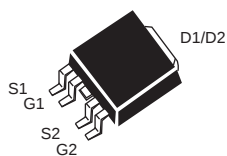


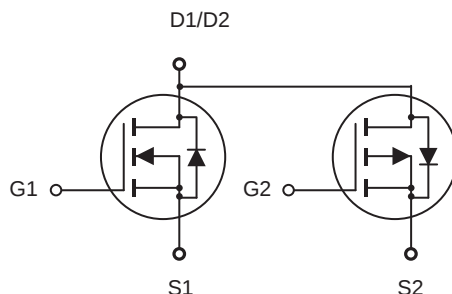
## Dual Enhancement Mode Field Effect Transistor (N and P Channel)

### FEATURES

- 40V , 14A ,  $R_{DS(ON)} = 32m\Omega$  @  $V_{GS} = 10V$ .  
 $R_{DS(ON)} = 46m\Omega$  @  $V_{GS} = 4.5V$ .
- -40V , -12A ,  $R_{DS(ON)} = 45m\Omega$  @  $V_{GS} = 10V$ .  
 $R_{DS(ON)} = 65m\Omega$  @  $V_{GS} = 4.5V$ .
- Super high dense cell design for extremely low  $R_{DS(ON)}$ .
- High power and current handling capability.
- Lead free product is acquired.
- TO-252-4L package.



CEU SERIES  
TO-252-4L



### ABSOLUTE MAXIMUM RATINGS $T_C = 25^\circ\text{C}$ unless otherwise noted

| Parameter                                                                                 | Symbol         | N-Channel  | P-Channel | Units               |
|-------------------------------------------------------------------------------------------|----------------|------------|-----------|---------------------|
| Drain-Source Voltage                                                                      | $V_{DS}$       | 40         | 40        | V                   |
| Gate-Source Voltage                                                                       | $V_{GS}$       | $\pm 20$   | $\pm 20$  | V                   |
| Drain Current-Continuous <sup>e</sup>                                                     | $I_D^e$        | 14         | -12       | A                   |
| Drain Current-Pulsed <sup>a</sup>                                                         | $I_{DM}$       | 56         | -48       | A                   |
| Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$<br>- Derate above $25^\circ\text{C}$ | $P_D$          | 10.4       |           | W                   |
|                                                                                           |                | 0.08       |           | W/ $^\circ\text{C}$ |
| Operating and Store Temperature Range                                                     | $T_J, T_{stg}$ | -55 to 150 |           | $^\circ\text{C}$    |

### Thermal Characteristics

| Parameter                               | Symbol          | Limit | Units              |
|-----------------------------------------|-----------------|-------|--------------------|
| Thermal Resistance, Junction-to-Case    | $R_{\theta JC}$ | 12    | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction-to-Ambient | $R_{\theta JA}$ | 50    | $^\circ\text{C/W}$ |

## N-Channel Electrical Characteristics T<sub>A</sub> = 25°C unless otherwise noted

| Parameter                                                                                                                                                                                                                                                                                                                                                                                              | Symbol       | Test Condition                                            | Min | Typ  | Max  | Units      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------------------------------------------|-----|------|------|------------|
| Off Characteristics                                                                                                                                                                                                                                                                                                                                                                                    |              |                                                           |     |      |      |            |
| Drain-Source Breakdown Voltage                                                                                                                                                                                                                                                                                                                                                                         | $BV_{DSS}$   | $V_{GS} = 0V, I_D = 250\mu A$                             | 40  |      |      | V          |
| Zero Gate Voltage Drain Current                                                                                                                                                                                                                                                                                                                                                                        | $I_{DSS}$    | $V_{DS} = 40V, V_{GS} = 0V$                               |     |      | 1    | $\mu A$    |
| Gate Body Leakage Current, Forward                                                                                                                                                                                                                                                                                                                                                                     | $I_{GSSF}$   | $V_{GS} = 20V, V_{DS} = 0V$                               |     |      | 100  | nA         |
| Gate Body Leakage Current, Reverse                                                                                                                                                                                                                                                                                                                                                                     | $I_{GSSR}$   | $V_{GS} = -20V, V_{DS} = 0V$                              |     |      | -100 | nA         |
| On Characteristics                                                                                                                                                                                                                                                                                                                                                                                     |              |                                                           |     |      |      |            |
| Gate Threshold Voltage                                                                                                                                                                                                                                                                                                                                                                                 | $V_{GS(th)}$ | $V_{GS} = V_{DS}, I_D = 250\mu A$                         | 1   |      | 3    | V          |
| Static Drain-Source                                                                                                                                                                                                                                                                                                                                                                                    | $R_{DS(on)}$ | $V_{GS} = 10V, I_D = 7A$                                  |     | 25   | 32   | m $\Omega$ |
| On-Resistance                                                                                                                                                                                                                                                                                                                                                                                          |              | $V_{GS} = 4.5V, I_D = 5A$                                 |     | 35   | 46   | m $\Omega$ |
| Dynamic Characteristics <sup>d</sup>                                                                                                                                                                                                                                                                                                                                                                   |              |                                                           |     |      |      |            |
| Forward Transconductance                                                                                                                                                                                                                                                                                                                                                                               | $g_{FS}^c$   | $V_{DS} = 10V, I_D = 7A$                                  |     | 3    |      | S          |
| Input Capacitance                                                                                                                                                                                                                                                                                                                                                                                      | $C_{iss}$    | $V_{DS} = 20V, V_{GS} = 0V, f = 1.0 MHz$                  |     | 1050 |      | pF         |
| Output Capacitance                                                                                                                                                                                                                                                                                                                                                                                     | $C_{oss}$    |                                                           |     | 155  |      | pF         |
| Reverse Transfer Capacitance                                                                                                                                                                                                                                                                                                                                                                           | $C_{rss}$    |                                                           |     | 95   |      | pF         |
| Switching Characteristics <sup>d</sup>                                                                                                                                                                                                                                                                                                                                                                 |              |                                                           |     |      |      |            |
| Turn-On Delay Time                                                                                                                                                                                                                                                                                                                                                                                     | $t_{d(on)}$  | $V_{DD} = 20V, I_D = 6A, V_{GS} = 10V, R_{GEN} = 3\Omega$ |     | 14   | 30   | ns         |
| Turn-On Rise Time                                                                                                                                                                                                                                                                                                                                                                                      | $t_r$        |                                                           |     | 10   | 20   | ns         |
| Turn-Off Delay Time                                                                                                                                                                                                                                                                                                                                                                                    | $t_{d(off)}$ |                                                           |     | 17   | 35   | ns         |
| Turn-Off Fall Time                                                                                                                                                                                                                                                                                                                                                                                     | $t_f$        |                                                           |     | 18   | 35   | ns         |
| Total Gate Charge                                                                                                                                                                                                                                                                                                                                                                                      | $Q_g$        | $V_{DS} = 20V, I_D = 6A, V_{GS} = 10V$                    |     | 20.5 | 27   | nC         |
| Gate-Source Charge                                                                                                                                                                                                                                                                                                                                                                                     | $Q_{gs}$     |                                                           |     | 3.5  |      | nC         |
| Gate-Drain Charge                                                                                                                                                                                                                                                                                                                                                                                      | $Q_{gd}$     |                                                           |     | 4.0  |      | nC         |
| Drain-Source Diode Characteristics and Maximum Ratings                                                                                                                                                                                                                                                                                                                                                 |              |                                                           |     |      |      |            |
| Drain-Source Diode Forward Current <sup>b</sup>                                                                                                                                                                                                                                                                                                                                                        | $I_S$        |                                                           |     |      | 8    | A          |
| Drain-Source Diode Forward Voltage <sup>c</sup>                                                                                                                                                                                                                                                                                                                                                        | $V_{SD}$     | $V_{GS} = 0V, I_S = 1.0A$                                 |     |      | 1.2  | V          |
| Notes :<br>a.Repetitive Rating : Pulse width limited by maximum junction temperature.<br>b.Surface Mounted on FR4 Board, $t \leq 10$ sec.<br>c.Pulse Test : Pulse Width $\leq 300\mu s$ , Duty Cycle $\leq 2\%$ .<br>d.Guaranteed by design, not subject to production testing.<br>e.Calculated continuous current based on the maximum allowable junction temperature. Package limitation current=8A. |              |                                                           |     |      |      |            |

## P-Channel Electrical Characteristics $T_A = 25^\circ\text{C}$ unless otherwise noted

| Parameter                                                                                                           | Symbol       | Test Condition                                               | Min | Typ  | Max  | Units     |
|---------------------------------------------------------------------------------------------------------------------|--------------|--------------------------------------------------------------|-----|------|------|-----------|
| Off Characteristics                                                                                                 |              |                                                              |     |      |      |           |
| Drain-Source Breakdown Voltage                                                                                      | $BV_{DSS}$   | $V_{GS} = 0V, I_D = -250\mu A$                               | -40 |      |      | V         |
| Zero Gate Voltage Drain Current                                                                                     | $I_{DSS}$    | $V_{DS} = -40V, V_{GS} = 0V$                                 |     |      | -1   | $\mu A$   |
| Gate Body Leakage Current, Forward                                                                                  | $I_{GSSF}$   | $V_{GS} = 20V, V_{DS} = 0V$                                  |     |      | 100  | nA        |
| Gate Body Leakage Current, Reverse                                                                                  | $I_{GSSR}$   | $V_{GS} = -20V, V_{DS} = 0V$                                 |     |      | -100 | nA        |
| On Characteristics                                                                                                  |              |                                                              |     |      |      |           |
| Gate Threshold Voltage                                                                                              | $V_{GS(th)}$ | $V_{GS} = V_{DS}, I_D = -250\mu A$                           | -1  |      | -3   | V         |
| Static Drain-Source                                                                                                 | $R_{DS(on)}$ | $V_{GS} = -10V, I_D = -5A$                                   |     | 37   | 45   | $m\Omega$ |
| On-Resistance                                                                                                       |              | $V_{GS} = -4.5V, I_D = -3A$                                  |     | 50   | 65   | $m\Omega$ |
| Dynamic Characteristics <sup>d</sup>                                                                                |              |                                                              |     |      |      |           |
| Forward Transconductance <sup>c</sup>                                                                               | $g_{FS}$     | $V_{DS} = -10V, I_D = -5A$                                   |     | 3    |      | S         |
| Input Capacitance                                                                                                   | $C_{iss}$    | $V_{DS} = -20V, V_{GS} = 0V, f = 1.0\text{ MHz}$             |     | 1120 |      | pF        |
| Output Capacitance                                                                                                  | $C_{oss}$    |                                                              |     | 210  |      | pF        |
| Reverse Transfer Capacitance                                                                                        | $C_{rss}$    |                                                              |     | 125  |      | pF        |
| Switching Characteristics <sup>d</sup>                                                                              |              |                                                              |     |      |      |           |
| Turn-On Delay Time                                                                                                  | $t_{d(on)}$  | $V_{DD} = -20V, I_D = -5A, V_{GS} = -10V, R_{GEN} = 3\Omega$ |     | 13   | 26   | ns        |
| Turn-On Rise Time                                                                                                   | $t_r$        |                                                              |     | 6    | 12   | ns        |
| Turn-Off Delay Time                                                                                                 | $t_{d(off)}$ |                                                              |     | 38   | 64   | ns        |
| Turn-On Fall Time                                                                                                   | $t_f$        |                                                              |     | 7    | 14   | ns        |
| Total Gate Charge                                                                                                   | $Q_g$        | $V_{DS} = -20V, I_D = -5A, V_{GS} = -10V$                    |     | 19.2 | 25.3 | nC        |
| Gate-Source Charge                                                                                                  | $Q_{gs}$     |                                                              |     | 3    |      | nC        |
| Gate-Drain Charge                                                                                                   | $Q_{gd}$     |                                                              |     | 4    |      | nC        |
| Drain-Source Diode Characteristics and Maximum Ratings                                                              |              |                                                              |     |      |      |           |
| Drain-Source Diode Forward Current <sup>b</sup>                                                                     | $I_S$        |                                                              |     |      | -8   | A         |
| Drain-Source Diode Forward Voltage <sup>c</sup>                                                                     | $V_{SD}$     | $V_{GS} = 0V, I_S = -1.0A$                                   |     |      | -1.2 | V         |
| Notes :                                                                                                             |              |                                                              |     |      |      |           |
| a.Repetitive Rating : Pulse width limited by maximum junction temperature.                                          |              |                                                              |     |      |      |           |
| b.Surface Mounted on FR4 Board, $t \leq 10\text{ sec}$ .                                                            |              |                                                              |     |      |      |           |
| c.Pulse Test : Pulse Width $\leq 300\mu s$ , Duty Cycle $\leq 2\%$ .                                                |              |                                                              |     |      |      |           |
| d.Guaranteed by design, not subject to production testing.                                                          |              |                                                              |     |      |      |           |
| e.Calculated continuous current based on the maximum allowable junction temperature. Package limitation current=8A. |              |                                                              |     |      |      |           |

## N-CHANNEL

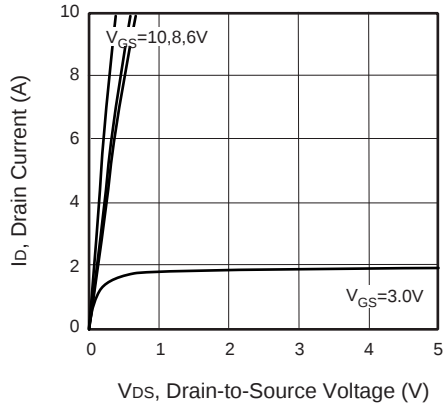


Figure 1. Output Characteristics

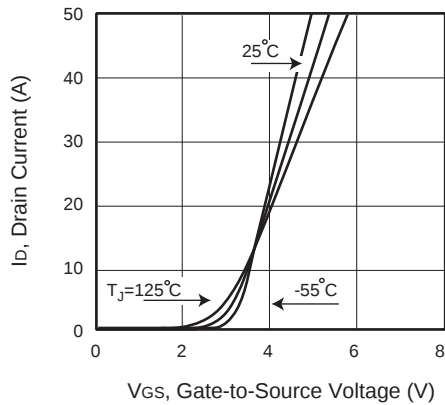


Figure 2. Transfer Characteristics

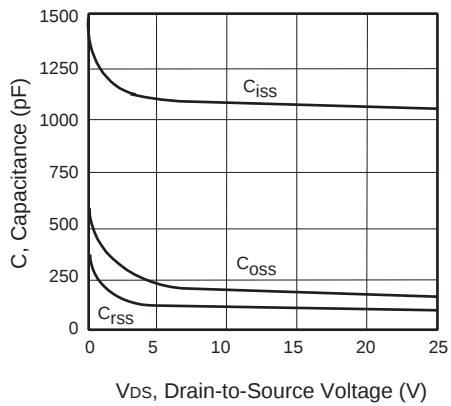


Figure 3. Capacitance

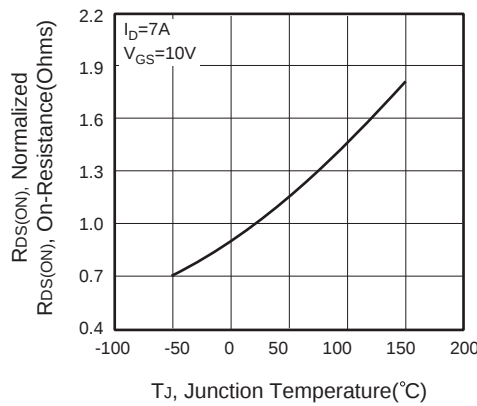


Figure 4. On-Resistance Variation with Temperature

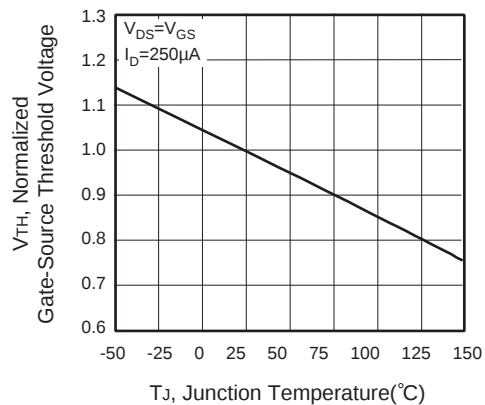


Figure 5. Gate Threshold Variation with Temperature

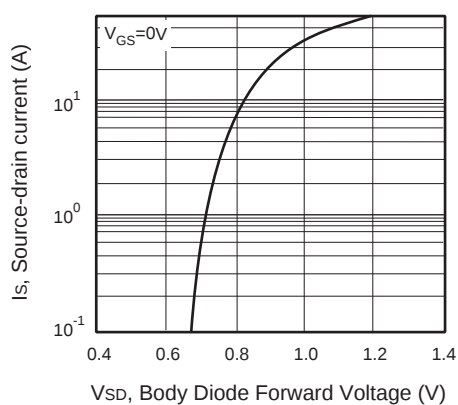


Figure 6. Body Diode Forward Voltage Variation with Source Current

## P-CHANNEL

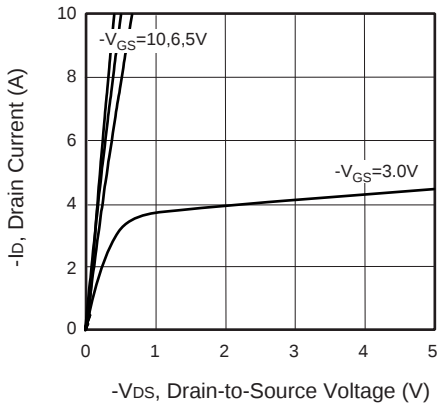


Figure 7. Output Characteristics

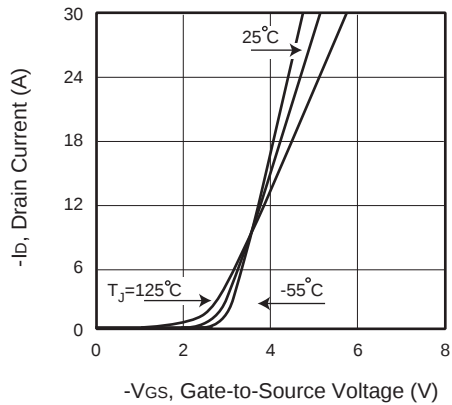


Figure 8. Transfer Characteristics

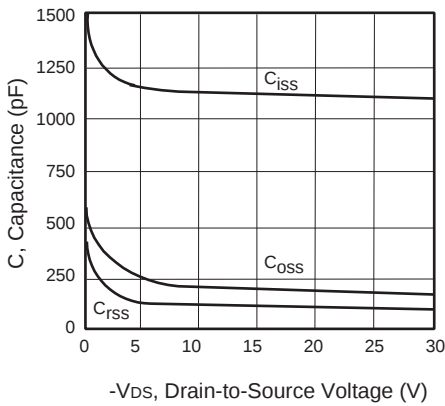


Figure 9. Capacitance

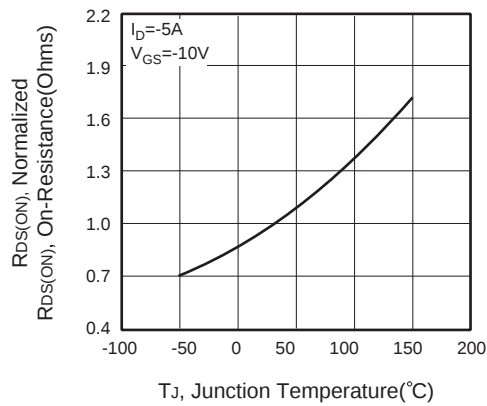


Figure 10. On-Resistance Variation with Temperature

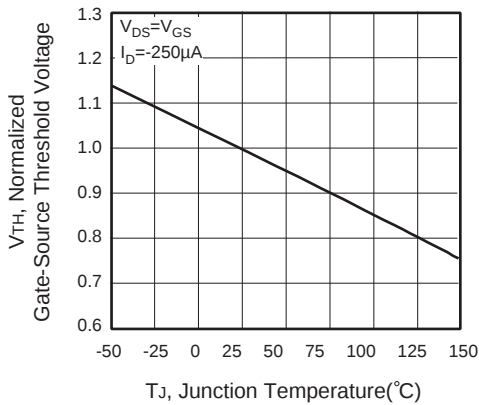


Figure 11. Gate Threshold Variation with Temperature

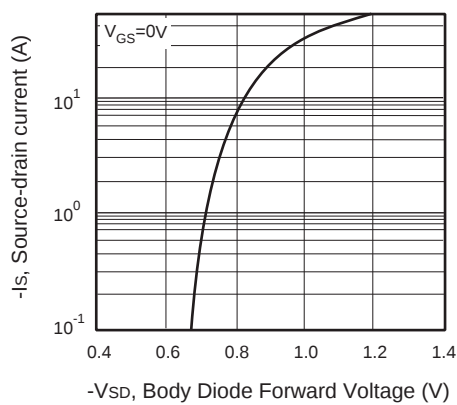


Figure 12. Body Diode Forward Voltage Variation with Source Current

## N-CHANNEL

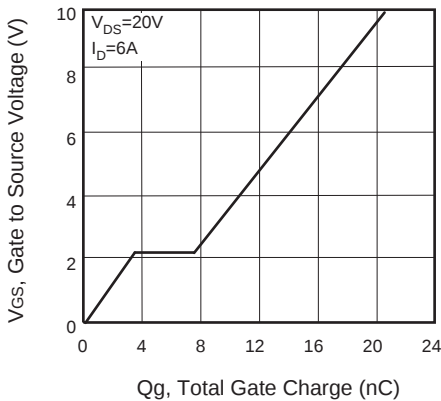


Figure 13. Gate Charge

## P-CHANNEL

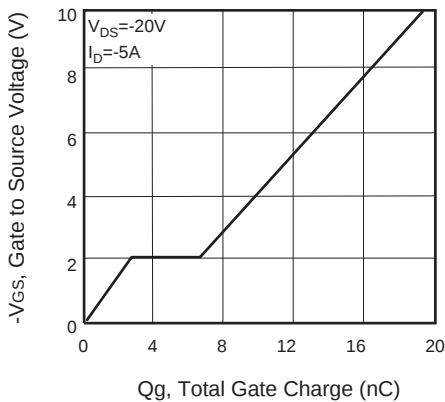


Figure 15. Gate Charge

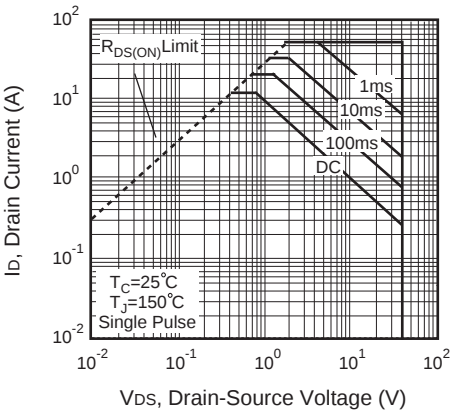


Figure 14. Maximum Safe Operating Area

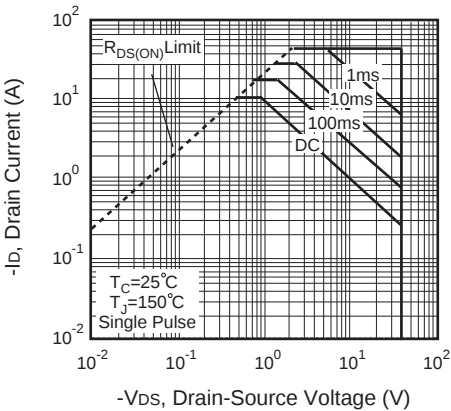


Figure 16. Maximum Safe Operating Area

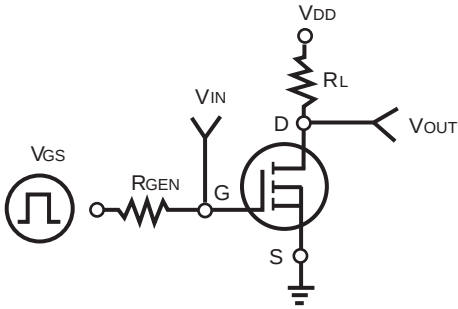


Figure 17. Switching Test Circuit

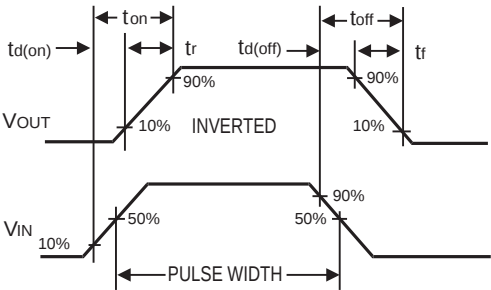


Figure 18. Switching Waveforms

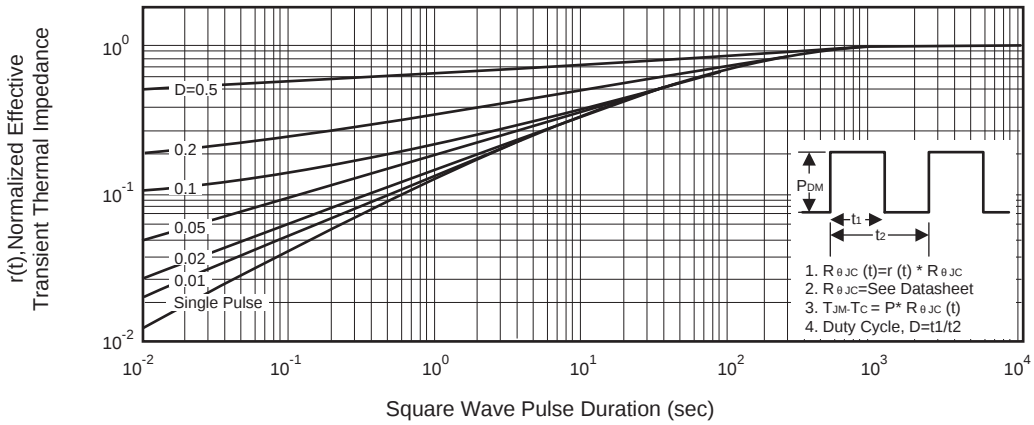


Figure 19. Normalized Thermal Transient Impedance Curve