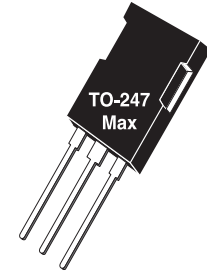


## Ultra Fast NPT - IGBT<sup>®</sup> with Ultra Soft Recovery Diode

The Ultra Fast 650V NPT-IGBT<sup>®</sup> family of products is the newest generation of IGBTs optimized for outstanding ruggedness and best trade-off between conduction and switching losses.

### Features

- Low Saturation Voltage
- Low Tail Current
- RoHS Compliant 
- Smooth Reverse Recovery
- Short Circuit Withstand Rated
- High Frequency Switching
- Ultra Low Leakage Current
- Snap-free Switching



Combi (IGBT and Diode)



Unless stated otherwise, Microsemi discrete IGBTs contain a single IGBT die. This device is recommended for applications such as induction heating (IH), motor control, general purpose inverters and uninterruptible power supplies (UPS).

### MAXIMUM RATINGS

All Ratings:  $T_C = 25^\circ\text{C}$  unless otherwise specified.

Symbol	Parameter	Ratings	Unit
$V_{CES}$	Collector Emitter Voltage	650	V
$V_{GE}$	Gate-Emitter Voltage	$\pm 30$	
$I_{C1}$	Continuous Collector Current @ $T_C = 25^\circ\text{C}$	134	A
$I_{C2}$	Continuous Collector Current @ $T_C = 110^\circ\text{C}$	65	
$I_{CM}$	Pulsed Collector Current <sup>①</sup>	280	
SCWT	Short Circuit Withstand Time: $V_{CE} = 600V, V_{GE} = 15V, T_C = 125^\circ\text{C}$	10	$\mu\text{s}$
$P_D$	Total Power Dissipation @ $T_C = 25^\circ\text{C}$	595	W
$T_J, T_{STG}$	Operating and Storage Junction Temperature Range	-55 to 150	$^\circ\text{C}$
$T_L$	Max. Lead Temp. for Soldering: 0.063" from Case for 10 Sec.	300	

### STATIC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Min	Typ	Max	Unit
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage ( $V_{GE} = 0V, I_C = 350\mu\text{A}$ )	650			Volts
$V_{GE(TH)}$	Gate Threshold Voltage ( $V_{CE} = V_{GE}, I_C = 1.0\text{mA}, T_J = 25^\circ\text{C}$ )	3.5	5.0	6.5	
$V_{CE(ON)}$	Collector-Emitter On Voltage ( $V_{GE} = 15V, I_C = 70A, T_J = 25^\circ\text{C}$ )		1.9	2.4	
	Collector-Emitter On Voltage ( $V_{GE} = 15V, I_C = 70A, T_J = 125^\circ\text{C}$ )		2.4		
	Collector-Emitter On Voltage ( $V_{GE} = 15V, I_C = 140A, T_J = 25^\circ\text{C}$ )		2.6		
$I_{CES}$	Collector Cut-off Current ( $V_{CE} = 650V, V_{GE} = 0V, T_J = 25^\circ\text{C}$ ) <sup>②</sup>		20	350	$\mu\text{A}$
	Collector Cut-off Current ( $V_{CE} = 650V, V_{GE} = 0V, T_J = 125^\circ\text{C}$ ) <sup>②</sup>		200		
$I_{GES}$	Gate-Emitter Leakage Current ( $V_{GE} = \pm 20V$ )			$\pm 250$	nA



**CAUTION: These Devices are Sensitive to Electrostatic Discharge. Proper Handling Procedures Should Be Followed.**

DYNAMIC CHARACTERISTICS

APT70GR65B2DU40

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$C_{ies}$	Input Capacitance	Capacitance $V_{GE} = 0V, V_{CE} = 25V$ $f = 1MHz$		4250		pF
$C_{oes}$	Output Capacitance			847		
$C_{res}$	Reverse Transfer Capacitance			415		
$V_{GEP}$	Gate to Emitter Plateau Voltage	Gate Charge		7.0		V
$Q_g^{(3)}$	Total Gate Charge	$V_{GE} = 15V$		226	305	nC
$Q_{ge}$	Gate-Emitter Charge	$V_{CE} = 325V$		26	35	
$Q_{gc}$	Gate- Collector Charge	$I_C = 70A$		104	140	
$t_{d(on)}$	Turn-On Delay Time	Inductive Switching (25°C) $V_{CC} = 433V$ $V_{GE} = 15V$ $I_C = 70A$		18		ns
$t_r$	Current Rise Time			49		
$t_{d(off)}$	Turn-Off Delay Time			170		
$t_f$	Current Fall Time			67		
$E_{on2}^{(5)}$	Turn-On Switching Energy	$R_G = 4.3\Omega^{(4)}$		1868	2800	μJ
$E_{off}^{(6)}$	Turn-Off Switching Energy	$T_J = +25^\circ C$		1470	2205	
$t_{d(on)}$	Turn-On Delay Time	Inductive Switching (125°C) $V_{CC} = 433V$ $V_{GE} = 15V$ $I_C = 70A$		17		ns
$t_r$	Current Rise Time			51		
$t_{d(off)}$	Turn-Off Delay Time			190		
$t_f$	Current Fall Time			74		
$E_{on2}^{(5)}$	Turn-On Switching Energy	$R_G = 4.3\Omega^{(4)}$		2616	3920	μJ
$E_{off}^{(6)}$	Turn-Off Switching Energy	$T_J = +125^\circ C$		1900	2865	

THERMAL AND MECHANICAL CHARACTERISTICS

Symbol	Characteristic	Min	Typ	Max	Unit
$R_{\theta JC}$	Junction to Case Thermal Resistance (IGBT)			0.21	°C/W
	Junction to Case Thermal Resistance (Diode)			0.61	
$R_{\theta JA}$	Junction to Ambient Thermal Resistance			40	
$W_T$	Package Weight		0.22		oz
			6.2		g

- 1 Repetitive Rating: Pulse width and case temperature limited by maximum junction temperature.
  - 2 Pulse test: Pulse Width < 380μs, duty cycle < 2%.
  - 3 See Mil-Std-750 Method 3471.
  - 4  $R_G$  is external gate resistance, not including internal gate resistance or gate driver impedance. (MIC4452)
  - 5  $E_{on2}$  is the energy loss at turn-on and includes the charge stored in the freewheeling diode.
  - 6  $E_{off}$  is the clamped inductive turn-off energy measured in accordance with JEDEC standard JESD24-1.
- Microsemi reserves the right to change, without notice, the specifications and information contained herein.

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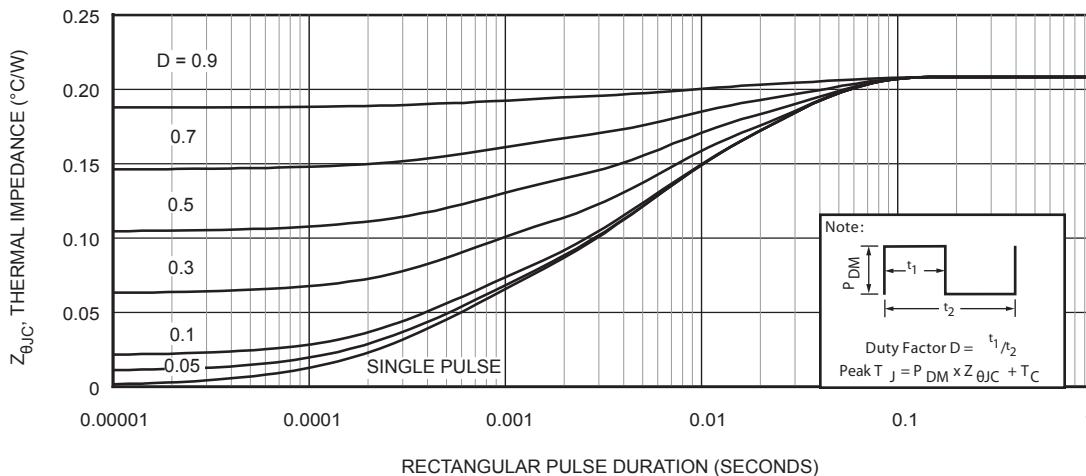


Figure 1, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

TYPICAL PERFORMANCE CURVES

APT70GR65B2DU40

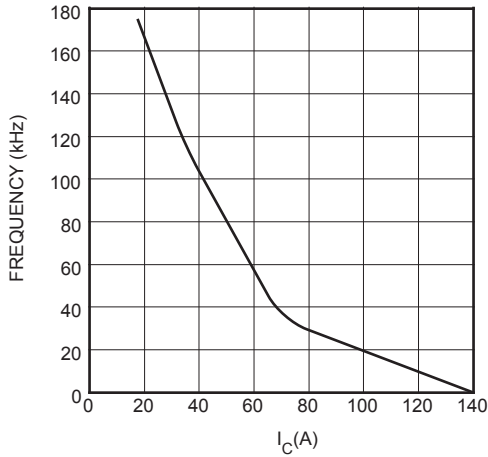


FIGURE 2, Max Frequency vs Current ( $T_{case} = 75^{\circ}C$ )

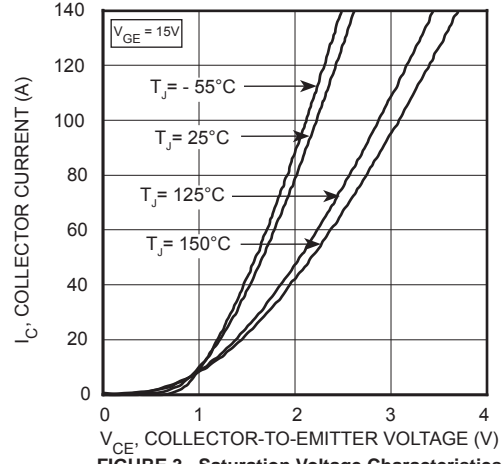


FIGURE 3, Saturation Voltage Characteristics

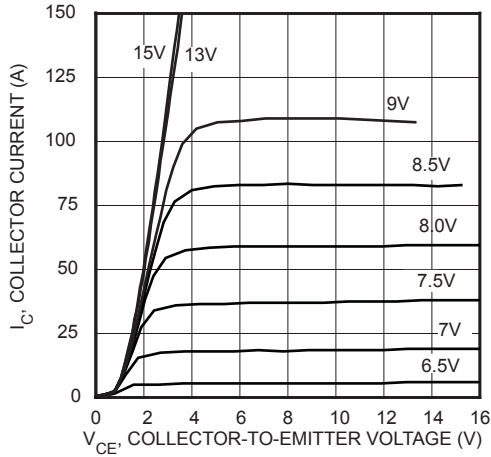


FIGURE 4, Output Characteristics ( $T_j = 25^{\circ}C$ )

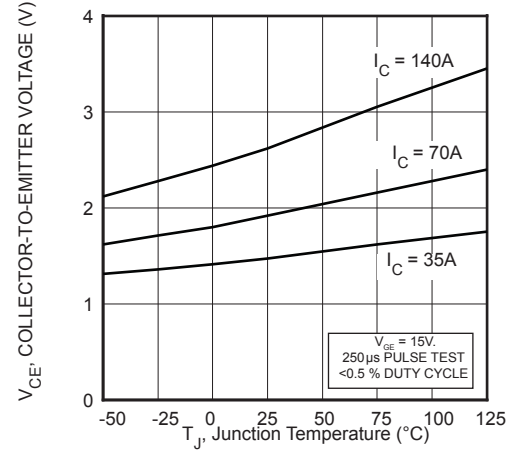


FIGURE 5, On State Voltage vs Junction Temperature

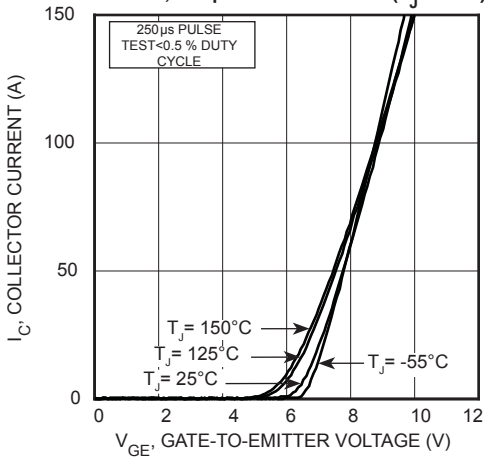


FIGURE 6, Transfer Characteristics

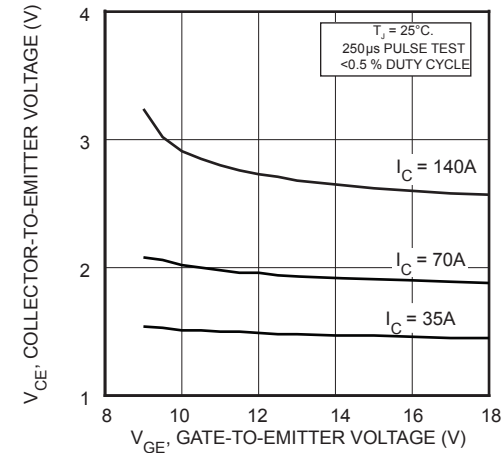


FIGURE 7, On State Voltage vs Gate-to-Emitter Voltage

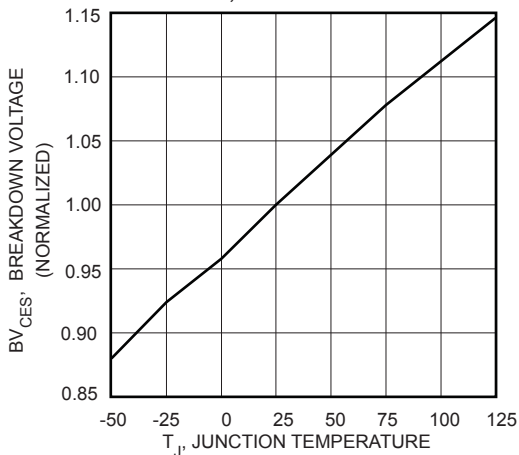


FIGURE 8, Breakdown Voltage vs Junction Temperature

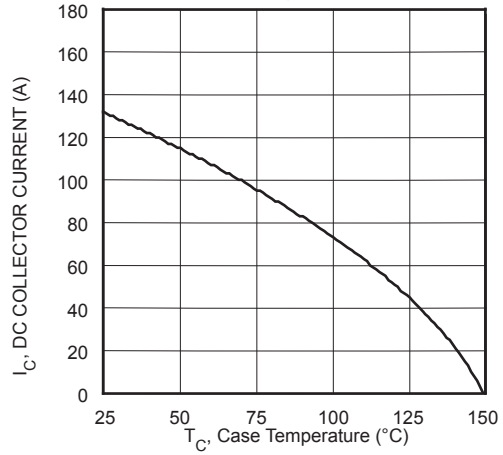


FIGURE 9, DC Collector Current vs Case Temperature

TYPICAL PERFORMANCE CURVES

APT70GR65B2DU40

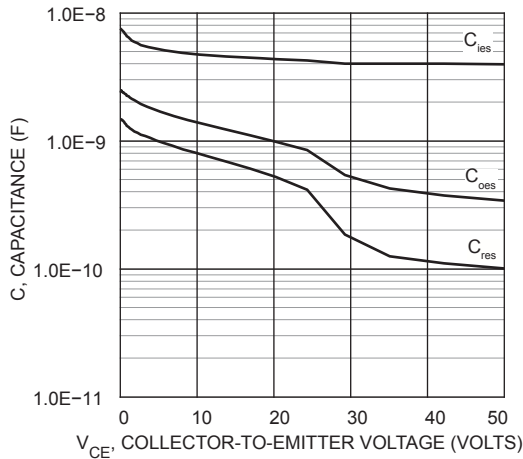


FIGURE 10, Capacitance vs Collector-To-Emitter Voltage

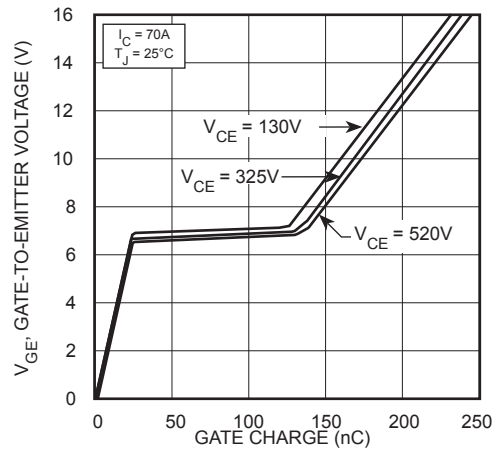


FIGURE 11, Gate charge

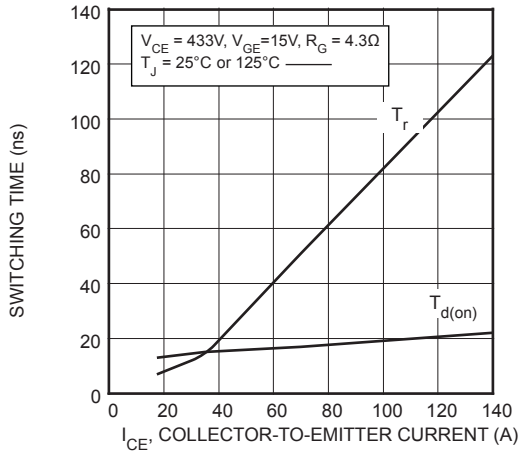


FIGURE 12, Turn-On Time vs Collector Current

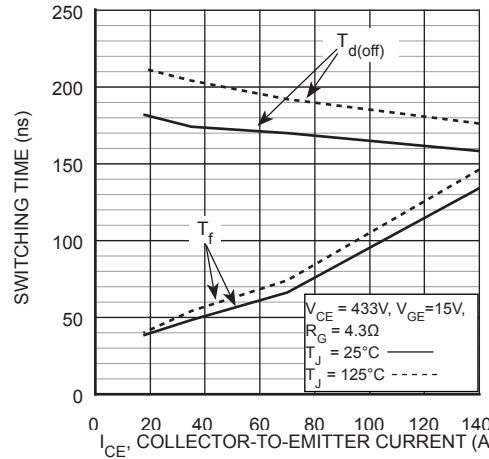


FIGURE 13, Turn-Off Time vs Collector Current

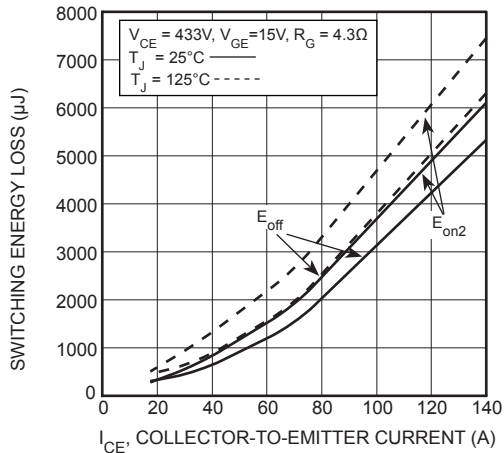


FIGURE 14, Energy Loss vs Collector Current

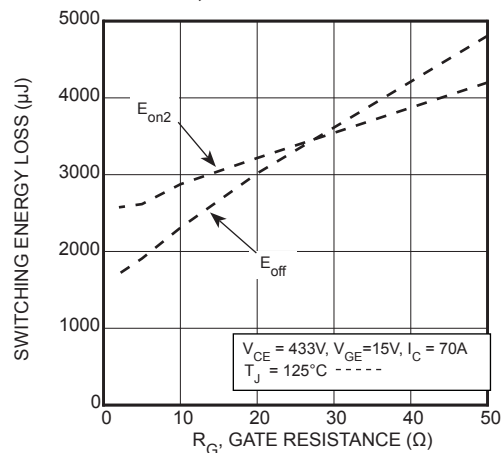


FIGURE 15, Energy Loss vs Gate Resistance

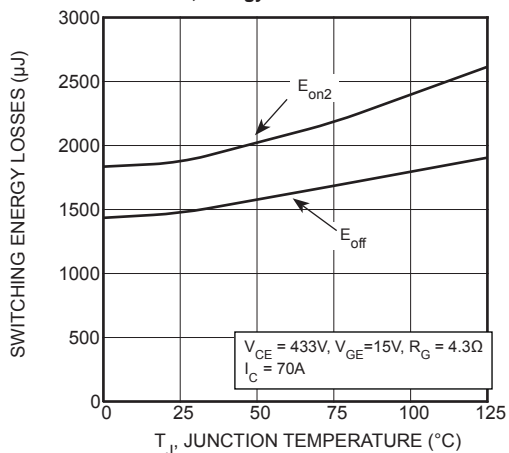


FIGURE 16, Switching Energy vs Junction Temperature

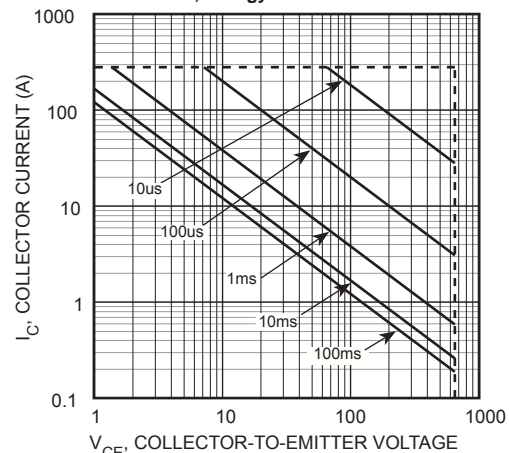


FIGURE 17, Minimum Switching Safe Operating Area

# ULTRA SOFT RECOVERY ANTI-PARALLEL DIODE

## MAXIMUM RATINGS

All Ratings:  $T_C = 25^\circ\text{C}$  unless otherwise specified.

Symbol	Characteristic / Test Conditions	Ratings	Unit
$I_F$	Maximum D.C. Forward Current	$T_C = 25^\circ\text{C}$	57
		$T_C = 75^\circ\text{C}$	40
$I_{FSM}$	Non-Repetitive Forward Surge Current ( $T_J = 25^\circ\text{C}$ , $t_p = 10\text{ms}$ , Half Sine)	210	Amps

## STATIC ELECTRICAL CHARACTERISTICS

Symbol	Characteristic / Test Conditions	Min	Typ	Max	Unit
$V_F$	Forward Voltage		$I_F = 40\text{A}$	3.0	Volts
			$I_F = 80\text{A}$	3.9	
			$I_F = 40\text{A}$ , $T_J = 125^\circ\text{C}$	2.3	

## DYNAMIC CHARACTERISTICS

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$t_{rr}$	Reverse Recovery Time	$I_F = 1.0\text{A}$ , $\text{dif}/\text{dt} = -100\text{A}/\mu\text{s}$ , $V_R = 30\text{V}$ , $T_J = 25^\circ\text{C}$		25		ns
$t_{rr}$	Reverse Recovery Time	$I_F = 40\text{Amps}$ $\text{dif}/\text{dt} = -200\text{A}/\mu\text{s}$ $V_R = 433\text{Volts}$ $T_J = 25^\circ\text{C}$		75		ns
$Q_{rr}$	Reverse Recovery Charge			111		nC
$I_{rrm}$	Maximum Reverse Recovery Current			4		Amps
$E_{rr}$	Reverse Recovery Energy			2		$\mu\text{J}$
$t_{rr}$	Reverse Recovery	$I_F = 40\text{Amps}$ $\text{dif}/\text{dt} = -200\text{A}/\mu\text{s}$ $V_R = 433\text{Volts}$ $T_J = 125^\circ\text{C}$		362		ns
$Q_{rr}$	Reverse Recovery Charge			1062		nC
$I_{rrm}$	Maximum Reverse Recovery Current			8		Amps
$E_{rr}$	Reverse Recovery Energy			83		$\mu\text{J}$
$t_{rr}$	Reverse Recovery	$I_F = 40\text{Amps}$ $\text{dif}/\text{dt} = -1000\text{A}/\mu\text{s}$ $V_R = 433\text{Volts}$ $T_J = 125^\circ\text{C}$		160		ns
$Q_{rr}$	Reverse Recovery Charge			1648		nC
$I_{rrm}$	Maximum Reverse Recovery Current			25		Amps
$E_{rr}$	Reverse Recovery Energy			261		$\mu\text{J}$
S	Softness Factor (tb/ta)	$I_F = 20\text{A}$ , $\text{dif}/\text{dt} = -1000\text{A}/\mu\text{s}$ , $V_R = 433\text{V}$ , $T_J = 125^\circ\text{C}$		3		

## TYPICAL PERFORMANCE CURVES

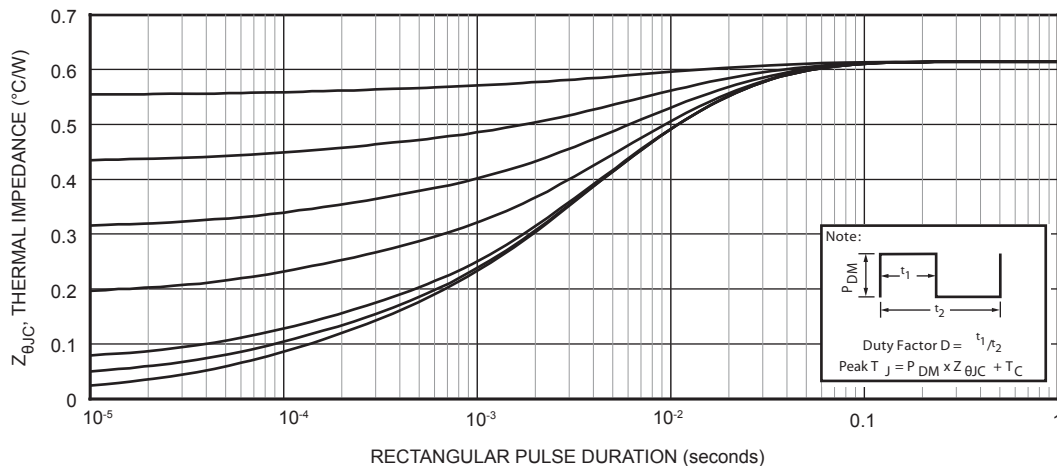
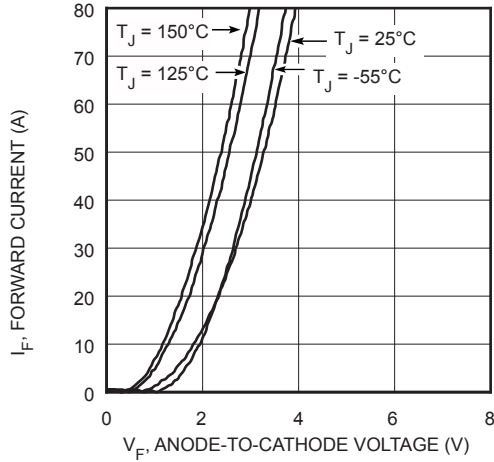


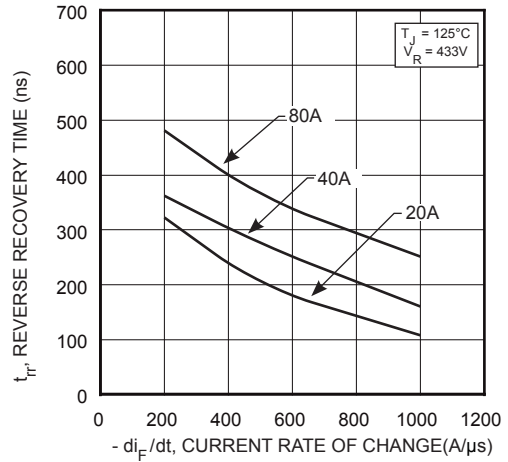
FIGURE 18. MAXIMUM EFFECTIVE TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE vs. PULSE DURATION

**TYPICAL PERFORMANCE CURVES**

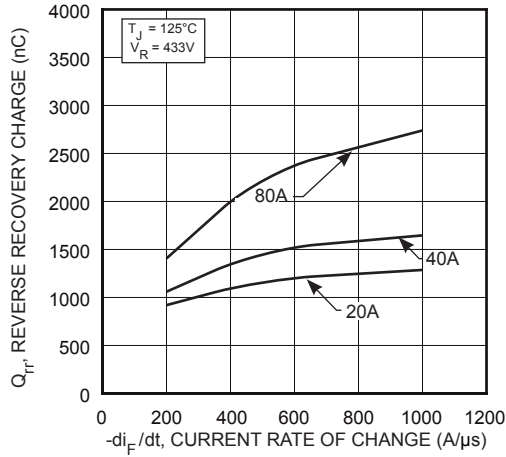
**APT70GR65B2DU40**



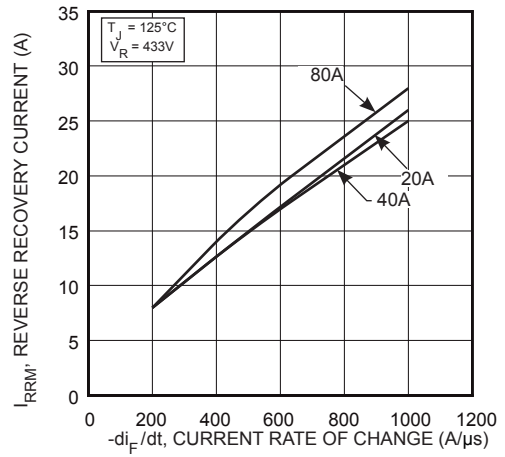
**FIGURE 19. Forward Current vs. Forward Voltage**



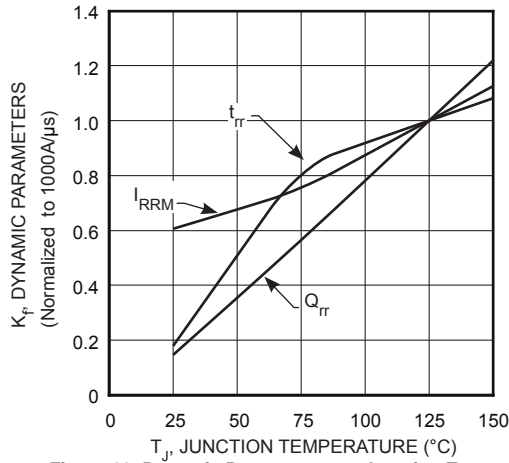
**Figure 20. Reverse Recovery Time vs. Current Rate of Change**



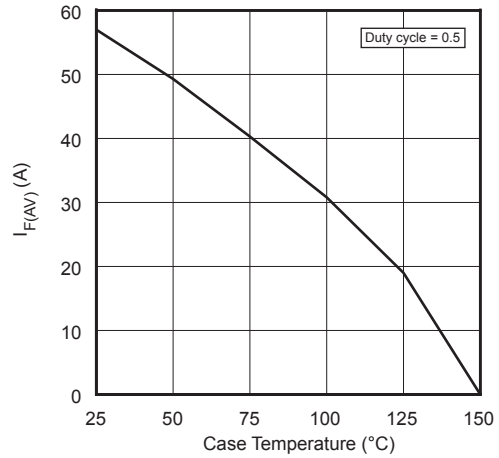
**Figure 21. Reverse Recovery Charge vs. Current Rate of Change**



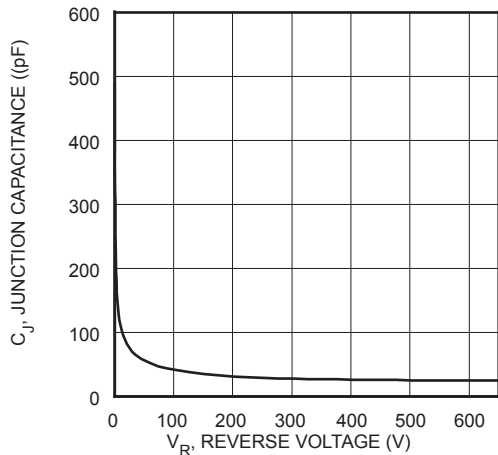
**Figure 22. Reverse Recovery Current vs. Current Rate of Change**



**Figure 23. Dynamic Parameters vs. Junction Temperature**



**Figure 24. Max Average Forward Current vs. Case Temperature**



**Figure 25. Junction Capacitance vs. Reverse Voltage**

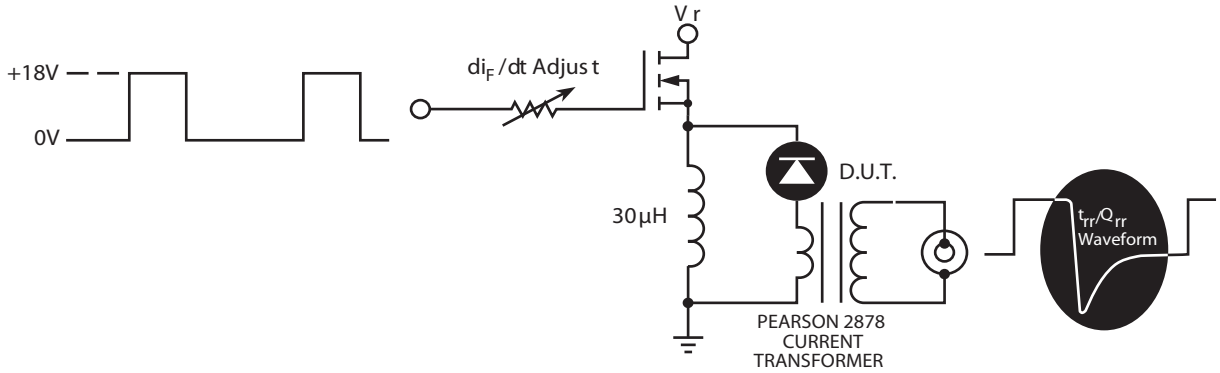


Figure 26. Diode Test Circuit

- 1  $I_F$  - Forward Conduction Current
- 2  $di_F/dt$  - Rate of Diode Current Change Through Zero Crossing.
- 3  $I_{RRM}$  - Maximum Reverse Recovery Current
- 4  $t_a$  - Time to reach Maximum Reverse Recovery Current ( $I_{RRM}$ ).
- 5  $t_b$  - Time from Maximum Reverse Recovery Current ( $I_{RRM}$ ) to projected zero crossing based on a straight line from  $I_{RRM}$  through 25%  $I_{RRM}$ .
- 6  $t_{rr}$  - Reverse Recovery Time measured from zero crossing where diode current goes from positive to negative, to the point at which the straight line through  $I_{RRM}$  and 0.25,  $I_{RRM}$  passes through zero.
- 7  $Q_{rr}$  - Area Under the Curve Defined by  $I_{RRM}$  and  $t_{rr}$ .

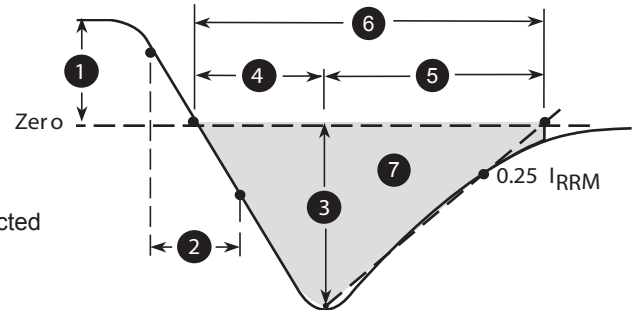
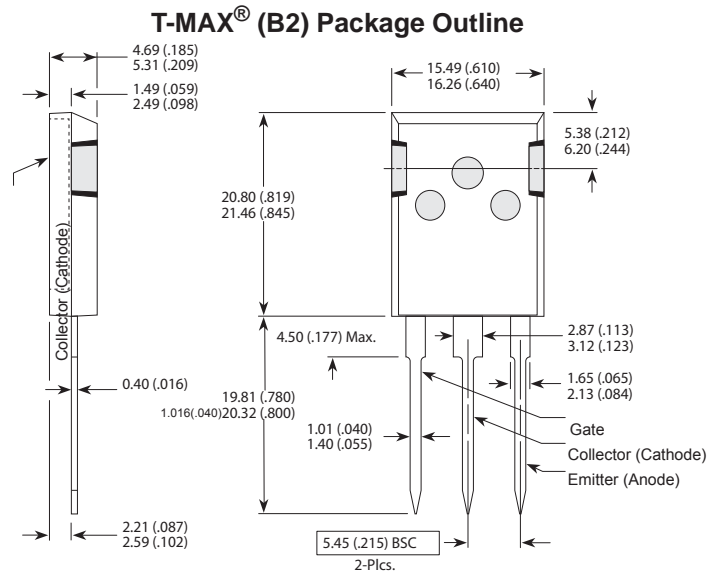


Figure 27. Diode Reverse Recovery Waveform Definition



These dimensions are equal to the TO-247 without the mounting hole.  
Dimensions in Millimeters and (Inches)

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