**XC6193x1xx**

- $V_{IN}=3.0V, V_{SW}=V_{IN}>0V$
- $C_{IN}=0.1\mu F, C_{L}=0.1\mu F$

**XC6193x3xx**

- $V_{IN}=3.0V, V_{SW}=V_{IN}>0V$
- $C_{IN}=0.1\mu F, C_{L}=0.1\mu F$

**XC6193x5xx**

- $V_{IN}=3.0V, V_{SW}=V_{IN}>0V$
- $C_{IN}=0.1\mu F, C_{L}=0.1\mu F$
• TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(8) Turn-Off Delay Time vs. Ambient Temperature

**XC6193Ax03**

$V_{IN}=3.0V, V_{SW}>0V$

$C_{IN}=0.1\mu F, C_{L}=0.1\mu F$

**XC6193Ax05**

$V_{IN}=3.0V, V_{SW}=V_{IN}>0V$

$C_{IN}=0.1\mu F, C_{L}=0.1\mu F$

**XC6193Ax10**

$V_{IN}=3.0V, V_{SW}>0V$

$C_{IN}=0.1\mu F, C_{L}=0.1\mu F$

**XC6193Ax15**

$V_{IN}=3.0V, V_{SW}=V_{IN}>0V$

$C_{IN}=0.1\mu F, C_{L}=0.1\mu F$
(9) Main driver On Resistor vs. Ambient Temperature

**XC6193 Series**

Turn-On State, $V_{IN}=1.8V$
$C_{IN}=0.1\mu F, C_{L}=0.1\mu F$

**Ambient Temperature : Ta[°C]**

Main driver On Resistor : $R_{ON}[\Omega mm]$

-50 -25 0 25 50 75 100 125

**XC6193 Series**

Turn-On State, $V_{IN}=2.0V$
$C_{IN}=0.1\mu F, C_{L}=0.1\mu F$

**Ambient Temperature : Ta[°C]**

Main driver On Resistor : $R_{ON}[\Omega mm]$

-50 -25 0 25 50 75 100 125

**XC6193 Series**

Turn-On State, $V_{IN}=3.0V$
$C_{IN}=0.1\mu F, C_{L}=0.1\mu F$

**Ambient Temperature : Ta[°C]**

Main driver On Resistor : $R_{ON}[\Omega mm]$

-50 -25 0 25 50 75 100 125

**XC6193 Series**

Turn-On State, $V_{IN}=6.0V$
$C_{IN}=0.1\mu F, C_{L}=0.1\mu F$

**Ambient Temperature : Ta[°C]**

Main driver On Resistor : $R_{ON}[\Omega mm]$

-50 -25 0 25 50 75 100 125
(10) SW pin "H" "L" Voltage vs. Ambient Temperature

**XC6193 Series**

- $V_{IN} = 1.8V$
- $C_{IN} = 0.1\mu F, C_{L} = 0.1\mu F$

- $V_{SW \ "H" \ Voltage}$
- $V_{SW \ "L" \ Voltage}$

**XC6193 Series**

- $V_{IN} = 3.0V$
- $C_{IN} = 0.1\mu F, C_{L} = 0.1\mu F$

- $V_{SW \ "H" \ Voltage}$
- $V_{SW \ "L" \ Voltage}$

**XC6193 Series**

- $V_{IN} = 6.0V$
- $C_{IN} = 0.1\mu F, C_{L} = 0.1\mu F$

- $V_{SW \ "H" \ Voltage}$
- $V_{SW \ "L" \ Voltage}$

Ambient Temperature : $T_a [\degree C]$
(11) SHDN pin "H" "L" Voltage vs. Ambient Temperature

**XC6193 Series**

- **V\text{\textsubscript{IN}}=1.8V**
- **C\text{\textsubscript{IN}}=0.1\mu\text{F}, C\text{\textsubscript{L}}=0.1\mu\text{F}

(12) GATE pin Resistance vs. Ambient Temperature

**XC6193 Series**

- **V\text{\textsubscript{IN}}=3.0V**
- **C\text{\textsubscript{IN}}=0.1\mu\text{F}, C\text{\textsubscript{L}}=0.1\mu\text{F}

(13) $C\text{\textsubscript{L}}$ Discharge Current vs. Ambient Temperature

**XC6193 Series**

- **Turn-Off State, $V\text{\textsubscript{OUT}}=0.3V$**
- **C\text{\textsubscript{IN}}=0.1\mu\text{F}, C\text{\textsubscript{L}}=0.1\mu\text{F}**
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(14) Inrush Current caused by load capacitance

Inrush Current

\[ I_{\text{inrush}} = \frac{C \times V_{\text{in}}}{R} \]

\[ C_L = 47uF \]
\[ C_L = 22uF \]
\[ C_L = 10uF \]
\[ C_L = 1uF \]

\[ V_{\text{OUT}} = 2.0V / \text{div} \]
\[ I_{\text{inrush}} = 100mA / \text{div} \]
\[ \text{Time} = 400 \mu\text{sec} / \text{div} \]
## PACKAGING INFORMATION

For the latest package information go to, [www.torexsemi.com/technical-support/packages](http://www.torexsemi.com/technical-support/packages)

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<td>USP-8B06</td>
<td>USP-8B06 Power Dissipation</td>
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■ MARKING RULE
● USP-8B06

① represents product series.

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② represents Type and Turn-On delay time.

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<td>1</td>
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<td>1s.</td>
<td>XC6193A1****-G</td>
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<td>2</td>
<td>or the SHDN pin</td>
<td>3s.</td>
<td>XC6193A3****-G</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>5s.</td>
<td>XC6193A5****-G</td>
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<td>0.2s.</td>
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<td>5</td>
<td>Shut-down: By the SHDN pin</td>
<td>1s.</td>
<td>XC6193B1****-G</td>
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<tr>
<td>6</td>
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<td>3s.</td>
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<td>7</td>
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<td>5s.</td>
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③ represents Turn-Off delay time.

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④, ⑤ represents production lot number
01~09, 0A~0Z, 11~9Z, A1~A9, AA~AZ, B1~ZZ in order.
(G, I, J, O, Q, W excluded)
* No character inversion used.
1. The product and product specifications contained herein are subject to change without notice to improve performance characteristics. Consult us, or our representatives before use, to confirm that the information in this datasheet is up to date.

2. The information in this datasheet is intended to illustrate the operation and characteristics of our products. We neither make warranties or representations with respect to the accuracy or completeness of the information contained in this datasheet nor grant any license to any intellectual property rights of ours or any third party concerning with the information in this datasheet.

3. Applicable export control laws and regulations should be complied and the procedures required by such laws and regulations should also be followed, when the product or any information contained in this datasheet is exported.

4. The product is neither intended nor warranted for use in equipment of systems which require extremely high levels of quality and/or reliability and/or a malfunction or failure which may cause loss of human life, bodily injury, serious property damage including but not limited to devices or equipment used in 1) nuclear facilities, 2) aerospace industry, 3) medical facilities, 4) automobile industry and other transportation industry and 5) safety devices and safety equipment to control combustions and explosions. Do not use the product for the above use unless agreed by us in writing in advance.

5. Although we make continuous efforts to improve the quality and reliability of our products; nevertheless Semiconductors are likely to fail with a certain probability. So in order to prevent personal injury and/or property damage resulting from such failure, customers are required to incorporate adequate safety measures in their designs, such as system fail safes, redundancy and fire prevention features.

6. Our products are not designed to be Radiation-resistant.

7. Please use the product listed in this datasheet within the specified ranges.

8. We assume no responsibility for damage or loss due to abnormal use.

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