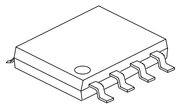
# ULTRA SMALL, LOW INPUT VOLTAGE, LOW $R_{ON}$, LOAD SWITCHES



SOP-8

## ■ DESCRIPTION

UTC **US2236095D** are ultra-small, low ON resistance ($R_{ON}$) load switches with controlled turn on. The devices contain a P-channel MOSFET that operates over an input voltage range of 1.0~3.6V. The switch is controlled by an on/off input (ON), which is capable of interfacing directly with low-voltage control signals. In UTC **US2236095D** a 120Ω on-chip load resistor is added for output quick discharge when the switch is turned off.

## ■ FEATURES

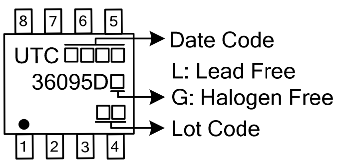
* Low Input Voltage: 1.0V~3.6V
* Ultra-Low ON Resistance
  $R_{ON}$ = 78 mΩ at $V_{IN}$ = 3.6V
  $R_{ON}$ = 93 mΩ at $V_{IN}$ = 2.5V
  $R_{ON}$ = 109 mΩ at $V_{IN}$ = 1.8V
  $R_{ON}$ = 146 mΩ at $V_{IN}$ = 1.2V
* 500mA Maximum Continuous Switch Current
* Ultra Low Quiescent Current: 82nA at 1.8V
* Ultra Low Shutdown Current: 44nA at 1.8V
* Low Control Input Thresholds Enable Use of 1.2V/1.8V/2.5V/3.3V Logic
* Controlled Slew Rate to Avoid Inrush Currents
  US2236095: 40µs $T_R$

## ■ ORDERING INFORMATION

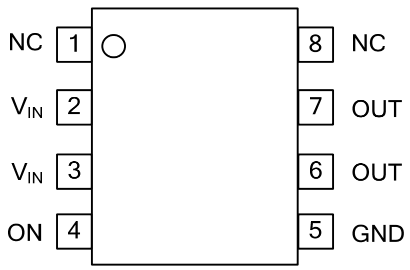
| Ordering Number | | Package | Packing |
|---|---|---|---|
| Lead Free | Halogen Free | | |
| US2236095DL-S08-R | US2236095DG-S08-R | SOP-8 | Tape Reel |

US2236095DG-S08-R
(1)Packing Type — (1) R: Tape Reel
(2)Package Type — (2) S08: SOP-8
(3)Green Package — (3) G: Halogen Free and Lead Free, L: Lead Free

## ■ MARKING



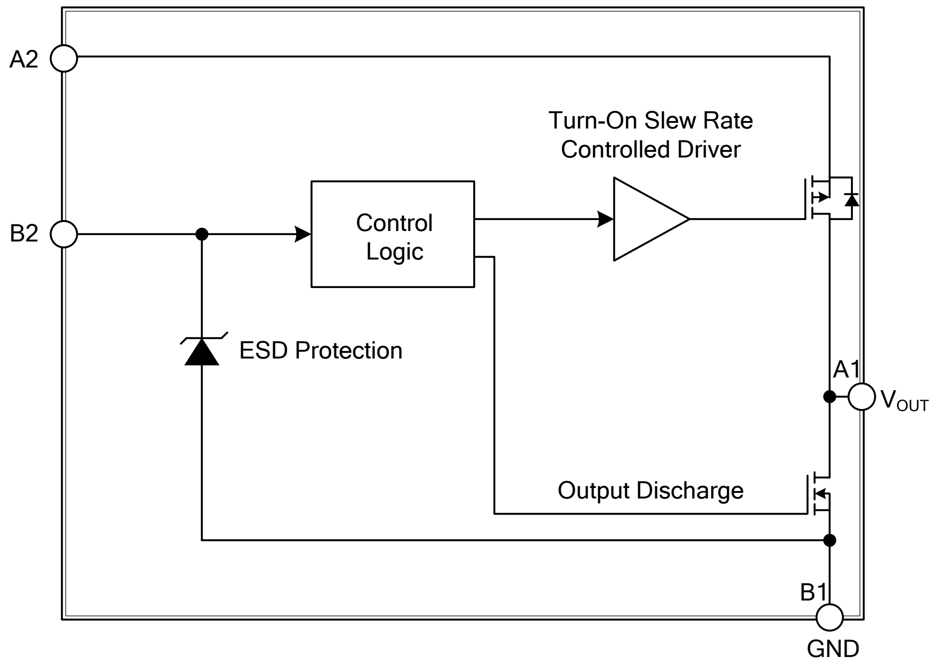
## ■ PIN CONFIGURATION




## ■ PIN DESCRIPTION

| PIN NO. | PIN NAME | DESCRIPTION |
|---|---|---|
| 1, 8 | NC | |
| 2, 3 | $V_{IN}$ | Switch input, bypass this input with a ceramic capacitor to ground |
| 4 | ON | Switch control input, active high |
| 5 | GND | Ground |
| 6, 7 | $V_{OUT}$ | Switch output |

## ■ BLOCK DIAGRAM




FUNCTION TABLE

| ON (Control Input) | $V_{IN}$ to $V_{OUT}$ | $V_{OUT}$ to GND |
|---|---|---|
| L | OFF | ON |
| H | ON | OFF |

## ■ ABSOLUTE MAXIMUM RATING

| PARAMETER | SYMBOL | RATINGS | UNIT |
|---|---|---|---|
| Input Voltage Range | $V_{IN}$ | 4.0 | V |
| Output Voltage Range | $V_{OUT}$ | $V_{IN}$+0.3 | V |
| Input Voltage Range | $V_{ON}$ | 4.0 | V |
| Maximum Continuous Switch Current | $I_{MAX}$ | 500 | mA |
| Power Dissipation | $P_D$ | 0.48 | W |
| Maximum junction Temperature | $T_J$ | +125 | °C |
| Operating Temperature Range | $T_{OPR}$ | -40 ~ +85 | °C |
| Storage Temperature Range | $T_{STG}$ | -65 ~ +150 | °C |

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

## ■ THERMAL DATA

| PARAMETER | SYMBOL | RATINGS | UNIT |
|---|---|---|---|
| Junction to Ambient | $\theta_{JA}$ | 205 | °C/W |

## ■ RECOMMENDED OPERATING CONDITIONS

| PARAMETER | SYMBOL | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| Input Voltage Range | $V_{IN}$ | 1.0 | | 3.6 | V |
| Output Voltage Range | $V_{OUT}$ | | | $V_{IN}$ | |
| High-Level Input Voltage, ON | $V_{IH}$ | 0.85 | | 3.6 | V |
| Low-Level Input Voltage, ON | $V_{IL}$ | | | 0.4 | V |
| Input Capacitor (Note) | $C_{IN}$ | 1.0 | | | μF |

Note: See Application Information.

## ■ ELECTRICAL CHARACTERISTICS ($V_{IN}$=1.0V~3.6V, $T_A$=25°C unless otherwise specified)

| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN | TYP (Note) | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| Quiescent Current | $I_{IN}$ | $I_{OUT}$=0, $V_{IN}$=$V_{ON}$ | $V_{IN}$=1.1V | | 37 | 120 | nA |
| | | | $V_{IN}$=1.8V | | 82 | 235 | |
| | | | $V_{IN}$=3.6V | | 204 | 880 | |
| OFF-State Supply Current | $I_{IN\ (OFF)}$ | $V_{ON}$=GND, OUT=Open | $V_{IN}$=1.1V | | 22 | 210 | nA |
| | | | $V_{IN}$=1.8V | | 44 | 260 | |
| | | | $V_{IN}$=3.6V | | 137 | 700 | |
| OFF-State Switch Current | $I_{IN\ (LEAKAGE)}$ | $V_{ON}$=GND, $V_{OUT}$=0 | $V_{IN}$=1.1V | | 22 | 140 | nA |
| | | | $V_{IN}$=1.8V | | 45 | 230 | |
| | | | $V_{IN}$=3.6V | | 137 | 610 | |
| ON-State Resistance | $R_{ON}$ | $I_{OUT}$=-200mA | $V_{IN}$=3.6V | | 78 | 95 | mΩ |
| | | | $V_{IN}$=2.5V | | 93 | 110 | |
| | | | $V_{IN}$=1.8V | | 109 | 130 | |
| | | | $V_{IN}$=1.2V | | 146 | 200 | |
| | | | $V_{IN}$=1.1V | | 174 | 330 | |
| Output Pulldown Resistance | $R_{PD}$ | $V_{IN}$=3.3V, $V_{ON}$=0, $I_{OUT}$=30mA (UTC US2236095D/UTC US2236095DB only) | | | 88 | 120 | Ω |
| ON input Leakage Current | $I_{ON}$ | $V_{ON}$=1.1V~3.6 V or GND | | | | 25 | nA |

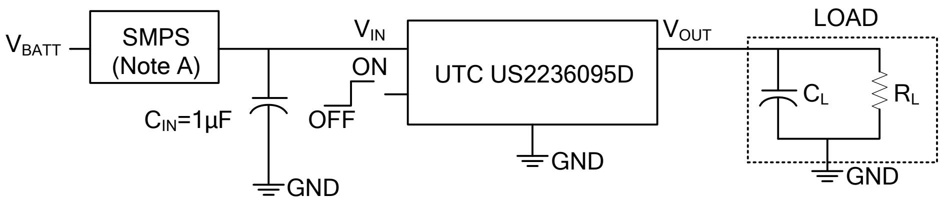
Note: Typical values are at the specified $V_{IN}$ and $T_A$=25°C.

■ SWITCHING CHARACTERISTICS ($V_{IN}$=3.6V, $T_A$=25°C unless otherwise specified)

| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| Turn-ON Time | $t_{ON}$ | $R_L$=500Ω | $C_L$=0.1μF | | 33 | | μs |
| | | | $C_L$=1μF | | 39 | | |
| | | | $C_L$=3.3μF | | 46 | | |
| Turn-OFF Time | $t_{OFF}$ | $R_L$=500Ω | $C_L$=0.1μF | | 7 | | μs |
| | | | $C_L$=1μF | | 46 | | |
| | | | $C_L$=3.3μF | | 156 | | |
| $V_{OUT}$ Rise Time | $t_R$ | $R_L$=500Ω | $C_L$=0.1μF | | 25 | | μs |
| | | | $C_L$=1μF | | 28 | | |
| | | | $C_L$=3.3μF | | 34 | | |
| $V_{OUT}$ Fall Time | $t_F$ | $R_L$=500Ω | $C_L$=0.1μF | | 14 | | μs |
| | | | $C_L$=1μF | | 139 | | |
| | | | $C_L$=3.3μF | | 512 | | |

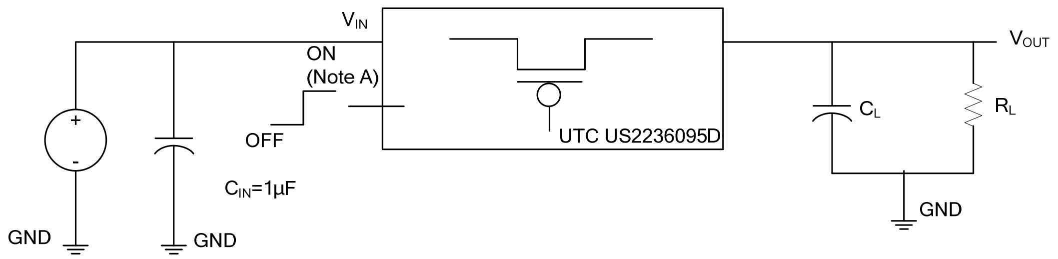
Note: $R_L$_Chip =120Ω.

## ■ TYPICAL APPLICATIONS



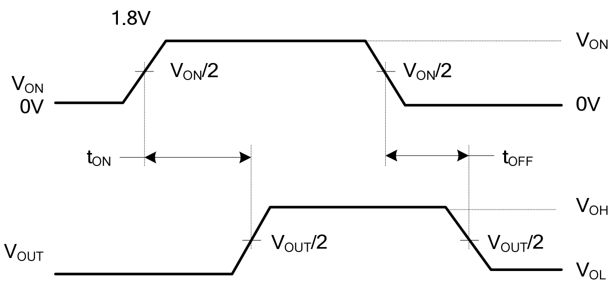

Note A. Switched mode power supply

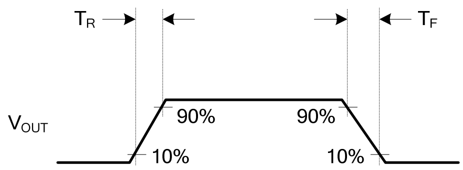
## ■ TEST CIRCUIT AND WAVEFORMS




Note A. $T_{RISE}$ and $T_{FALL}$ of the control signal is 100ns.

TEST CIRCUIT



## ■ APPLICATION INFORMATION

**ON/OFF Control**

The ON pin controls the state of the switch. Activating ON continuously holds the switch in the on state so long as there is no fault. ON is active-high and has a low threshold, making it capable of interfacing with low voltage signals. The ON pin is compatible with standard GPIO logic threshold. It can be used with any microcontroller with 1.2V, 1.8V, 2.5V or 3.3V GPIOs.

**Input Capacitor**

To limit the voltage drop on the input supply caused by transient in-rush currents when the switch turns on into a discharged load capacitor or short-circuit, a capacitor needs to be placed between $V_{IN}$ and GND. A 1.0μF ceramic capacitor, $C_{IN}$, place close to the pins is usually sufficient. Higher values of $C_{IN}$ can be use to further reduce the voltage drop during high current application. When switching heavy loads, it is recommended to have an input capacitor about 10 times higher than the output capacitor, this in order to avoid excessive voltage drop.

**Output Capacitor**

Due to the integral body diode in the PMOS switch, a $C_{IN}$ greater than $C_L$ is highly recommended. A $C_L$ greater than $C_{IN}$ can cause $V_{OUT}$ to exceed $V_{IN}$ when the system supply is removed. This could result in current flow through the body diode from $V_{OUT}$ to $V_{IN}$.

**Board Layout**

For best performance, all traces should be as short as possible. To be most effective, the input and output capacitors should be placed close to the device to minimize the effects that parasitic trace inductances may have on normal and short-circuit operation. Using wide traces for $V_{IN}$, $V_{OUT}$, and GND helps minimize the parasitic electrical effects along with minimizing the case-to-ambient thermal impedance.