

## CEB4060AL-VB Datasheet

### N-Channel 60 V (D-S) MOSFET

#### PRODUCT SUMMARY

$V_{DS}$ (V)	$R_{DS(on)}$ ( $\Omega$ )	$I_D$ (A) <sup>a, e</sup>	$Q_g$ (Max)
60	0.032 at $V_{GS} = 10$ V	50	66 nC
	0.035 at $V_{GS} = 4.5$ V	40	

#### FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- Surface Mount
- Available in Tape and Reel
- Dynamic  $dV/dt$  Rating
- Logic-Level Gate Drive
- Fast Switching
- Compliant to RoHS Directive 2002/95/EC



**RoHS\***  
 COMPLIANT  
 HALOGEN  
**FREE**  
 Available



N-Channel MOSFET

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

PARAMETER				SYMBOL	LIMIT	UNIT
Drain-Source Voltage				$V_{DS}$	60	V
Gate-Source Voltage				$V_{GS}$	$\pm 10$	
Continuous Drain Current <sup>f</sup>	$V_{GS}$ at 10 V	$T_C = 25\text{ }^{\circ}\text{C}$		$I_D$	50	A
Continuous Drain Current		$T_C = 100\text{ }^{\circ}\text{C}$			36	
Pulsed Drain Current <sup>a</sup>				$I_{DM}$	200	
Linear Derating Factor					1.0	W/ $^{\circ}\text{C}$
Linear Derating Factor (PCB Mount) <sup>e</sup>					0.025	
Single Pulse Avalanche Energy <sup>b</sup>				$E_{AS}$	400	mJ
Maximum Power Dissipation	$T_C = 25\text{ }^{\circ}\text{C}$			$P_D$	150	W
Maximum Power Dissipation (PCB Mount) <sup>e</sup>	$T_A = 25\text{ }^{\circ}\text{C}$				3.7	
Peak Diode Recovery $dV/dt$ <sup>c</sup>				$dV/dt$	4.5	V/ns
Operating Junction and Storage Temperature Range				$T_J, T_{stg}$	- 55 to + 175	$^{\circ}\text{C}$
Soldering Recommendations (Peak Temperature) <sup>d</sup>	for 10 s				300 <sup>d</sup>	

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- $V_{DD} = 25$  V, starting  $T_J = 25^\circ\text{C}$ ,  $L = 179$   $\mu\text{H}$ ,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 51$  A (see fig. 12).
- $I_{SD} \leq 51$  A,  $dI/dt \leq 250$  A/ $\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 175^\circ\text{C}$ .
- 1.6 mm from case.
- When mounted on 1" square PCB (FR-4 or G-10 material).
- Current limited by the package, (die current = 51 A).

**THERMAL RESISTANCE RATINGS**

PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	$R_{thJA}$	-	62	°C/W
Maximum Junction-to-Ambient (PCB Mount) <sup>a</sup>	$R_{thJA}$	-	40	
Maximum Junction-to-Case (Drain)	$R_{thJC}$	-	1.0	

**Note**

a. When mounted on 1" square PCB (FR-4 or G-10 material).

**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
Static							
Drain-Source Breakdown Voltage	$V_{DS}$	$V_{GS} = 0, I_D = 250\text{ }\mu\text{A}$		60	-	-	V
$V_{DS}$ Temperature Coefficient	$\Delta V_{DS}/T_J$	Reference to 25 °C, $I_D = 1\text{ mA}$		-	0.070	-	V/°C
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$		1.0	-	3.0	V
Gate-Source Leakage	$I_{GSS}$	$V_{GS} = \pm 10\text{ V}$		-	-	$\pm 100$	nA
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$		-	-	25	$\mu\text{A}$
		$V_{DS} = 48\text{ V}, V_{GS} = 0\text{ V}, T_J = 150\text{ }^{\circ}\text{C}$		-	-	250	
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}$	$I_D = 21\text{ A}^b$	-	0.032	-	$\Omega$
		$V_{GS} = 4.5\text{ V}$	$I_D = 15\text{ A}^b$	-	0.035	-	
Forward Transconductance	$g_{fs}$	$V_{DS} = 25\text{ V}, I_D = 21\text{ A}^b$		23	-	-	S
Dynamic							
Input Capacitance	$C_{iss}$	$V_{GS} = 0\text{ V},$ $V_{DS} = 25\text{ V},$ $f = 1.0\text{ MHz, see fig. 5}$		-	3000	-	pF
Output Capacitance	$C_{oss}$			-	1000	-	
Reverse Transfer Capacitance	$C_{rss}$			-	200	-	
Total Gate Charge	$Q_g$	$V_{GS} = 5.0\text{ V}$	$I_D = 51\text{ A}, V_{DS} = 48\text{ V},$ see fig. 6 and 13 <sup>b</sup>	-	60	-	nC
Gate-Source Charge	$Q_{gs}$			-	10	-	
Gate-Drain Charge	$Q_{gd}$			-	40	-	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = 30\text{ V}, I_D = 51\text{ A},$ $R_g = 4.6\text{ }\Omega, R_D = 0.56\text{ }\Omega,$ see fig. 10 <sup>b</sup>		-	17	-	ns
Rise Time	$t_r$			-	230	-	
Turn-Off Delay Time	$t_{d(off)}$			-	42	-	
Fall Time	$t_f$			-	110	-	
Internal Drain Inductance	$L_D$	Between lead, 6 mm (0.25") from package and center of die contact		-	4.5	-	nH
Internal Source Inductance	$L_S$			-	7.5	-	
Drain-Source Body Diode Characteristics							
Continuous Source-Drain Diode Current	$I_S$	MOSFET symbol showing the integral reverse p - n junction diode		-	-	50 <sup>c</sup>	A
Pulsed Diode Forward Current <sup>a</sup>	$I_{SM}$			-	-	200	
Body Diode Voltage	$V_{SD}$	$T_J = 25\text{ }^{\circ}\text{C}, I_S = 51\text{ A}, V_{GS} = 0\text{ V}^b$		-	-	2.5	V
Body Diode Reverse Recovery Time	$t_{rr}$	$T_J = 25\text{ }^{\circ}\text{C}, I_F = 51\text{ A}, dI/dt = 100\text{ A}/\mu\text{s}^b$		-	130	180	ns
Body Diode Reverse Recovery Charge	$Q_{rr}$			-	0.84	1.3	$\mu\text{C}$
Forward Turn-On Time	$t_{on}$	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )					

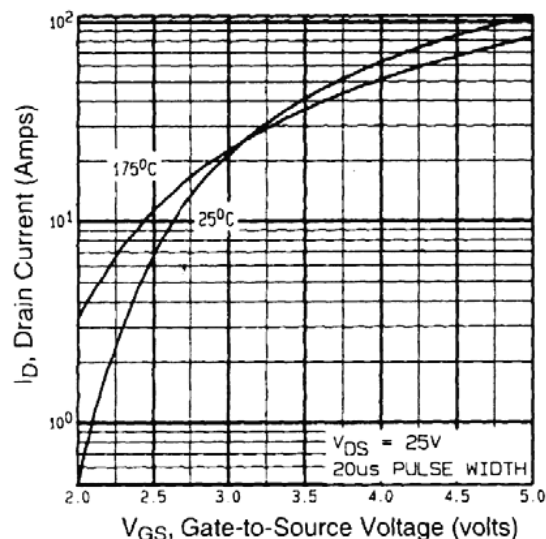
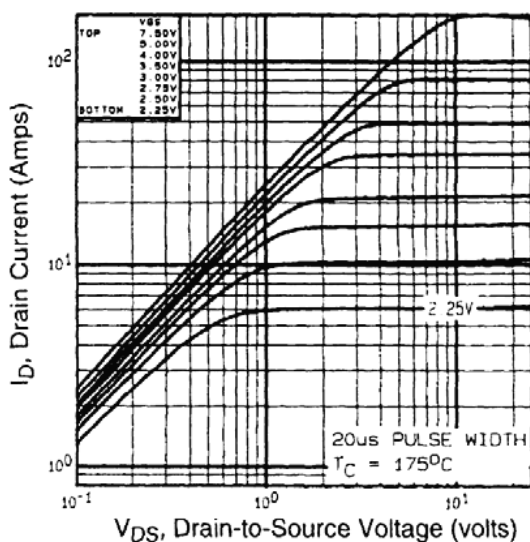
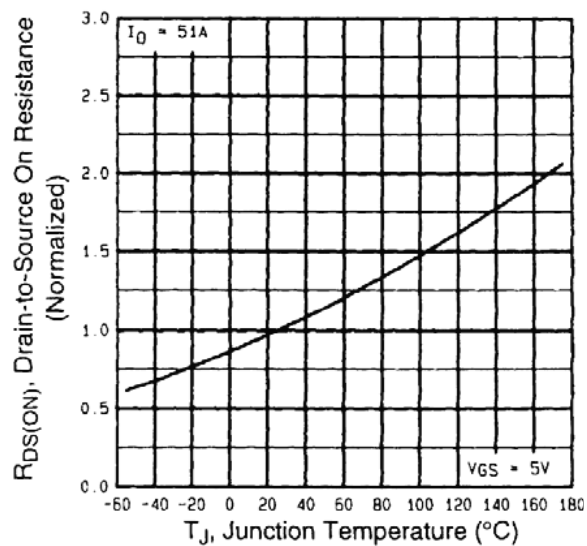
**Notes**

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).

b. Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .

c. Current limited by the package, (Die Current = 51 A).

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

**Fig. 1 - Typical Output Characteristics,  $T_C = 25\text{ }^{\circ}\text{C}$** 

**Fig. 3 - Typical Transfer Characteristics**

**Fig. 2 - Typical Output Characteristics,  $T_C = 150\text{ }^{\circ}\text{C}$** 

**Fig. 4 - Normalized On-Resistance vs. Temperature**

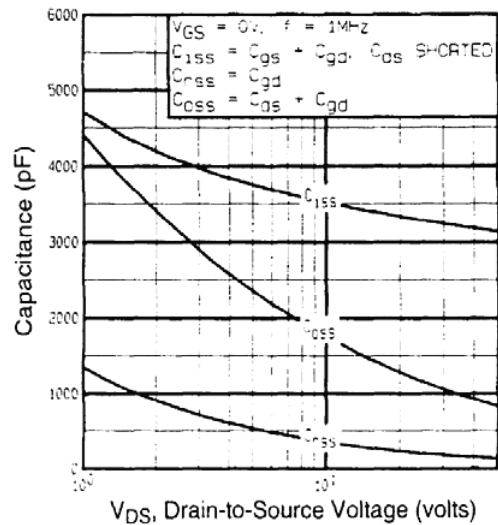


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

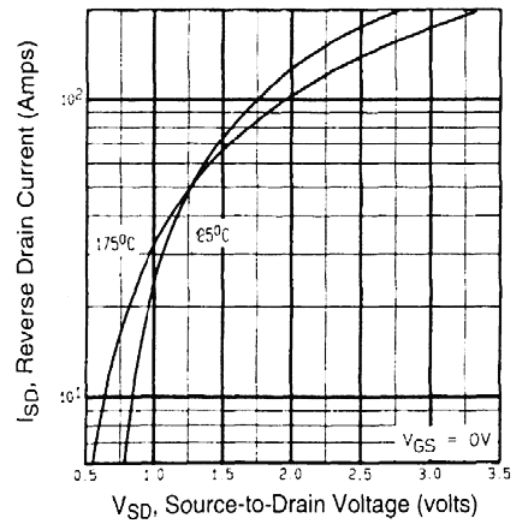


Fig. 7 - Typical Source-Drain Diode Forward Voltage

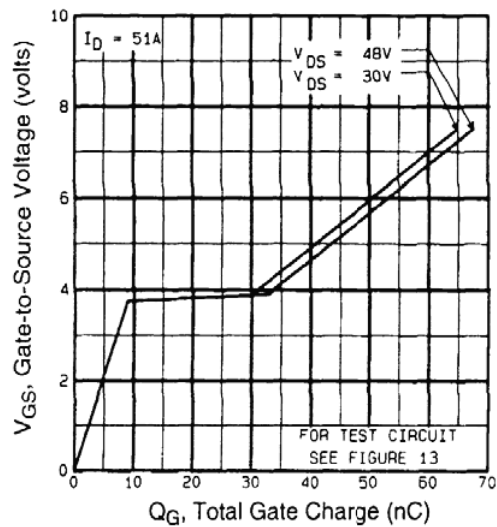


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

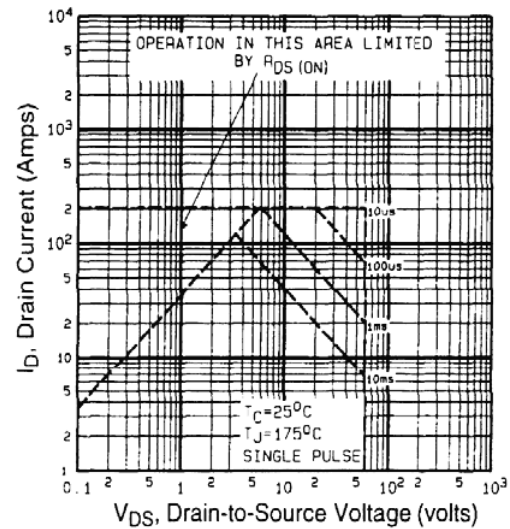


Fig. 8 - Maximum Safe Operating Area

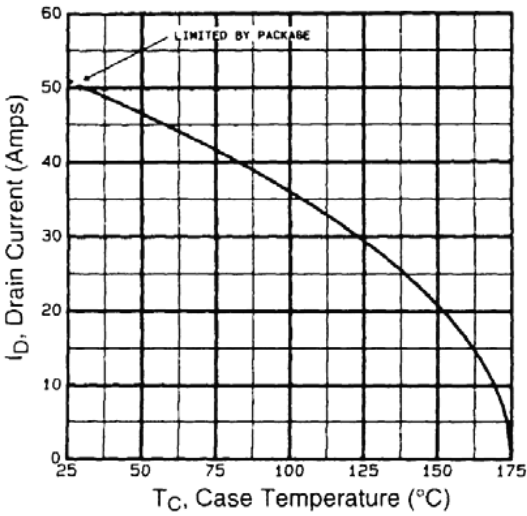


Fig. 9 - Maximum Drain Current vs. Case Temperature

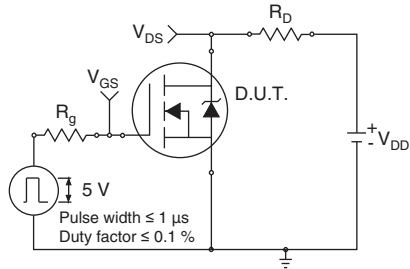


Fig. 10a - Switching Time Test Circuit

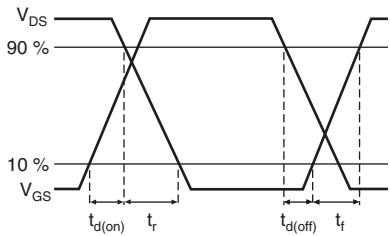


Fig. 10b - Switching Time Waveforms

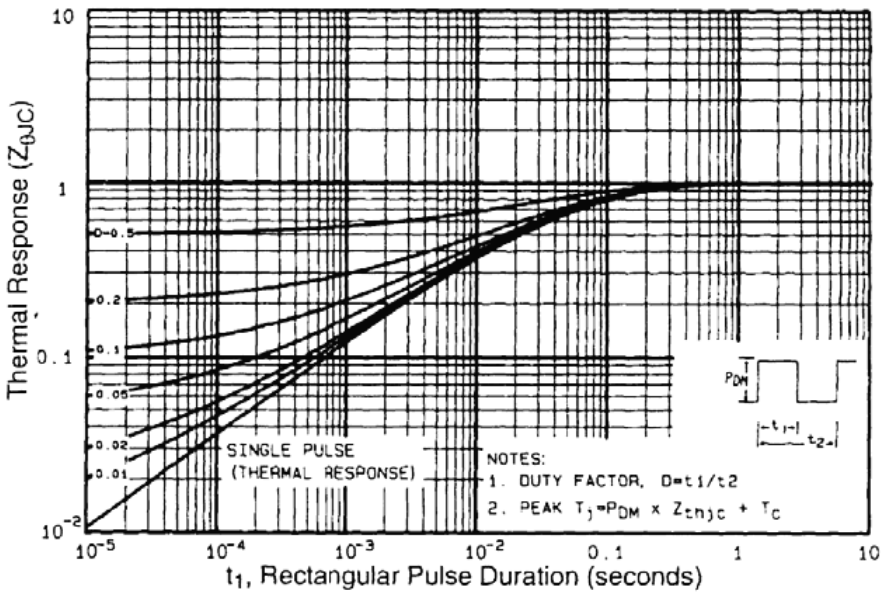


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case



Fig. 12a - Unclamped Inductive Test Circuit



Fig. 12b - Unclamped Inductive Waveforms



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

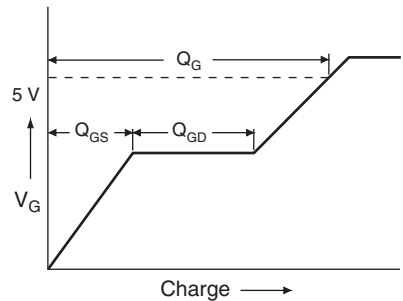
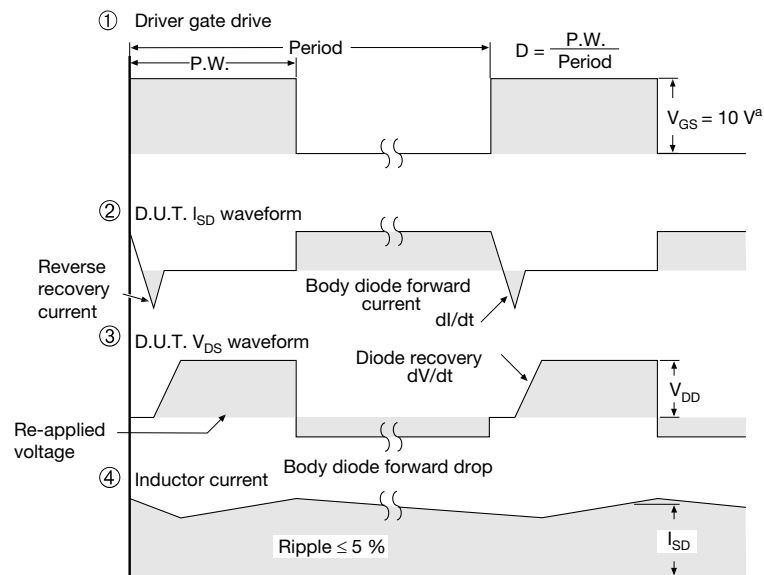
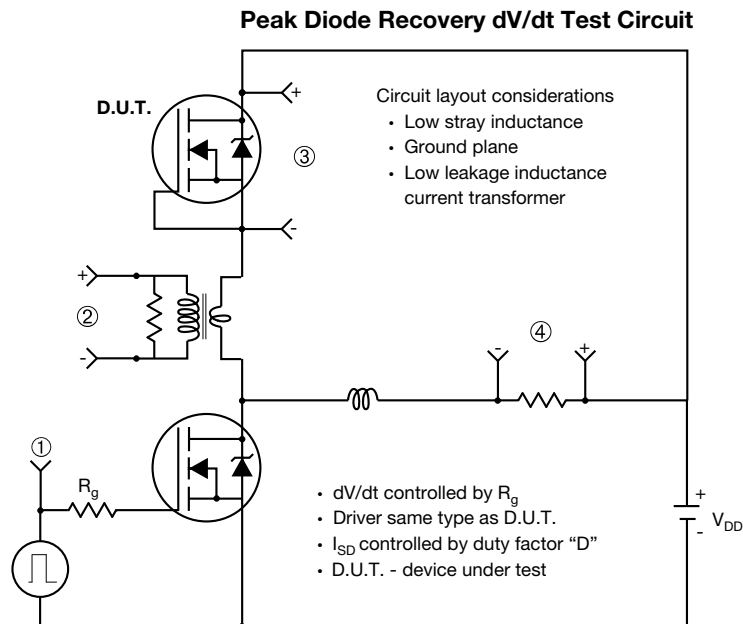


Fig. 13a - Basic Gate Charge Waveform



Fig. 13b - Gate Charge Test Circuit

**Note**

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

**Fig. 14 - For N-Channel**

**RECOMMENDED MINIMUM PADS FOR D<sup>2</sup>PAK: 3-Lead**

Recommended Minimum Pads  
Dimensions in Inches/(mm)



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