MITSUMI

The PWM control IC for AC-DC converter

# MM3663 Series

## Overview

The MM3663 is the current mode PWM controller IC, designed for flyback converter. This IC can substantially reduce standby power by the start up circuit using the 500V high breakdown process, burst mode operating in low load, and optimization of supply current. Frequency reduction function in load of middle range and minimum frequency limit function prevent chattering noise in low load, and improve average efficiency. Select function of maximum frequency (66kHz or 100kHz) and adjustment function of FB pin voltage for oscillation stop which is innovation expand flexibility of the power supply design. Others, frequency jittering function, X capacitor discharge function make the measures of EMI easy. The MM3663 which has various protection functions can assist safety design of power supply.

## Features

- Start up circuit by 500V high breakdown process reduce start up circuit loss.
- Current mode PWM controller (select function of maximum oscillating frequency, 66kHz or 100kHz)
- Frequency reduction function in load of middle range improve avearge efficiency.
- Low voltage of UVLO and low supply current in oscillation stop reduce standby power more.
- Noise diffusion, downsize filter by frequency jitter function in all range.
- X capacitor discharge function which don't increase standby power can make the measures of EMI easy.
- A balance of standby power and output ripple in burst mode can be adjusted by adjustment function of FB pin voltage for oscillation stop. (GATE output stop voltage)
- Input voltage correction function of load current in over current protection realize flat correction characteristics.
- Substantial protection functions included, current detect pin open detection, auxiliary winding short detection, and so on.
- The CB certification in the X capacitor discharge function is acquired.
  【IEC 60065 (ed.8)、IEC 60950-1 (ed.2)、IEC 62368-1 (ed.2)】

## Main specifications

- HV Pin Voltage : 500V
- Operating Supply Voltage : 10V to 24V
- Supply Current : Typ. 0.7mA 0.3mA at burst mode
- Maximum Frequency : Typ. 66kHz or 100kHz

## Packages

- SOP-8J

## Application

- Flat panel TV
- DVD Player, BD Player, BD Recorder
- Printer, Copying Machine, FAX
- AC/DC Adapters
- Various Power Supplies

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## Model Name

M M 3 6 6 3 X F F E

Series name (A) (B) (C) (D)

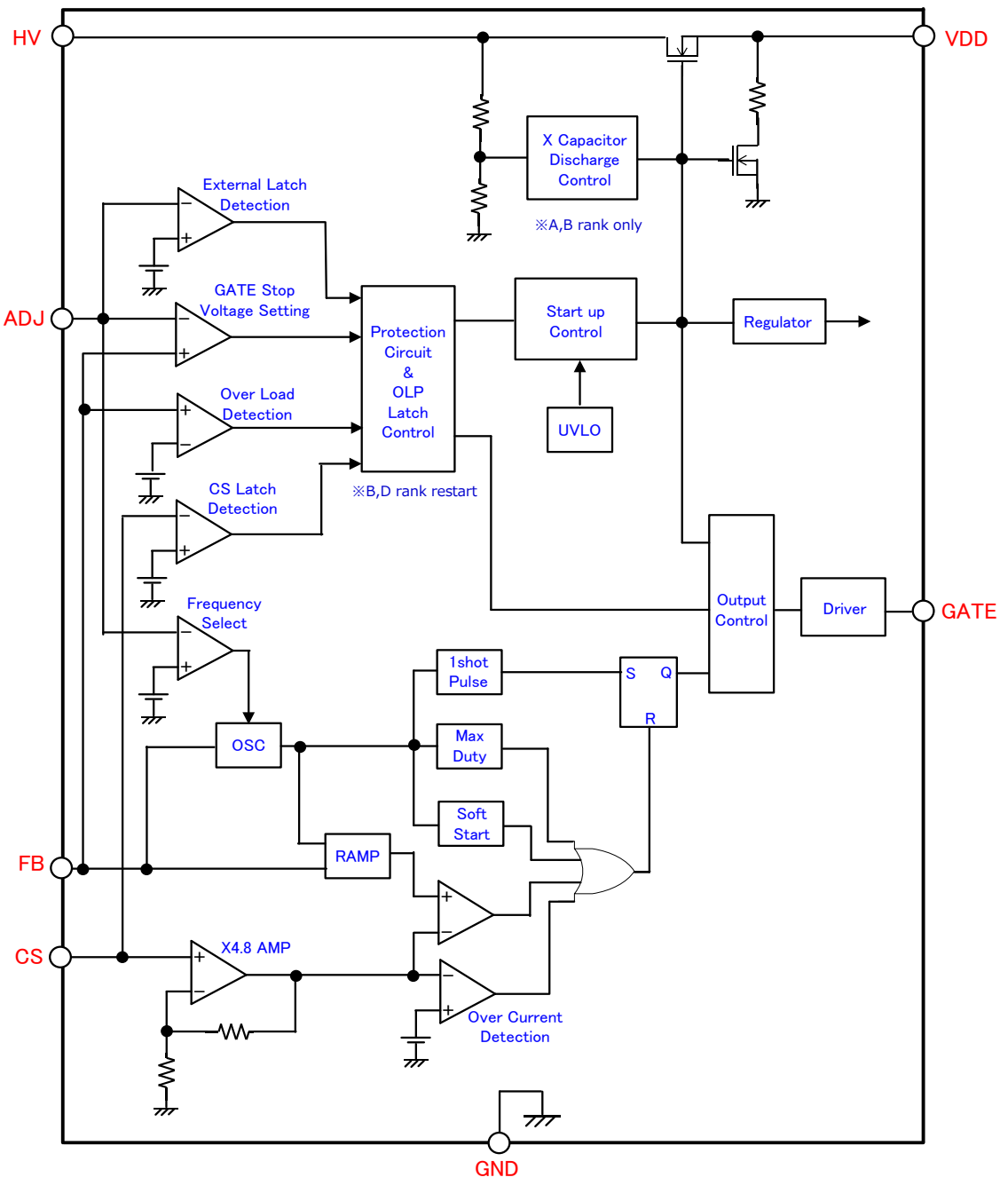
| (A) Function Type | |
|---|---|
| A | Latch off in Over Load Protection with X Capacitor Discharge |
| B | Auto restart in Over Load Protection with X Capacitor Discharge |
| C | Latch off in Over Load Protection |
| D | Auto restart in Over Load Protection |

| (C) Packing Specifications | |
|---|---|
| F | F Housing |
| | |

※ (B) Package → SOP-8J

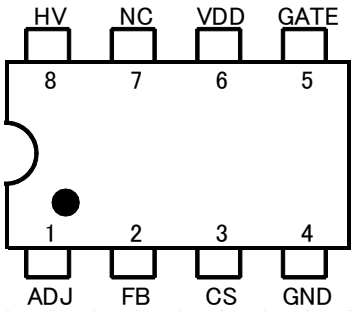
※ (D) Emboss Tape

## Block Diagram



## Pin Configuration

- SOP-8J




| Pin No. | Symbol | Function |
|---|---|---|
| 1 | ADJ | GATE output stop voltage setting, external latch input, and oscillator frequency select pin |
| 2 | FB | Feedback input pin |
| 3 | CS | Current sense pin |
| 4 | GND | Ground pin |
| 5 | GATE | Output pin |
| 6 | VDD | Power supply input pin |
| 7 | NC | No connection |
| 8 | HV | High voltage startup pin |

## Absolute Maximum Ratings

(Ta=25℃, unless otherwise specified)

| Item | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Storage temperature | Tstg | -40 | 150 | ℃ |
| Operating Temperature | Topr | -30 | 125 | ℃ |
| VDD Pin Voltage | VDD | -0.3 | 30 | V |
| ADJ Pin Voltage | VADJ | -0.3 | 5 | V |
| CS Pin Voltage | VCS | -0.3 | 5 | V |
| FB Pin Voltage | VFB | -0.3 | 5 | V |
| GATE Pin Voltage | VGATE | -0.3 | VDD | V |
| Gate Pin Peak Current | IOH | - | -0.5 | A |
| | IOL | - | 1 | A |
| HV Pin Voltage | VHV | -0.3 | 500 | V |
| Power Dissipation | Pd | - | 300 | mW |

## Recommended Operating Conditions

(Ta=25℃, unless otherwise specified)

| Item | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Operating Supply Voltage | Vop | 10 | 24 | V |
| HV Pin Input Voltage | Vhvop | 100 | 450 | V |
| HV Pin Connection Resistance | Rvh | 2.2 | 22 | kΩ |
| X Capacitor Capacitance | Cx | 0.1 | 6 | uF |
| VDD Pin Capacitance | Cvdd | 10 | 100 | uF |
| Operating Temperature | Top | -30 | 105 | ℃ |

## Electrical Characteristics

(Ta=25℃ , VDD=15V, FB=2V, CS=0V, ADJ=0.8V unless otherwise specified)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit | *1 |
|---|---|---|---|---|---|---|---|
| High Voltage Input Section (HV Pin) | | | | | | | |
| HV Input Current 1 | Ihv1 | HV=450V,VDD=23V<br>A,B rank only | 10 | 16 | 27 | μA | A |
| HV Input Current 2 | Ihv2 | HV=120V,VDD=5V | 7 | 10.5 | 13 | mA | A |
| AC Interception Detect Voltage Level（※） | Vac | HV=120V peak<br>A,B rank only | 65 | 75 | 85 | % | A |
| AC Interception Detect Time | Tac | HV=120V,VDD=23V<br>A,B rank only | 20 | 30 | 40 | ms | A |
| X Capacitor Discharge Current （※） | Ixc | HV=120V,VDD=15V<br>A,B rank only | 1.4 | - | - | mA | A |
| Power Supply Input Section (VDD Pin) | | | | | | | |
| Source Current in Startup | Istr | HV=120V,VDD=5V | -12.8 | -10.3 | -6.8 | mA | A |
| Source Current in Latch | Ilat | HV=120V,VDD=10V | -12 | -9.5 | -6 | mA | A |
| Operating Start Voltage | Vddon | VDD=15 → 23V | 19.5 | 21 | 22.5 | V | B |
| Operating Stop Voltage | Vddoff | VDD=15 → 5V | 6 | 6.5 | 7 | V | B |
| Upper Level Voltage in Latch （※） | Vddlat1 | Latch mode | - | - | 15 | V | A |
| Lower Level Voltage in Latch （※） | Vddlat2 | Latch mode | 10.5 | - | - | V | A |
| Supply Current1 | Idd1 | CL=Open | 0.55 | 0.7 | 0.85 | mA | B |
| Supply Current2 | Idd2 | FB=0V | 0.2 | 0.3 | 0.4 | mA | B |
| Supply Current in Latch | Iddlat | Latch mode, FB=5V | 0.15 | 0.25 | 0.35 | mA | A |
| VDD Over Voltage Detection | Vddovp | VDD=15 → 29.5V | 25.3 | 27.3 | 29.3 | V | B |
| VDD Over Voltage Detection Delay Time | Tvddovp | VDD=15 → 29.5V | 25 | 50 | 190 | μs | B |
| Various Function Settings Section (ADJ Pin) | | | | | | | |
| ADJ Voltage for 66kHz | Vadj1 | | - | - | 1.21 | V | B |
| ADJ Voltage for 100kHz | Vadj2 | | 1.39 | - | - | V | B |
| External Latch Stop Level | Vext | ADJ=0.5 → 0.3V | 0.35 | - | - | V | B |
| ADJ Source Current | Iadj | | -4.3 | -4 | -3.7 | μA | C |

※ guaranteed by design

*1 The test circuit symbols.

## Electrical Characteristics

(Ta=25℃ , VDD=15V, FB=2V, CS=0V, ADJ=0.8V unless otherwise specified)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit | *1 |
|---|---|---|---|---|---|---|---|
| Feedback Section (FB Pin) | | | | | | | |
| Maximum Duty Cycle (※) | Dmax | f=Fmax | 75 | 84 | 91 | % | B |
| FB Source Current | Ifb | FB=0V | -90 | -58 | -40 | μA | D |
| Gate Stop Voltage 1 | Voff1 | Fmax=66kHz,ADJ=0.8V | 0.72 | 0.8 | 0.88 | V | B |
| Gate Stop Voltage 2 | Voff2 | Fmax=100kHz,ADJ=2.24V | 0.72 | 0.8 | 0.88 | V | B |
| Gate Stop Voltage Hysteresis Range (※) | Voffhys | Fmax=66kHz,ADJ=0.8V | - | 60 | - | mV | B |
| Over Load Detection Voltage | Vfbolp | VDD=10V,FB=3.4→4.6V | 3.5 | 4 | 4.5 | V | B |
| Over Load Timer (※) | Tfbolp | FB=3.4→4.6V | 190 | 250 | 310 | ms | B |
| Restart Timer (※) | Trestart | FB=3.4→4.6V<br>B,D rank only | 1.5 | 2 | 2.5 | s | B |
| Current Detection Section (CS Pin) | | | | | | | |
| Voltage Gain (※) | Avcs | | - | 4.8 | - | V/V | E |
| Over Current Detection Voltage1 (※) | Vthcs1 | Duty=20% | 0.432 | 0.455 | 0.478 | V | E |
| Over Current Detection Voltage2 (※) | Vthcs2 | Duty=40% | 0.508 | 0.535 | 0.562 | V | E |
| Minimum On Time1 | Tmo1 | CS=1V | 410 | 610 | 810 | ns | E |
| Minimum On Time2 | Tmo2 | Soft Start Range<br>Over Load Range | 220 | 320 | 420 | ns | E |
| GATE Output Delay Time (※) | Toff | | - | 200 | - | ns | E |
| CS Source Current (※) | Ics | | - | -0.8 | - | μA | F |
| CS Latch Stop Detection Voltage | Vthcslat | CS=2→3V | 2.25 | 2.5 | 2.75 | V | E |
| Output Section (GATE Pin) | | | | | | | |
| L Output Voltage | Voutl | Iol=100mA | 0.5 | 1.2 | 2.2 | V | G |
| H Output Voltage | Vouth | Ioh=-100mA | 11 | 12.5 | 14 | V | H |
| Rise Time | Trise | CL=1nF | 30 | 60 | 100 | ns | I |
| Fall Time | Tfall | CL=1nF | 20 | 40 | 70 | ns | I |
| Soft Start Section | | | | | | | |
| Soft Start Time 1 (※) | Tss1 | Fmax=66kHz | - | 4.8 | - | ms | B |
| Soft Start Time 2 (※) | Tss2 | Fmax=100kHz | - | 6.4 | - | ms | B |

※ guaranteed by design

*1 The test circuit symbols.

## Electrical Characteristics

(Ta=25℃ , VDD=15V, FB=2V, CS=0V, ADJ=0.8V unless otherwise specified)

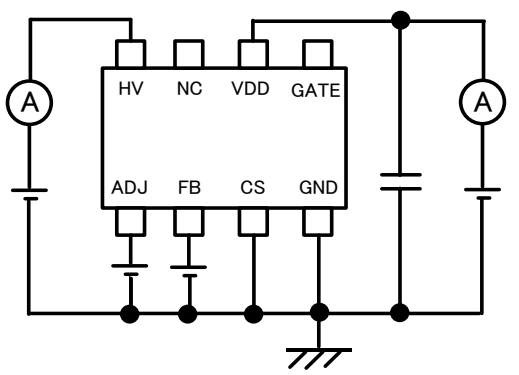
| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit | *1 |
|---|---|---|---|---|---|---|---|
| Oscillator Section | | | | | | | |
| Maximum Frequency1 | Fmax1 | | 60 | 66 | 72 | kHz | B |
| Maximum Frequency2 | Fmax2 | ADJ=2.24V | 90 | 100 | 110 | kHz | B |
| Frequency Change Ratio due to the power supply voltage | Fcrv | VDD = 10 ～ 24 V | -2 | - | 2 | % | B |
| Frequency Change Ratio due to temperature (※) | Fcrt | Ta = -30 ～ 125 ℃ | -5 | - | 5 | % | B |
| Jitta Change Ratio 1 | Fjcr1 | Fmax=66kHz | ±3 | ±5.5 | ±8 | % | B |
| Jitta Change Ratio 2 | Fjcr2 | Fmax=100kHz | ±5.5 | ±8.5 | ±11.5 | % | B |
| FB Pin Threshold Voltage at Frequency Decrease Biginning (※) | Vfbd | | 1.54 | 1.6 | 1.66 | V | B |
| FB Pin Threshold Voltage at Frequency Increase Biginning (※) | Vfbi | | 1.44 | 1.5 | 1.56 | V | B |
| Minimum Frequency1 | Fmin1 | FB=1.2V | 20 | 22 | 24 | kHz | B |
| Minimum Frequency2 | Fmin2 | FB=1.2V, ADJ=2.24V | 19 | 21 | 23 | kHz | B |

※ guaranteed by design

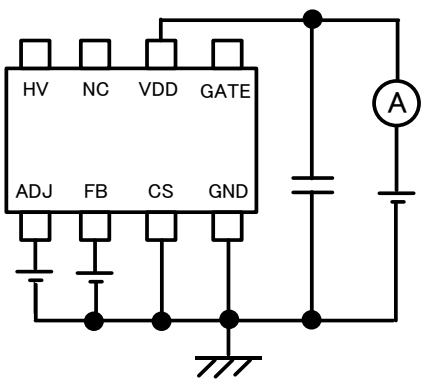
*1 The test circuit symbols.

## Test Circuit

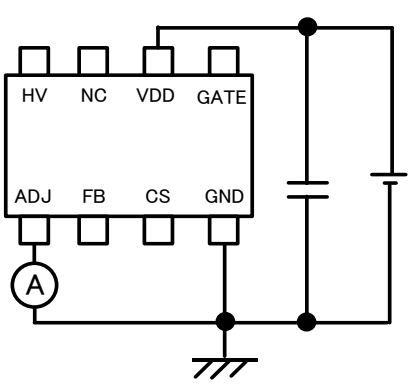
TEST CIRCUIT A



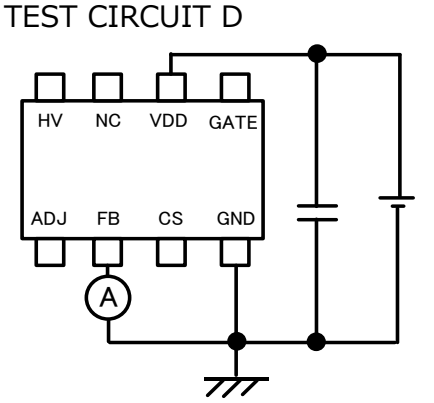

TEST CIRCUIT B



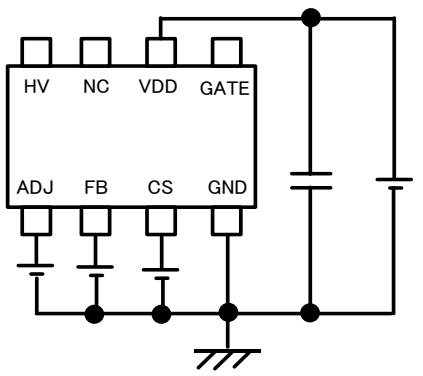

TEST CIRCUIT C



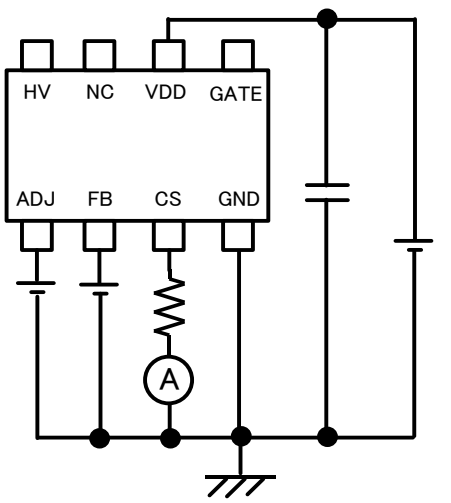

TEST CIRCUIT D




TEST CIRCUIT E

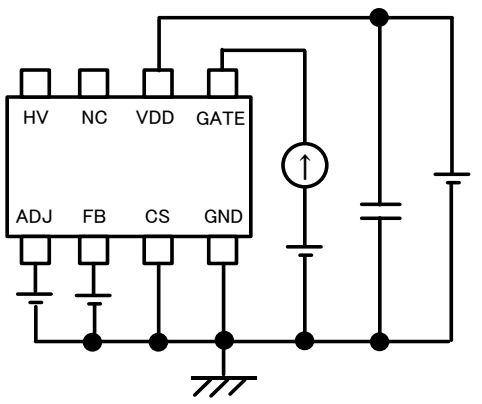



TEST CIRCUIT F

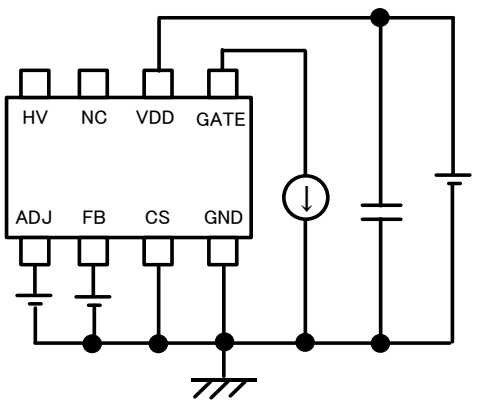


## Test Circuit

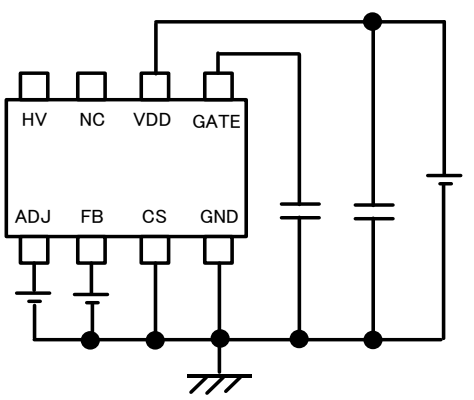
TEST CIRCUIT G




TEST CIRCUIT H

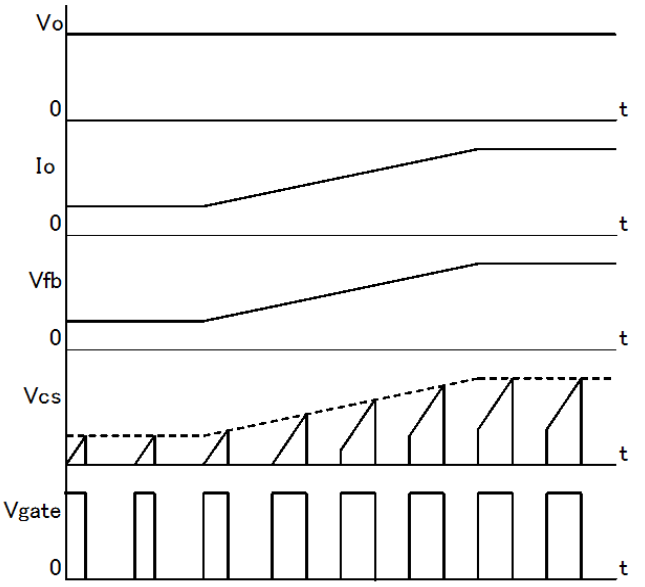



TEST CIRCUIT I

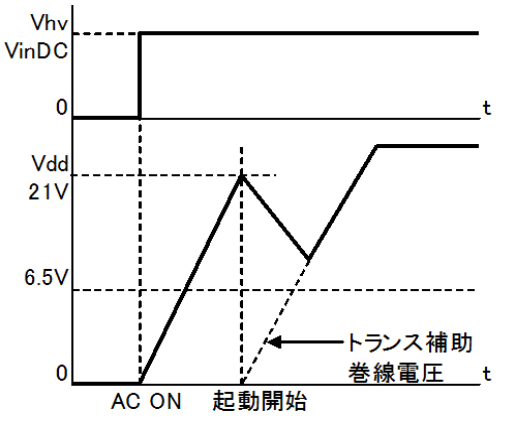


## Timing Chart

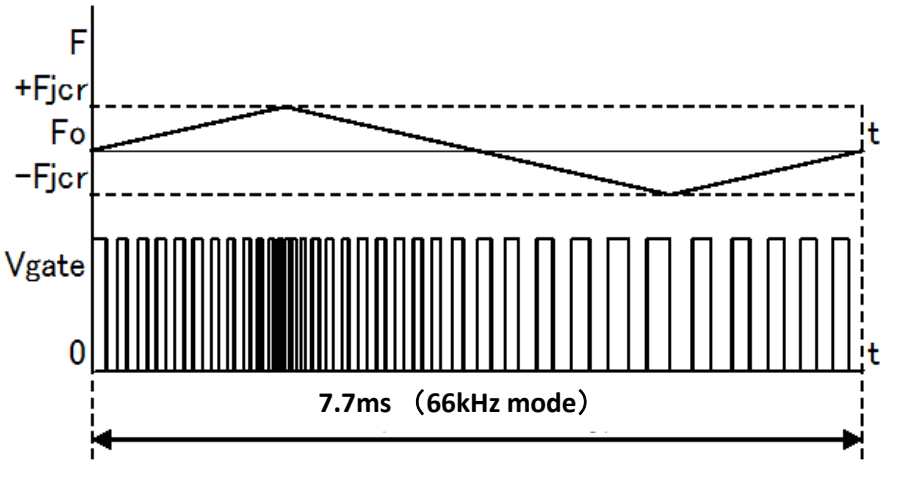
Current mode control




VDD start up characteristics

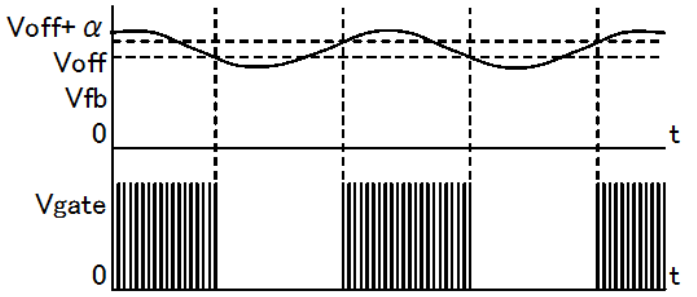



Frequency jitter function

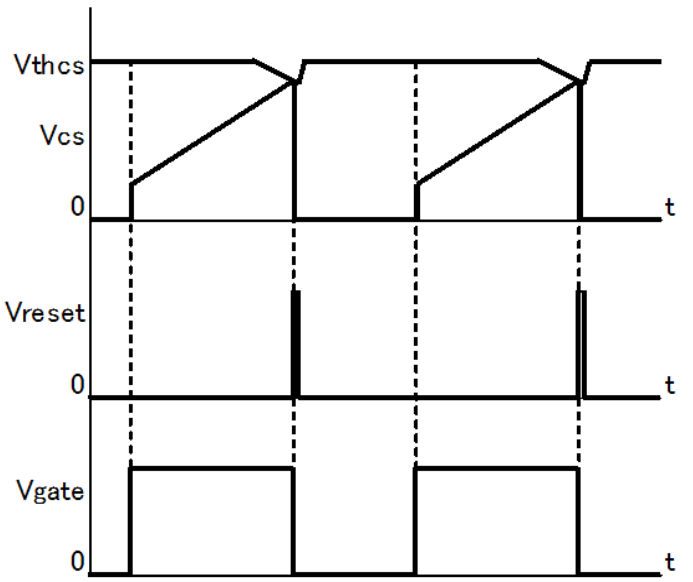


## Timing Chart

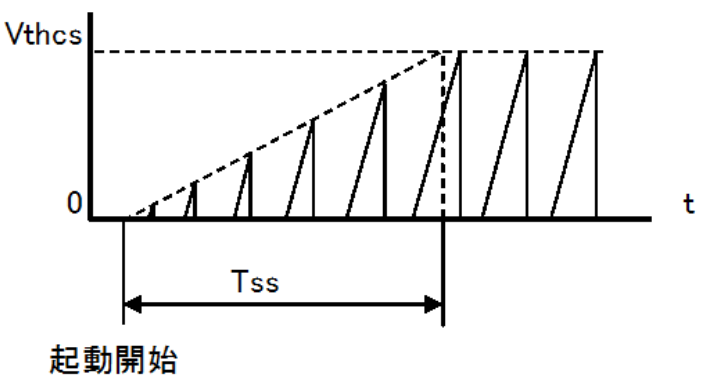
Burst mode operation




Slope compensation

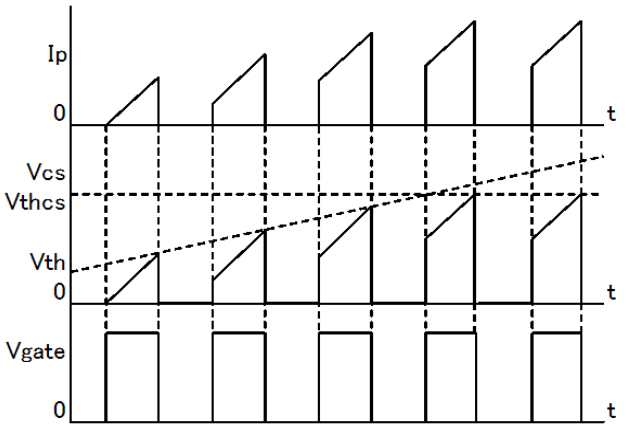



Soft start



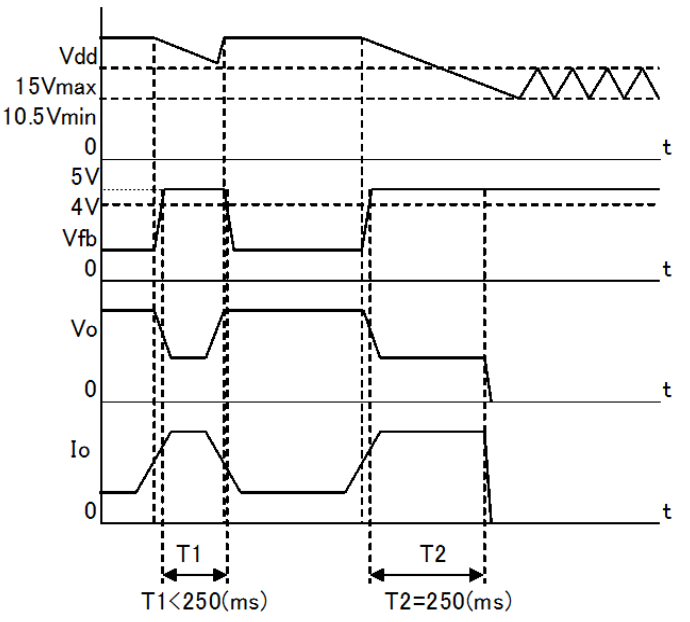
## Timing Chart

Over current protection

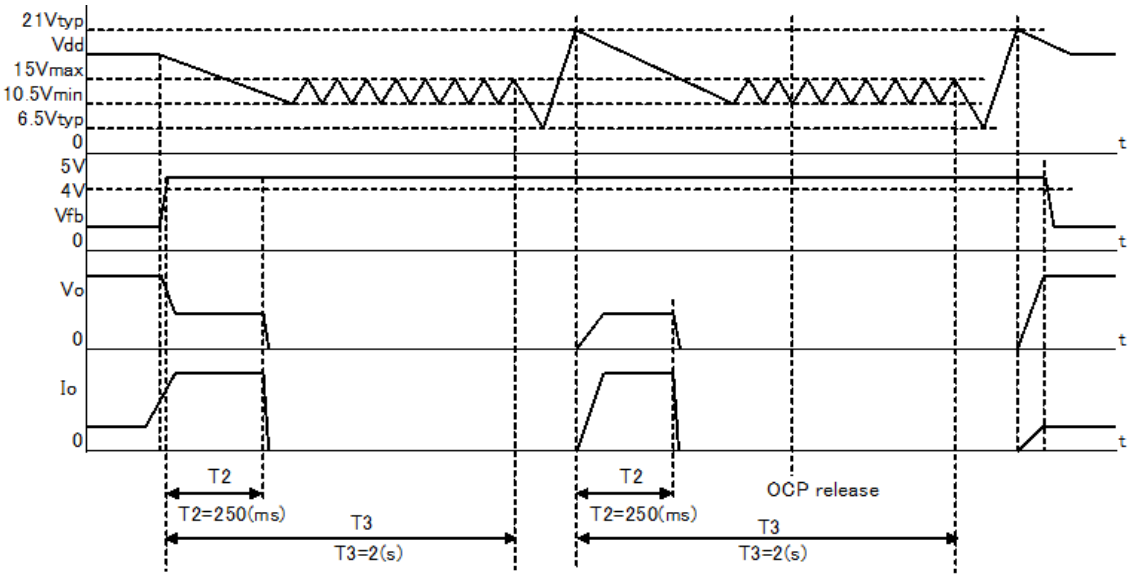



Over load protection

・Latch Type

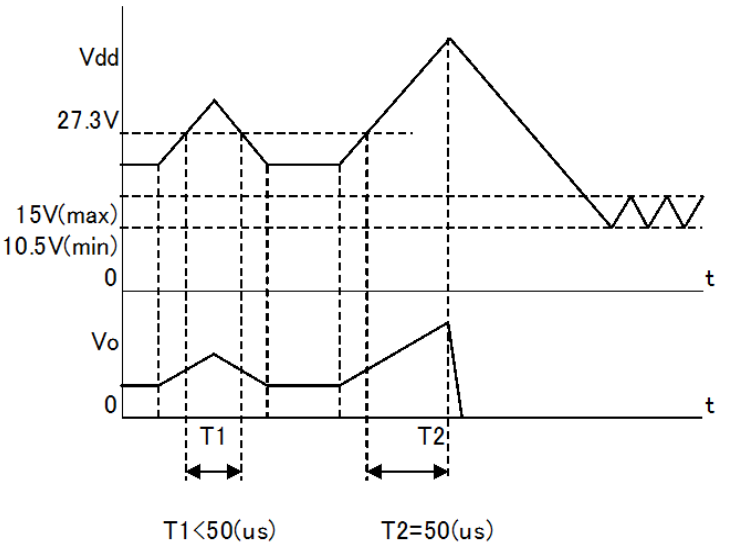



・Auto restart Type

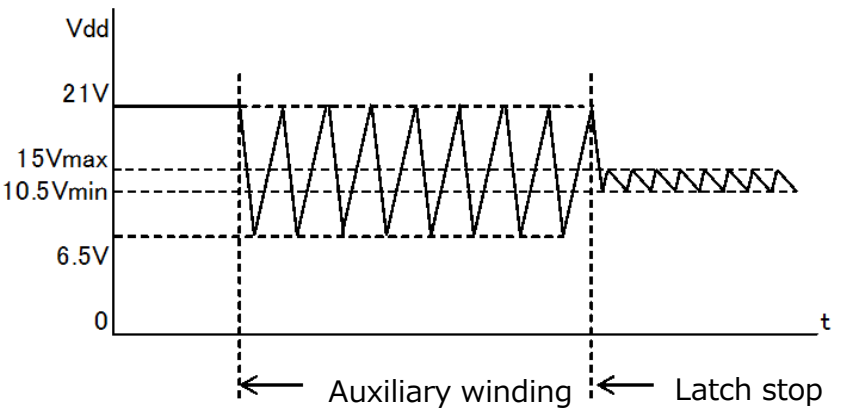


## Timing Chart

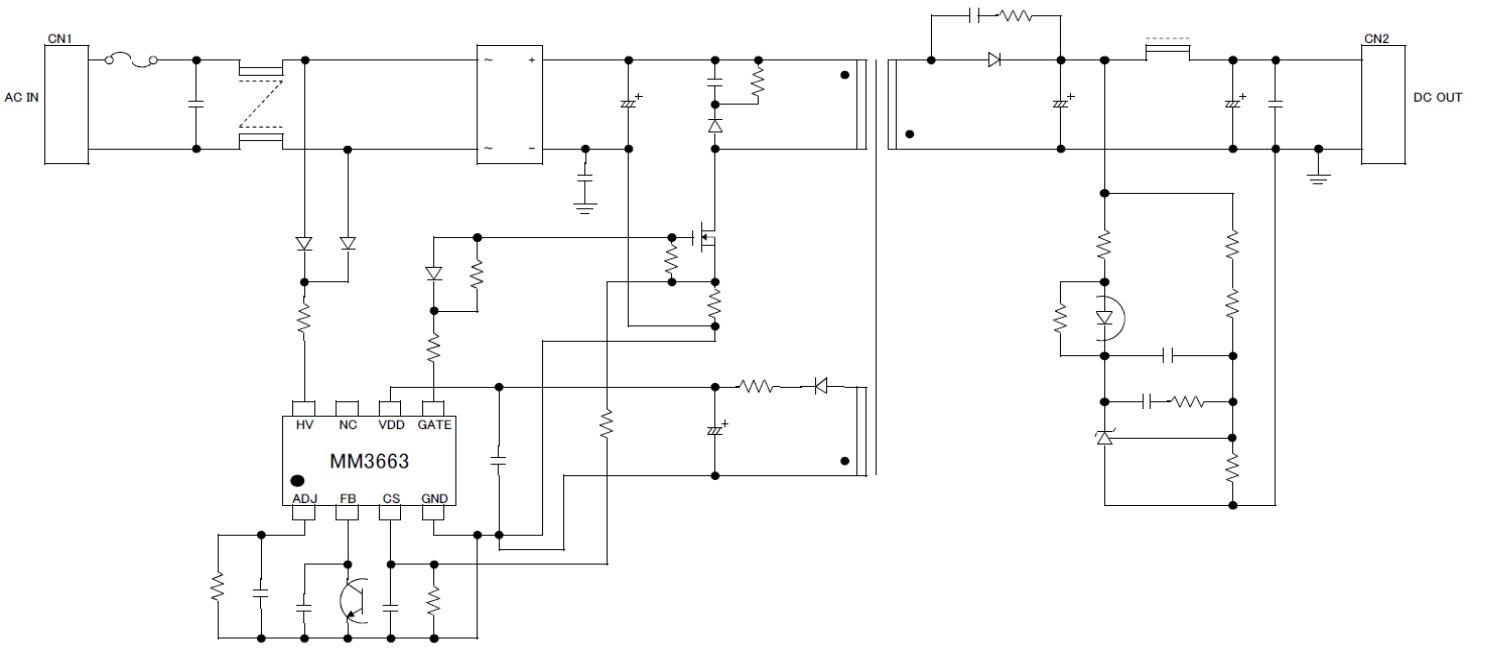
Over voltage protection




Auxiliary winding short protection



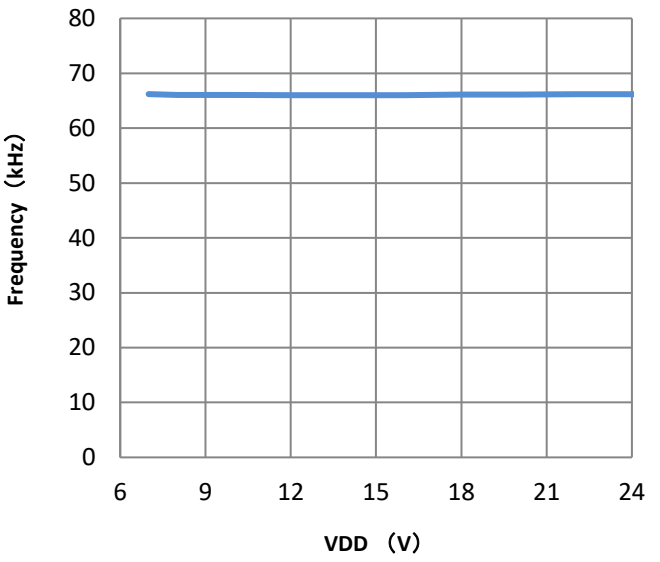

## Typical Application Circuit



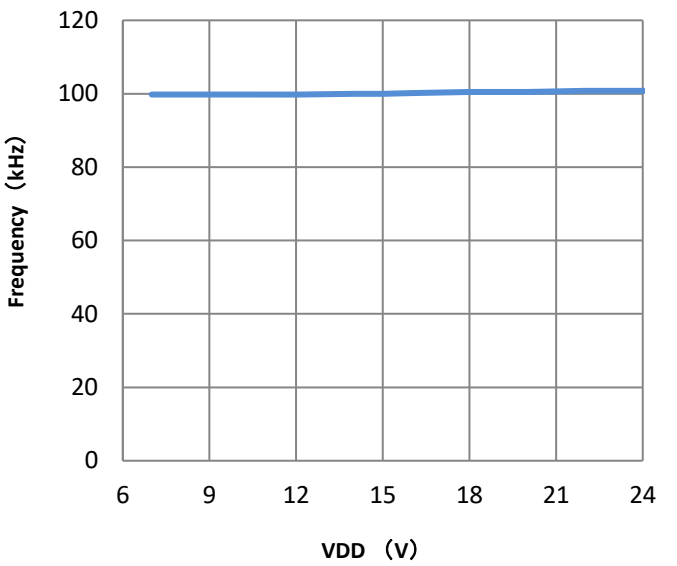
## Typical Performance Characteristics

(Ta=25℃, unless otherwise specified)

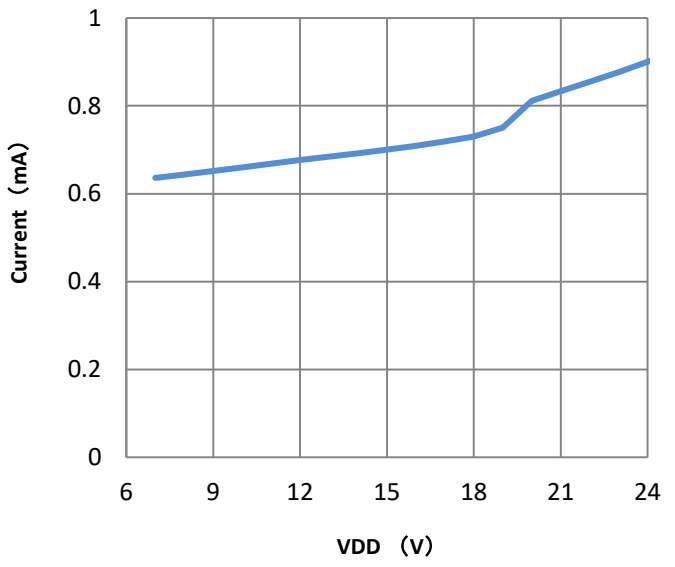
Maximum Frequency 1 vs. VDD Pin Voltage



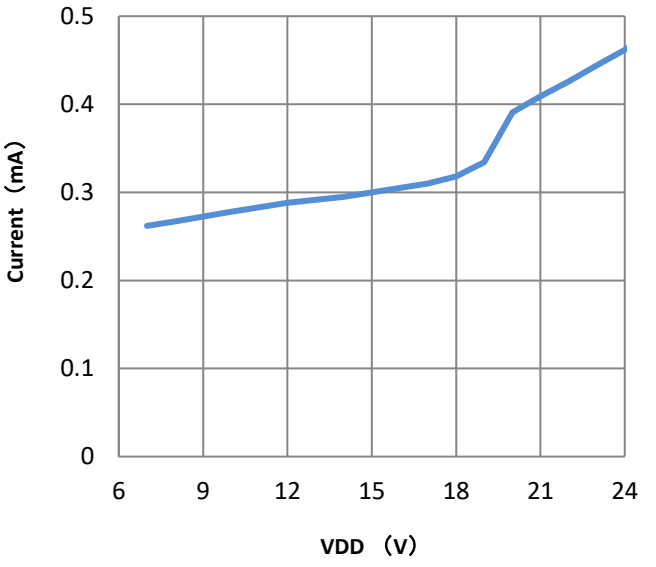

Maximum Frequency 2 vs. VDD Pin Voltage



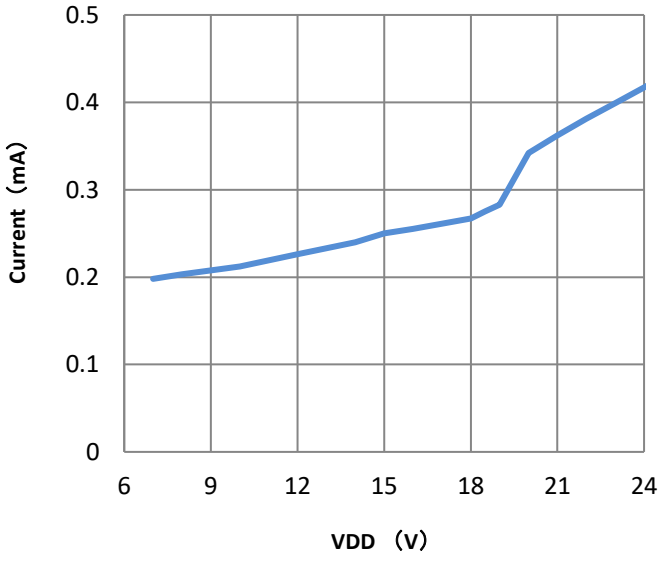

Supply Current 1 vs. VDD Pin Voltage



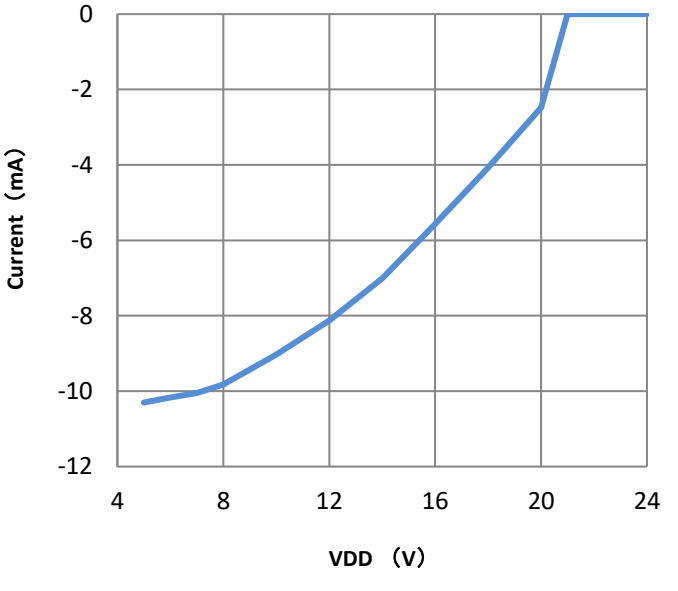

Supply Current 2 vs. VDD Pin Voltage




Supply Current in Latch vs. VDD Pin Voltage



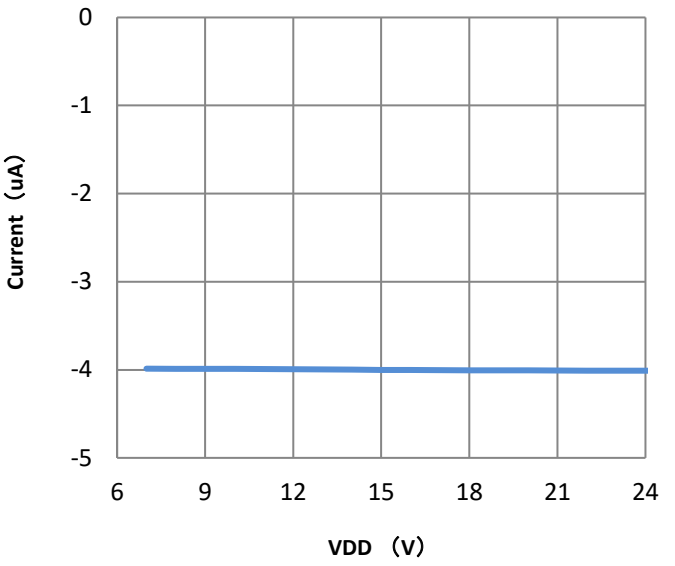

Source Current in Startup vs. VDD Pin Voltage



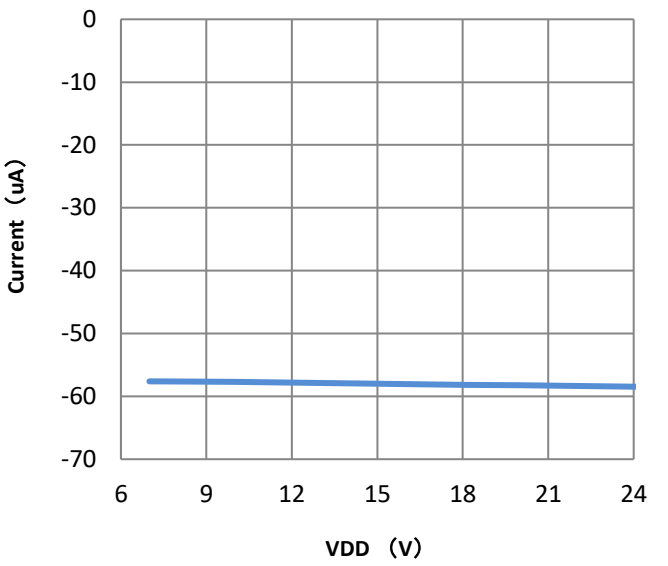
## Typical Performance Characteristics

(Ta=25℃, unless otherwise specified)

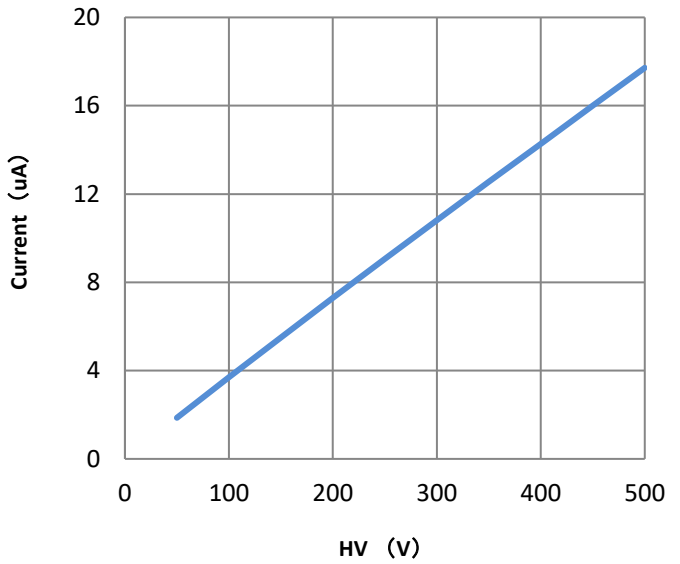
ADJ Source Current vs. VDD Pin Voltage



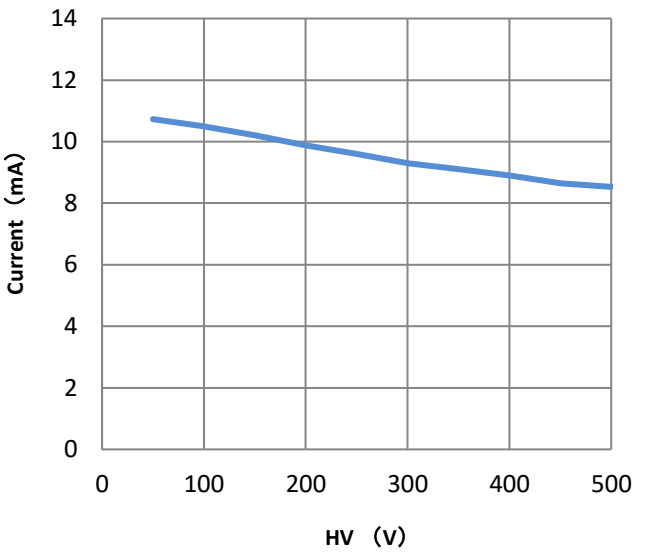

FB Source Current vs. VDD Pin Voltage



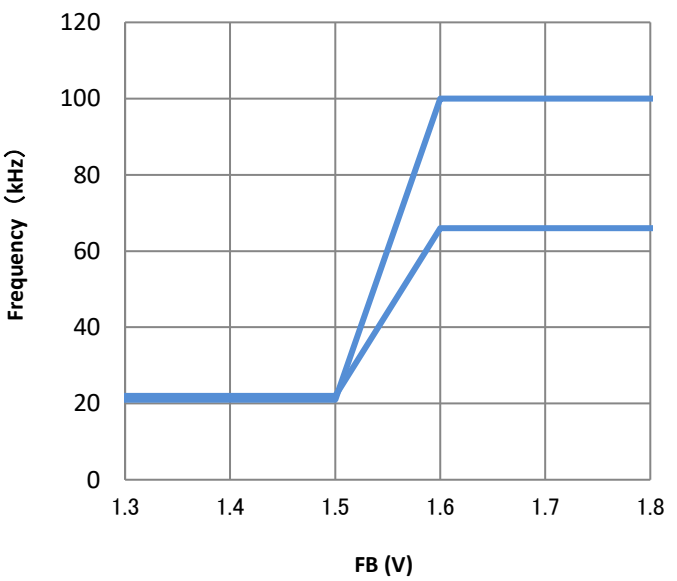

HV Input Current 1 vs. HV Pin Voltage



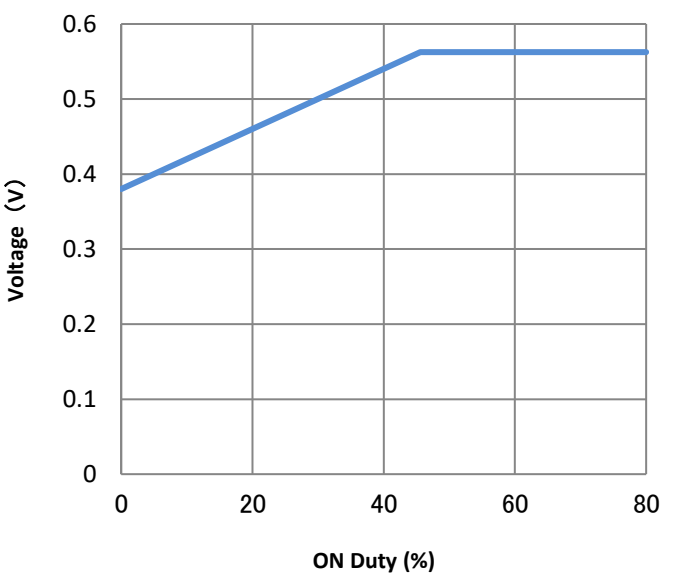

HV Input Current 2 vs. HV Pin Voltage




Frequency vs. FB Pin Voltage

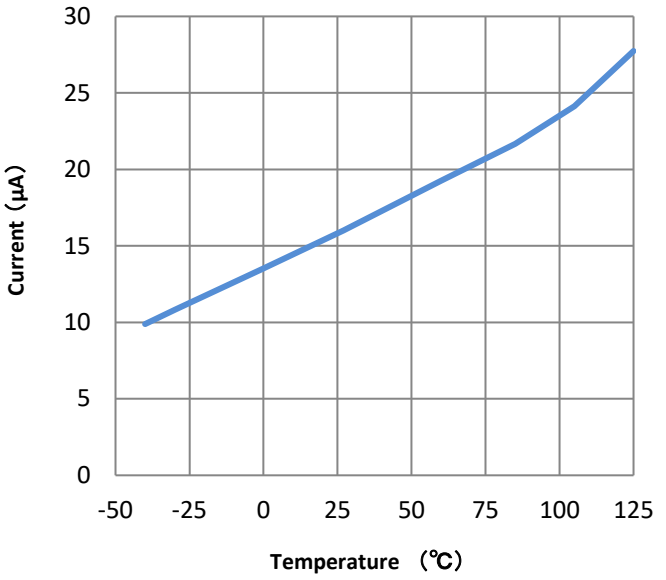



Over Current Detection Voltage vs. ON Duty

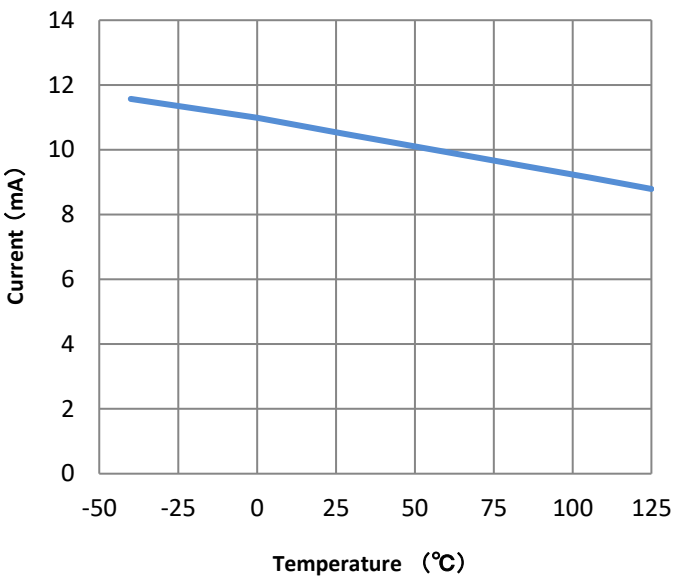


## Typical Performance Characteristics

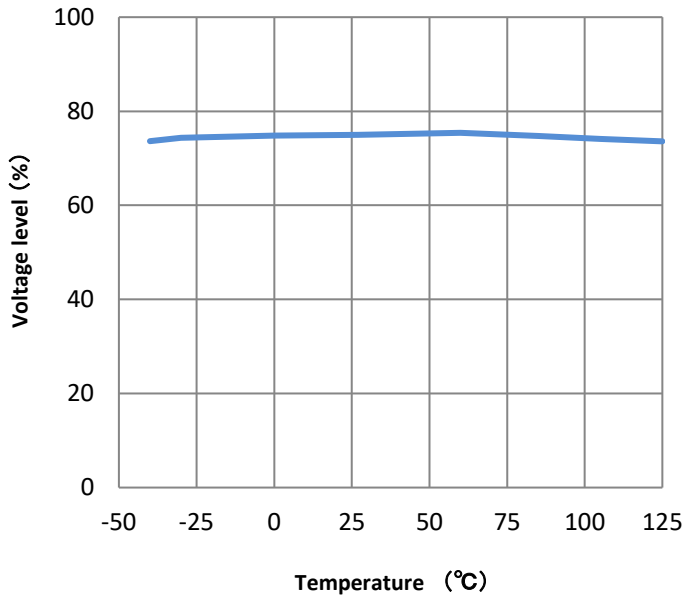
HV Input Current 1 vs. Temperature



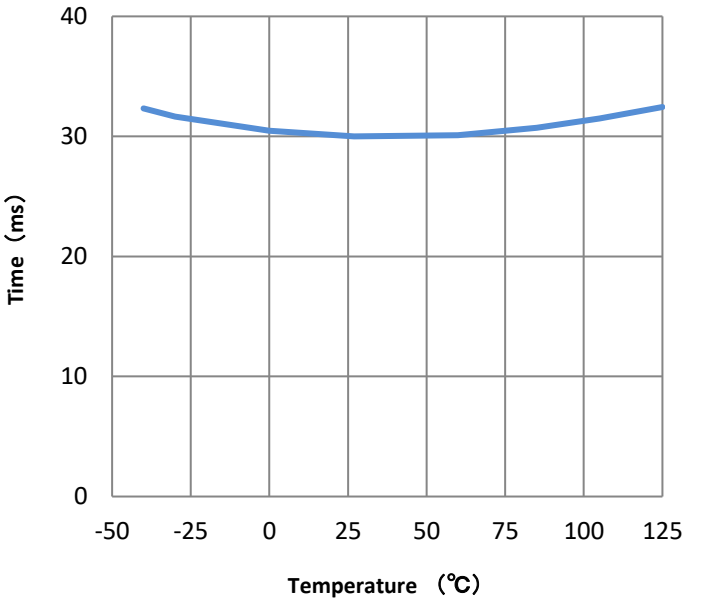

HV Input Current 2 vs. Temperature



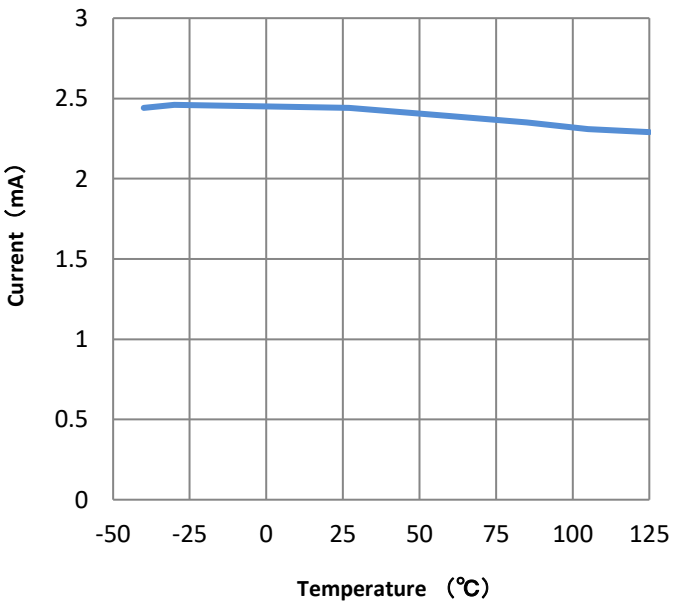

AC Interception Detect Voltage Level vs. Temperature



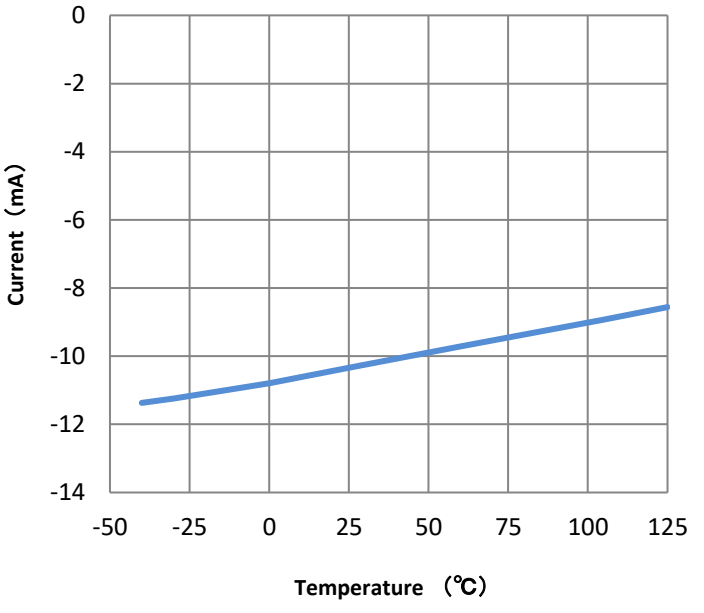

AC Interception Detect Time vs. Temperature




X Capacitor Discharge Current vs. Temperature

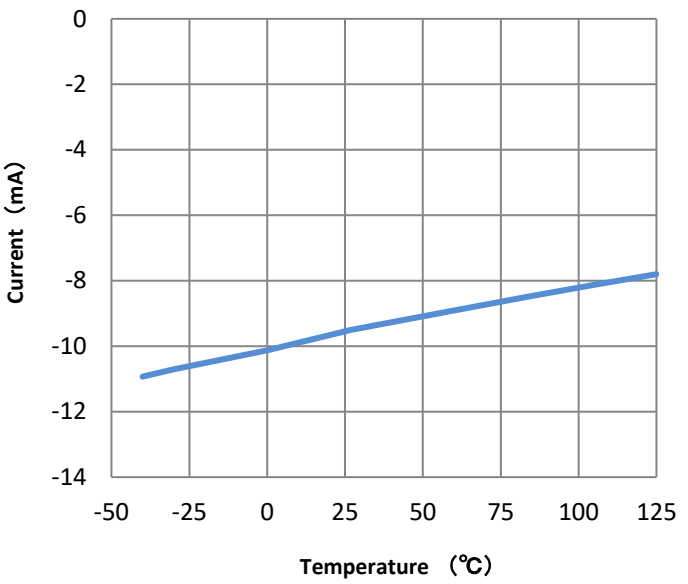



Source Current in Startup vs. Temperature

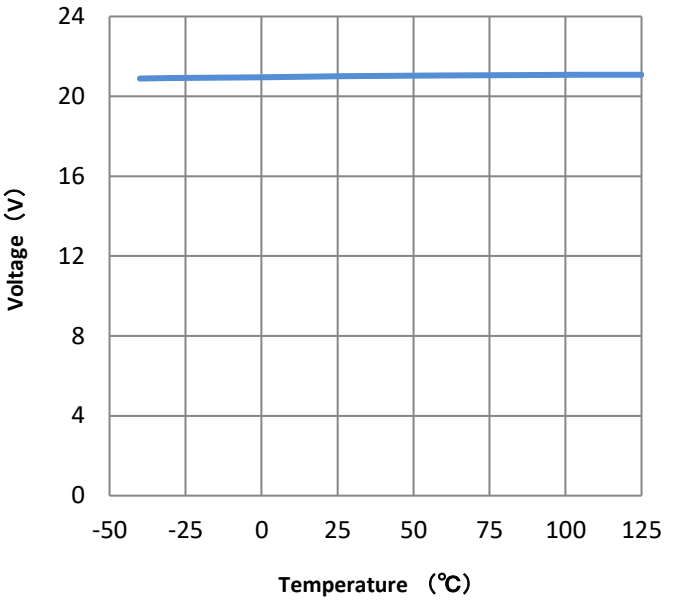


## Typical Performance Characteristics

Source Current in Latch vs. Temperature




Operating Start Voltage vs. Temperature




Operating Stop Voltage vs. Temperature




Upper Level Voltage in Latch vs. Temperature



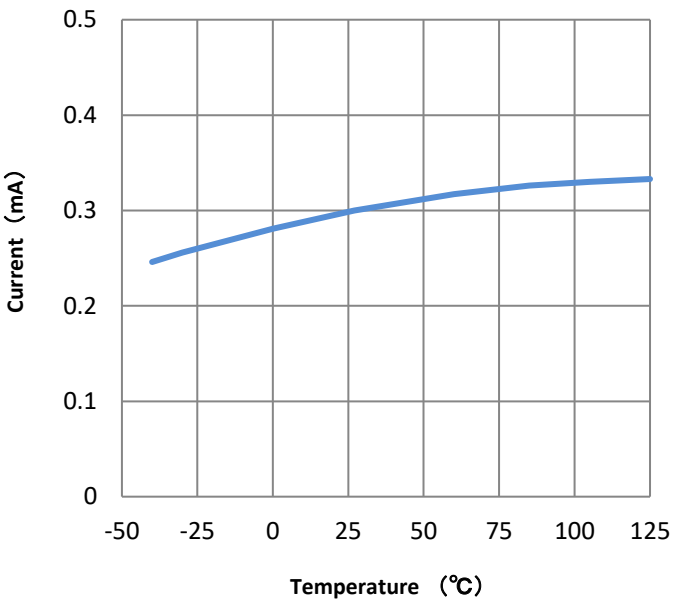

Lower Level Voltage in Latch vs. Temperature



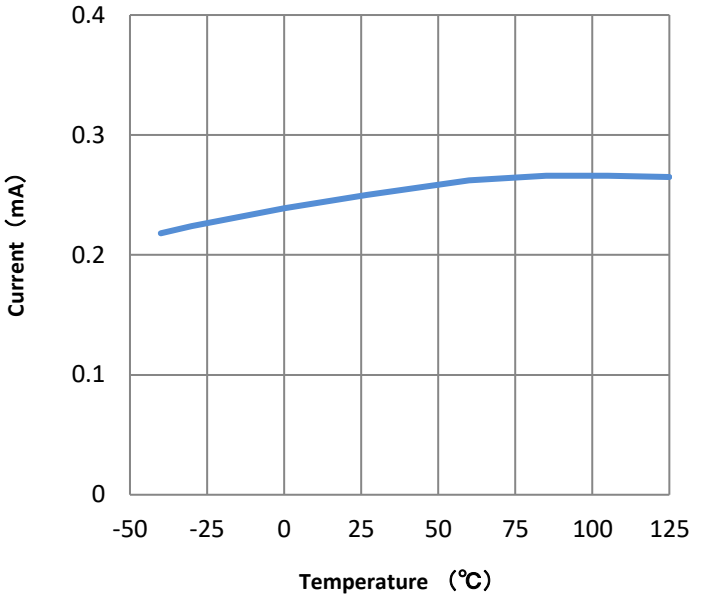

Supply Current 1 vs. Temperature

## Typical Performance Characteristics

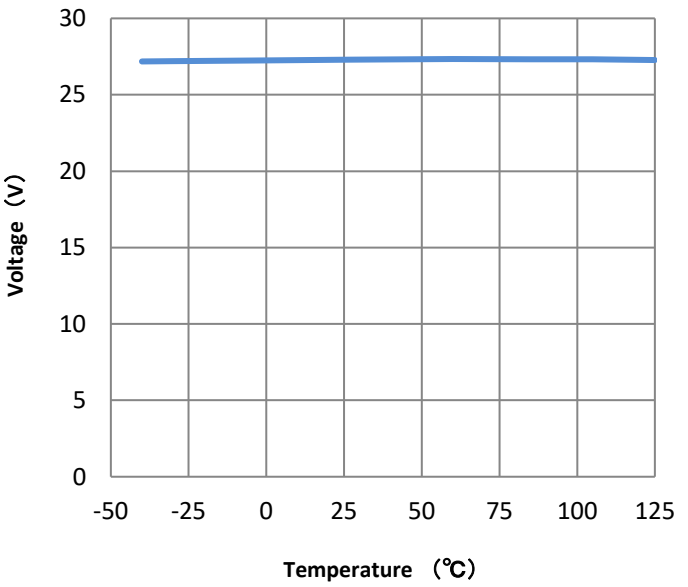
Supply Current 2 vs. Temperature



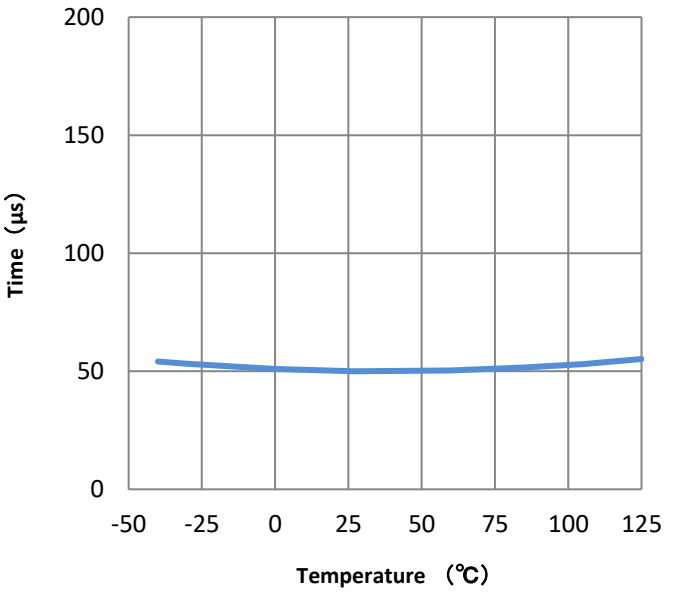

Supply Current in Latch vs. Temperature



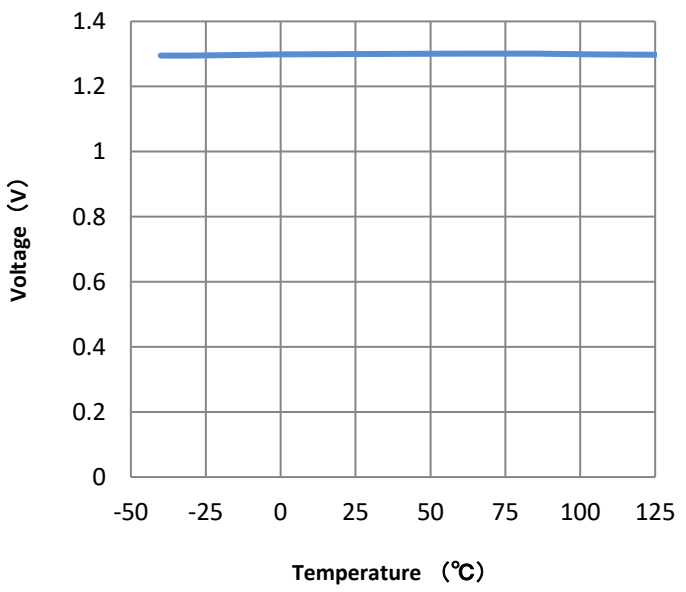

VDD Over Voltage Detection vs. Temperature



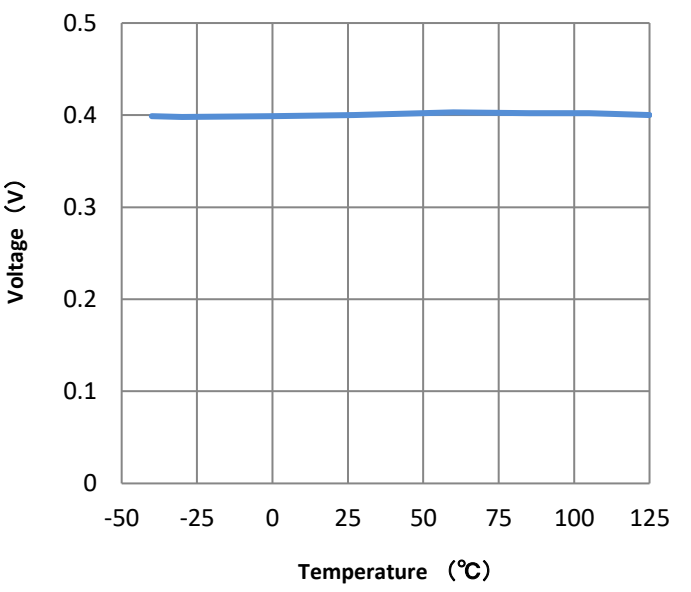

VDD Over Voltage Detection Delay Time vs. Temperature




Frequency Switching Voltage vs. Temperature

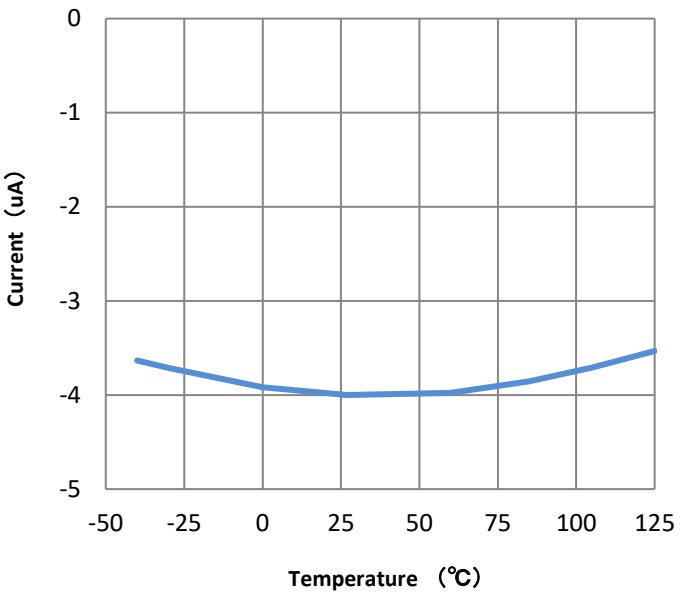



External Latch Stop Lebel vs. Temperature

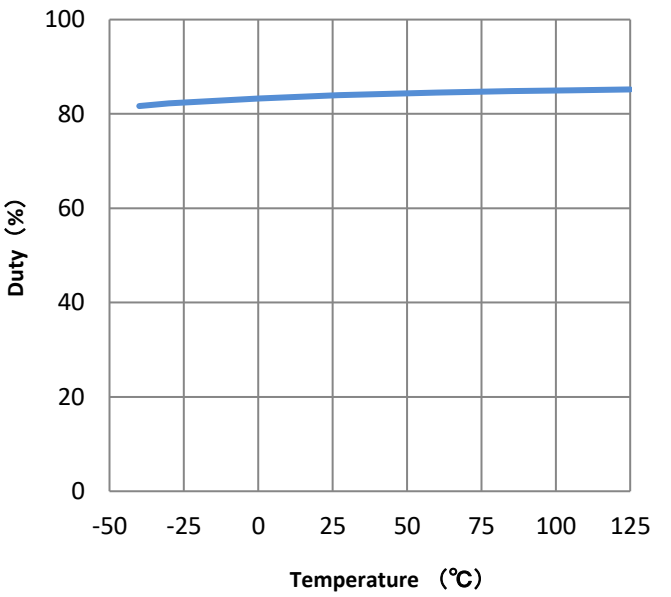


## Typical Performance Characteristics

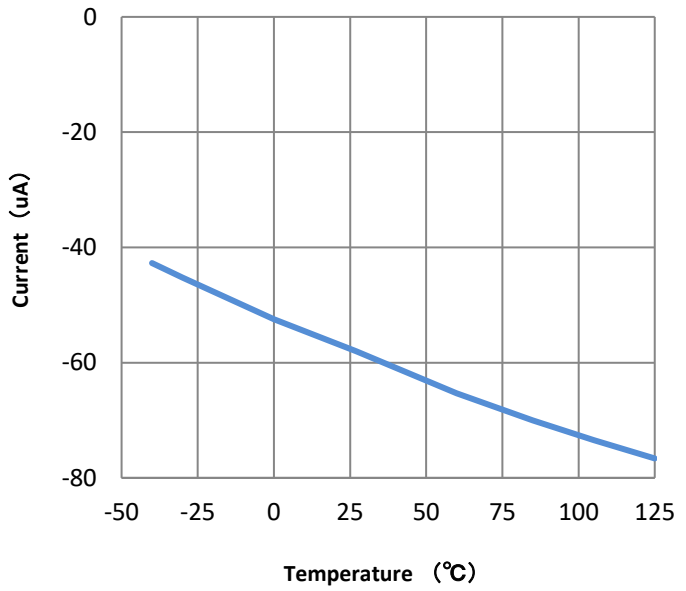
ADJ Source Current vs. Temperature



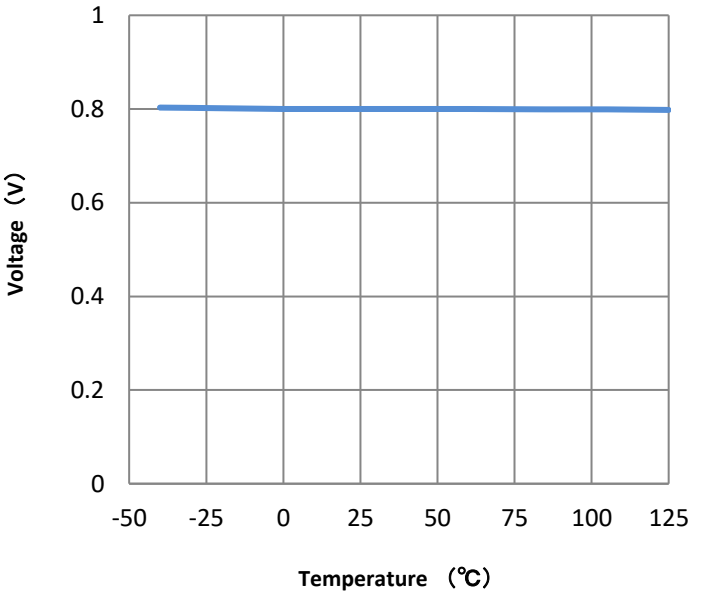

Maximum Duty Cycle vs. Temperature



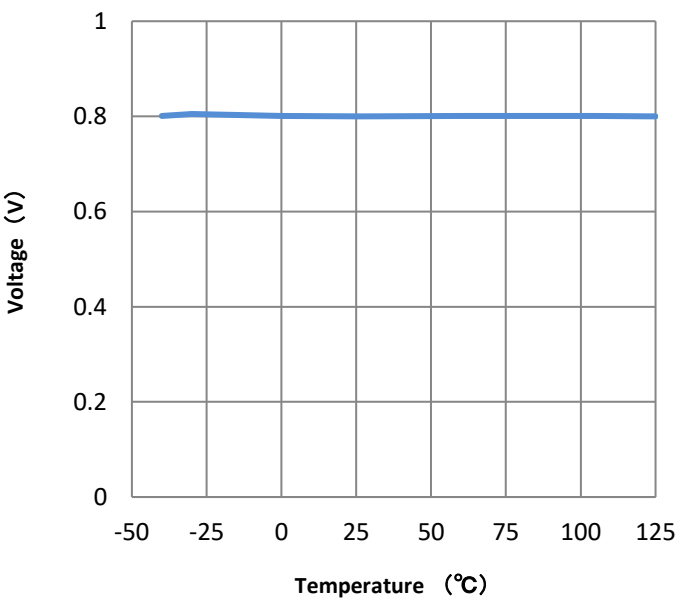

FB Source Current vs. Temperature



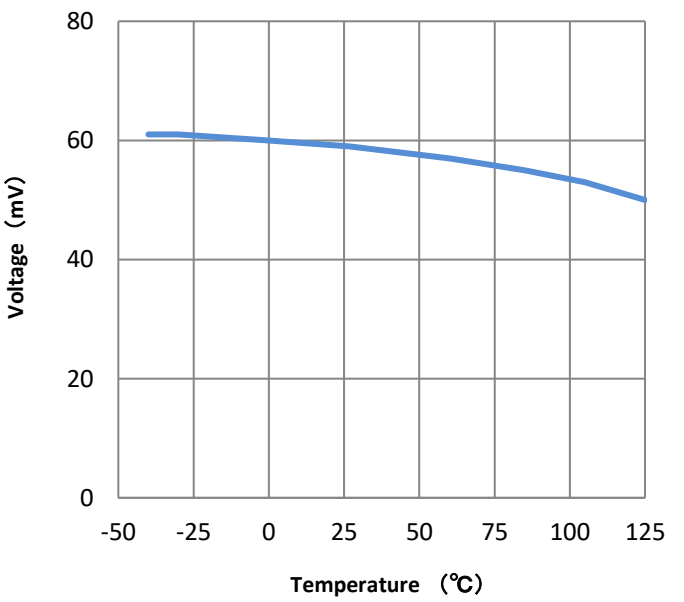

Gate Stop Voltage 1 vs. Temperature




Gate Stop Voltage 2 vs. Temperature

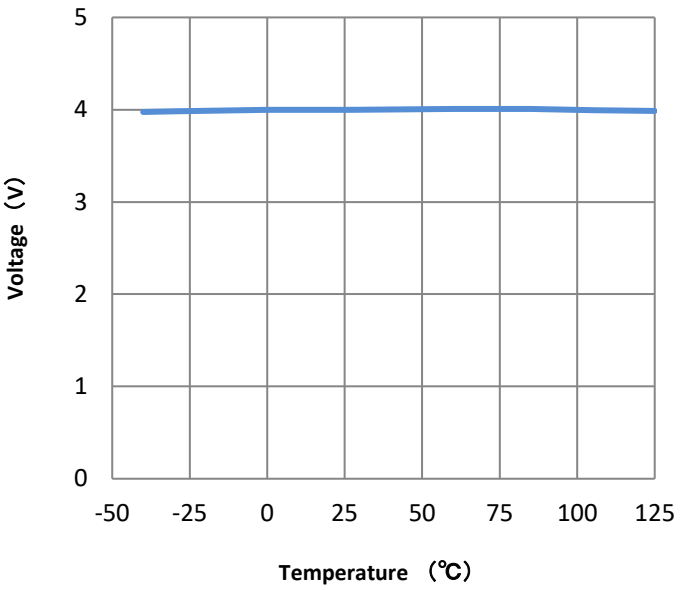



Gate Stop Voltage Hysteresis Range vs. Temperature

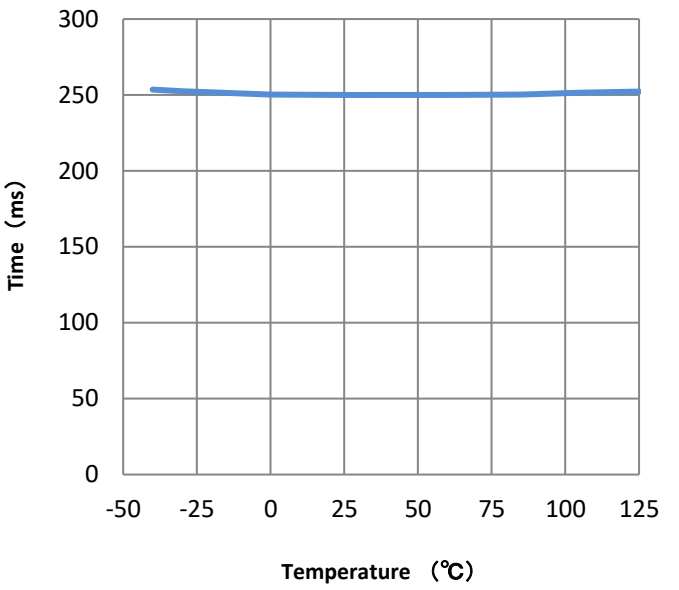


## Typical Performance Characteristics

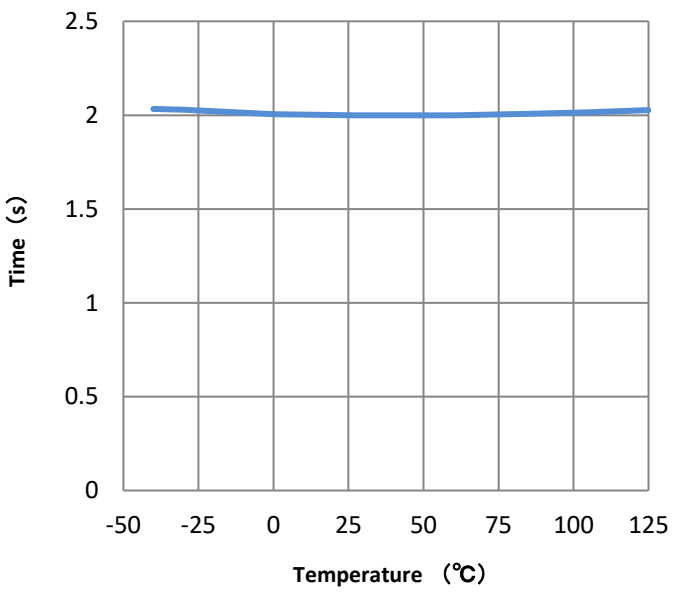
Over Load Detection Voltage vs. Temperature



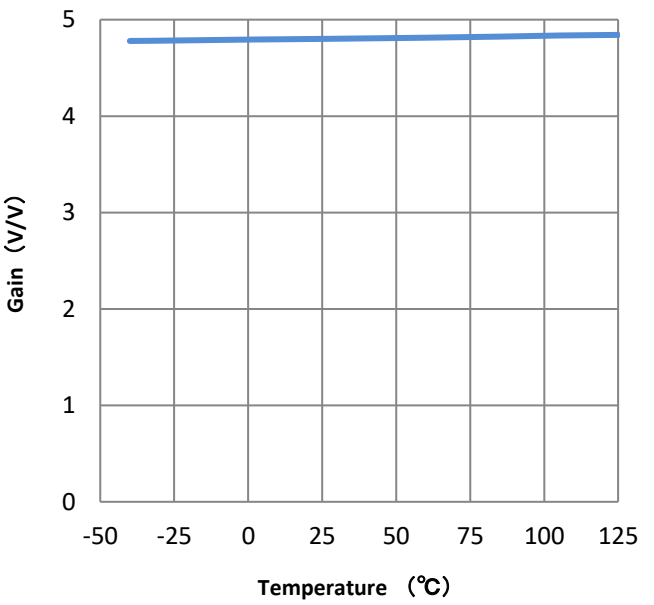

Over Load Timer vs. Temperature



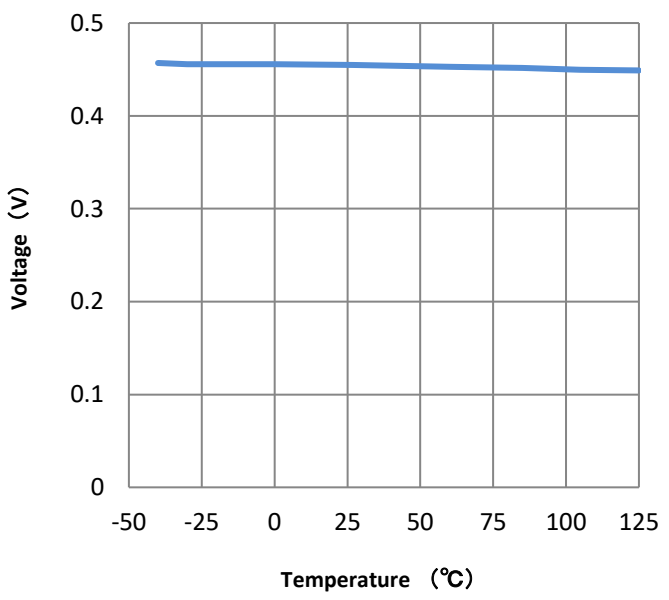

Restart Timer vs. Temperature



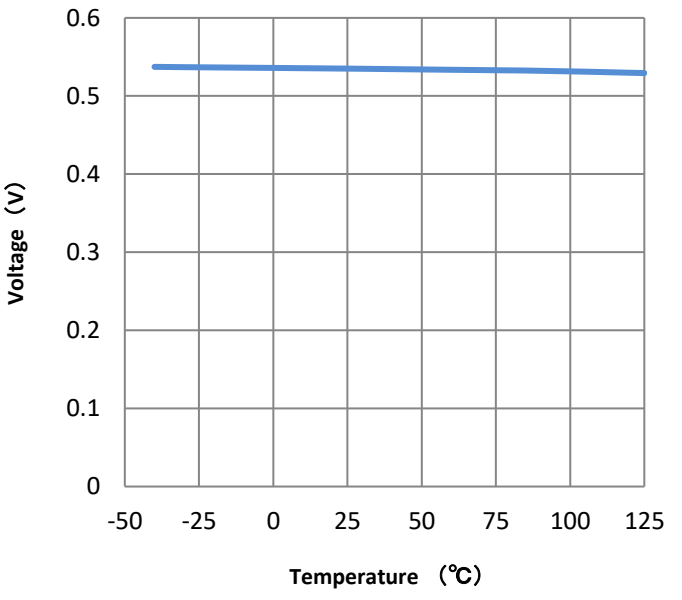

Voltage Gain vs. Temperature




Over Current Detection Voltage 1 vs. Temperature

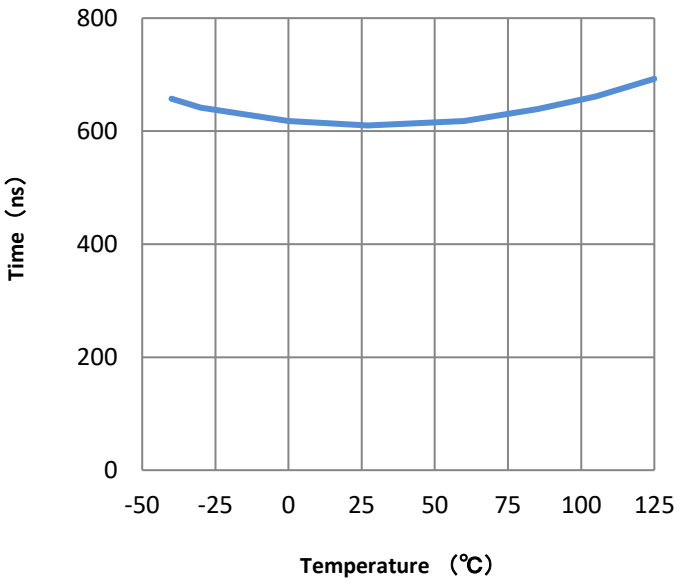



Over Current Detection Voltage 2 vs. Temperature

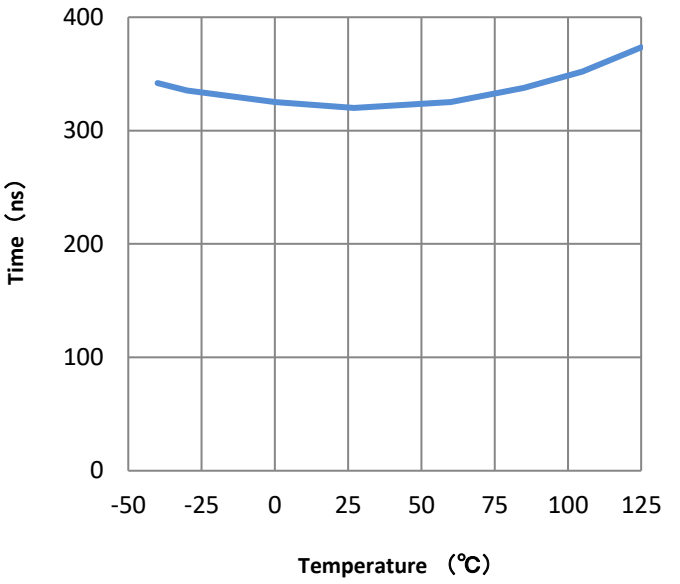


## Typical Performance Characteristics

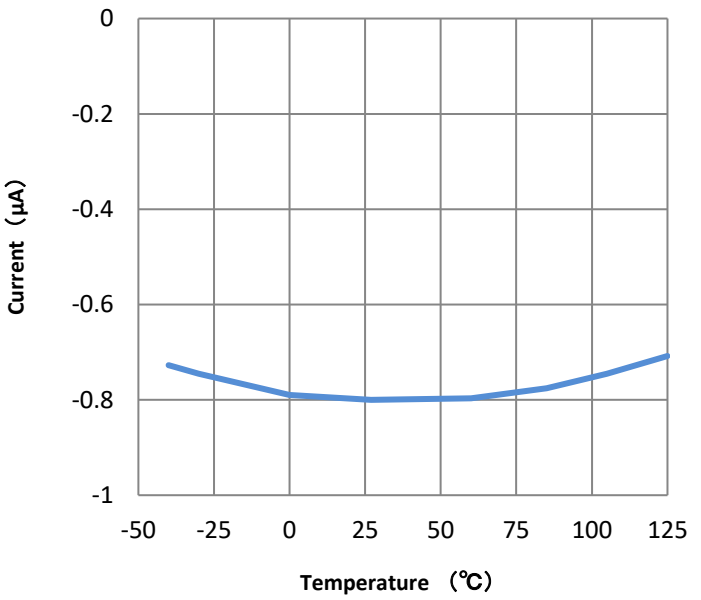
Minimum On Time 1 vs. Temperature



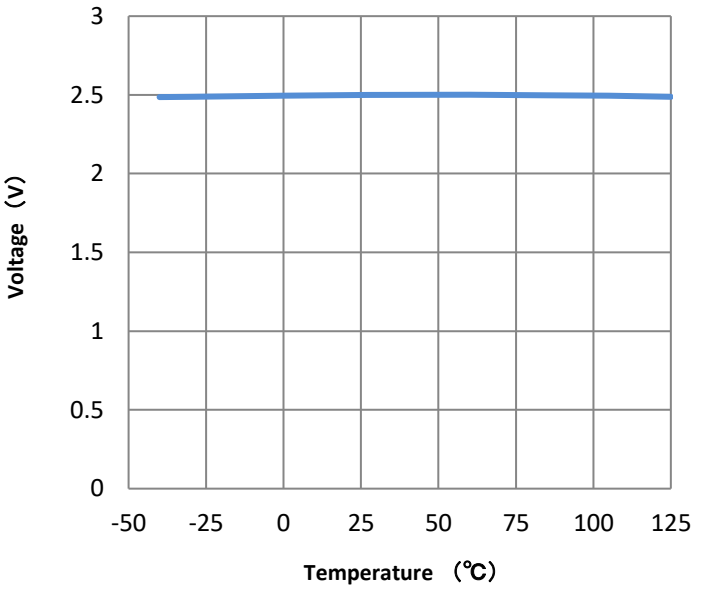

Minimum On Time 2 vs. Temperature



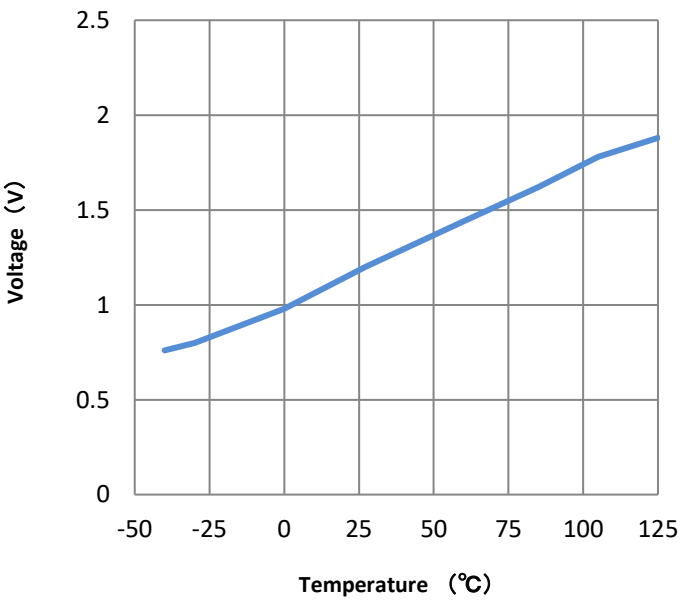

CS Source Current vs. Temperature



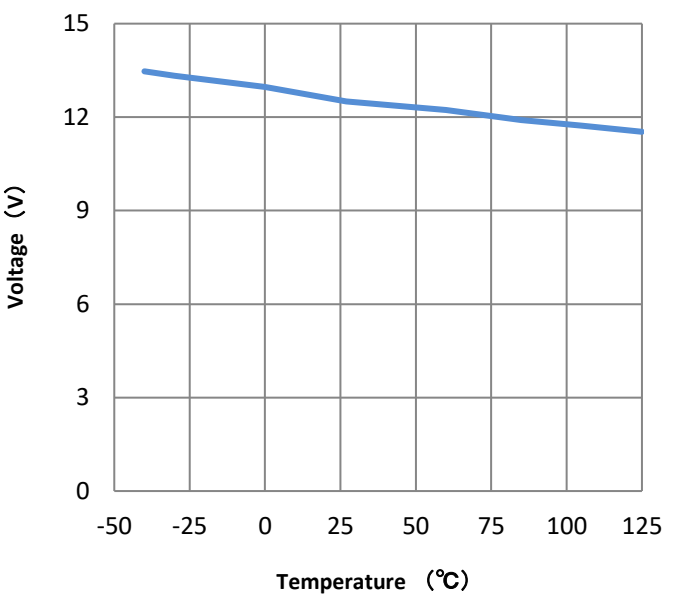

CS Latch Stop Detection Voltage vs. Temperature




L Output Voltage vs. Temperature

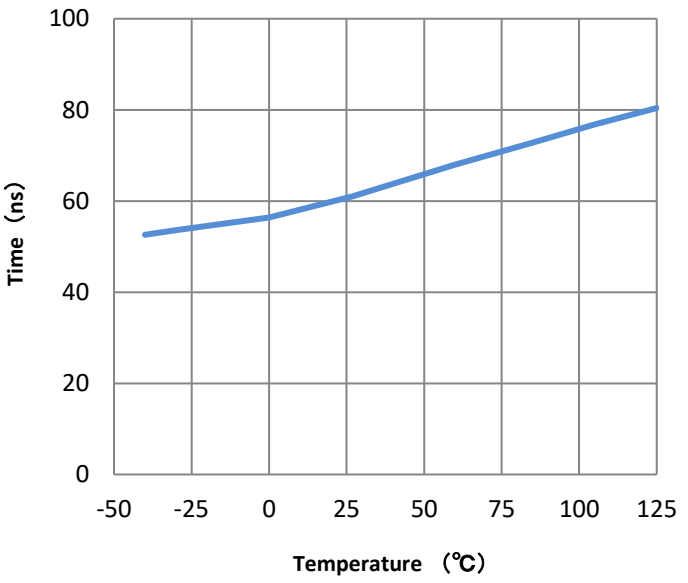



H Output Voltage vs. Temperature

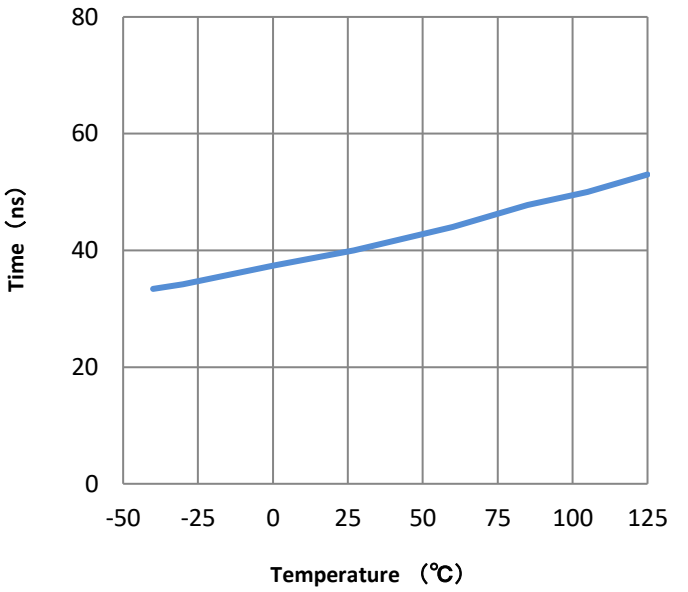


## Typical Performance Characteristics

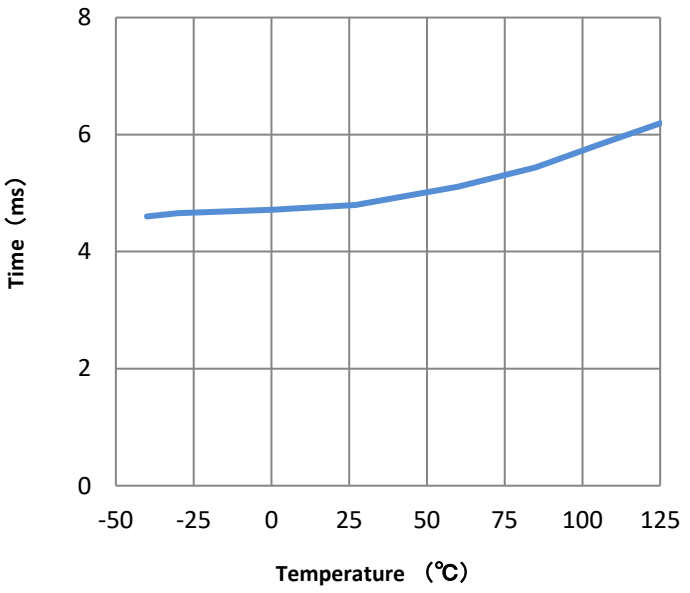
Rise Time vs. Temperature



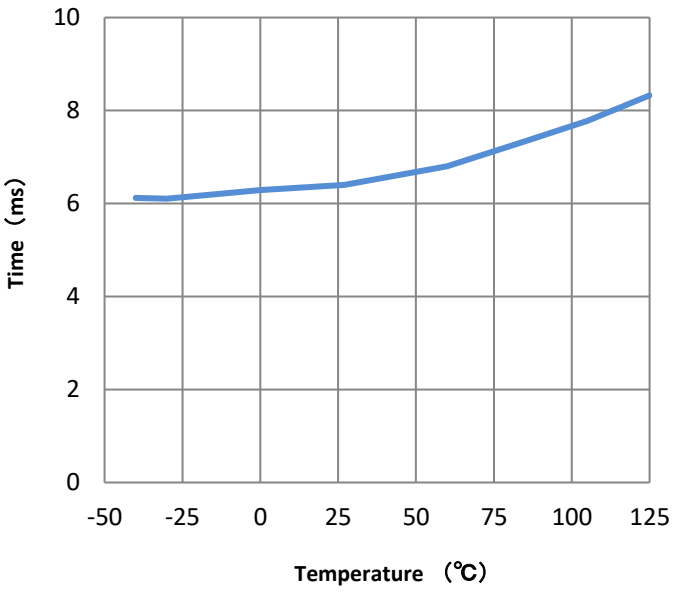

Fall Time vs. Temperature



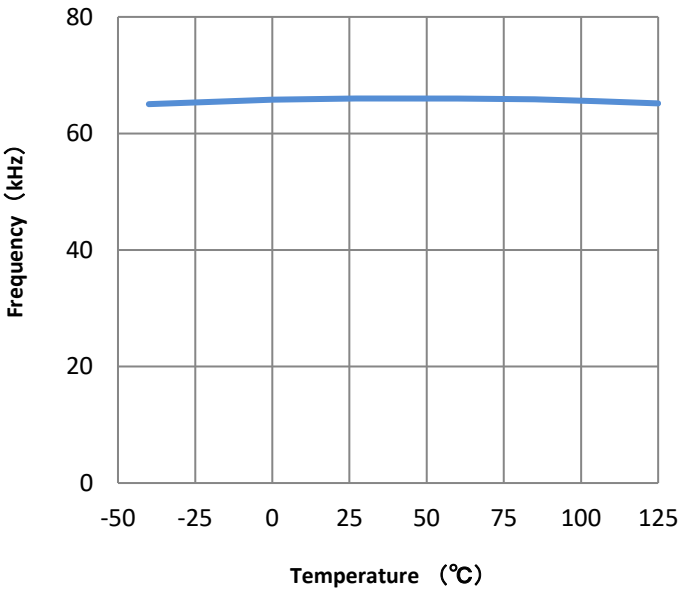

Soft Start Time 1 vs. Temperature



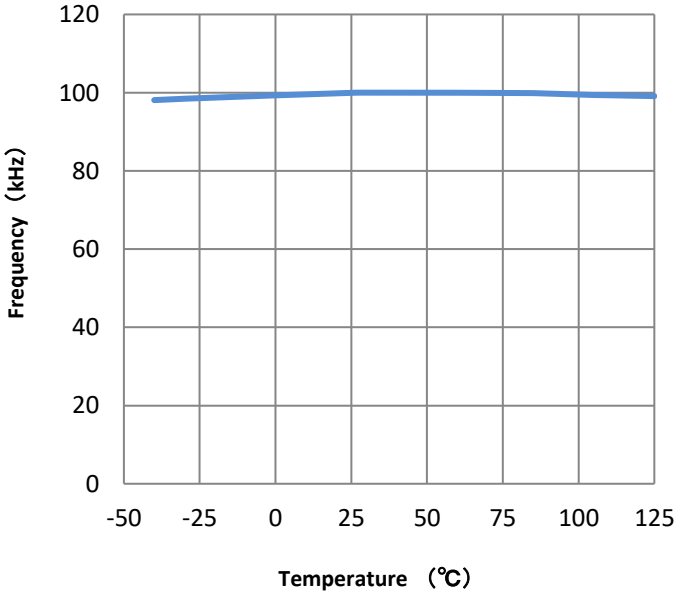

Soft Start Time 2 vs. Temperature




Maximum Frequency 1 vs. Temperature

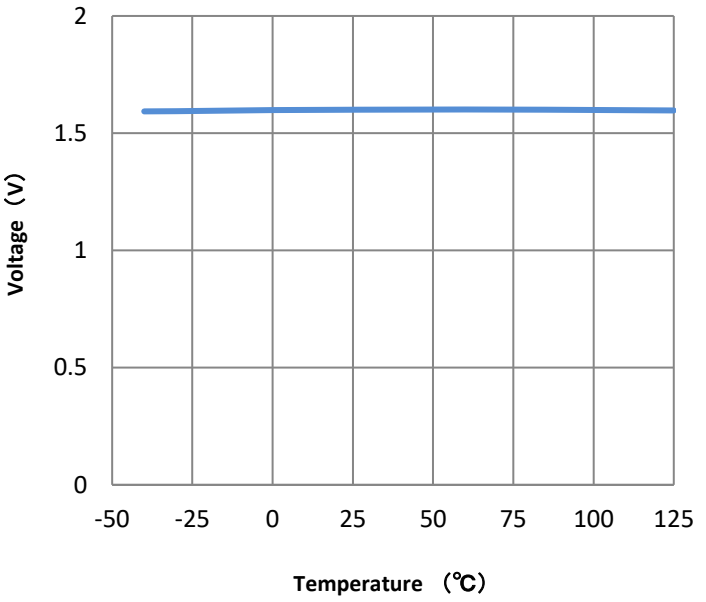



Maximum Frequency 2 vs. Temperature

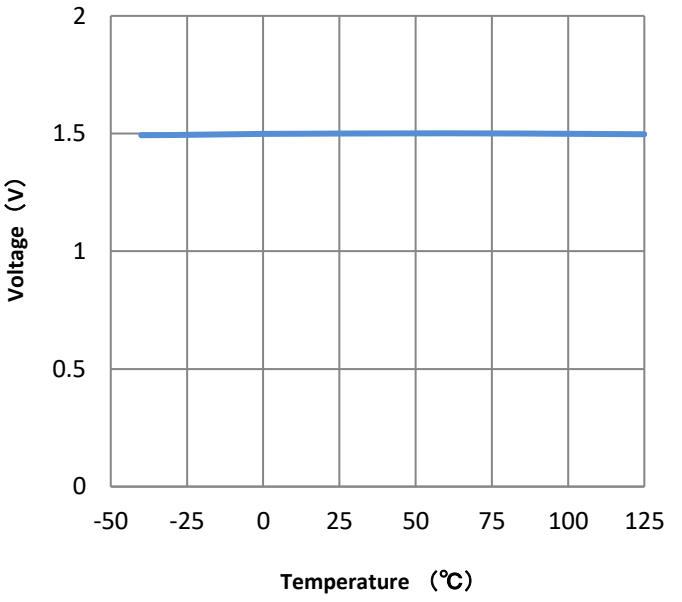


## Typical Performance Characteristics

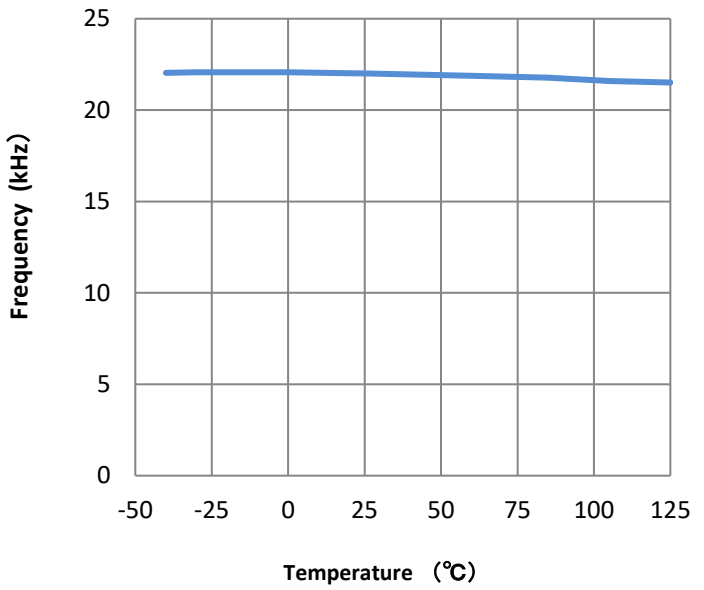
Frequency Decrease Biginning Voltage vs. Temperature



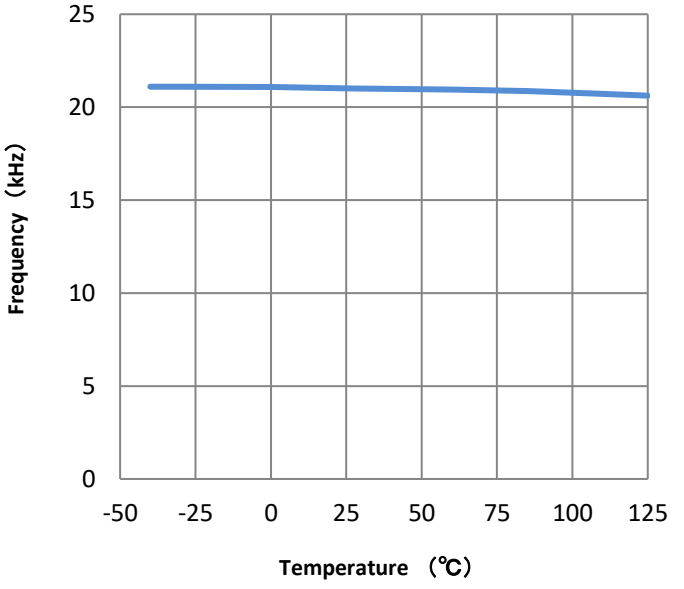

Frequency Increase Biginning Voltage vs. Temperature




Minimum Frequency 1 vs. Temperature




Minimum Frequency 2 vs. Temperature



## Dimensions

Package : SOP-8J

| UNIT | mm |
|---|---|