

# BUK655-450B-VB Datasheet

## N-Channel 600V (D-S) Power MOSFET

| PRODUCT SUMMARY           |                        |       |
|---------------------------|------------------------|-------|
| $V_{DS}$ (V)              | 600                    |       |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.780 |
| $Q_g$ max. (nC)           | 49                     |       |
| $Q_{gs}$ (nC)             | 13                     |       |
| $Q_{gd}$ (nC)             | 20                     |       |
| Configuration             | Single                 |       |

### FEATURES

- Low gate charge  $Q_g$  results in simple drive requirement
- Improved gate, avalanche and dynamic  $dV/dt$  ruggedness
- Fully characterized capacitance and avalanche voltage and current

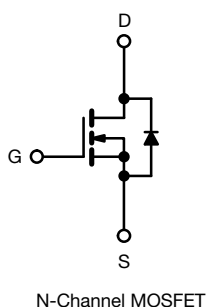


### APPLICATIONS

- Switch mode power supply (SMPS)
- Uninterruptible power supply
- High speed power switching

### APPLICABLE OFF LINE SMPS TOPOLOGIES

- Active clamped forward
- Main switch



| ABSOLUTE MAXIMUM RATINGS (T <sub>C</sub> = 25 °C, unless otherwise noted) |                         |                         |                                   |             |          |
|---------------------------------------------------------------------------|-------------------------|-------------------------|-----------------------------------|-------------|----------|
| PARAMETER                                                                 |                         |                         | SYMBOL                            | LIMIT       | UNIT     |
| Drain-Source Voltage                                                      |                         |                         | V <sub>DS</sub>                   | 600         | V        |
| Gate-Source Voltage                                                       |                         |                         | V <sub>GS</sub>                   | ± 30        |          |
| Continuous Drain Current                                                  | V <sub>GS</sub> at 10 V | T <sub>C</sub> = 25 °C  | I <sub>D</sub>                    | 8.0         | A        |
|                                                                           |                         | T <sub>C</sub> = 100 °C |                                   | 5.8         |          |
| Pulsed Drain Current <sup>a</sup>                                         |                         |                         | I <sub>DM</sub>                   | 37          |          |
| Linear Derating Factor                                                    |                         |                         |                                   | 1.3         | W/°C     |
| Single Pulse Avalanche Energy <sup>b</sup>                                |                         |                         | E <sub>AS</sub>                   | 290         | mJ       |
| Repetitive Avalanche Current <sup>a</sup>                                 |                         |                         | I <sub>AR</sub>                   | 8.0         | A        |
| Repetitive Avalanche Energy <sup>a</sup>                                  |                         |                         | E <sub>AR</sub>                   | 17          | mJ       |
| Maximum Power Dissipation                                                 | T <sub>C</sub> = 25 °C  |                         | P <sub>D</sub>                    | 170         | W        |
| Peak Diode Recovery dV/dt <sup>c</sup>                                    |                         |                         | dV/dt                             | 5.0         | V/ns     |
| Operating Junction and Storage Temperature Range                          |                         |                         | T <sub>J</sub> , T <sub>stg</sub> | -55 to +150 | °C       |
| Soldering Recommendations (Peak temperature) <sup>d</sup>                 | for 10 s                |                         |                                   | 300         |          |
| Mounting Torque                                                           | 6-32 or M3 screw        |                         |                                   | 10          | lbf · in |
|                                                                           |                         |                         |                                   | 1.1         | N · m    |

### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 6.8\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 9.2\text{ A}$  (see fig. 12).
- $I_{SD} \leq 9.2\text{ A}$ ,  $dI/dt \leq 50\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$ .
- 1.6 mm from case.

| THERMAL RESISTANCE RATINGS          |            |      |      |      |
|-------------------------------------|------------|------|------|------|
| PARAMETER                           | SYMBOL     | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient         | $R_{thJA}$ | -    | 62   | °C/W |
| Case-to-Sink, Flat, Greased Surface | $R_{thCS}$ | 0.50 | -    |      |
| Maximum Junction-to-Case (Drain)    | $R_{thJC}$ | -    | 0.75 |      |

| SPECIFICATIONS (T <sub>J</sub> = 25 °C, unless otherwise noted) |                                  |                                                                                                                                                          |                                                                                  |      |       |       |       |
|-----------------------------------------------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|------|-------|-------|-------|
| PARAMETER                                                       | SYMBOL                           | TEST CONDITIONS                                                                                                                                          |                                                                                  | MIN. | TYP.  | MAX.  | UNIT  |
| Static                                                          |                                  |                                                                                                                                                          |                                                                                  |      |       |       |       |
| Drain-Source Breakdown Voltage                                  | V <sub>DS</sub>                  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                                                                           |                                                                                  | 600  | -     | -     | V     |
| V <sub>DS</sub> Temperature Coefficient                         | ΔV <sub>DS</sub> /T <sub>J</sub> | Reference to 25 °C, I <sub>D</sub> = 1 mA                                                                                                                |                                                                                  | -    | 660   | -     | mV/°C |
| Gate-Source Threshold Voltage                                   | V <sub>GS(th)</sub>              | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                                                                              |                                                                                  | 2.0  | -     | 4.0   | V     |
| Gate-Source Leakage                                             | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 30 V                                                                                                                                 |                                                                                  | -    | -     | ± 100 | nA    |
| Zero Gate Voltage Drain Current                                 | I <sub>DSS</sub>                 | V <sub>DS</sub> = 600 V, V <sub>GS</sub> = 0 V                                                                                                           |                                                                                  | -    | -     | 25    | μA    |
|                                                                 |                                  | V <sub>DS</sub> = 480 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                                                  |                                                                                  | -    | -     | 250   |       |
| Drain-Source On-State Resistance                                | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V                                                                                                                                   | I <sub>D</sub> = 5.5 A <sup>b</sup>                                              | -    | 0.780 | -     | Ω     |
| Forward Transconductance                                        | g <sub>fs</sub>                  | V <sub>DS</sub> = 50 V, I <sub>D</sub> = 5.5 A                                                                                                           |                                                                                  | 5.5  | -     | -     | S     |
| Dynamic                                                         |                                  |                                                                                                                                                          |                                                                                  |      |       |       |       |
| Input Capacitance                                               | C <sub>iss</sub>                 | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 25 V,<br>f = 1.0 MHz, see fig. 5                                                                             |                                                                                  | -    | 1400  | -     | pF    |
| Output Capacitance                                              | C <sub>oss</sub>                 |                                                                                                                                                          |                                                                                  | -    | 180   | -     |       |
| Reverse Transfer Capacitance                                    | C <sub>rss</sub>                 |                                                                                                                                                          |                                                                                  | -    | 7.1   | -     |       |
| Output Capacitance                                              | C <sub>oss</sub>                 | V <sub>GS</sub> = 0 V                                                                                                                                    | V <sub>DS</sub> = 1.0 V, f = 1.0 MHz                                             | -    | 1957  | -     | pF    |
| Effective Output Capacitance                                    | C <sub>oss eff.</sub>            |                                                                                                                                                          | V <sub>DS</sub> = 480 V, f = 1.0 MHz                                             | -    | 49    | -     |       |
|                                                                 |                                  |                                                                                                                                                          | V <sub>DS</sub> = 0 V to 480 V                                                   | -    | 96    | -     |       |
| Total Gate Charge                                               | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                                                   | I <sub>D</sub> = 8.0A, V <sub>DS</sub> = 400 V<br>see fig. 6 and 13 <sup>b</sup> | -    | -     | 49    | nC    |
| Gate-Source Charge                                              | Q <sub>gs</sub>                  |                                                                                                                                                          |                                                                                  | -    | -     | 13    |       |
| Gate-Drain Charge                                               | Q <sub>gd</sub>                  |                                                                                                                                                          |                                                                                  | -    | -     | 20    |       |
| Turn-On Delay Time                                              | t <sub>d(on)</sub>               | V <sub>DD</sub> = 300 V, I <sub>D</sub> = 8.0 A<br>R <sub>g</sub> = 9.1 Ω, R <sub>D</sub> = 35.5 Ω, see fig. 10 <sup>b</sup>                             |                                                                                  | -    | 13    | -     | ns    |
| Rise Time                                                       | t <sub>r</sub>                   |                                                                                                                                                          |                                                                                  | -    | 25    | -     |       |
| Turn-Off Delay Time                                             | t <sub>d(off)</sub>              |                                                                                                                                                          |                                                                                  | -    | 30    | -     |       |
| Fall Time                                                       | t <sub>f</sub>                   |                                                                                                                                                          |                                                                                  | -    | 22    | -     |       |
| Gate Input Resistance                                           | R <sub>g</sub>                   | f = 1 MHz, open drain                                                                                                                                    |                                                                                  | 0.5  | -     | 3.2   | Ω     |
| Drain-Source Body Diode Characteristics                         |                                  |                                                                                                                                                          |                                                                                  |      |       |       |       |
| Continuous Source-Drain Diode Current                           | I <sub>S</sub>                   | MOSFET symbol showing the integral reverse p - n junction diode<br> |                                                                                  | -    | -     | 9.2   | A     |
| Pulsed Diode Forward Current <sup>a</sup>                       | I <sub>SM</sub>                  |                                                                                                                                                          |                                                                                  | -    | -     | 37    |       |
| Body Diode Voltage                                              | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 8.0 A, V <sub>GS</sub> = 0 V <sup>b</sup>                                                                       |                                                                                  | -    | -     | 1.5   | V     |
| Body Diode Reverse Recovery Time                                | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = 8.0 A, dI/dt = 100 A/μs <sup>b</sup>                                                                            |                                                                                  | -    | 530   | 800   | ns    |
| Body Diode Reverse Recovery Charge                              | Q <sub>rr</sub>                  |                                                                                                                                                          |                                                                                  | -    | 3.0   | 4.4   | μC    |
| Forward Turn-On Time                                            | t <sub>on</sub>                  | Intrinsic turn-on time is negligible (turn-on is dominated by L <sub>S</sub> and L <sub>D</sub> )                                                        |                                                                                  |      |       |       |       |

**Notes**

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- $C_{oss\text{ eff.}}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DS}$ .

## TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)





Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage



Fig. 7 - Typical Source-Drain Diode Forward Voltage



Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage



Fig. 8 - Maximum Safe Operating Area



Fig. 9 - Maximum Drain Current vs. Case Temperature



Fig. 10a - Switching Time Test Circuit



Fig. 10b - Switching Time Waveforms



Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case



Fig. 12a - Unclamped Inductive Test Circuit



Fig. 12b - Unclamped Inductive Waveforms



Fig. 12c - Maximum Avalanche Energy vs. Drain Current



Fig. 13a - Basic Gate Charge Waveform

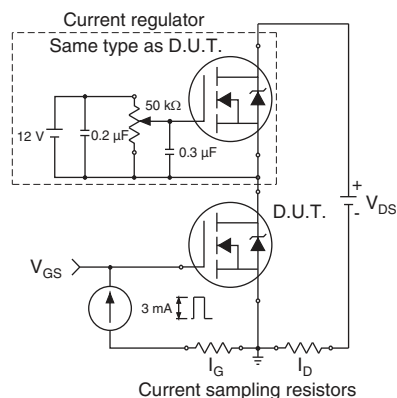


Fig. 13b - Gate Charge Test Circuit

### Peak Diode Recovery dV/dt Test Circuit

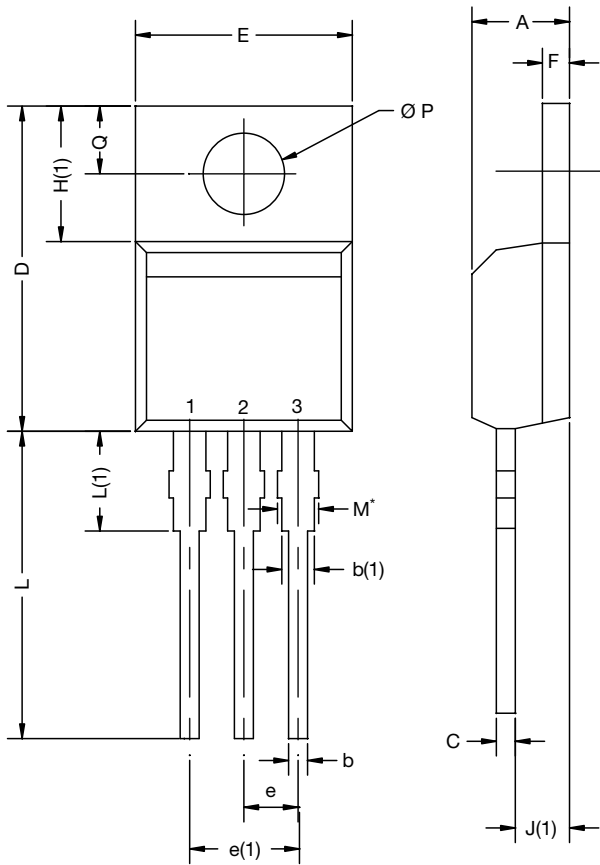


#### Note

a.  $V_{GS} = 5 V$  for logic level devices

Fig. 14 - For N-Channel

## TO-220AB



| DIM.            | MILLIMETERS |       | INCHES |       |
|-----------------|-------------|-------|--------|-------|
|                 | MIN.        | MAX.  | MIN.   | MAX.  |
| A               | 4.24        | 4.65  | 0.167  | 0.183 |
| b               | 0.69        | 1.02  | 0.027  | 0.040 |
| b(1)            | 1.14        | 1.78  | 0.045  | 0.070 |
| c               | 0.36        | 0.61  | 0.014  | 0.024 |
| D               | 14.33       | 15.85 | 0.564  | 0.624 |
| E               | 9.96        | 10.52 | 0.392  | 0.414 |
| e               | 2.41        | 2.67  | 0.095  | 0.105 |
| e(1)            | 4.88        | 5.28  | 0.192  | 0.208 |
| F               | 1.14        | 1.40  | 0.045  | 0.055 |
| H(1)            | 6.10        | 6.71  | 0.240  | 0.264 |
| J(1)            | 2.41        | 2.92  | 0.095  | 0.115 |
| L               | 13.36       | 14.40 | 0.526  | 0.567 |
| L(1)            | 3.33        | 4.04  | 0.131  | 0.159 |
| $\varnothing P$ | 3.53        | 3.94  | 0.139  | 0.155 |
| Q               | 2.54        | 3.00  | 0.100  | 0.118 |

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DWG: 6031

### Note

- M\* = 0.052 inches to 0.064 inches (dimension including protrusion), heatsink hole for HVM

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