

SLG59M1655V

An Ultra-small, 7.8 mΩ, 9 A, Single-channel Load Switch with Reverse-current Blocking

Pin Description

| Pin # | Pin Name | Type | Pin Description |
|--------------|----------|--------|--|
| 1, 2, 6, 7 | D | MOSFET | Drain terminal connections of the n-channel MOSFET. Connect a low-ESR 10-μF (or larger) capacitor from the D pins (Pins 1, 2, 6, and 7) to ground. Capacitors used at V_D should be rated at 10 V or higher. |
| 3, 5 | ON | Input | A low-to-high transition on these pins initiates the operation of the SLG59M1655V's state machine. ON is an asserted HIGH, level-sensitive CMOS input with $ON_V_{IL} < 0.3\text{ V}$ and $ON_V_{IH} > 0.85\text{ V}$. While there is an internal pull-down circuit to GND ($\sim 4\text{ M}\Omega$), connect these pins directly to a general-purpose output (GPO) of a microcontroller, an application processor, or a system controller. |
| 4 | VDD | VDD | VDD supplies the power for the operation of the load switch and internal control circuitry. Bypass the VDD pin to GND with a 0.1 μF (or larger) capacitor. |
| 8, 9, 13, 14 | S | MOSFET | Source terminal connections of the n-channel MOSFET. Connect a low-ESR 10-μF (up to C_{LOAD}) capacitor from the S pins (Pins 8, 9, 13, and 14) to ground. Capacitors used at V_S should be rated at 10 V or higher. |
| 10, 12 | CAP | Input | A low-ESR, stable dielectric, ceramic surface-mount capacitor connected from the CAP pins (Pins 10 & 12) to GND sets the V_S slew rate and overall turn-on time of the SLG59M1655V. For additional information, please consult the C_{SLEW} typical performance characteristics on Page 5. Capacitors used at C_{SLEW} should be rated at 10 V or higher. |
| 11 | GND | GND | Ground connection. Connect this pin to the system's analog or power ground plane. |

Ordering Information

| Part Number | Type | Production Flow |
|---------------|---------------------------|-----------------------------|
| SLG59M1655V | STDFN 14L | Industrial, -40 °C to 85 °C |
| SLG59M1655VTR | STDFN 14L (Tape and Reel) | Industrial, -40 °C to 85 °C |

SLG59M1655V

An Ultra-small, 7.8 mΩ, 9 A, Single-channel Load Switch with Reverse-current Blocking

Absolute Maximum Ratings

| Parameter | Description | Conditions | Min. | Typ. | Max. | Unit |
|----------------------------|---|--|------|------|------|------|
| V _{DD} | Power Supply | | -- | -- | 6 | V |
| T _S | Storage Temperature | | -65 | -- | 150 | °C |
| ESD _{HBM} | ESD Protection | Human Body Model | 2000 | -- | -- | V |
| ESD _{CDM} | ESD Protection | Charged Device Model | 1000 | -- | -- | V |
| MSL | Moisture Sensitivity Level | | 1 | | | |
| θ _{JA} | Package Thermal Resistance, Junction-to-Ambient | 1mm x 3mm 14L STDFN; Determined using 1 in ² , 1.2 oz. copper pads under VIN and VOUT on FR4 pcb material | -- | 71 | -- | °C/W |
| W _{DIS} | Package Power Dissipation | | -- | -- | 1.2 | W |
| MOSFET IDS _{CONT} | Max Continuous Switch Current | | | | 9 | A |
| MOSFET IDS _{PK} | Peak Current from Drain to Source | For no more than 10 continuous seconds out of every 100 seconds | -- | -- | 12 | A |

Note: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Electrical Characteristics

T_A = -40 °C to 85 °C, unless otherwise noted.

| Parameter | Description | Conditions | Min. | Typ. | Max. | Unit |
|-----------------------|--|--|--|------|-----------------|------|
| V _{DD} | Power Supply Voltage | | 2.5 | -- | 5.5 | V |
| I _{DD} | Power Supply Current, when OFF | | -- | 0.1 | 1 | μA |
| | Power Supply Current, when ON | | -- | 50 | 100 | μA |
| RDS _{ON} | ON Resistance | T _A 25°C, I _{DS} = 0.1 A | -- | 7.8 | 10.5 | mΩ |
| | | T _A 70°C, I _{DS} = 0.1 A | -- | 9.0 | 12.1 | mΩ |
| | | T _A 85°C, I _{DS} = 0.1 A | | 8.4 | 12.7 | mΩ |
| MOSFET IDS | Current from Drain to Source | Continuous | -- | -- | 9 | A |
| IDS _{LKG} | IDS Leakage (Reverse Blocking enabled) | V _S = 1.0 V to 5.0 V, V _{DD} = V _D = 0 V, ON = LOW | -- | 0.5 | 5.0 | μA |
| V _D | Drain Voltage | | 0.85 | -- | V _{DD} | V |
| T _{ON_Delay} | ON Delay Time | 50% ON to V _S Ramp Start, R _{LOAD} = 20 Ω, C _{LOAD} = 10 μF, | -- | 270 | 500 | μs |
| T _{Total_ON} | Total Turn On Time | 50% ON to 90% V _S | Set by External C _{SLEW} ¹ | | | ms |
| | | Example: C _{SLEW} = 4 nF, V _{DD} = V _D = 5 V, R _{LOAD} = 20 Ω, C _{LOAD} = 10 μF | -- | 1.1 | -- | ms |
| V _{S(SR)} | V _S Slew Rate | 10% V _S to 90% V _S | Set by External C _{SLEW} ¹ | | | V/ms |
| | | Example: C _{SLEW} = 4 nF, V _{DD} = V _D = 5 V, R _{LOAD} = 20 Ω, C _{LOAD} = 10 μF | -- | 6.0 | -- | V/ms |

SLG59M1655V

An Ultra-small, 7.8 mΩ, 9 A, Single-channel Load Switch with Reverse-current Blocking

Electrical Characteristics (continued)

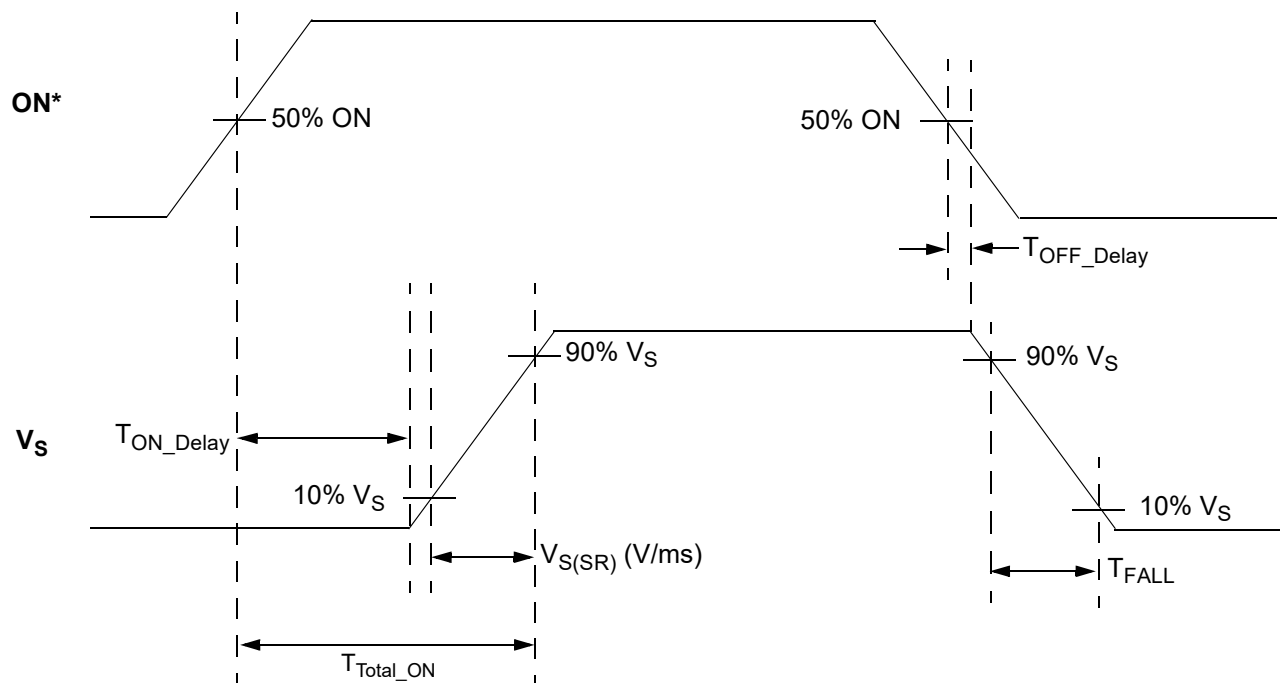
$T_A = -40\text{ }^{\circ}\text{C}$ to $85\text{ }^{\circ}\text{C}$, unless otherwise noted.

| Parameter | Description | Conditions | Min. | Typ. | Max. | Unit |
|------------------------------|--------------------------------------|--|------|------|-----------------|--------------------|
| $T_{\text{OFF_Delay}}$ | OFF Delay Time | 50% ON to V_S Fall Start, $V_{\text{DD}} = V_D = 5\text{ V}$, $R_{\text{LOAD}} = 20\text{ }\Omega$, no C_{LOAD} | -- | 1.7 | 3 | μs |
| $\text{ON_}V_{\text{IH}}$ | High Input Voltage on ON pin | | 0.85 | -- | V_{DD} | V |
| $\text{ON_}V_{\text{IL}}$ | Low Input Voltage on ON pin | | -0.3 | 0 | 0.3 | V |
| C_{LOAD} | Output Load Capacitance | C_{LOAD} connected from S to GND | -- | -- | 1000 | μF |
| THERM_{ON} | Thermal shutoff turn-on temperature | | -- | 125 | -- | $^{\circ}\text{C}$ |
| $\text{THERM}_{\text{OFF}}$ | Thermal shutoff turn-off temperature | | -- | 100 | -- | $^{\circ}\text{C}$ |
| $\text{THERM}_{\text{TIME}}$ | Thermal shutoff time | | -- | -- | 1 | ms |

Notes:

1. Refer to typical timing parameter vs. C_{SLEW} performance charts for additional information when available.

$T_{\text{ON_Delay}}$, $V_{\text{S(SR)}}$, and $T_{\text{Total_ON}}$ Timing Details



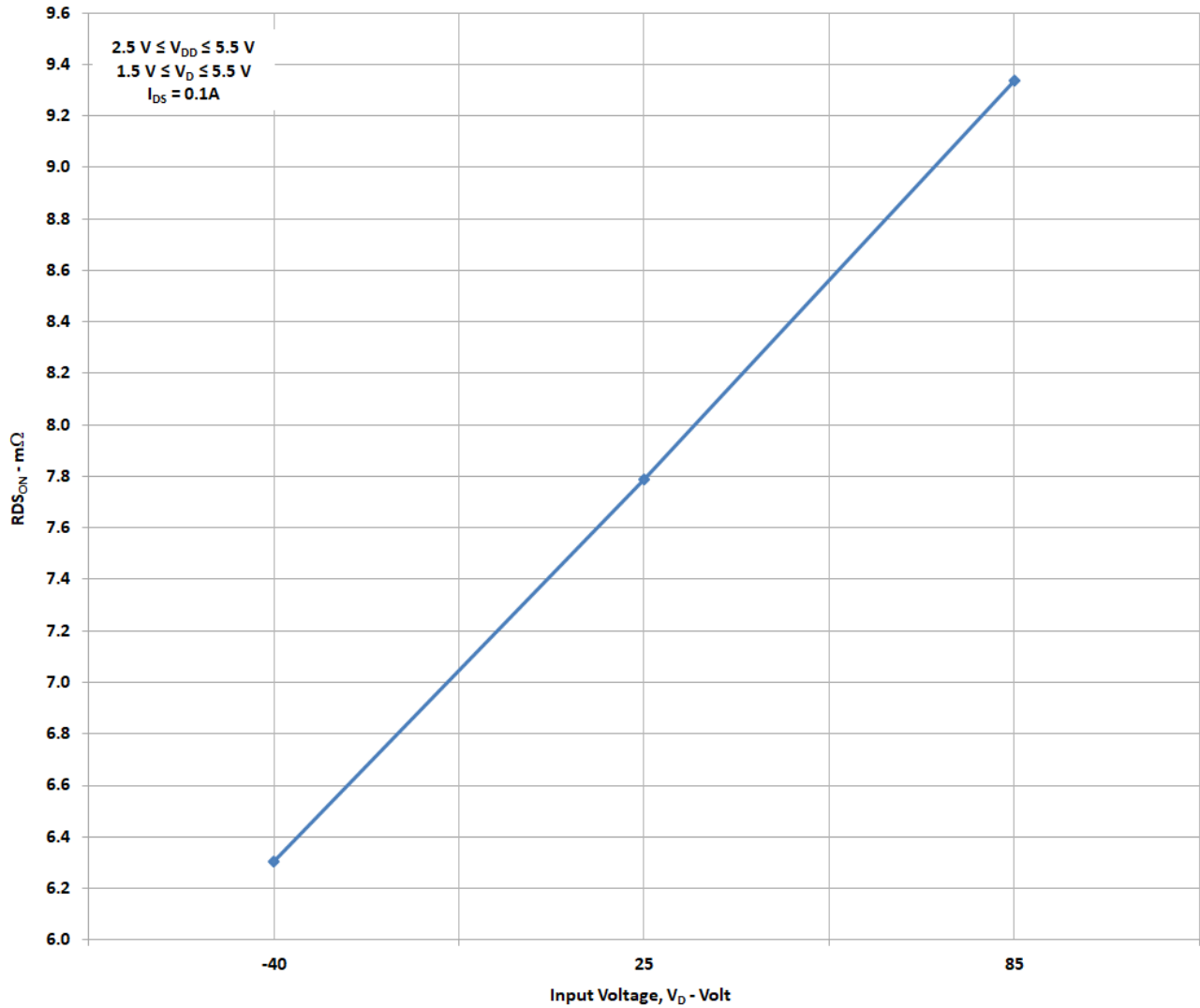
Note: *Rise and Fall Times of the ON Signal are 100 ns

SLG59M1655V

An Ultra-small, 7.8 mΩ, 9 A, Single-channel Load Switch with Reverse-current Blocking

Typical Performance Characteristics

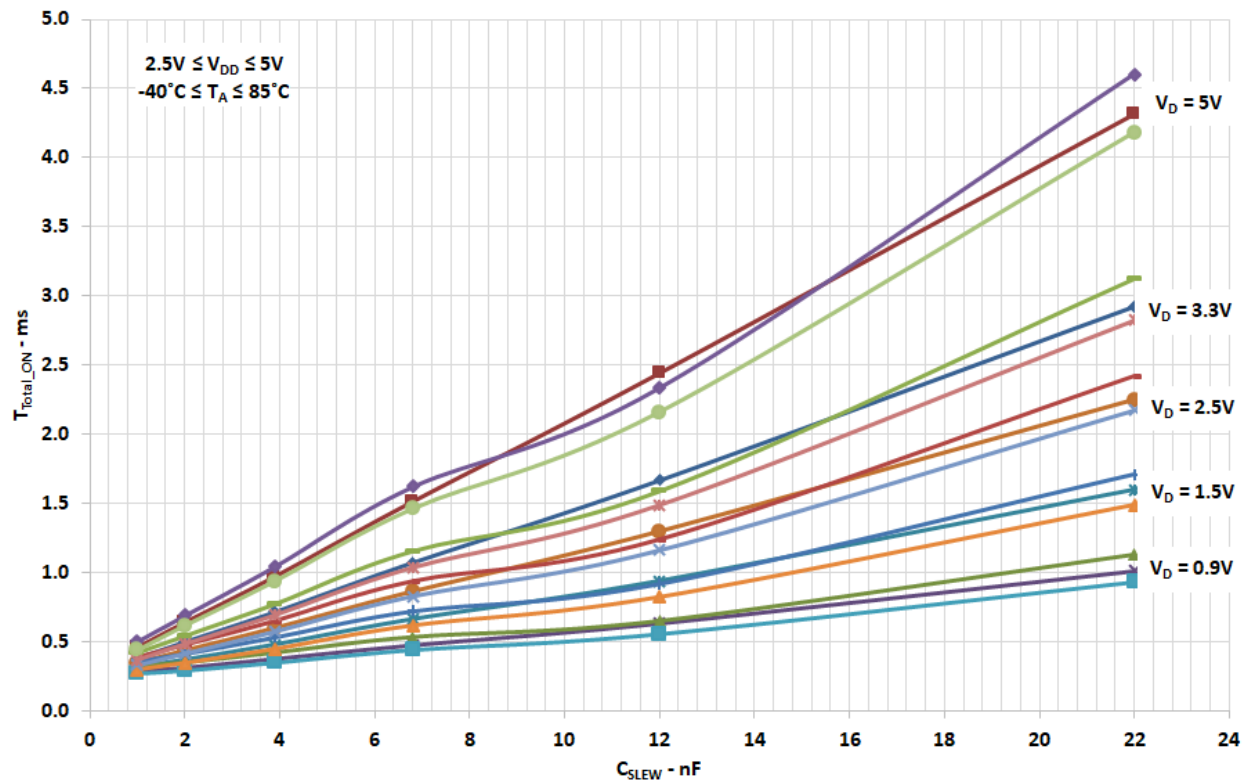
$R_{DS(on)}$ vs. Temperature, V_{DD} , and V_D



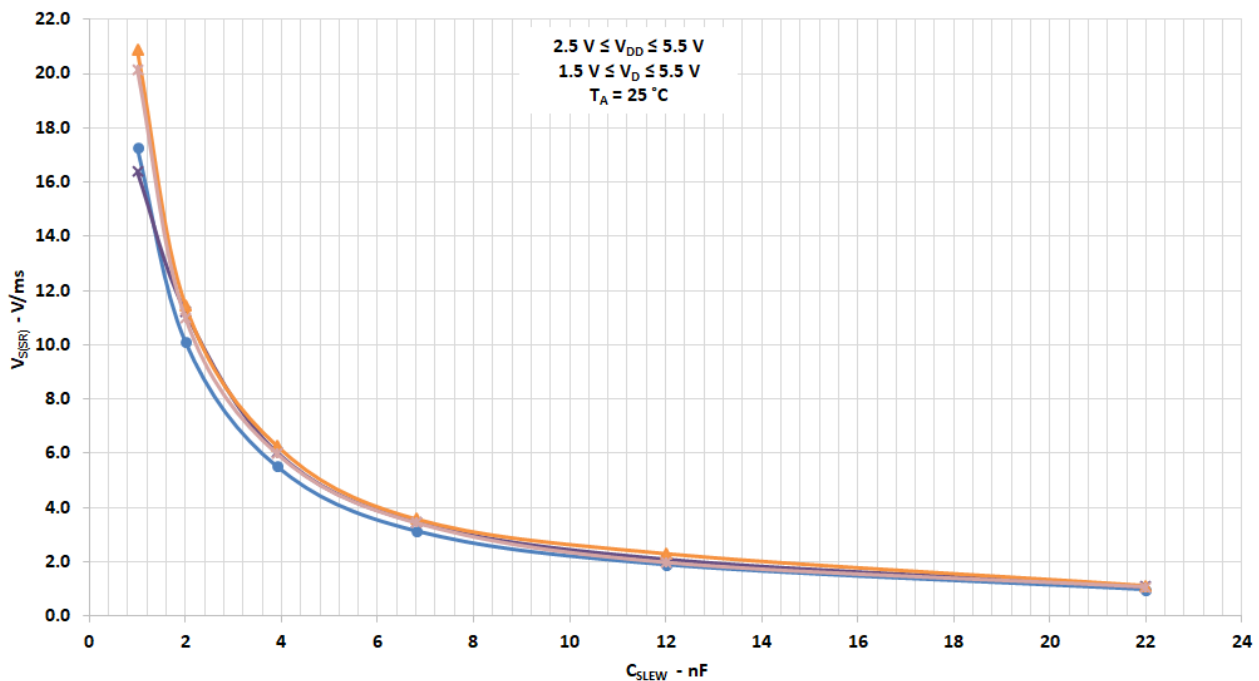
SLG59M1655V

An Ultra-small, 7.8 mΩ, 9 A, Single-channel Load Switch with Reverse-current Blocking

$T_{\text{Total_ON}}$ vs. C_{SLEW} , V_{DD} , V_{D} , and Temperature



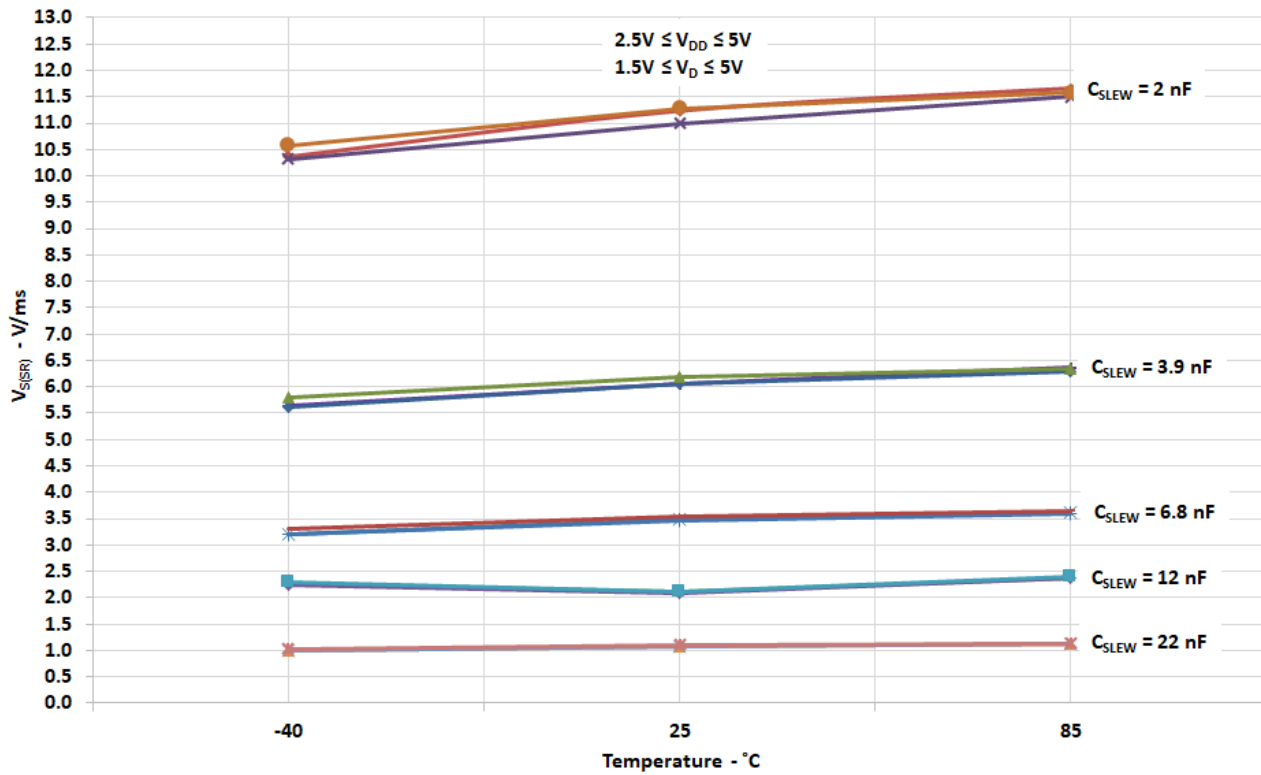
$V_{\text{S(SR)}}$ vs. C_{SLEW} , V_{DD} , and V_{D}



SLG59M1655V

An Ultra-small, 7.8 mΩ, 9 A, Single-channel Load Switch with Reverse-current Blocking

$V_{S(SR)}$ vs. Temperature, V_{DD} , V_D , and C_{SLEW}



SLG59M1655V

An Ultra-small, 7.8 mΩ, 9 A, Single-channel Load Switch with Reverse-current Blocking

SLG59M1655V Power-Up/Power-Down Sequence Considerations

To ensure glitch-free power-up under all conditions, apply V_{DD} first, followed by V_D after V_{DD} exceeds 1 V. Then allow V_D to reach 90% of its max value before toggling the ON pin from Low-to-High. Likewise, power-down in reverse order.

If V_{DD} and V_D need to be powered up simultaneously, glitching can be minimized by having a suitable load capacitor. A 10 μF C_{LOAD} will prevent glitches for rise times of V_{DD} and V_D higher than 2 ms.

If the ON pin is toggled HIGH before V_{DD} and V_D have reached their steady-state values, the load switch timing parameters may differ from datasheet specifications.

The slew rate of output V_S follows a linear ramp set by a capacitor connected to the CAP pin. A larger capacitor value at the CAP pin produces a slower ramp, reducing inrush current from capacitive loads.

Power Dissipation

The junction temperature of the SLG59M1655V depends on different factors such as board layout, ambient temperature, and other environmental factors. The primary contributor to the increase in the junction temperature of the SLG59M1655V is the power dissipation of its power MOSFET. Its power dissipation and the junction temperature in nominal operating mode can be calculated using the following equations:

$$PD = RDS_{ON} \times I_{DS}^2$$

where:

PD = Power dissipation, in Watts (W)

RDS_{ON} = Power MOSFET ON resistance, in Ohms (Ω)

I_{DS} = Output current, in Amps (A)

and

$$T_J = PD \times \Theta_{JA} + T_A$$

where:

T_J = Junction temperature, in Celsius degrees (°C)

Θ_{JA} = Package thermal resistance, in Celsius degrees per Watt (°C/W)

T_A = Ambient temperature, in Celsius degrees (°C)

For more information on GreenFET load switch features, please visit our website and see App Note “AN-1068 GreenFET and High Voltage GreenFET Load Switch Basics”.

SLG59M1655V

An Ultra-small, 7.8 mΩ, 9 A, Single-channel Load Switch with Reverse-current Blocking

Layout Guidelines:

1. The VDD pin needs a 0.1 μF and 10 μF external capacitors to smooth pulses from the power supply. Locate these capacitors as close as possible to the SLG59M1655V's PIN4.
2. Since the D and S pins dissipate most of the heat generated during high-load current operation, it is highly recommended to make power traces as short, direct, and wide as possible. A good practice is to make power traces with an absolute minimum widths of 15 mils (0.381 mm) per Ampere. A representative layout, shown in Figure 1, illustrates proper techniques for heat to transfer as efficiently as possible out of the device;
3. To minimize the effects of parasitic trace inductance on normal operation, it is recommended to connect input C_{IN} and output C_{LOAD} low-ESR capacitors as close as possible to the SLG59M1655V's D and S pins;
4. The GND pin should be connected to system analog or power ground plane.

SLG59M1655V Evaluation Board:

A GreenFET Evaluation Board for SLG59M1655V is designed according to the statements above and is illustrated on Figure 1. Please note that evaluation board has D_Sense and S_Sense pads. They cannot carry high currents and dedicated only for $R_{DS(on)}$ evaluation.

Please solder your SLG59M1655V here

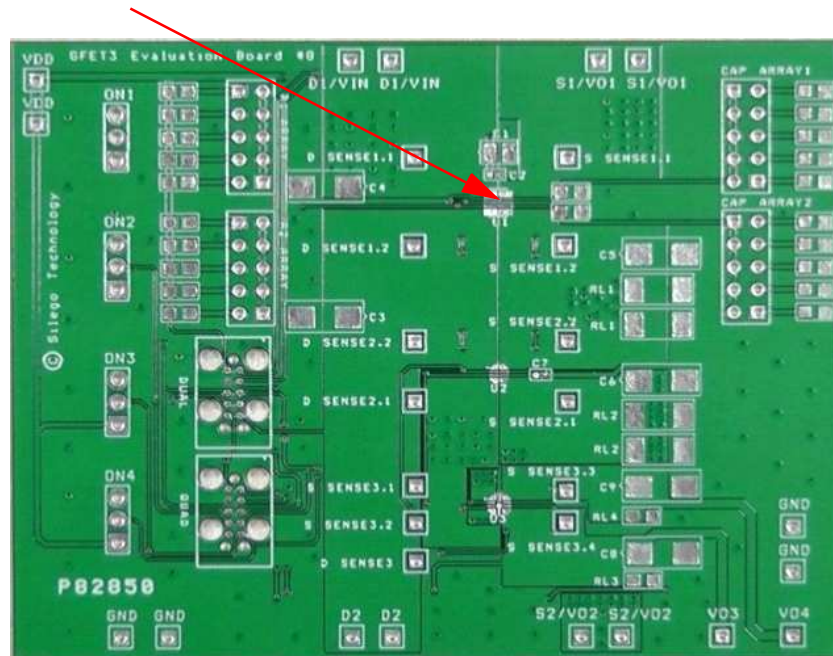


Figure 1. SLG59M1655V Evaluation Board.

SLG59M1655V

An Ultra-small, 7.8 mΩ, 9 A, Single-channel Load Switch with Reverse-current Blocking

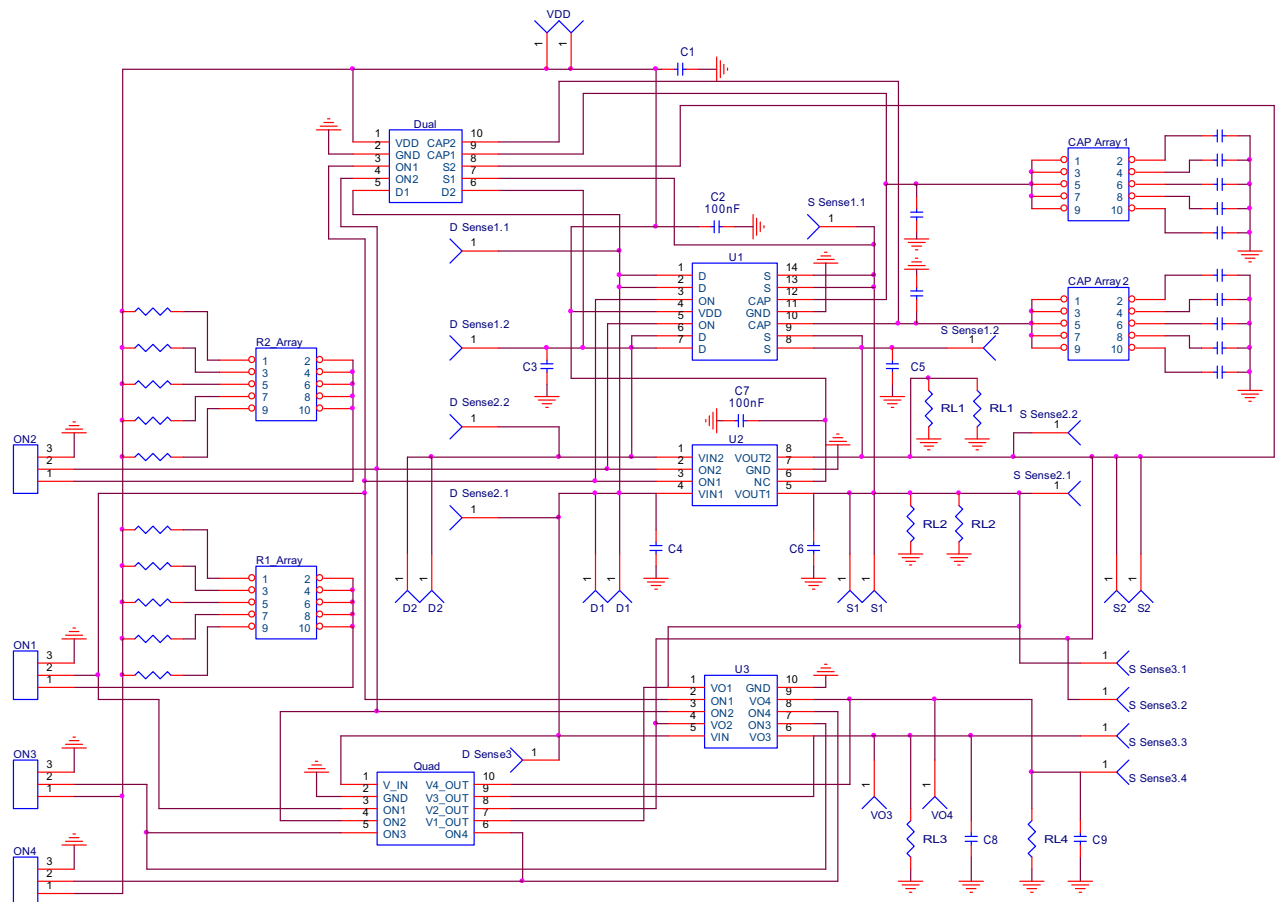


Figure 2. SLG59M1655V Evaluation Board Connection Circuit.

SLG59M1655V

An Ultra-small, 7.8 mΩ, 9 A, Single-channel Load Switch with Reverse-current Blocking

Basic Test Setup and Connections

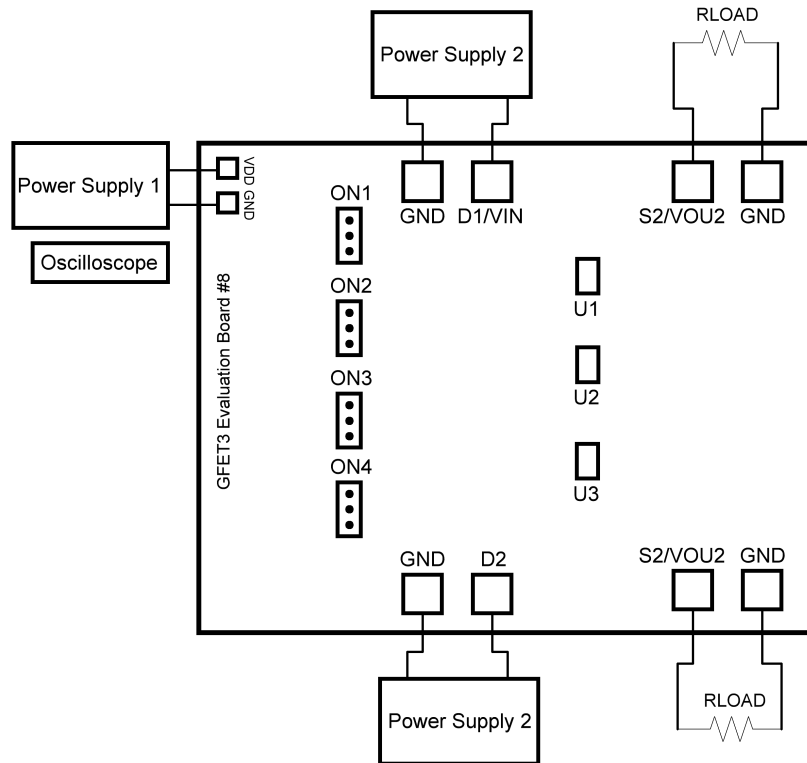


Figure 3. Typical connections for GFET3 Evaluation.

EVB Configuration

1. Connect oscilloscope probes to D1/VIN, D2, S1/VO1, S1/VO2, ON1, ON2 etc.;
2. Turn on Power Supply 1 and set desired V_{DD} from 2.5 V...5.5 V range;
3. Turn on Power Supply 2 and set desired V_D from 0.85 V...5.5 V range;
4. Toggle the ON signal High or Low to observe SLG59M1655V operation.

SLG59M1655V

An Ultra-small, 7.8 mΩ, 9 A, Single-channel Load Switch with Reverse-current Blocking

Package Top Marking System Definition



PP - Part ID Field

DD- Date Code Field¹

L - Lot Traceability Code Field¹

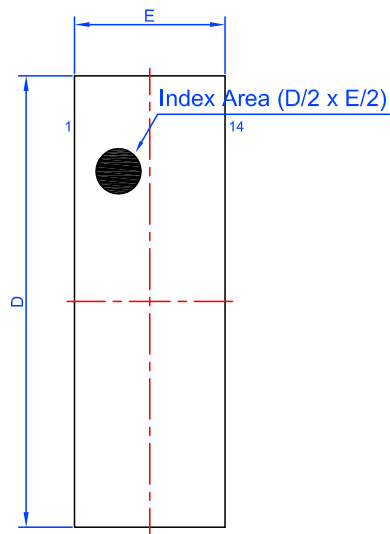
Note 1: Each character in code field can be alphanumeric A-Z and 0-9

SLG59M1655V

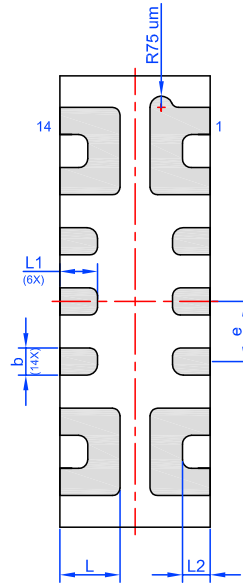
An Ultra-small, 7.8 mΩ, 9 A, Single-channel Load Switch with Reverse-current Blocking

Package Drawing and Dimensions

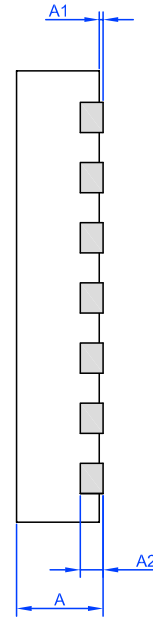
14 Lead STDFN Package 1 mm x 3 mm (Fused Lead)



Top View



BTM View



SIDE View

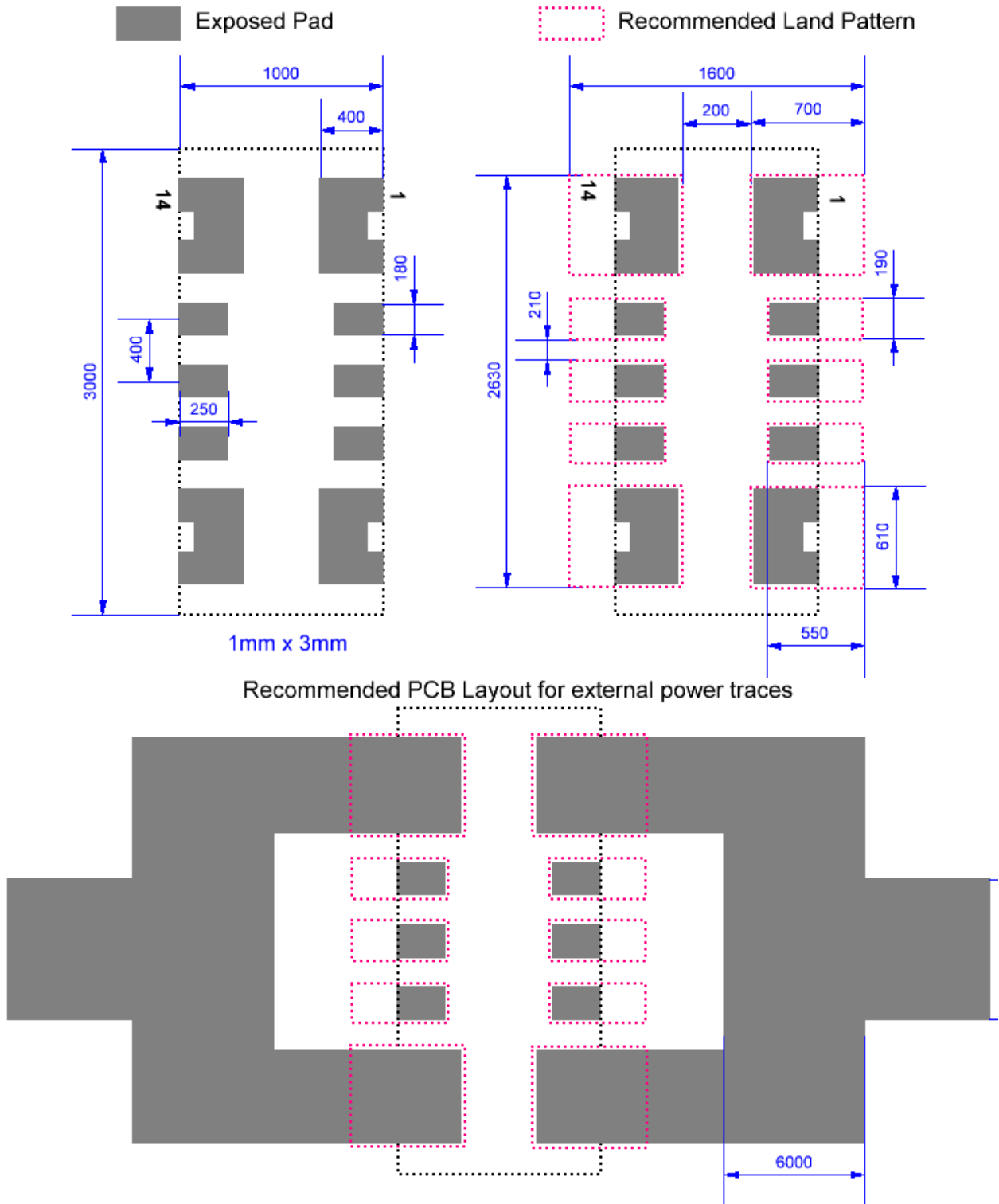
Unit: mm

| Symbol | Min | Nom. | Max | Symbol | Min | Nom. | Max |
|--------|----------|------|-------|--------|------|------|------|
| A | 0.50 | 0.55 | 0.60 | D | 2.95 | 3.00 | 3.05 |
| A1 | 0.005 | - | 0.050 | E | 0.95 | 1.00 | 1.05 |
| A2 | 0.10 | 0.15 | 0.20 | L | 0.35 | 0.40 | 0.45 |
| b | 0.13 | 0.18 | 0.23 | L1 | 0.20 | 0.25 | 0.30 |
| e | 0.40 BSC | | | L2 | 0.06 | 0.11 | 0.16 |

SLG59M1655V

An Ultra-small, 7.8 mΩ, 9 A, Single-channel Load Switch with Reverse-current Blocking

Recommended Land Pattern and PCB Layout



Note: All dimensions are in micrometers (μm)

SLG59M1655V

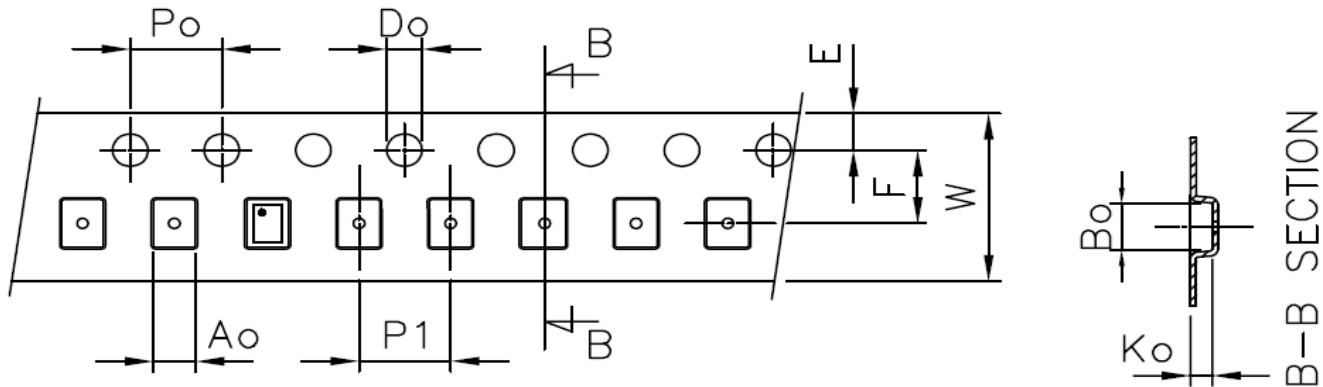
An Ultra-small, 7.8 mΩ, 9 A, Single-channel Load Switch with Reverse-current Blocking

Tape and Reel Specifications

| Package Type | # of Pins | Nominal Package Size [mm] | Max Units | | Reel & Hub Size [mm] | Leader (min) | | Trailer (min) | | Tape Width [mm] | Part Pitch [mm] |
|-------------------------------|-----------|---------------------------|-----------|---------|----------------------|--------------|-------------|---------------|-------------|-----------------|-----------------|
| | | | per Reel | per Box | | Pockets | Length [mm] | Pockets | Length [mm] | | |
| STDFN 14L 1x3mm 0.4P FC | 14 | 1x3x0.55mm | 3000 | 3000 | 178/60 | 100 | 400 | 100 | 400 | 8 | 4 |

Carrier Tape Drawing and Dimensions

| Package Type | Pocket BTM Length | Pocket BTM Width | Pocket Depth | Index Hole Pitch | Pocket Pitch | Index Hole Diameter | Index Hole to Tape Edge | Index Hole to Pocket Center | Tape Width |
|-------------------------------|-------------------|------------------|--------------|------------------|--------------|---------------------|-------------------------|-----------------------------|------------|
| | A0 | B0 | K0 | P0 | P1 | D0 | E | F | W |
| STDFN 14L 1x3mm 0.4P FC | 1.15 | 3.15 | 0.7 | 4 | 4 | 1.5 | 1.75 | 3.5 | 8 |



Recommended Reflow Soldering Profile

Please see IPC/JEDEC J-STD-020: latest revision for reflow profile based on package volume of 1.65 mm³ (nominal). More information can be found at www.jedec.org.

SLG59M1655V

An Ultra-small, 7.8 mΩ, 9 A, Single-channel Load Switch with Reverse-current Blocking

Revision History

| Date | Version | Change |
|------------|---------|--|
| 2/3/2022 | 1.04 | Updated Company name and logo Fixed typos |
| 10/12/2018 | 1.03 | Clarified Pin Names Updated style and formatting Added Layout Guidelines |
| 1/20/2016 | 1.02 | Updated IDD values |
| 1/14/2016 | 1.01 | Updated Title, General Description, and Features Updated Pin Descriptions Updated text for clarity |
| 10/7/2015 | 1.00 | Production Release |
| 10/6/2015 | 0.50 | Preliminary Release |
| 10/6/2015 | 0.10 | Advanced Release |

IMPORTANT NOTICE AND DISCLAIMER

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES ("RENESAS") PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD-PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers who are designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only to develop an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third-party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising from your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

(Disclaimer Rev.1.01)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit www.renesas.com/contact-us/.

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.