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Enhanced power switch

Not recommended for new design

Features

- 90 mΩ high-side MOSFET switch
- 500 mA continuous current per channel
- Thermal and short-circuit protection with overcurrent logic output
- Operating range from 2.7 to 5.5 V
- CMOS- and TTL-compatible enable inputs
- 2.5 ms typical rise time
- Undervoltage lock out
- 10 μA maximum standby supply current
- Ambient temperature range, 0 °C to 85 °C
- 2 kV ESD protection
- Fault-blanking

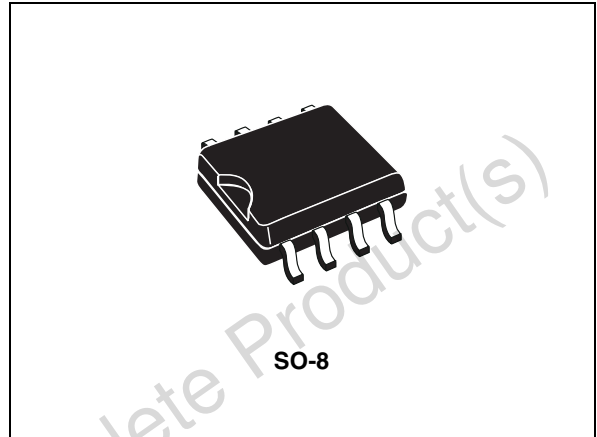


Table 1. Device summary

| Order code | Package | Packaging |
|--------------------------|---------|---------------|
| ST2041BDR ⁽¹⁾ | SO-8 | Tape and reel |

1. Not recommended for new design (refer to STMPS2141MTR). Contact ST sales office for availability.

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1 Description

The ST2041 power distribution switch is intended for applications where heavy capacitive loads and short-circuits are likely to be encountered. These devices incorporate 90 m Ω N-channel MOSFET high-side power switches for power-distribution. The switch is controlled by a logic enable input. Gate drive is provided by an internal charge pump designed to control the power-switch rise times and fall times to minimize current surges during switching. The charge pump requires no external components and allows operation from supplies as low as 2.7 V.

When the output load exceeds the current-limit threshold or a short is present, the device limits the output current to a safe level by switching into a constant-current mode, pulling the overcurrent logic output low. When continuous heavy overloads and short-circuits increase the power dissipation in the switch, causing the junction temperature to rise, a thermal protection circuit shuts off the switch to prevent damage. Recovery from a thermal shutdown is automatic once the device has cooled sufficiently. Internal circuitry ensures the switch remains off until valid input voltage is present.

2 Schematic diagram and pin connections

Figure 1. Schematic diagram

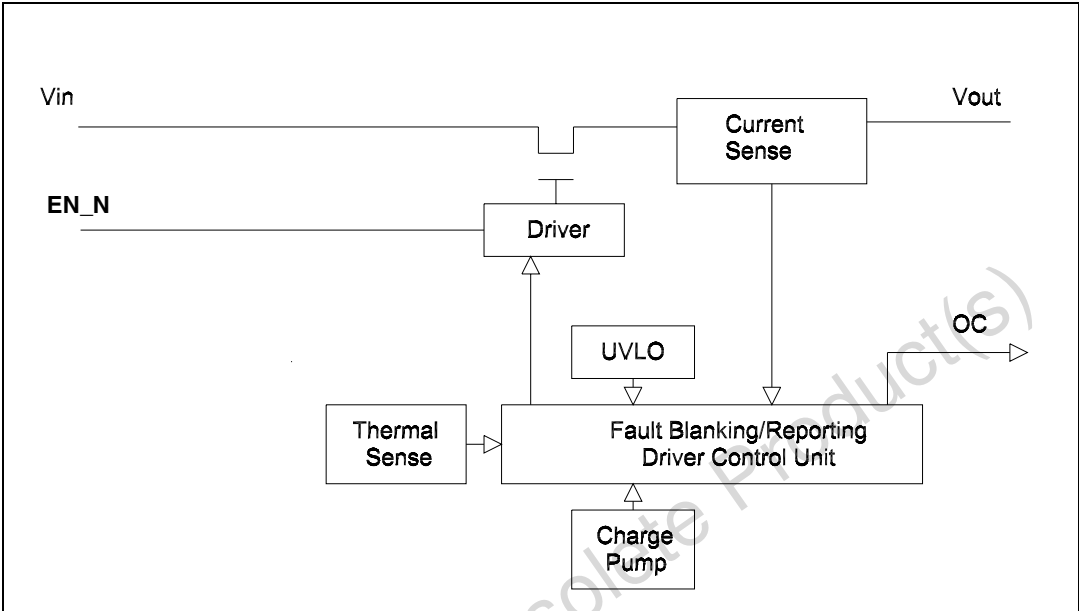


Figure 2. Pin connections (top view)

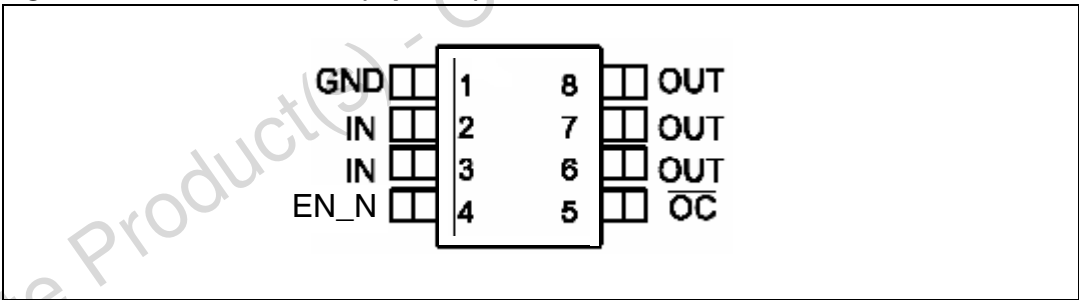


Table 2. Pin functions

| Pin | Name | Type | Description |
|-----|------|------|--|
| 1 | GND | - | Ground |
| 2 | IN1 | - | V _{CC} input, 2.7-5.5 V |
| 3 | IN2 | - | V _{CC} input, 2.7-5.5 V |
| 4 | EN_N | I | Enable (active low) |
| 5 | OC | O | Open drain output for fault indication |
| 6 | OUT3 | - | Output |
| 7 | OUT2 | - | Output |
| 8 | OUT1 | - | Output |

3 Functional descriptions

3.1 Fault-blanking

ST devices feature a 10 ms fault-blanking. Fault-blanking allows current-limit faults, including momentary short-circuit faults that occur when hot-swapping a capacitive load, and also ensures that no fault is issued during power-up. When a load transient causes the device to enter current limit, an internal counter starts. If the load fault persists beyond the 10 ms fault-blanking timeout, the FAULT output asserts low. Load-transient faults less than 10 ms (typical) will not cause a FAULT output assertion. Only current-limit faults are blanked. Die overtemperature faults and input voltage drops below the undervoltage lock out (UVLO) threshold will cause an immediate fault output.

3.2 Overcurrent/overtemperature protection

In overcurrent or short-circuit condition, the switch limits the current at 500 mA. If temperature of die goes above limit value, the switch turns OFF.

3.3 Undervoltage lock out (UVLO)

When input voltage drops below critical value, the power switch turns OFF to prevent improper operation due to low voltage.

4 Maximum rating

Stressing the device above the rating listed in the “Absolute maximum ratings” table may cause permanent damage to the device. These are stress ratings only, and operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Refer also to the STMicroelectronics™ SURE program and other relevant quality documents.

Table 3. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|------------|--------------------------------|--------------------|------|
| V_I | Input voltage range | -0.3-6.0 | V |
| V_O | Output voltage range | -0.3-($V_I+0.3$) | V |
| V_{IENX} | EN input voltage range | -0.3-6.0 | V |
| I_O | Continuous output current | Internally limited | |
| ESD | ESD protection level | 2 | kV |
| T_J | Junction operating temperature | -40 to 125 | °C |
| T_{STG} | Storage temperature | -55 to 150 | °C |

Recommended operating conditions

Table 4. Recommended operating conditions

| Symbol | Parameter | Min | Typ | Max | Unit |
|--------|---------------------------|-----|-----|-----|------|
| V_I | Input voltage | 2.7 | 5.0 | 5.5 | V |
| V_O | Output voltage | 0 | 5.0 | 5.5 | V |
| I_O | Continuous output current | 0 | - | 500 | mA |

5 Electrical characteristics

Table 5. Electrical characteristics ($T_J = 25\text{ °C}$, $V_I = 5.0\text{ V}$)

| Symbol | Parameter | Test conditions | Min | Typ | Max | Unit |
|--------------|---|--|-----|-----|-----|------|
| $R_{DS(on)}$ | Static drain-source on-state resistance | $V_I = 3.3\text{ V}$ $-40 < T_J < 125\text{ °C}$ | | 100 | 145 | mΩ |
| | | $V_I = 5.0\text{ V}$ $-40 < T_J < 125\text{ °C}$ | | 90 | 135 | |
| | | $V_I = 3.3\text{ V}$ $T_J = 25\text{ °C}$ | | 90 | 130 | |
| | | $V_I = 5.0\text{ V}$ $T_J = 25\text{ °C}$ | | 80 | 110 | |
| t_r | Output rise time ⁽¹⁾ | $V_I = 5.5\text{ V}$ $R_L = 10\text{ Ω}$ $C_L = 1\text{ μF}$ | | 2.5 | | ms |
| | | $V_I = 2.7\text{ V}$ $R_L = 10\text{ Ω}$ $C_L = 1\text{ μF}$ | | 3 | | ms |
| t_f | Output fall time ⁽¹⁾ | $V_I = 5.5\text{ V}$ $R_L = 10\text{ Ω}$ $C_L = 1\text{ μF}$ | | 0.3 | | ms |
| | | $V_I = 2.7\text{ V}$ $R_L = 10\text{ Ω}$ $C_L = 1\text{ μF}$ | | 0.2 | | ms |
| T_{ON} | Turn-on time ⁽¹⁾ | $R_L = 10\text{ Ω}$ $C_L = 100\text{ μF}$ | | | 20 | ms |
| T_{OFF} | Turn-off time ⁽¹⁾ | $R_L = 10\text{ Ω}$ $C_L = 100\text{ μF}$ | | | 40 | ms |

1. Not tested in production, specified by design.

Table 6. Current limit characteristics ($V_I = 5.5\text{ V}$, $I_O = \text{rated current}$, $T_J = 25\text{ }^\circ\text{C}$, unless otherwise specified)

| Symbol | Parameter | Test conditions | Min | Typ | Max | Unit |
|----------|------------------------------|--|-----|-----|-----|------|
| I_{OS} | Short-circuit output current | $V_I = 5\text{ V}$ OUT connected to GND, device enabled into short-circuit | 0.7 | 1.0 | 1.3 | A |

Table 7. Supply current characteristics ($V_I = 5.5\text{ V}$, $I_O = \text{rated current}$, $T_J = 25\text{ }^\circ\text{C}$, unless otherwise specified)

| Symbol | Parameter | Test conditions | Min | Typ | Max | Unit |
|---------------|------------------------|---|-----|-----|-----|---------------|
| I_{OFF} | Switch turned OFF | No load | | 1.0 | 5.0 | μA |
| | | No load; $-40 < T_J < 125\text{ }^\circ\text{C}$ | | | 10 | μA |
| I_{ON} | Switch turned ON | No load | | 70 | 90 | μA |
| | | No load; $-40 < T_J < 125\text{ }^\circ\text{C}$ | | | 100 | μA |
| $I_{leakage}$ | Output leakage current | Output grounded, switch is OFF | | | 10 | μA |
| | | Output grounded, switch is OFF; $-40 < T_J < 125\text{ }^\circ\text{C}$ | | | 20 | μA |

Table 8. Thermal characteristics ($V_I = 5.5\text{ V}$, $I_O = \text{rated current}$, $T_J = 25\text{ }^\circ\text{C}$, unless otherwise specified)

| Symbol | Parameter | Test conditions | Min | Typ | Max | Unit |
|--------|--------------------------------|-----------------|-----|-----|-----|------------------|
| T1 | Thermal shutdown threshold | | 135 | | | $^\circ\text{C}$ |
| T2 | Recovery from thermal shutdown | | 125 | | | $^\circ\text{C}$ |
| Hyst | Hysteresis | | | 10 | | $^\circ\text{C}$ |

Table 9. UVLO characteristics ($V_I = 5.5\text{ V}$, $I_O = \text{rated current}$, $T_J = 25\text{ }^\circ\text{C}$, unless otherwise specified)

| Symbol | Parameter | Test conditions | Min | Typ | Max | Unit |
|------------|--------------------------------|-----------------|-----|-----|-----|------|
| V_{UVLO} | Undervoltage lockout threshold | | 2.0 | | 2.5 | V |
| Hyst | Hysteresis | | | 100 | | mV |

Table 10. OC pin characteristics ($V_I = 5.5\text{ V}$, $I_O = \text{rated current}$, $T_J = 25\text{ }^\circ\text{C}$, unless otherwise specified)

| Symbol | Parameter | Test conditions | Min | Typ | Max | Unit |
|-------------|---|-----------------|-----|-----|-----|---------------|
| OC blanking | OCx assertion and de-assertion ⁽¹⁾ | | 4 | 8 | 15 | mS |
| V_O | Output low voltage | | | | 0.4 | V |
| I_{OFF} | OFF current | | | | 1.0 | μA |

1. Not tested in production, specified by design.

Table 11. EN_N pin characteristics ($V_I = 5.5\text{ V}$, $I_O = \text{rated current}$, $T_J = 25\text{ }^\circ\text{C}$, unless otherwise specified)

| Symbol | Parameter | Test conditions | Min | Typ | Max | Unit |
|----------|--------------------------|------------------------------------|------|-----|-----|---------------|
| V_{IH} | High level input voltage | $V_I = 2.7\text{ to }5.5\text{ V}$ | 2.0 | | | V |
| V_{IL} | Low level input voltage | $V_I = 4.5\text{ to }5.5\text{ V}$ | | | 0.8 | V |
| | | $V_I = 2.7\text{ to }4.5\text{ V}$ | | | 0.4 | V |
| I_I | Input current | $V_{IENX} = 0\text{ V or }V_I$ | -0.5 | | 0.5 | μA |

6 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

Obsolete Product(s) - Obsolete Product(s)

Figure 3. SO-8 package outline

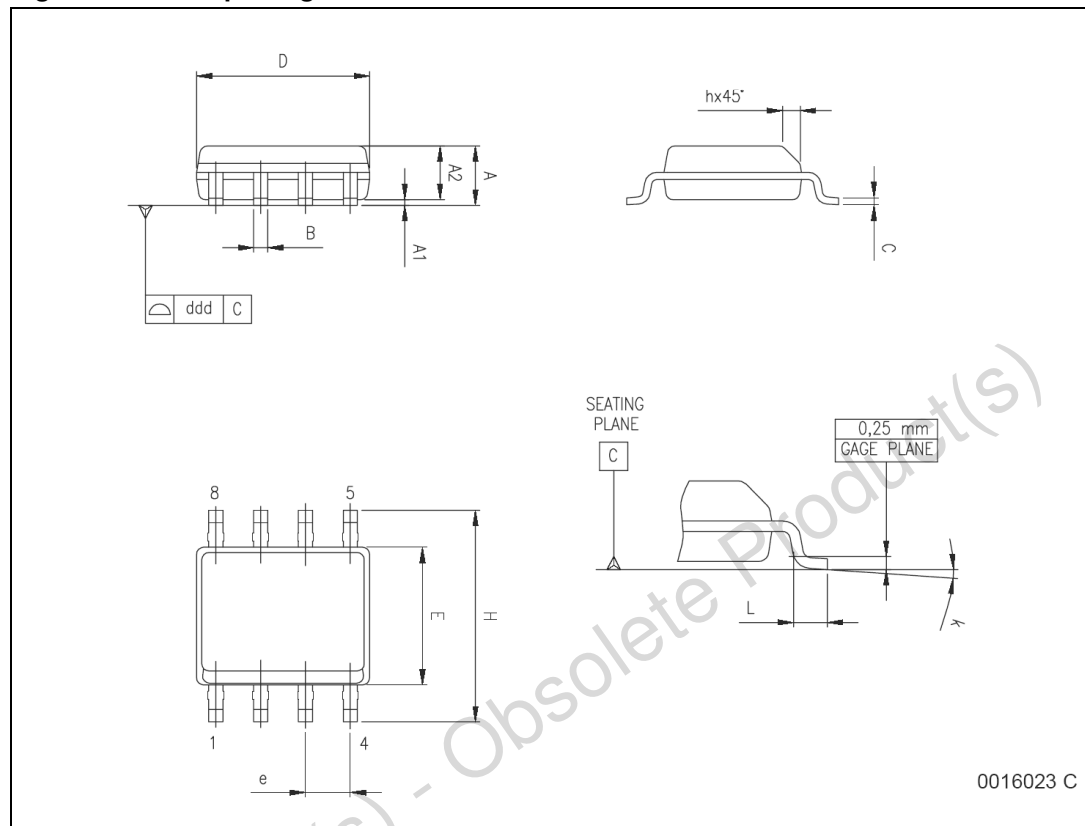


Table 12. SO-8 mechanical data

| Symbol | Millimeters | | | inches | | |
|--------|-------------|------|------|--------|-------|-------|
| | Min | Typ | Max | Min | Typ | Max |
| A | 1.35 | | 1.75 | 0.053 | | 0.069 |
| A1 | 0.10 | | 0.25 | 0.004 | | 0.010 |
| A2 | 1.10 | | 1.65 | 0.043 | | 0.065 |
| B | 0.33 | | 0.51 | 0.013 | | 0.020 |
| C | 0.19 | | 0.25 | 0.007 | | 0.010 |
| D | 4.80 | | 5.00 | 0.189 | | 0.197 |
| E | 3.80 | | 4.00 | 0.15 | | 0.157 |
| e | | 1.27 | | | 0.050 | |
| H | 5.80 | | 6.20 | 0.228 | | 0.244 |
| h | 0.25 | | 0.50 | 0.010 | | 0.020 |
| L | 0.40 | | 1.27 | 0.016 | | 0.050 |
| k | 8° (max.) | | | | | |
| ddd | | | 0.10 | | | 0.004 |

7 Revision history

Table 13. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 05-May-2006 | 1 | Initial release. |
| 20-Feb-2008 | 2 | Document restructured and converted to new ST template, watermark removed. |
| 24-Nov-2010 | 3 | Document reformatted, added “Not Recommended for New Design” and Note 1 below Table 1 , updated ECOPACK [®] text in Section 6 , corrected typo in Features , Section 1 , Table 2 , Section 3 , Section 4 , Table 3 , Table 5 to Table 11 . |

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