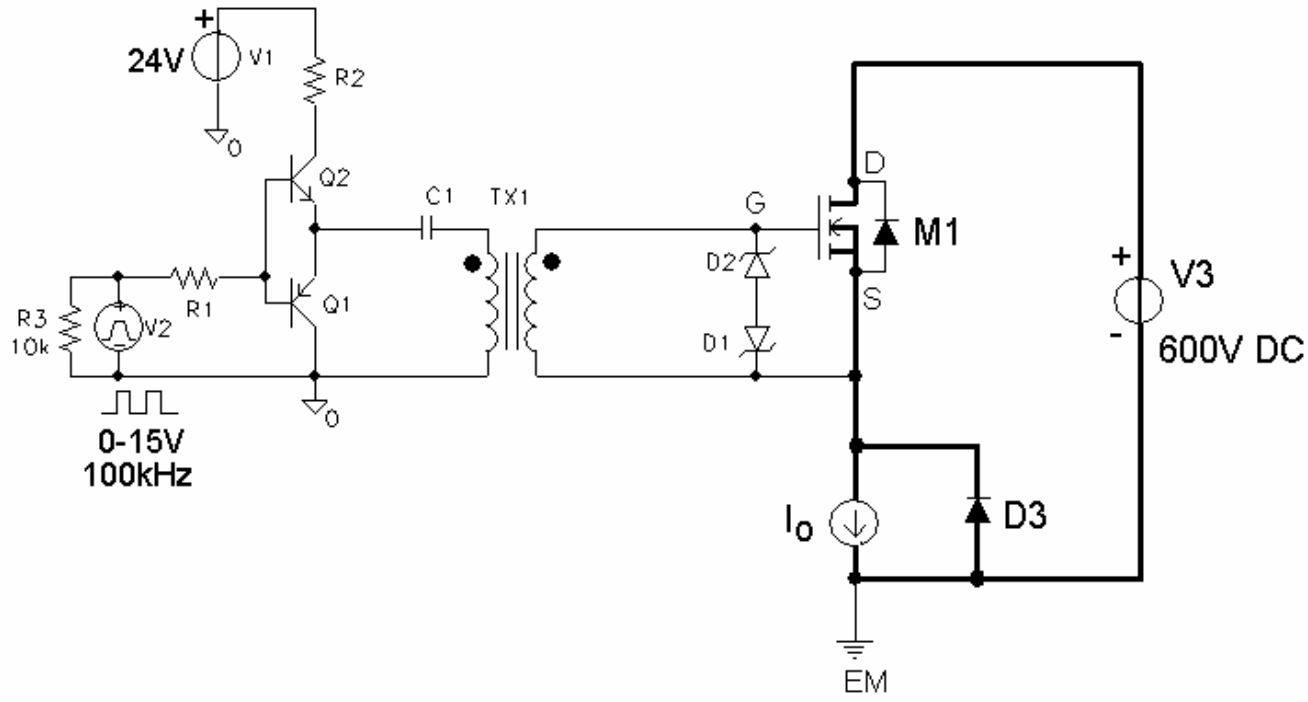
VISER-NET-SPECIJALISTIČKE STUDIJE
PREDMET: Upravljanje Elektroenergetskim Pretvaračima

DOMAĆI ZADATAK_02

Dimenzionisati elemente u pobudnom kolu MOSFET prekidača, koje je prikazano na slici. MOSFET M1 je IXFL 60N80P (proizvodnje IXYS) za 800V/40A. Tehnički podaci za tranzistor M1 su dati u PRILOGU-1. Struja opterećenja koju ovo kolo treba da prekida je $I_0 = 30A$. Iz naponskog izvora V2 se generišu pobudni naponski impulsi 0-15V prekidačke učestanosti 100kHz i promenljivog koeficijenta režima rada ("duty-cycle"). Pojačanja tranzistora Q1 i Q2 su $\beta = 200$, naponi baza-emitor u linearnom režimu su $V_{BE} = 0.6V$, a u stanju zasićenja su $V_{BES} = 0.7V$. Naponi kolektor-emiter u stanju zasićenja su $V_{CES} = 0.7V$. Podaci za impulsni transformator TX1 su dati u PRILOGU-2. Tehnički podaci za diodu D3 su dati u PRILOGU-3. Za projektovano kolo na slici odrediti minimalnu i maksimalnu srednju vrednost struje tranzistora M1, kao i opseg podešavanja snage na opterećenju. Procenti maksimalnu trenutnu vrednost struje tranzistora M1, kao i njegove prekidačke gubitke i gubitke u stanju vođenja.



PRILOG-1

IXYS

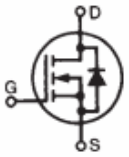
PolarHV™ HiPerFET Power MOSFET ISOPLUS264™

IXFL 60N80P

(Electrically Isolated Back Surface)

N-Channel Enhancement Mode
Avalanche Rated
Fast Intrinsic Diode

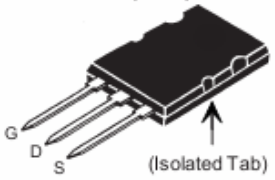
V_{DSS} = 800 V
I_{D25} = 40 A
$R_{DS(on)}$ ≤ 150 mΩ
t_{rr} ≤ 250 ns



Symbol	Test Conditions	Maximum Ratings	
V_{DSS}	T_J = 25°C to 150°C	800	V
V_{DGR}	T_J = 25°C to 150°C; R_{GS} = 1 MΩ	800	V
V_{GSS}	Continuous	±30	V
V_{GSM}	Transient	±40	V
I_{D25}	T_C = 25°C	40	A
I_{DM}	T_C = 25°C, pulse width limited by T_{JM}	150	A
I_{AR}	T_C = 25°C	30	A
E_{AR}	T_C = 25°C	100	mJ
E_{AS}	T_C = 25°C	5	J
dv/dt	$I_S \le I_{DM}$, di/dt ≤100 A/µs, $V_{DD} \le V_{DSS}$, T_J ≤150°C, R_G = 2 Ω	20	V/ns
P_D	T_C = 25°C	625	W
T_J		-55 ... +150	°C
T_{JM}		150	°C
T_{stg}		-55 ... +150	°C
T_L	1.6 mm (0.062 in.) from case for 10 s	300	°C
V_{ISOL}	50/60 Hz, RMS, t = 1 min	2500	V~
	I_{ISOL} ≤1 mA, t = 1 s	3000	V~
F_C	Mounting force	28..150 / 6.4..30	N/lb
Weight		5	g

Symbol	Test Conditions (T_J = 25°C, unless otherwise specified)	Characteristic Values Min.	Typ.	Max.	
BV_{DSS}	V_{GS} = 0 V, I_D = 3 mA	800			V
$V_{GS(th)}$	$V_{DS} = V_{GS}$, I_D = 8 mA	3.0		5.0	V
I_{GSS}	V_{GS} = ±30 V_{DC}, V_{DS} = 0			±200	nA
I_{DSS}	$V_{DS} = V_{DSS}$, V_{GS} = 0 V			25	µA
	T_J = 125°C			3000	µA
$R_{DS(on)}$	V_{GS} = 10 V, $I_D = I_T$, Note 1			150	mΩ

ISOPLUS264 ™ (IXFL)



G = Gate D = Drain
S = Source

Features

- International standard isolated package
- UL recognized package
- Silicon chip on Direct-Copper-Bond substrate
  - High power dissipation
  - Isolated mounting surface
  - 2500V electrical isolation
- Unclamped Inductive Switching (UIS) rated
- Low package inductance
  - easy to drive and to protect
- Fast intrinsic diode

Advantages

- Easy to mount
- Space savings
- High power density

Symbol	Test Conditions (T_J = 25° C, unless otherwise specified)	Characteristic Values Min.	Typ.	Max.	
g_{fs}	V_{DS} = 20 V; I_D = I_T, Note 1	35	67		S
C_{iss}	V_{GS} = 0 V, V_{DS} = 25 V, f = 1 MHz		18		nF
C_{oss}			1200		pF
C_{rss}			44		pF
$t_{d(on)}$	V_{GS} = 10 V, V_{DS} = 0.5 V_{DSS}, I_D = I_T R_G = 1 Ω (External)		36		ns
t_r			29		ns
$t_{d(off)}$			110		ns
t_f			26		ns
$Q_{g(on)}$	V_{GS} = 10 V, V_{DS} = 0.5 V_{DSS}, I_D = I_T		250		nC
Q_{gs}			90		nC
Q_{gd}			78		nC
R_{thJC}				0.20	°C/W
R_{thCS}			0.13		°C/W

Source-Drain Diode

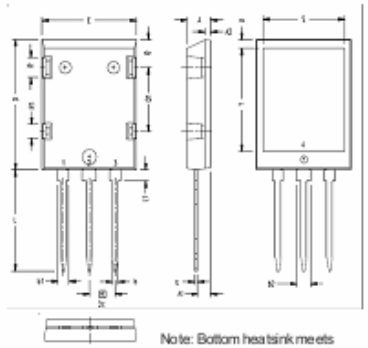
Symbol	Test Conditions (T_J = 25° C, unless otherwise specified)	Characteristic Values Min.	Typ.	Max.	
I_S	V_{GS} = 0 V			60	A
I_{SM}	Repetitive			150	A
V_{SD}	I_F = I_S, V_{GS} = 0 V, Note 1			1.5	V
t_{rr}	I_F = 25A, -di/dt = 100 A/µs			250	ns
Q_{RM}	V_R = 100V		0.6		µC
I_{RM}			6.0		A

Notes:

1. Pulse test, t ≤300 µs, duty cycle d≤ 2 %

Test Current I_T = 30 A

ISOPLUS264 (IXFL) Outline



Note: Bottom heatsink meets 2500Vrms Isolation to the other pins.

SYM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	.190	.205	4.83	5.21
A1	.102	.118	2.59	3.00
A2	.045	.055	1.17	1.40
b	.045	.055	1.14	1.40
b1	.087	.102	2.21	2.59
b2	.111	.126	2.82	3.20
c	.020	.029	0.51	0.74
D	1.020	1.040	25.91	26.42
E	.770	.789	19.56	20.09
e	.215 BSC		5.46 BSC	
L	.780	.820	19.81	20.83
L1	.080	.100	2.03	2.59
Q	.210	.235	5.33	5.97
Q1	.490	.513	12.45	13.03
R	.150	.180	3.81	4.57
R1	.100	.130	2.54	3.30
S	.668	.690	16.97	17.53
T	.801	.821	20.34	20.85
U	.085	.080	1.85	3.03

Ref: IXYSCO0128R0

Fig. 1. Output Characteristics @ 25°C

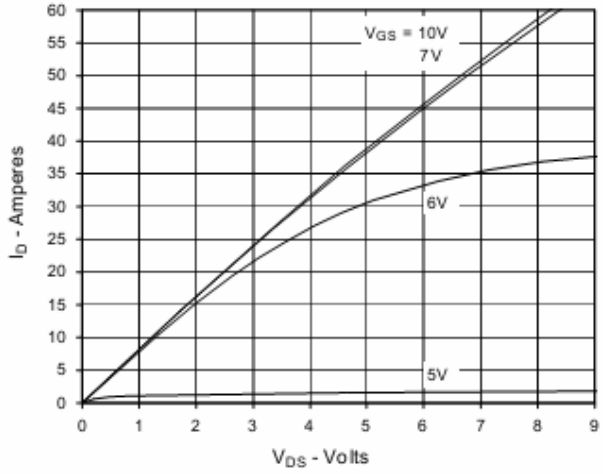


Fig. 2. Extended Output Characteristics @ 25°C

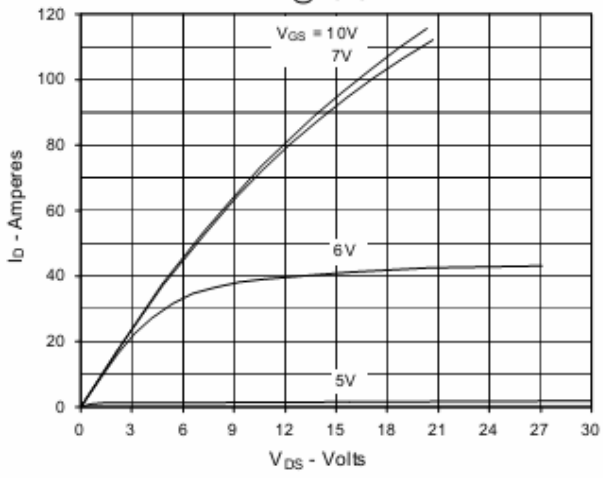


Fig. 3. Output Characteristics @ 125°C

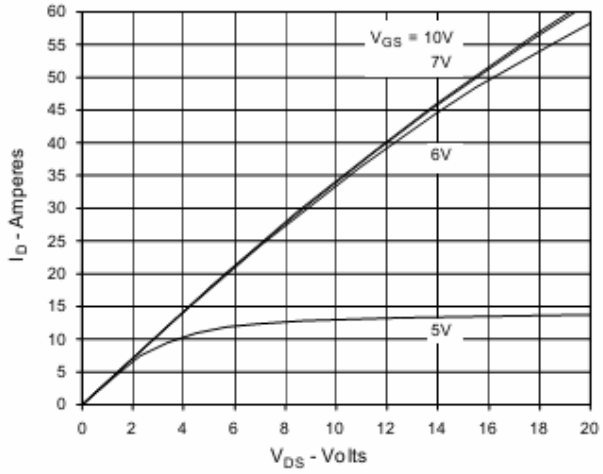


Fig. 4. $R_{DS(on)}$ Normalized to I_D = 30A Value vs. Junction Temperature

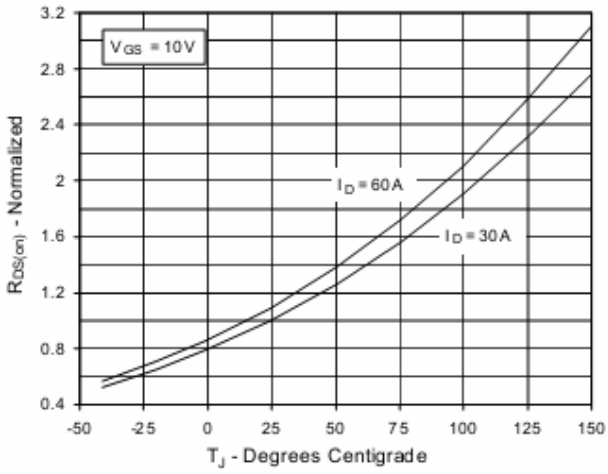


Fig. 5. $R_{DS(on)}$ Normalized to I_D = 30A Value vs. Drain Current

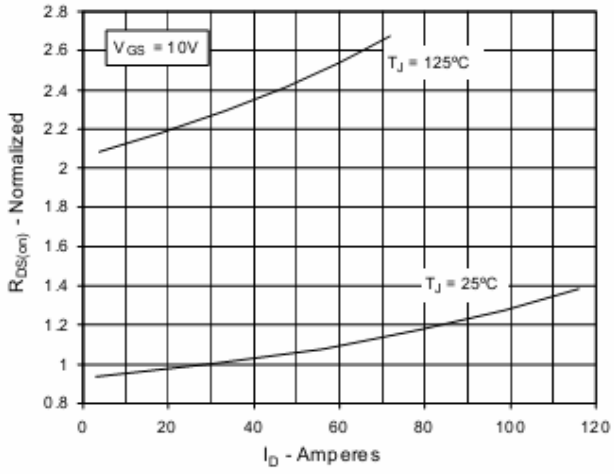


Fig. 6. Maximum Drain Current vs. Case Temperature

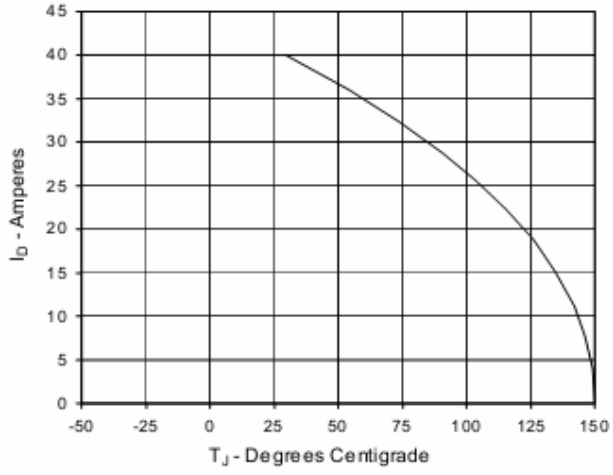


Fig. 7. Input Admittance

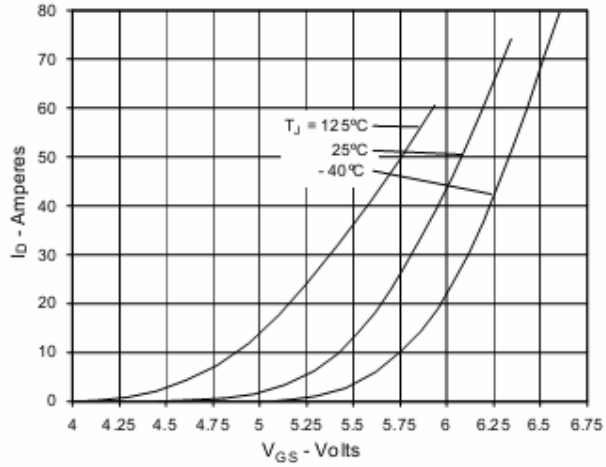


Fig. 8. Transconductance

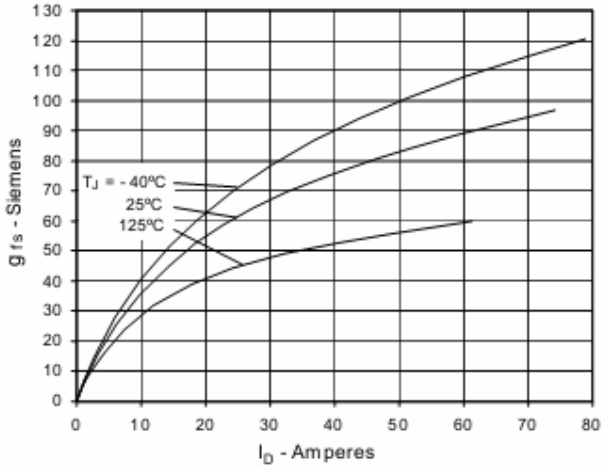


Fig. 9. Forward Voltage Drop of Intrinsic Diode

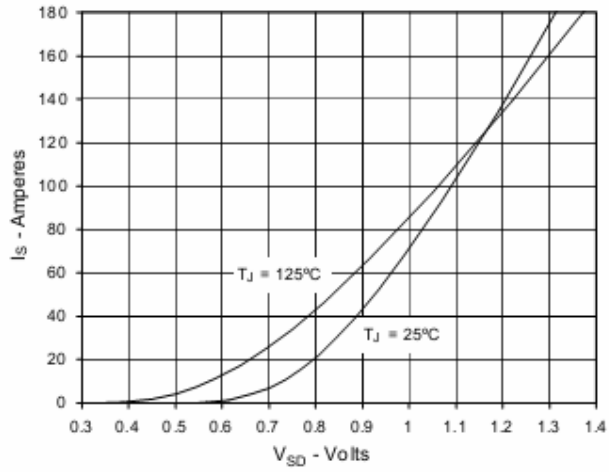


Fig. 10. Gate Charge

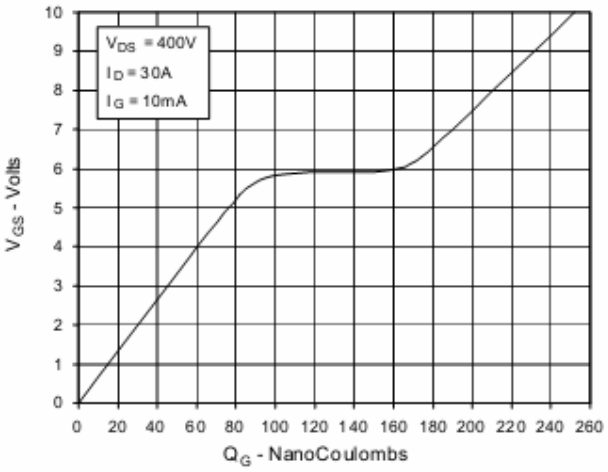


Fig. 11. Capacitance

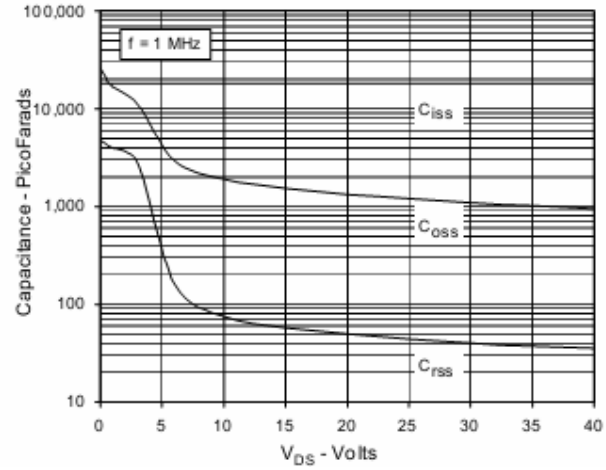
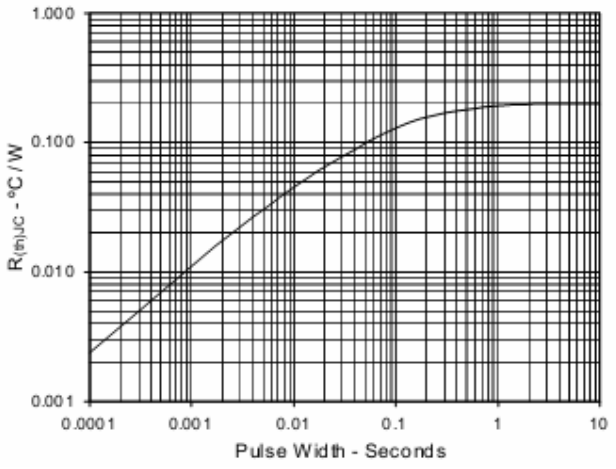


Fig. 12. Maximum Transient Thermal Resistance



PRILOG-2

MOSFET GATE DRIVE TRANSFORMERS

Pulse® A TECHNITROL COMPANY

RoHS COMPLIANT

- International safety construction, VDE approved
- 3750V_{RMS} gate to drive winding test
- Useful operating frequency from 20kHz to 100kHz

Electrical Specifications @ 25°C — Operating Temperature 0°C to 70°C

Part Number	Turns Ratio (±5%)	Inductance 1V_{RMS} 1 kHz Term 1-2 (µH MIN)	Leakage[1] Inductance Term 1-2 (µH MAX)	DCR Drive Winding (Ω MAX)	DCR Gate Winding (Ω MAX)	C_{ww} Drive To Gate (pf MAX)	C_{ww} Gate To Gate (pf MAX)	Typical Operating Frequency (kHz)
PE-63385NL	1:1	1500	4.0	0.40	0.75	50	NA	20-100
PE-63387NL*	1:1:1	1500	4.0	0.40	0.75	50	130	20-100
PE-63386NL	1:1.5	1500	4.0	0.40	2.50	50	NA	20-100
PE-63388NL	1:1.5:1.5	1500	4.0	0.40	2.50	50	130	20-100

***NOTE:** Also Available with a U-L B1 Insulation (1446C) system, tested to 4400Vrms for 1 minute as **PE-68448NL.**

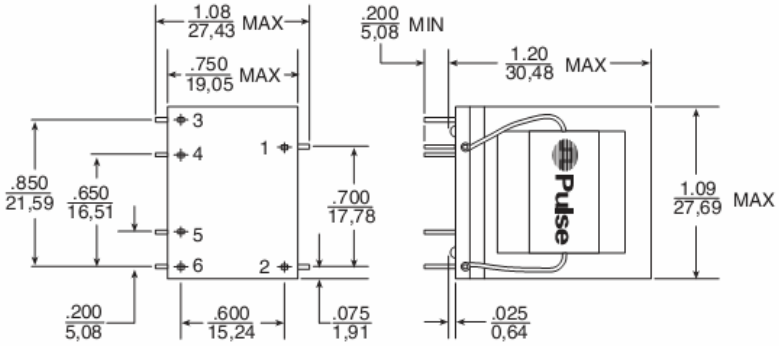
Maximum Ratings

Rating	Sym	PE-63385 PE-63386	PE-63387 PE-63388	Unit
Drive Excitation, Unipolar	ET_U[6]	200	320	V-µs
Drive Excitation, Bipolar	ET_B[6]	400	640	V-µs
Secondary RMS Current	I_{SR}[7]	640	500	ma
Operating & Storage Temp.	T_{OP}, T_{STG}	105	105	°C

Dielectric Strength

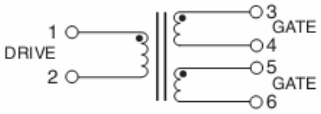
Test Between	RMS Test Volts 60Hz, 1 Minute Hold
Gate-Drive	3750
Gate-Gate	1500
Gate-Core	2000
Drive-Core	1750

Mechanical



Schematics

PE-63385NL/PE-63386NL



PE-63387NL/PE-63388NL/PE-68448NL

NOTES: 1. Measured with secondaries shorted
2. Pins .025/0,64 square solderable
3. Unused pins not provided
4. Pin numbers not marked on part
5. Mounting header flammability rating: UL-94V0
6 At 2480 Gauss
7. At 200 CM/Amp

Dimensions: Inches / mm
Unless otherwise specified, all tolerances are ± .010 / 0,25

PRILOG-3

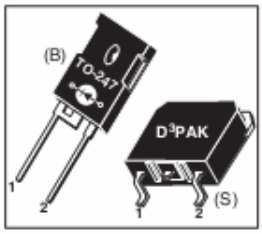
ADVANCED POWER TECHNOLOGY®

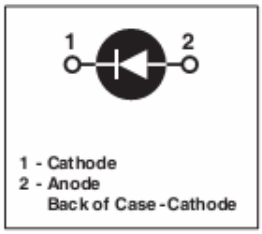
1000V 40A

APT40DQ100B APT40DQ100S
APT40DQ100BG* APT40DQ100SG*

*G Denotes RoHS Compliant, Pb Free Terminal Finish.

ULTRAFAST SOFT RECOVERY RECTIFIER DIODE





PRODUCT APPLICATIONS

- Anti-Parallel Diode
  - -Switchmode Power Supply
  - -Inverters
- Free Wheeling Diode
  - -Motor Controllers
  - -Converters
  - -Inverters
- Snubber Diode
- PFC

PRODUCT FEATURES

- Ultrafast Recovery Times
- Soft Recovery Characteristics
- Popular TO-247 Package or Surface Mount D³PAK Package
- Low Forward Voltage
- Low Leakage Current
- Avalanche Energy Rated

PRODUCT BENEFITS

- Low Losses
- Low Noise Switching
- Cooler Operation
- Higher Reliability Systems
- Increased System Power Density

MAXIMUM RATINGS

All Ratings: T_C = 25°C unless otherwise specified.

Symbol	Characteristic / Test Conditions	APT40DQ100B(G)_S(G)	UNIT
V_R	Maximum D.C. Reverse Voltage	1000	Volts
V_{RRM}	Maximum Peak Repetitive Reverse Voltage		
V_{RWM}	Maximum Working Peak Reverse Voltage		
$I_{F(AV)}$	Maximum Average Forward Current (T_C = 106°C, Duty Cycle = 0.5)	40	Amps
$I_{F(RMS)}$	RMS Forward Current (Square wave, 50% duty)	60	
I_{FSM}	Non-Repetitive Forward Surge Current (T_J = 45°C, 8.3ms)	210	
E_{AVL}	Avalanche Energy (1A, 40mH)	20	mJ
T_J, T_{STG}	Operating and StorageTemperature Range	-55 to 175	°C
T_L	Lead Temperature for 10 Sec.	300	

STATIC ELECTRICAL CHARACTERISTICS

Symbol	Characteristic / Test Conditions		MIN	TYP	MAX	UNIT
V_F	Forward Voltage	I_F = 40A		2.5	3.0	Volts
		I_F = 80A		3.08		
		I_F = 40A, T_J = 125°C		1.97		
I_{RM}	Maximum Reverse Leakage Current	V_R = 1000V			100	µA
		V_R = 1000V, T_J = 125°C			500	
C_T	Junction Capacitance, V_R = 200V			28		pF

DYNAMIC CHARACTERISTICS

APT40DQ100B(G)_S(G)

Symbol	Characteristic	Test Conditions	MIN	TYP	MAX	UNIT
t_{rr}	Reverse Recovery Time	I_F = 1A, di_F/dt = -100A/µs, V_R = 30V, T_J = 25°C	-	25		ns
t_{rr}	Reverse Recovery Time	I_F = 40A, di_F/dt = -200A/µs V_R = 667V, T_C = 25°C	-	250		ns
Q_{rr}	Reverse Recovery Charge		-	415		nC
I_{RRM}	Maximum Reverse Recovery Current		-	4	-	Amps
t_{rr}	Reverse Recovery Time	I_F = 40A, di_F/dt = -200A/µs V_R = 667V, T_C = 125°C	-	315		ns
Q_{rr}	Reverse Recovery Charge		-	1650		nC
I_{RRM}	Maximum Reverse Recovery Current		-	9	-	Amps
t_{rr}	Reverse Recovery Time	I_F = 40A, di_F/dt = -1000A/µs V_R = 667V, T_C = 125°C	-	145		ns
Q_{rr}	Reverse Recovery Charge		-	2660		nC
I_{RRM}	Maximum Reverse Recovery Current		-	29		Amps

THERMAL AND MECHANICAL CHARACTERISTICS

Symbol	Characteristic / Test Conditions	MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction-to-Case Thermal Resistance			.61	°C/W
W_T	Package Weight		0.22		oz
			5.9		g
Torque	Maximum Mounting Torque			10	lb•in
				1.1	N•m

APT Reserves the right to change, without notice, the specifications and information contained herein.

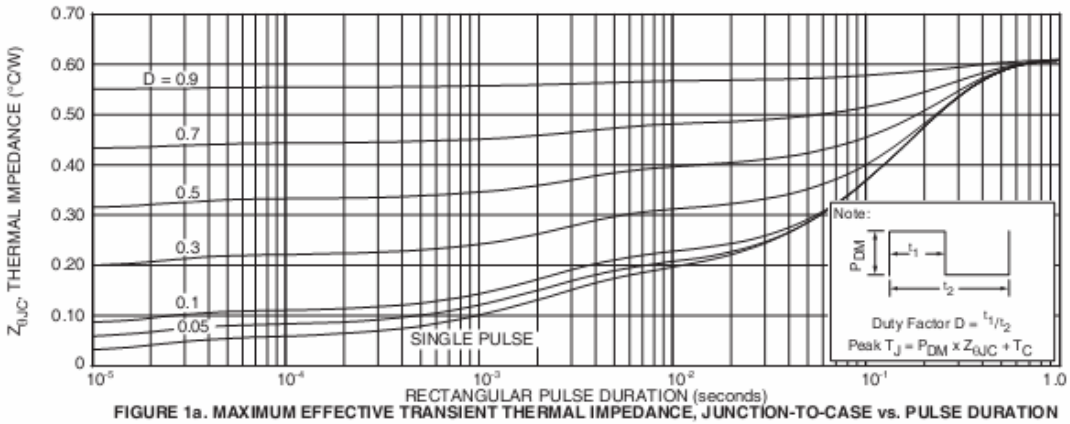


FIGURE 1a. MAXIMUM EFFECTIVE TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE vs. PULSE DURATION

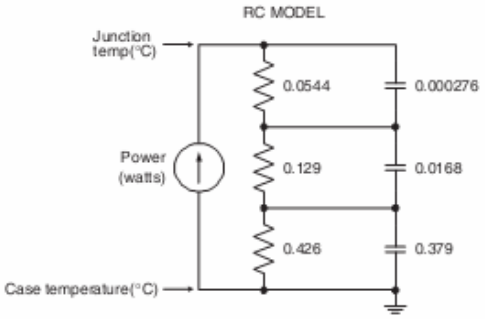


FIGURE 1b, TRANSIENT THERMAL IMPEDANCE MODEL

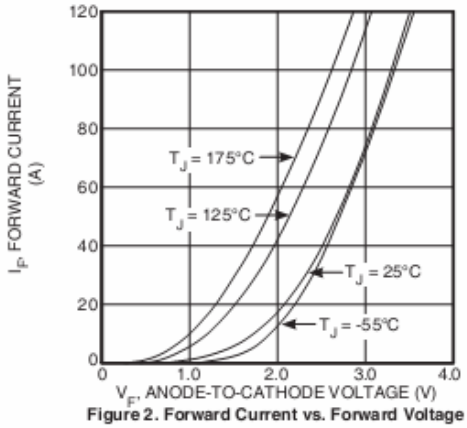


Figure 2. Forward Current vs. Forward Voltage

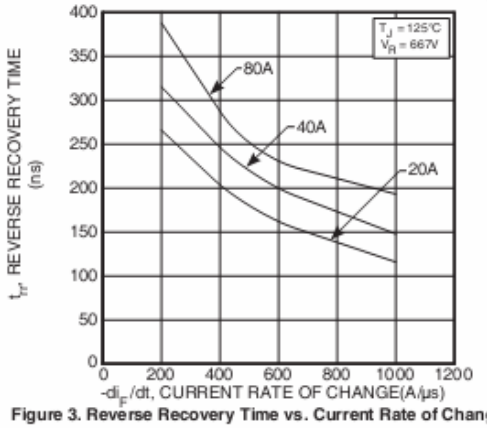


Figure 3. Reverse Recovery Time vs. Current Rate of Change

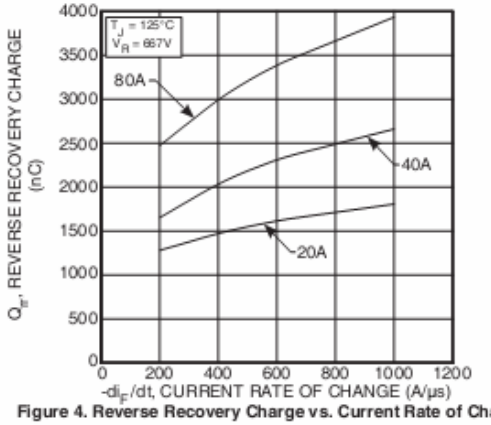


Figure 4. Reverse Recovery Charge vs. Current Rate of Change

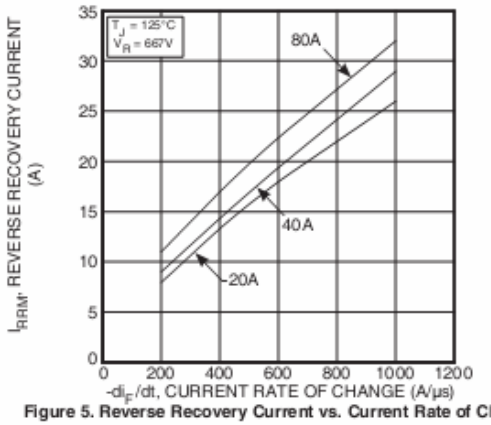


Figure 5. Reverse Recovery Current vs. Current Rate of Change

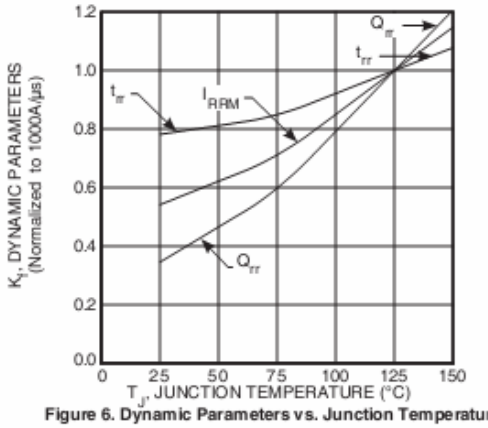


Figure 6. Dynamic Parameters vs. Junction Temperature

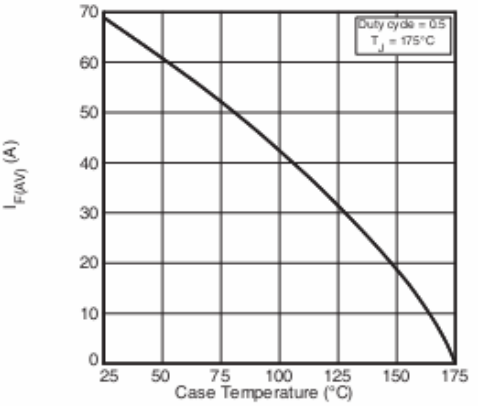


Figure 7. Maximum Average Forward Current vs. CaseTemperature

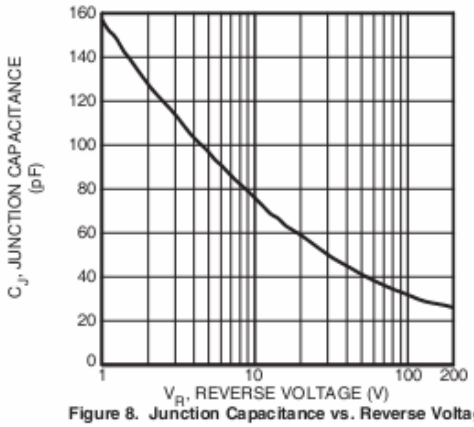


Figure 8. Junction Capacitance vs. Reverse Voltage

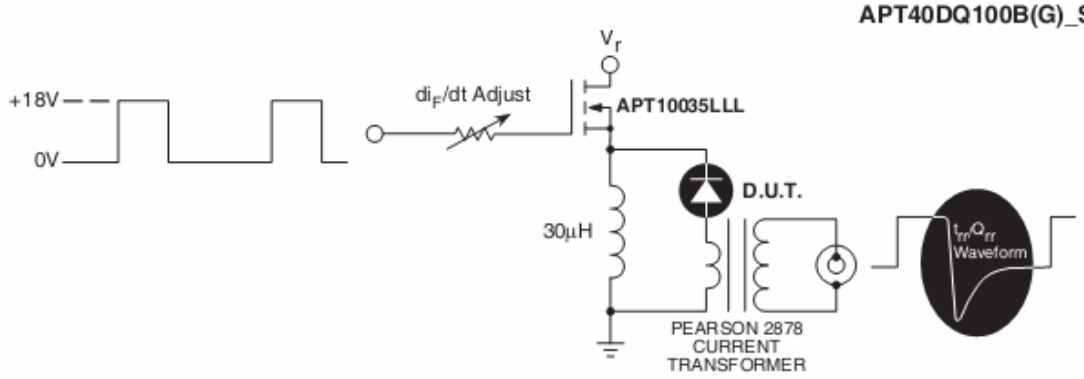


Figure 9. Diode Test Circuit

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_{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.
5. Q_{rr} - Area Under the Curve Defined by I_{RRM} and t_{rr}.

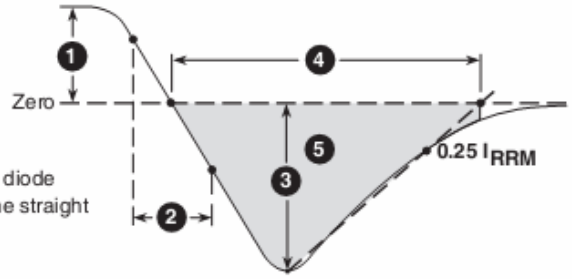
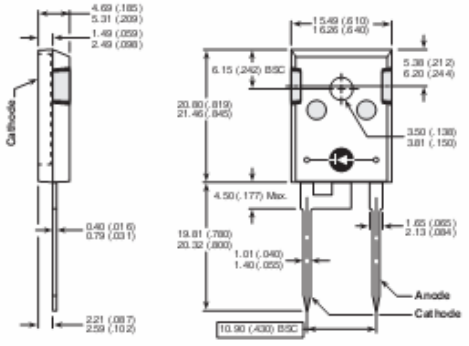


Figure 10, Diode Reverse Recovery Waveform and Definitions

TO-247 Package Outline

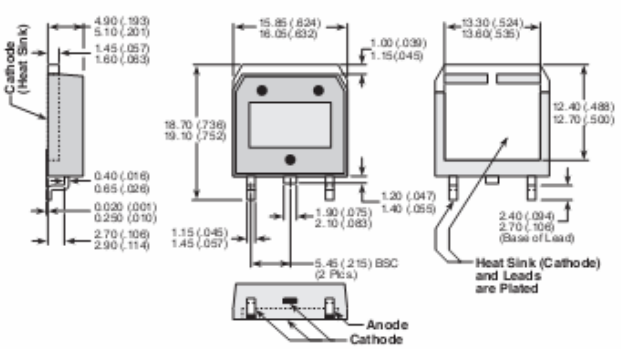
(e1) SAC: Tin, Silver, Copper



Dimensions in Millimeters and (Inches)

D^{3}PAK Package Outline

(e3) 100% Sn



Dimensions in Millimeters (Inches)