# UTC UNISONIC TECHNOLOGIES CO., LTD

## US2026A

*CMOS IC*

# DUAL-CHANNEL USB POWER SWITCH AND OVER-CURRENT PROTECTION

■ **DESCRIPTION**

The UTC **US2026A** is a standard dual channels power switch with independent over-current protection fault flag functions, optimized for bus-powered Universal Serial Bus (USB) and self-powered applications, including Notebook and desktop PC's that supply power to more than one port.

The UTC **US2026A** also offers thermal shutdown protection that reduces current consumption in fault modes for each switch and the entire device. With a 1ms delay on the fault FLAG output prevents erroneous over current reporting caused by in-rush currents during hot-plug events.

In addition, the UTC **US2026A** employs soft-start circuitry that minimizes in-rush current in applications where highly capacitive loads are employed.
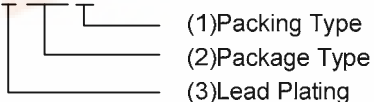
SOP-8

*Pb-free plating product number: US2026AL

■ **FEATURES**

* Two P-channel power MOSFET control switch
* 110μA Max operating current
* 5μA Max standby current
* 145 mΩ Max switch resistance
* 2.7V ~ 5.5V input voltage range
* 500mA minimum continuous load current
* Smooth turn-on eliminates in-rush induced voltage drop
* 1 ms fault flag delay filters Hot-Plug events
* Over-current protection
* Under-voltage lockout circuit
* Thermal shutdown protection
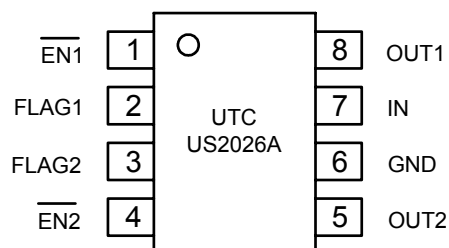* Flag indicates fault conditions

■ **ORDERING INFORMATION**

| Ordering Number | | Package | Packing |
|---|---|---|---|
| Normal | Lead Free Plating | | |
| US2026A-S08-R | US2026AL-S08-R | SOP-8 | Tape Reel |
| US2026A-S08-T | US2026AL-S08-T | SOP-8 | Tube |

US2026AL-S08-R

(1)Packing Type
(2)Package Type
(3)Lead Plating

(1) R: Tape Reel, T: Tube
(2) S08: SOP-8
(3) L: Lead Free Plating, Blank: Pb/Sn

QW-R502-086.B

# US2026A

■ **PIN CONFIGURATIONS**

```
         ___
         EN1  ┌1│  ○        8│ OUT1
              │                │
       FLAG1  ┌2│     UTC    7│ IN
              │    US2026A     │
       FLAG2  ┌3│            6│ GND
         ___   │                │
         EN2  ┌4│            5│ OUT2
```

■ **PIN DESCRIPTION**

| PIN NO | PIN NAME | DESCRIPTION |
|---|---|---|
| 1 | $\overline{EN1}$ | Switch1 Enable input: Logic-compatible enables inputs |
| 2 | FLAG1 | Fault Detection Flag 1 (OUTPUT): Active-low. N-ch open-drain. Indicates over-current, thermal shutdown, or UVLO conditions |
| 3 | FLAG2 | Fault Detection Flag 2 (OUTPUT): Active-low. N-ch open-drain. Indicates over-current, thermal shutdown, or UVLO conditions |
| 4 | $\overline{EN2}$ | Switch2 Enable input: Logic-compatible enables inputs |
| 5 | OUT2 | Switch2 OUTPUT: Drain of MOSFET for Output. Usually, connected to Load |
| 6 | GND | Ground |
| 7 | IN | Power input: Source of MOSFET for Output. Power Supply to Internal Circuitry of IC |
| 8 | OUT1 | Switch1 OUTPUT: Drain of MOSFET for Output. Usually, connected to Load |

# US2026A

■ **BLOCK DIAGRAM**

# US2026A

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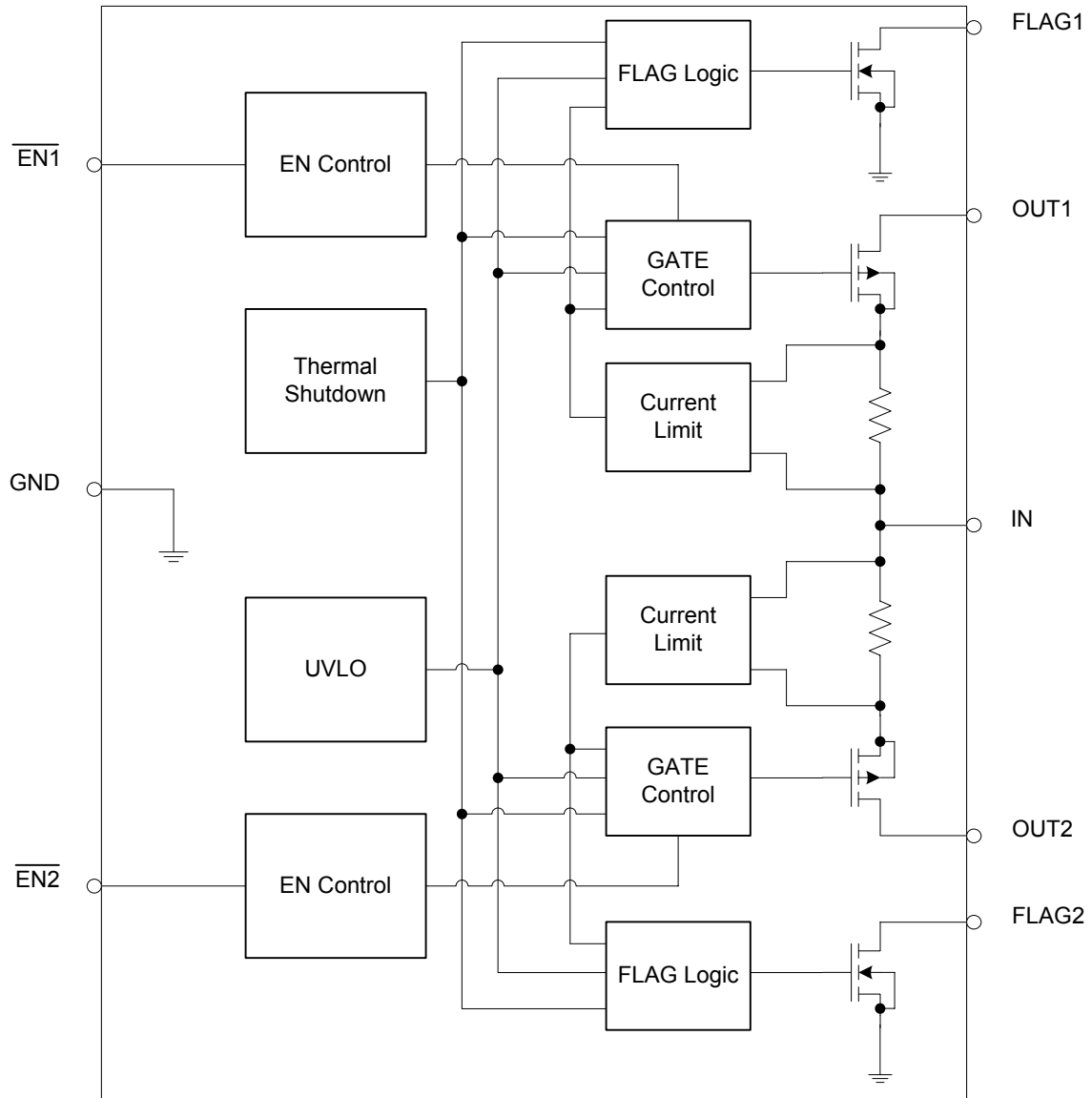
■ **ABSOLUTE MAXIMUM RATINGS**

| PARAMETER | SYMBOL | RATINGS | UNIT |
|---|---|---|---|
| Supply Voltage | $V_{IN}$ | -0.3 ~ +6 | V |
| Output Voltage | $V_{OUT}$ | -0.3 ~ +6 | V |
| Voltage at All Other Pins | $V_{OTHER}$ | -0.3 ~ +6 | V |
| Total Power Dissipation | $P_D$ | 300 | mW |
| Junction Temperature | $T_J$ | +150 | |
| Operating Temperature | $T_{OPR}$ | -40 ~ +85 | |
| Storage Temperature | $T_{STG}$ | -55 ~ +150 | |

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.

■ **RECOMMENDED OPERATION CONDITIONS**

| PARAMETER | SYMBOL | RATINGS | UNIT |
|---|---|---|---|
| Supply Voltage Range | $V_{IN}$ | +2.7 ~ +5.5 | V |
| Operating Temperature | $T_{OPR}$ | 0 ~ +70 | |

■ **ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C, $V_{IN}$ = 5.0V, $V_{EN}$ = 0V, unless otherwise specified.)

| PARAMETER | | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| **DC CHARACTERISTIC** | | | | | | | |
| $\overline{EN}$ Input Logic | High | $V_{IH}$ | (Note 1) | 2.4 | 1.7 | | V |
| | Low | $V_{IL}$ | (Note 1) | | 1.6 | 0.8 | V |
| Under-Voltage Lockout Threshold | | $V_{UVLO}$ | $V_{IN}$=increasing | | 2.3 | 2.7 | V |
| | | | Hysteresis voltage | | 100 | | mV |
| OUT Pins Continuous Output Current | | $I_{OUT}$ | Each Output | 0.5 | | | A |
| Over-Current Threshold | | $THD_{OC}$ | | | 1.5 | 2.2 | A |
| OUT Pins Output Leakage Current | | $I_{LEAK}$ | $V_{\overline{EN}}$ = $V_{IN}$ | | 0.01 | 10 | µA |
| $\overline{EN}$ Leakage Current | | $I_{EN}$ | $V_{\overline{EN}}$ = 0V or $V_{\overline{EN}}$= $V_{IN}$ | -0.5 | | 0.5 | µA |
| Supply Current | OFF | $I_{O(OFF)}$ | Switch-Off | | 1 | 5 | µA |
| | ON | $I_{O(ON)}$ | Switch-On | | | 110 | µA |
| Error FLAG Leakage Current | | $I_{FH}$ | $V_{FLAG}$ = 5V | | 0.01 | 1 | µA |
| On Resistance | | $R_{ON}$ | $V_{IN}$ = 5V, $I_{OUT}$ = 500mA, each switch | | 105 | 145 | mΩ |
| | | | $V_{IN}$ = 2.7V, $I_{OUT}$ = 500mA, each switch | | 135 | 180 | |
| FLAG Output Voltage | | $R_{FO}$ | $I_{FO}$ = 10 mA, $V_{IN}$ = 5.0V | | 10 | 20 | Ω |
| | | | $I_{FO}$ = 10 mA, $V_{IN}$ = 3.3V | | 11 | 30 | |
| | | | $I_{FO}$ = 10 mA, $V_{IN}$ = 2.7V | | 12 | 40 | |
| Over-Temperature Shutdown Threshold | | $THD_{OT}$ | $T_J$ Increasing, with no shorted output | | 155 | | °C |
| | | | $T_J$ Increasing, with shorted output (s) | | 145 | | |
| | | | $T_J$ Decreasing (Note 2) | | 135 | | |
| **AC CHARACTERISTIC** | | | | | | | |
| Over Current Flag Delay | | $t_{OC}$ | $R_L$ = 0 | | 1 | | ms |
| OUT Rise Time | | $t_R$ | $R_L$ = 10Ω | | 160 | | µs |
| OUT Fall Time | | $t_F$ | $R_L$ = 10Ω | | 5 | | µs |
| Turn on Delay, $\overline{EN}$ to OUT | | $t_{ON}$ | $R_L$ = 10Ω | | 240 | | µs |
| Turn off Delay, $\overline{EN}$ to OUT | | $t_{OFF}$ | $R_L$ = 10Ω | | 5 | | µs |

Note: 1. OFF is $\overline{EN}$ ≥ 2.4V and ON is $\overline{EN}$ ≤ 0.8V.
    2. Thermal Shutdown will protect the device from permanent damage.

# US2026A

■ **TEST CIRCUIT**

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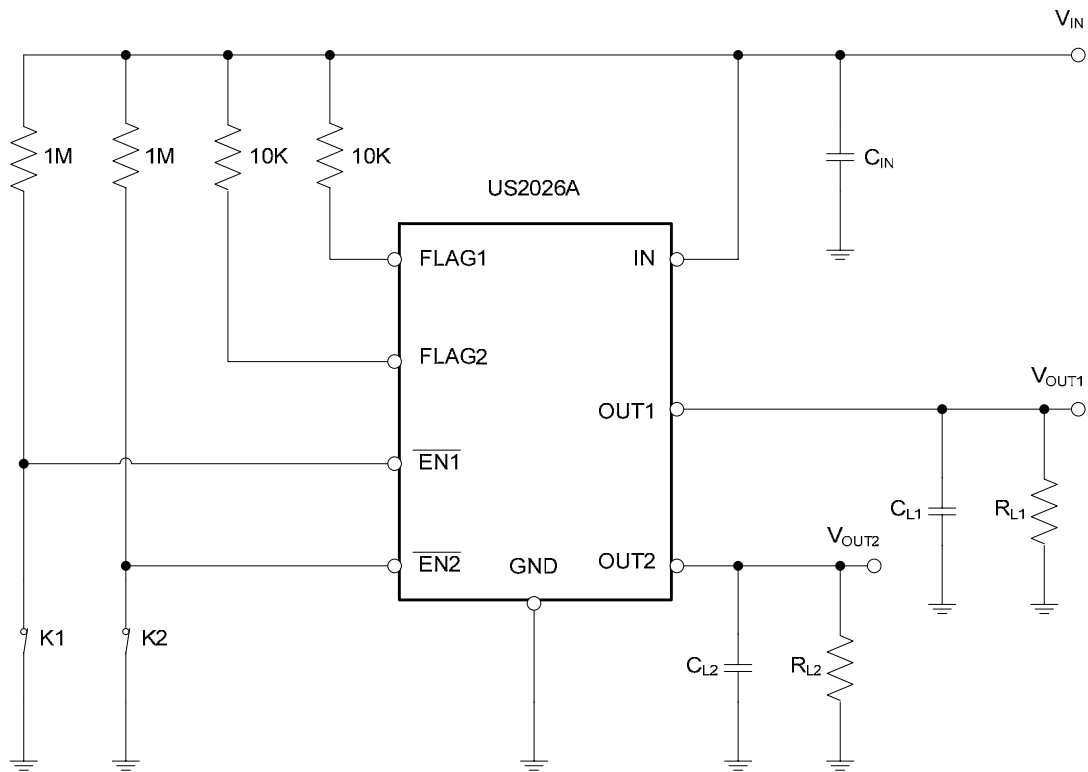
# US2026A

■ **TIMING DIAGRAM**
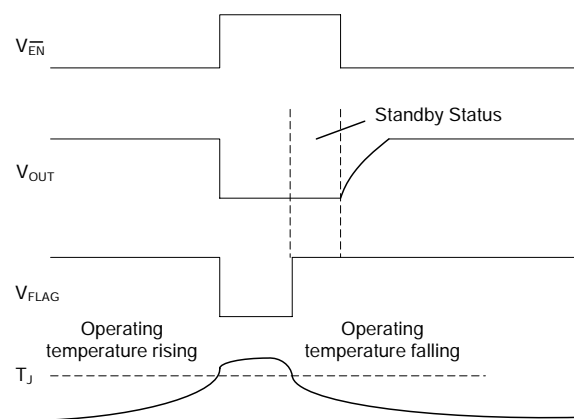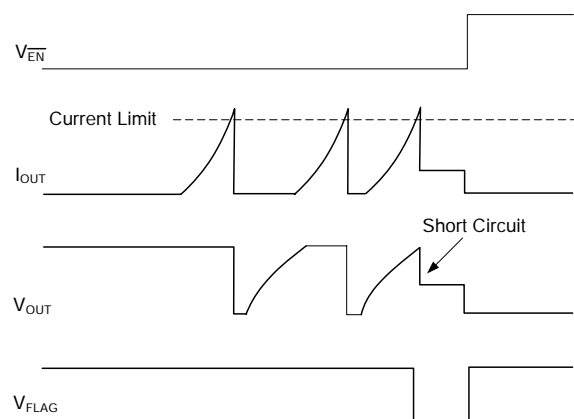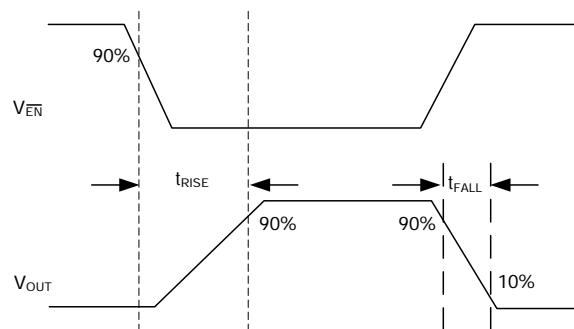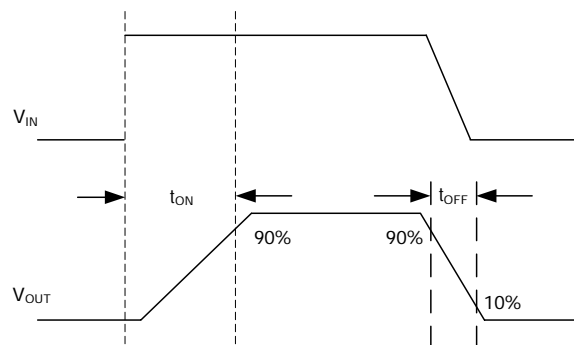
■ **FUNCTIONAL DESCRIPTION**

The UTC **US2026A** is dual P-Channel switches with active-low and active-high enable inputs, respectively. Fault conditions (such as UVLO, thermal shutdown and over-current) that appear will turn off the power switch, and the FLAG pin will go low. Of course, the two internal FLAG circuits also operate respectively.

**Input and Output**

IN (Input) is the power supply connection to the control circuitry and the source of the output MOSFET. OUTX (Output) is the connection to the drain of the output MOSFET. In a typical application circuit, current flows through the switch from IN to OUTX towards the load. If $V_{OUT}$ is greater than $V_{IN}$ when the switch is enabled, current will flow from OUTX to IN since the MOSFET is bi-directional.

**Power ON and OFF**

The UTC **US2026A** performs a soft-start operation on power application, which is to prevent an over-current or inrush-current from flowing through the switch from IN to OUTX towards to the load, while the high-capacity capacitor is connected to the OUTX.

**Thermal Shutdown**

The UTC **US2026A** is internally protected against excessive power dissipation by thermal shutdown protection circuit. If device junction temperature rise above approximately 145 , both switches are turned off, both fault FLAG outputs are activated, and they goes low. Hysteresis ensures that both switches turned off by thermal shutdown will not be turned on again until the die temperature is reduced to 135 . When the thermal shutdown circuit is activated, the output pins are in the OFF status. However, the UTC **US2026A** enters the standby status when $\overline{\text{EN}}$ pins are all inactive.

**Current Limit**

The current limit circuit is designed to protect the output MOSFET, the load and the IC supply from damage caused by excessive currents. The current limit threshold is preset internally, If an over-current is detected, the IC performs a slow-start operation again, it is assumed that output is short circuit, and FLAG pin will go low, FLAG output is available to indicate fault conditions independently to the USB controller.
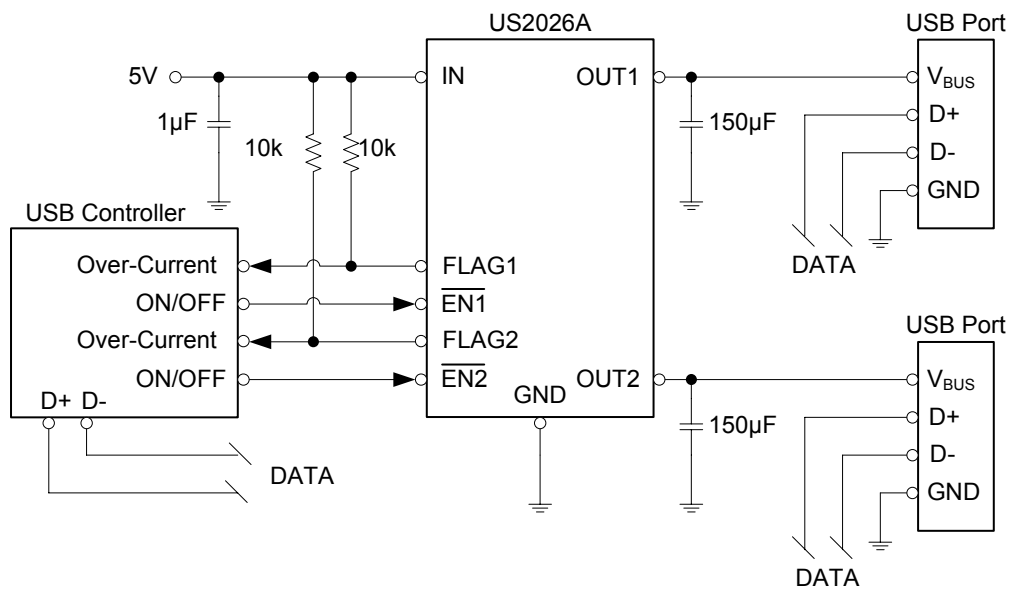
**Under-Voltage Lockout**

UVLO prevents the output MOSFET switch from turning on until input voltage exceeds 2.3V (typical). If input voltage drops below 2.2V (typical), UVLO shuts off the both output MOSFET switches and signals the FLAG.
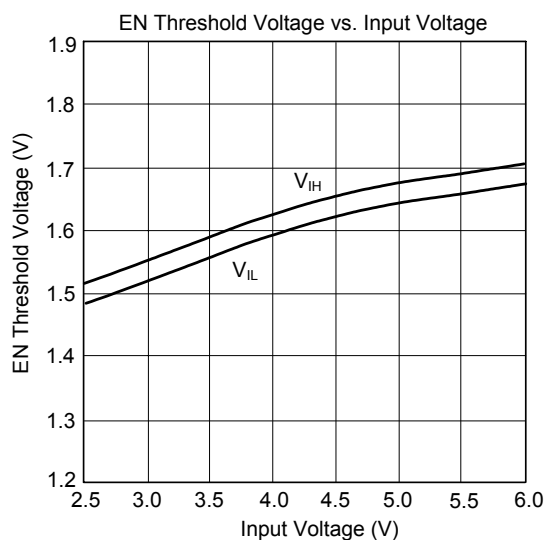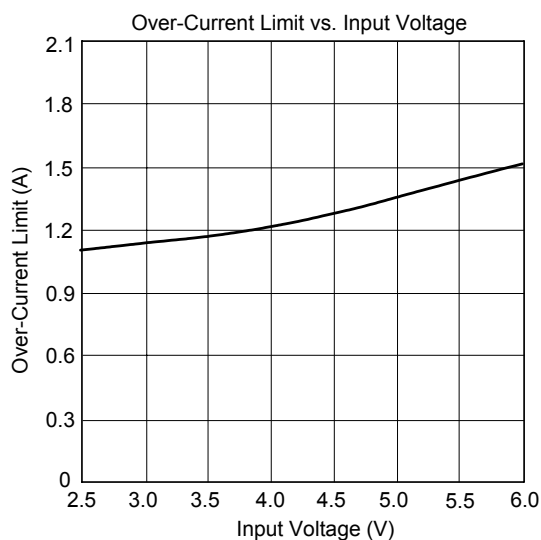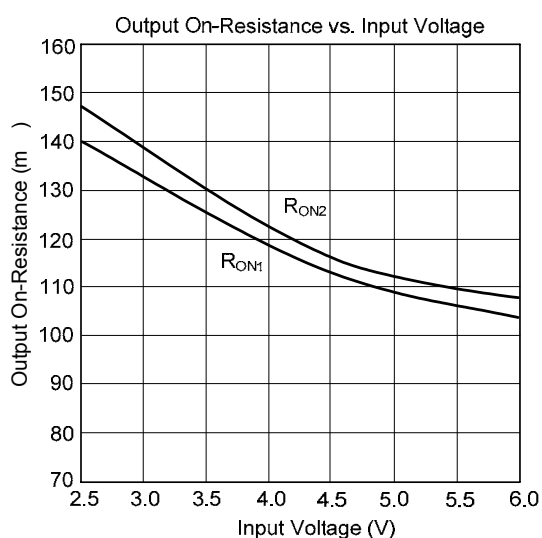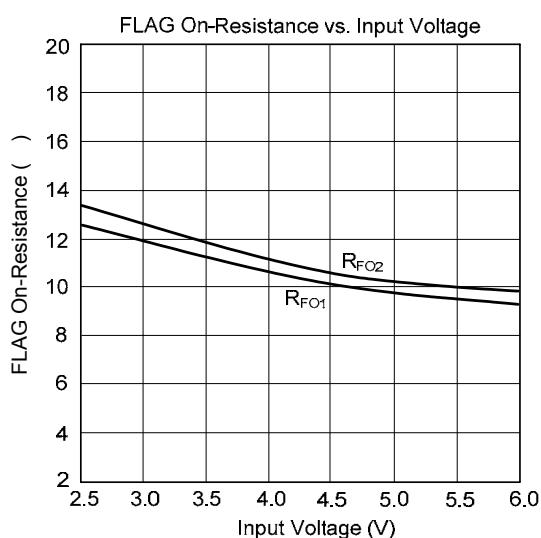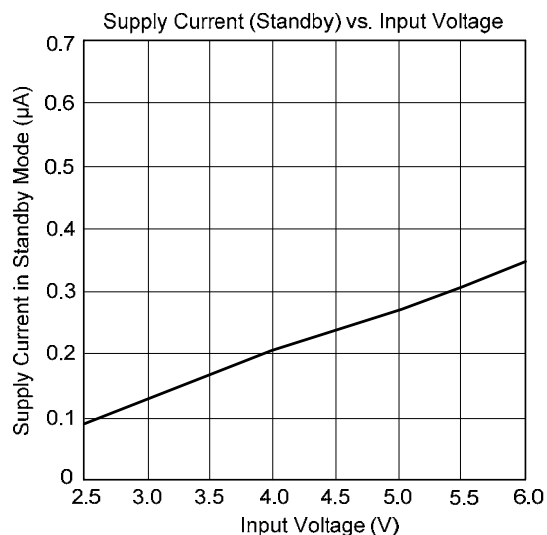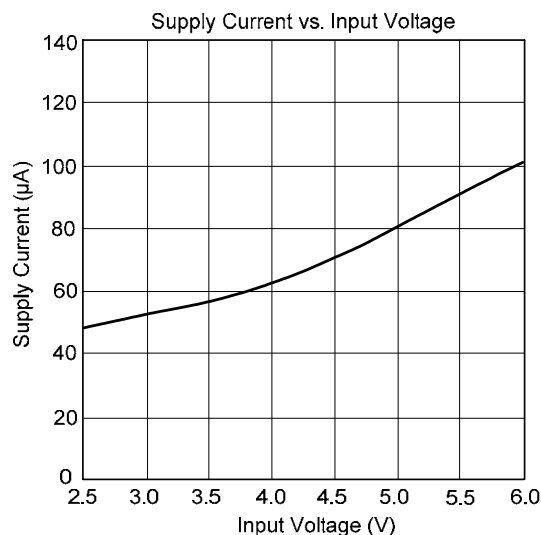
**Fault FLAG**

The fault FLAG is an output with open-drain of N-channel. The fault FLAG is pulled down when any of the conditions such as under-voltage, current limit and thermal shutdown. In a typical application circuit, the FALG pin has a pull-up resistor of 10kΩ to input voltage.
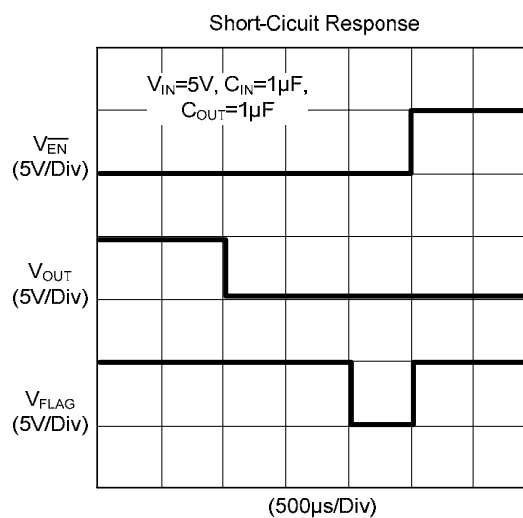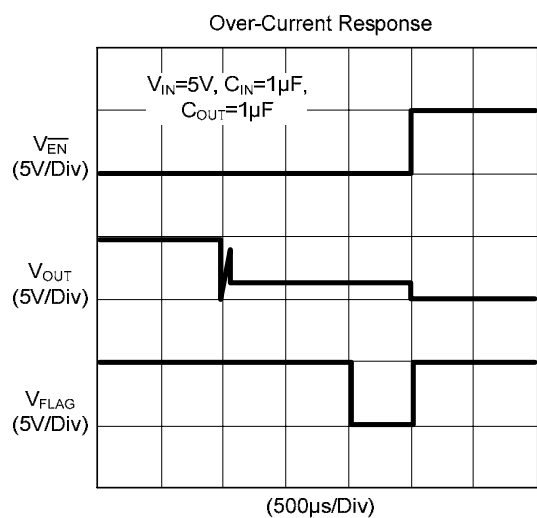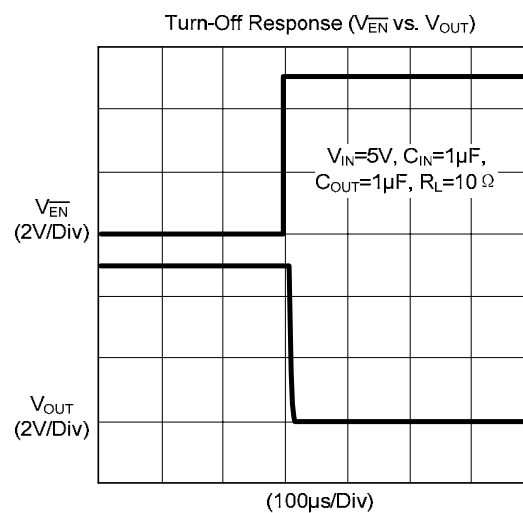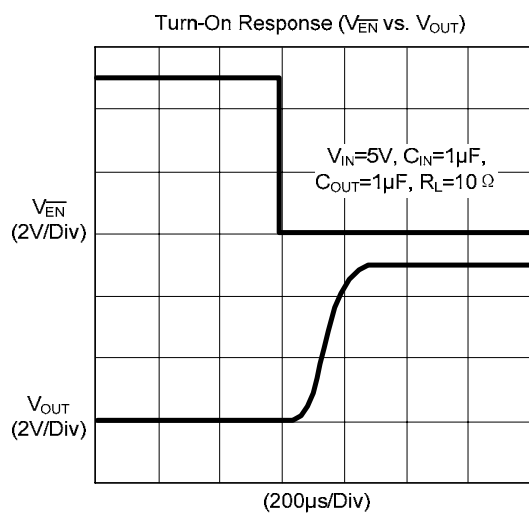
# US2026A

*CMOS IC*

■ **TYPICAL APPLICATION CIRCUIT**

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QW-R502-086.B

■ **TYPICAL CHARACTERISTICS** ($T_J$ = 25  , $V_{IN}$ = 5.0V, unless otherwise specified)

Supply Current vs. Input Voltage

Supply Current (Standby) vs. Input Voltage

FLAG On-Resistance vs. Input Voltage

Output On-Resistance vs. Input Voltage

Over-Current Limit vs. Input Voltage

EN Threshold Voltage vs. Input Voltage

# US2026A

■ **TYPICAL CHARACTERISTICS(Cont.)**

Turn-On Response (V$_{IN}$ vs. V$_{OUT}$)

V$_{IN}$ (2V/Div)

V$_{OUT}$ (2V/Div)

V$_{IN}$=5V, C$_{IN}$=1μF, C$_{OUT}$=1μF, R$_L$=10Ω

(200μs/Div)

Turn-Off Response (V$_{IN}$ vs. V$_{OUT}$)

V$_{IN}$ (2V/Div)

V$_{OUT}$ (2V/Div)

V$_{IN}$=5V, C$_{IN}$=1μF, C$_{OUT}$=1μF, R$_L$=10Ω

(100μs/Div)

Turn-On Response (V$_{\overline{EN}}$ vs. V$_{OUT}$)

V$_{\overline{EN}}$ (2V/Div)

V$_{OUT}$ (2V/Div)

V$_{IN}$=5V, C$_{IN}$=1μF, C$_{OUT}$=1μF, R$_L$=10 Ω

(200μs/Div)

Turn-Off Response (V$_{\overline{EN}}$ vs. V$_{OUT}$)

V$_{\overline{EN}}$ (2V/Div)

V$_{OUT}$ (2V/Div)

V$_{IN}$=5V, C$_{IN}$=1μF, C$_{OUT}$=1μF, R$_L$=10 Ω

(100μs/Div)

Over-Current Response

V$_{\overline{EN}}$ (5V/Div)

V$_{OUT}$ (5V/Div)

V$_{FLAG}$ (5V/Div)

V$_{IN}$=5V, C$_{IN}$=1μF, C$_{OUT}$=1μF

(500μs/Div)

Short-Cicuit Response

V$_{\overline{EN}}$ (5V/Div)

V$_{OUT}$ (5V/Div)

V$_{FLAG}$ (5V/Div)

V$_{IN}$=5V, C$_{IN}$=1μF, C$_{OUT}$=1μF

(500μs/Div)