# PowerMOS transistor
# Fast Recovery Diode FET

**BUK657-500A**
**BUK657-500B**
**BUK657-500C**

T-39-13

## GENERAL DESCRIPTION

N-channel enhancement mode field-effect power transistor in a plastic envelope.
FREDFET with fast recovery reverse diode, particularly suitable for motor control applications, eg. in full bridge configurations for which faster recovery characteristics simplify design for inductive loads.

## QUICK REFERENCE DATA

| SYMBOL | PARAMETER | MAX. | MAX. | MAX. | UNIT |
|---|---|---|---|---|---|
| | BUK657 | -500A | -500B | -500C | |
| $V_{DS}$ | Drain-source voltage | 500 | 500 | 500 | V |
| $I_D$ | Drain current (DC) | 10 | 9 | 8.5 | A |
| $P_{tot}$ | Total power dissipation | 150 | 150 | 150 | W |
| $R_{DS(ON)}$ | Drain-source on-state resistance | 0.65 | 0.8 | 0.9 | Ω |
| $t_{rr}$ | Diode reverse recovery time | 250 | 250 | 250 | ns |

## MECHANICAL DATA

*Dimensions in mm*

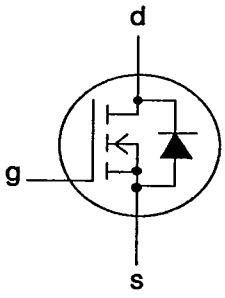
*Net Mass: 2g*

Pinning:

1 = Gate

2 = Drain

3 = Source



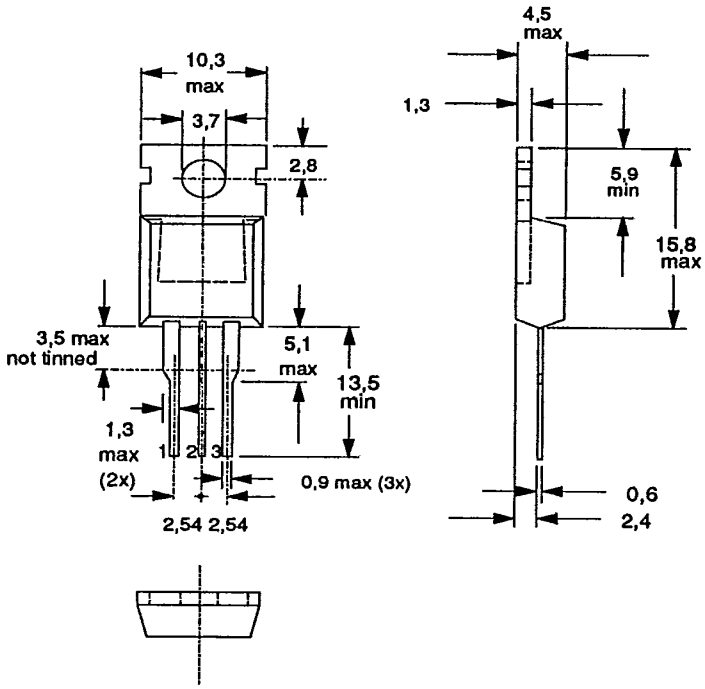




*Fig.1 TO220AB; drain connected to mounting base.*

**Notes**
1. Observe the general handling precautions for electrostatic-discharge sensitive devices (ESDs) to prevent damage to MOS gate oxide.
2. Accessories supplied on request: refer to Mounting instructions for TO220 envelopes.

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## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | | | UNIT |
|---|---|---|---|---|---|---|---|
| $V_{DS}$ | Drain-source voltage | - | - | 500 | | | V |
| $V_{DGR}$ | Drain-gate voltage | $R_{GS}$ = 20 kΩ | - | 500 | | | V |
| $\pm V_{GS}$ | Gate-source voltage | - | - | 30 | | | V |
| | | | | -500A | -500B | -500C | |
| $I_D$ | Drain current (DC) | $T_{mb}$ = 25 °C | - | 10 | 9 | 8.5 | A |
| $I_D$ | Drain current (DC) | $T_{mb}$ = 100 °C | - | 6.3 | 5.7 | 5.4 | A |
| $I_{DM}$ | Drain current (pulse peak value) | $T_{mb}$ = 25 °C | - | 40 | 36 | 34 | A |
| $P_{tot}$ | Total power dissipation | $T_{mb}$ = 25 °C | - | 150 | | | W |
| $T_{stg}$ | Storage temperature | - | - 55 | 150 | | | °C |
| $T_j$ | Junction Temperature | - | - | 150 | | | °C |

## THERMAL RESISTANCES

| | |
|---|---|
| From junction to mounting base | $R_{th\ j\text{-}mb}$ = 0.83 K/W |
| From junction to ambient | $R_{th\ j\text{-}a}$ = 60 K/W |

## STATIC CHARACTERISTICS

$T_{mb}$ = 25 °C unless otherwise specified

| SYMBOL | PARAMETER | CONDITIONS | | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $V_{GS}$ = 0 V; $I_D$ = 0.25 mA | | 500 | - | - | V |
| $V_{GS(TO)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$; $I_D$ = 1 mA | | 2.1 | 3.0 | 4.0 | V |
| $I_{DSS}$ | Zero gate voltage drain current | $V_{DS}$ = 500 V; $V_{GS}$ = 0 V; $T_j$ = 25 °C | | - | 2 | 20 | μA |
| $I_{DSS}$ | Zero gate voltage drain current | $V_{DS}$ = 500 V; $V_{GS}$ = 0 V; $T_j$ =125 °C | | - | 0.1 | 1.0 | mA |
| $I_{GSS}$ | Gate source leakage current | $V_{GS}$ = ±30 V; $V_{DS}$ = 0 V | | - | 10 | 100 | nA |
| $R_{DS(ON)}$ | Drain-source on-state resistance | $V_{GS}$ = 10 V; | BUK657-500A | - | 0.6 | 0.65 | Ω |
| | | $I_D$ = 6.5 A | BUK657-500B | - | 0.7 | 0.8 | Ω |
| | | | BUK657-500C | - | 0.8 | 0.9 | Ω |

## DYNAMIC CHARACTERISTICS

$T_{mb}$ = 25 °C unless otherwise specified

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $g_{fs}$ | Forward transconductance | $V_{DS}$ = 25 V; $I_D$ = 6.5 A | 5.0 | 8.0 | - | S |
| $C_{iss}$ | Input capacitance | $V_{GS}$ = 0 V; $V_{DS}$ = 25 V; f = 1 MHz | - | 1500 | 1800 | pF |
| $C_{oss}$ | Output capacitance | | - | 170 | 270 | pF |
| $C_{rss}$ | Feedback capacitance | | - | 70 | 120 | pF |
| $t_{d\ on}$ | Turn-on delay time | $V_{DD}$ = 30 V; $I_D$ = 2.8 A; | - | 20 | 40 | ns |
| $t_r$ | Turn-on rise time | $V_{GS}$ = 10 V; $R_{GS}$ = 50 Ω; | - | 60 | 90 | ns |
| $t_{d\ off}$ | Turn-off delay time | $R_{gen}$ = 50 Ω | - | 200 | 250 | ns |
| $t_f$ | Turn-off fall time | | - | 75 | 90 | ns |
| $L_d$ | Internal drain inductance | Measured from contact screw on tab to centre of die | - | 3.5 | - | nH |
| $L_d$ | Internal drain inductance | Measured from drain lead 6 mm from package to centre of die | - | 4.5 | - | nH |
| $L_s$ | Internal source inductance | Measured from source lead 6 mm from package to source bond pad | - | 7.5 | - | nH |

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## REVERSE DIODE RATINGS AND CHARACTERISTICS

$T_{mb}$ = 25 °C unless otherwise specified

| SYMBOL | PARAMETER | CONDITIONS | | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|---|
| $I_{DR}$ | Continuous reverse drain current | - | | - | - | 10 | A |
| $I_{DRM}$ | Pulsed reverse drain current | - | | - | - | 40 | A |
| $V_{SD}$ | Diode forward voltage | $I_F$ = 10 A ; | $V_{GS}$ = 0 V | - | 1.1 | 1.5 | V |
| $t_{rr}$ | Reverse recovery time | $I_F$ = 10 A; | $T_j$ = 25 °C | - | 180 | 250 | ns |
| | | $-dI_F/dt$ = | $T_j$ = 125 °C | - | 220 | 300 | ns |
| $Q_{rr}$ | Reverse recovery charge | 100 A/µs; | $T_j$ = 25 °C | - | 0.65 | 1.2 | µC |
| | | $V_{GS}$ = 0 V; | $T_j$ = 125 °C | - | 2.6 | 5.0 | µC |
| $I_{rrm}$ | Reverse recovery current | $V_R$ = 100 V | $T_j$ = 125 °C | - | 15 | - | A |

## AVALANCHE RATING

$T_{mb}$ = 25 °C unless otherwise specified

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $W_{DSS}$ | Drain-source non-repetitive unclamped inductive turn-off energy | $I_D$ = 10 A ; $V_{DD} \leq$ 250 V ; $V_{GS}$ = 10 V ; $R_{GS}$ = 50 Ω | - | - | 500 | mJ |

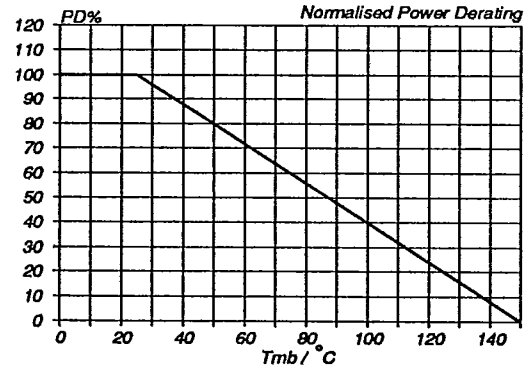


*Fig.2. Normalised power dissipation.*
*PD% = 100·$P_D/P_{D\,25\,°C}$ = f($T_{mb}$)*

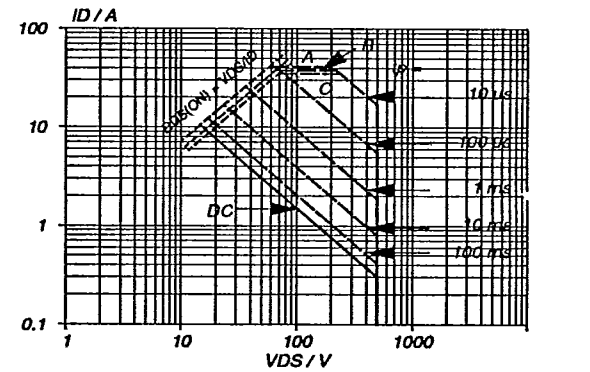


*Fig.4. Safe operating area. $T_{mb}$ = 25 °C*
*$I_D$ & $I_{DM}$ = f($V_{DS}$); $I_{DM}$ single pulse; parameter $t_p$*

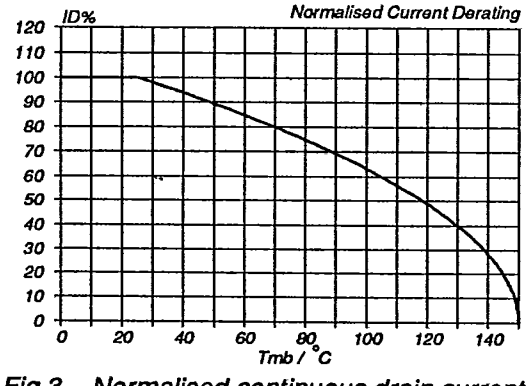


*Fig.3. Normalised continuous drain current.*
*ID% = 100·$I_D/I_{D\,25\,°C}$ = f($T_{mb}$); conditions: $V_{GS} \geq$ 10 V*

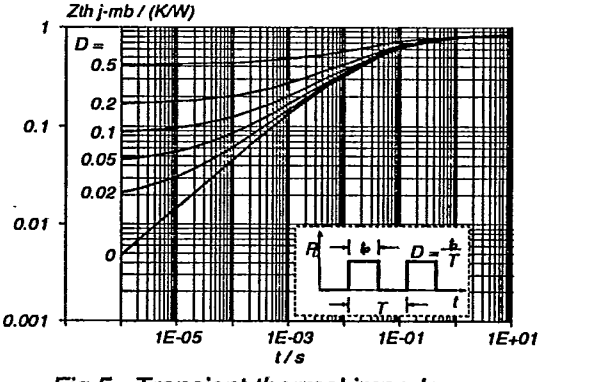


*Fig.5. Transient thermal impedance.*
*$Z_{th\,j\text{-}mb}$ = f(t); parameter D = $t_p/T$*

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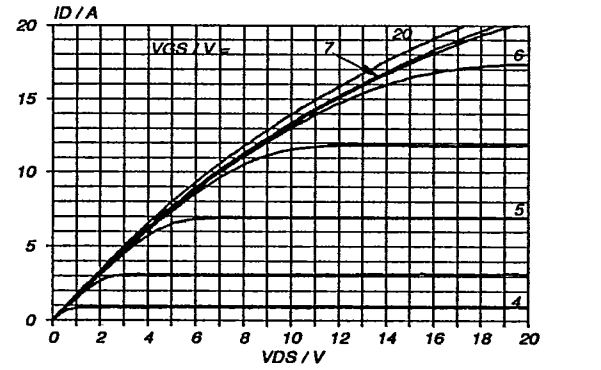


Fig.6.[1] Typical output characteristics, $T_j = 25$ °C. $I_D = f(V_{DS})$; parameter $V_{GS}$

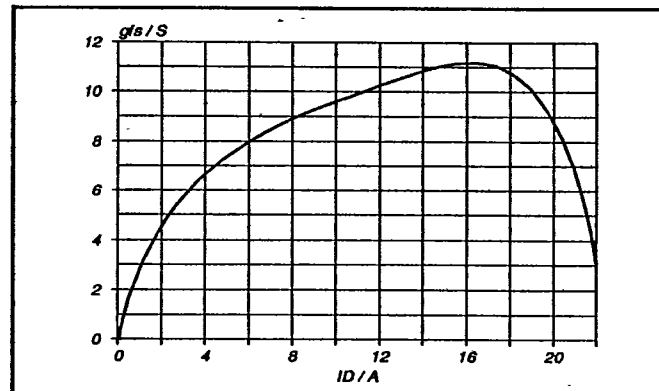


Fig.9. Typical transconductance, $T_j = 25$ °C. $g_{fs} = f(I_D)$; conditions: $V_{DS} = 25$ V

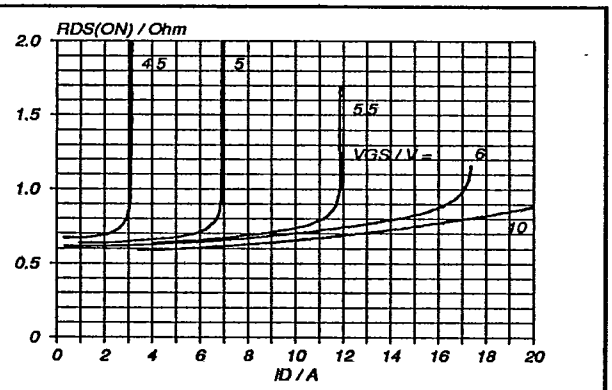


Fig.7. Typical on-state resistance, $T_j = 25$ °C. $R_{DS(ON)} = f(I_D)$; parameter $V_{GS}$

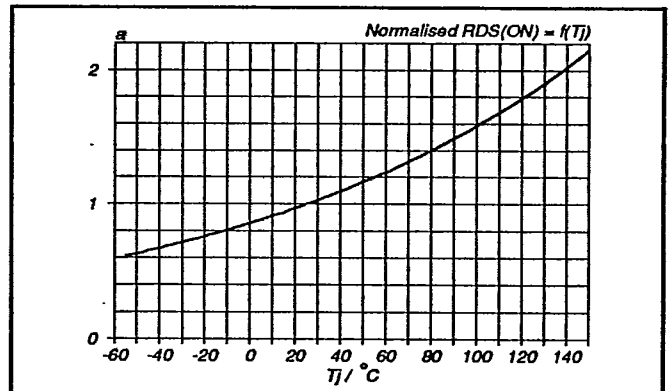


Fig.10. Normalised drain-source on-state resistance. $a = R_{DS(ON)}/R_{DS(ON)25\,°C} = f(T_j)$; $I_D = 6.5$ A; $V_{GS} = 10$ V

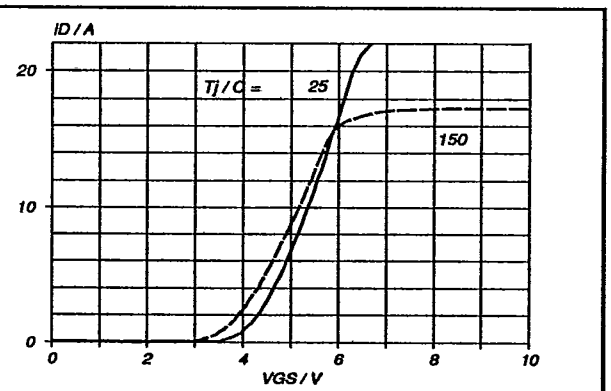


Fig.8. Typical transfer characteristics. $I_D = f(V_{GS})$ ; conditions: $V_{DS} = 25$ V; parameter $T_j$

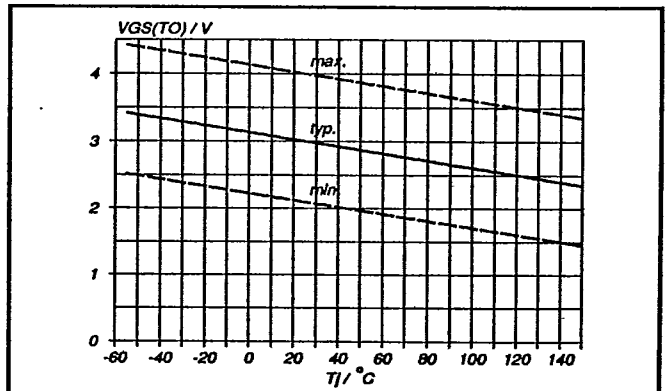


Fig.11. Gate threshold voltage. $V_{GS(TO)} = f(T_j)$; conditions: $I_D = 1$ mA; $V_{DS} = V_{GS}$

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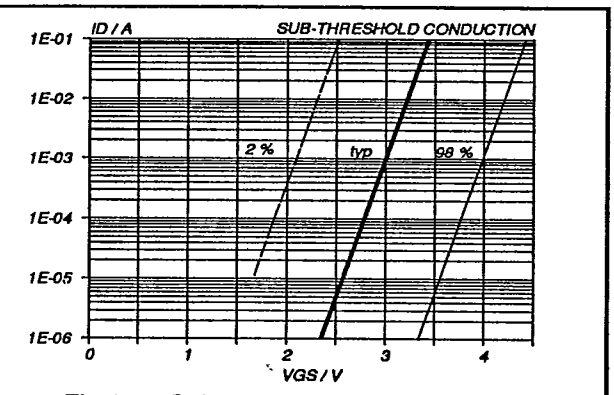


*Fig.12. Sub-threshold drain current.*
$I_D = f(V_{GS})$; *conditions:* $T_j = 25$ °C; $V_{DS} = V_{GS}$

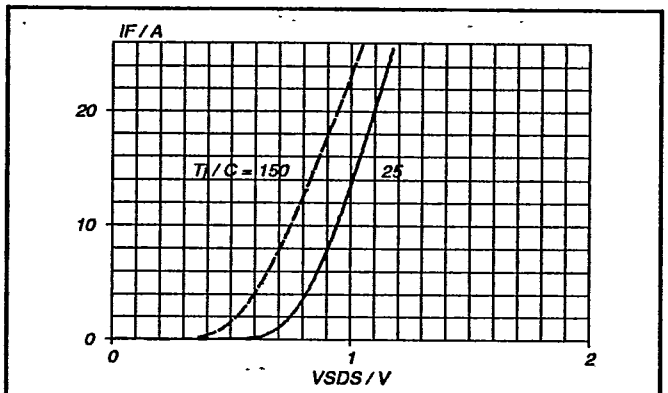


*Fig.15. Typical reverse diode current.*
$I_F = f(V_{SDS})$; *conditions:* $V_{GS} = 0$ V; *parameter* $T_j$

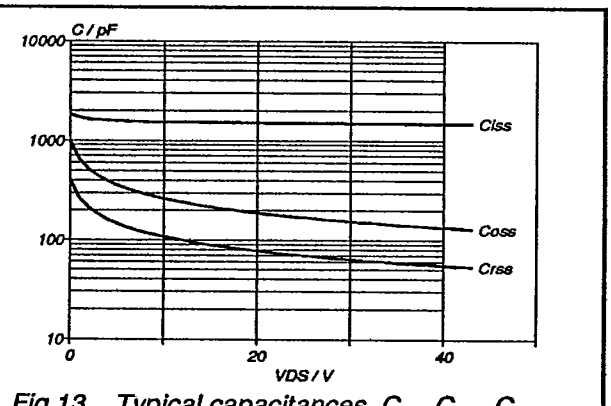


*Fig.13. Typical capacitances,* $C_{iss}$, $C_{oss}$, $C_{rss}$.
$C = f(V_{DS})$; *conditions:* $V_{GS} = 0$ V; $f = 1$ MHz

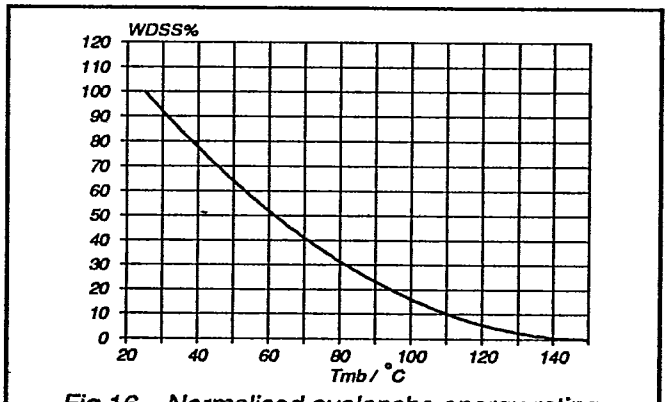


*Fig.16. Normalised avalanche energy rating.*
$W_{DSS}\% = f(T_{mb})$; *conditions:* $I_D = 10$ A

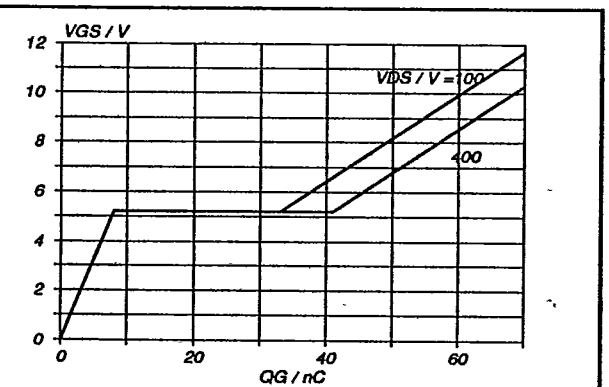


*Fig.14. Typical turn-on gate-charge characteristics.*
$V_{GS} = f(Q_G)$; *conditions:* $I_D = 10$ A; *parameter* $V_{DS}$

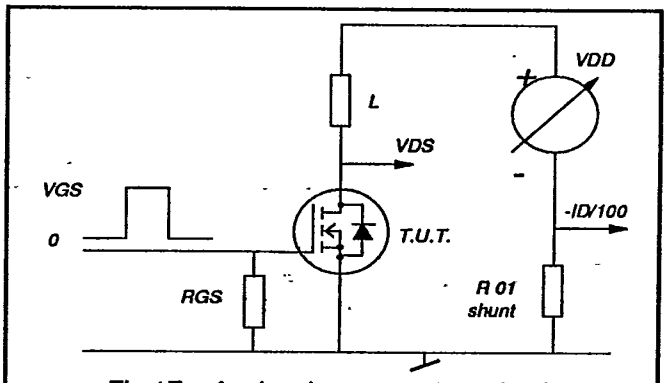


*Fig.17. Avalanche energy test circuit.*
$W_{DSS} = 0.5 \cdot LI_D^2 \cdot BV_{DSS}/(BV_{DSS} - V_{DD})$