WING ON GROUP

POWER™

PFP12N65E/PFF12N65E
650V N-Channel MOSFET

FEATURES
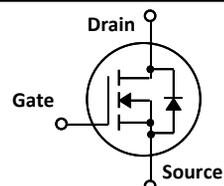
❑ Originative New Design
❑ 100% EAS Test
❑ Rugged Gate Oxide Technology
❑ Extremely Low Intrinsic Capacitances
❑ Remarkable Switching Characteristics
❑ Unequalled Gate Charge : 40 nC (Typ.)
❑ Extended Safe Operating Area
❑ Lower $R_{DS(ON)}$: 0.48 Ω (Typ.) @V_{GS}=10V

APPLICATION

❑ High current, High speed switching
❑ Suitable for power supplies, adaptors and PFC
❑ SMPS (Switched Mode Power Supplies)

BV_{DSS} = 650 V

$R_{DS(on)\ typ}$ = 0.48 Ω

I_D = 12.2 A

Drain
Gate
Source

TO-220

1.Gate 2. Drain 3. Source

TO-220F

1.Gate 2. Drain 3. Source

Absolute Maximum Ratings T_C=25℃ unless otherwise specified

Symbol	Parameter		PFP12N65E	PFF12N65E	Units
V_{DSS}	Drain-Source Voltage		650		V
I_D	Drain Current – Continuous (T_C = 25℃)		12.2	12.2*	A
	Drain Current – Continuous (T_C = 100℃)		7.7	7.7*	A
I_{DM}	Drain Current – Pulsed (Note 1)		48.8	48.8*	A
V_{GS}	Gate-Source Voltage		±30		V
E_{AS}	Single Pulsed Avalanche Energy (Note 2)		950		mJ
I_{AR}	Avalanche Current (Note 1)		12		A
E_{AR}	Repetitive Avalanche Energy (Note 1)		22		mJ
dv/dt	Peak Diode Recovery dv/dt (Note 3)		5.5		V/ns
P_D	Power Dissipation (T_C = 25℃)		223	51	W
	- Derate above 25℃		1.78	0.41	W/℃
T_J, T_{STG}	Operating and Storage Temperature Range		-55 to +150		℃
V_{ISO}	Insulation withstand voltage (DC)		-	3000	V
T_L	Maximum lead temperature for soldering purposes, 1/8" from case for 5 seconds		300		℃

* Drain current limited by maximum junction temperature

Thermal Resistance Characteristics

Symbol	Parameter	PFP12N65E	PFF12N65E	Units
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case	0.56	2.43	℃/W
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink	0.5	--	
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	62.5	62.5	

Electrical Characteristics T_C=25 °C unless otherwise specified

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
On Characteristics						
V_{GS}	Gate Threshold Voltage	$V_{DS} = V_{GS}$, I_D = 250 uA	2.0	--	4.0	V
$R_{DS(ON)}$	Static Drain-Source On-Resistance	V_{GS} = 10 V, I_D = 6.0 A	--	0.48	0.60	Ω
Off Characteristics						
BV_{DSS}	Drain-Source Breakdown Voltage	V_{GS} = 0 V, I_D = 250 uA	650	--	--	V
ΔBV_{DSS} /ΔT_J	Breakdown Voltage Temperature Coefficient	I_D = 250 uA, Referenced to25 ℃	--	0.5	--	V/℃
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 650 V, V_{GS} = 0 V	--	--	10	uA
		V_{DS} = 520 V, T_C = 125 ℃	--	--	100	uA
I_{GSSF}	Gate-Body Leakage Current, Forward	V_{GS} = 30 V, V_{DS} = 0 V	--	--	100	nA
I_{GSSR}	Gate-Body Leakage Current, Reverse	V_{GS} = -30 V, V_{DS} = 0 V	--	--	-100	nA
Dynamic Characteristics						
C_{iss}	Input Capacitance	V_{DS} = 25 V, V_{GS} = 0 V, f = 1.0 MHz	--	2630	3420	pF
C_{oss}	Output Capacitance		--	200	260	pF
C_{rss}	Reverse Transfer Capacitance		--	45	60	pF
R_g	Gate Input Resistance	f = 1.0 MHz, open drain	--	1.5	--	Ω
Switching Characteristics						
$t_{d(on)}$	Turn-On Time	V_{DS} = 325 V, I_D = 12.0 A, R_G = 25 Ω, R_L = 27 Ω	--	45	65	ns
t_r	Turn-On Rise Time		--	65	100	ns
$t_{d(off)}$	Turn-Off Delay Time		--	40	60	ns
t_f	Turn-Off Fall Time	(Note 4,5)	--	20	30	ns
Q_g	Total Gate Charge	V_{DS} = 520 V, I_D = 12.0 A, V_{GS} = 10 V	--	41	52	nC
Q_{gs}	Gate-Source Charge		--	15	--	nC
Q_{gd}	Gate-Drain Charge	(Note 4,5)	--	7	--	nC
Source-Drain Diode Maximum Ratings and Characteristics						
I_S	Continuous Source-Drain Diode Forward Current		--	--	12.2	A
I_{SM}	Pulsed Source-Drain Diode Forward Current		--	--	48.8	
V_{SD}	Source-Drain Diode Forward Voltage	I_S = 12 A, V_{GS} = 0 V	--	--	1.5	V
trr	Reverse Recovery Time	I_S = 12 A, V_{GS} = 0 V	--	390	--	us
Qrr	Reverse Recovery Charge	di_F/dt = 100 A/μs (Note 4)	--	4.5	--	uC

Notes ;

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2. I_{AS}=12A, V_{DD}=50V, R_G=25Ω, Starting T_J =25°C
3. I_{SD}≤12A, di/dt≤300A/μs, V_{DD}≤BV_{DSS} , Starting T_J =25 °C
4. Pulse Test : Pulse Width ≤ 300μs, Duty Cycle ≤ 2%
5. Essentially Independent of Operating Temperature

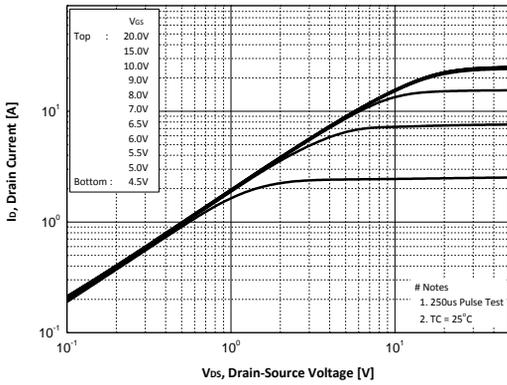# Typical Characteristics

Figure1. On Region Characteristics

	V_{GS}
Top :	20.0V
	15.0V
	10.0V
	9.0V
	8.0V
	7.0V
	6.5V
	6.0V
	5.5V
	5.0V
Bottom :	4.5V

I_D, Drain Current [A]

V_{DS}, Drain-Source Voltage [V]

Notes
1. 250us Pulse Test
2. TC = 25°C

Figure 2. Transfer Characteristics

I_D, Drain Current [A]

V_{GS}, Gate-Source Voltage [V]

150°C
75°C
25°C

Notes
1. VDS = 40V
2. 250us Pulse Test
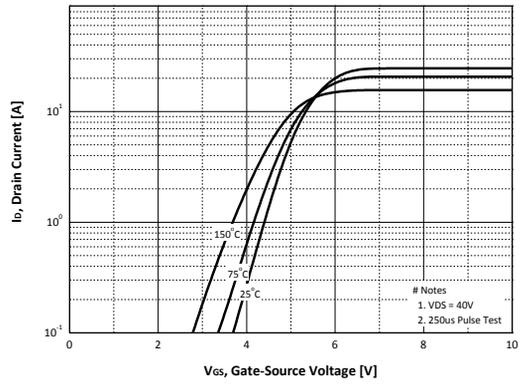
Figure 3. Static Drain-Source On Resistance

Drain-Source On-Resistance [ohm]

I_D, Drain Durrent [A]

VGS = 10V
VGS = 20V

Notes
1. TJ = 25°C
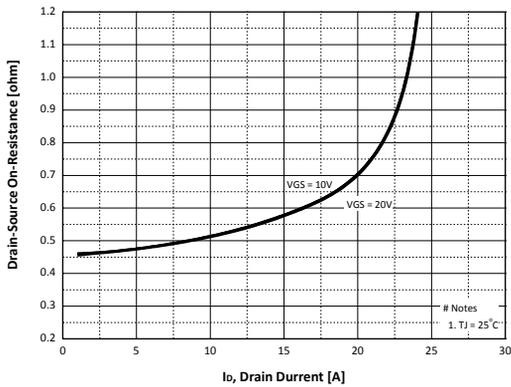
Figure 4. Body Diode Forward Voltage

I_{DR}, Reverse Drain Current [A]

V_{SD}, Source-Drain Voltage [V]

150°C
75°C
25°C

Notes
1. VGS = 0V
2. 250us Pulse Test
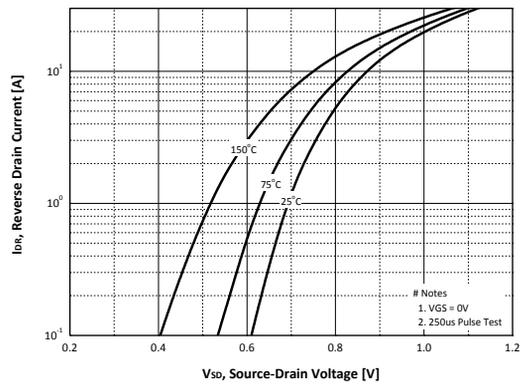
Figure 5. Capacitance Charateristics

Capacitance [pF]

V_{DS}, Drain-Source Voltage [V]

Ciss = Cgs + Cgd (Cds=Shorted)
Coss = Cds + Cgd
Crss = Cgd

Ciss
Coss
Crss

Notes
1. VGS = 0V
2. f = 1 MHz
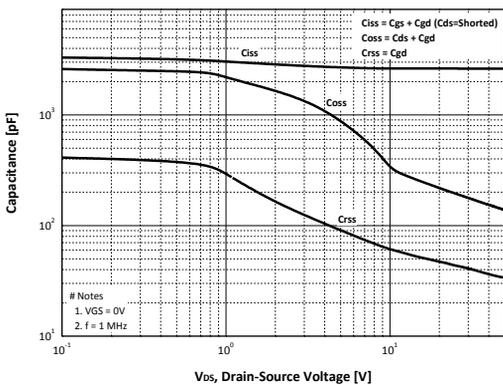
Figure 6. Gate Charge Characteristics

V_{GS}, Gate-Source Voltage [V]

Q_g, Total Gate Charge [nC]

V_{DS} = 520V
V_{DS} = 325V
V_{DS} = 130V

Note
1. ID = 12.0A
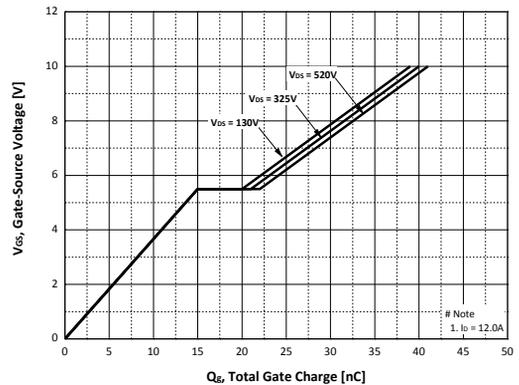
Typical Characteristics   (continued)

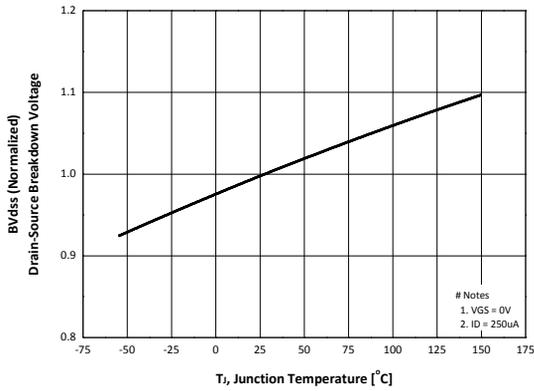**Figure 7. Breakdown Voltage Variation
vs. Temperature**

**Figure 8. On-Resistance Variation
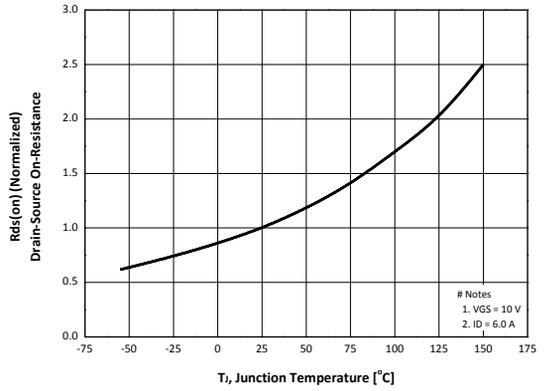vs. Temperature**
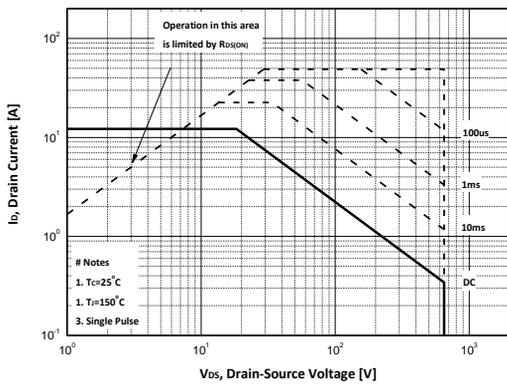

**Figure 9-1. Safe Operation Area
for PFP12N65E**

**Figure 9-2. Safe Operation Area
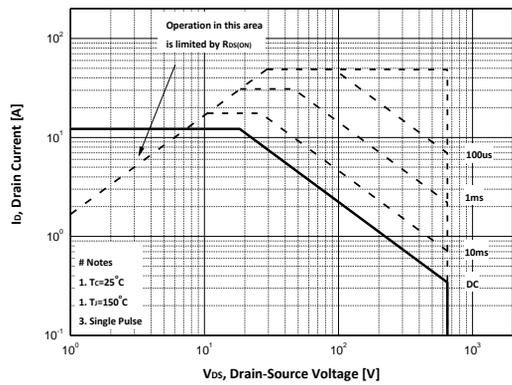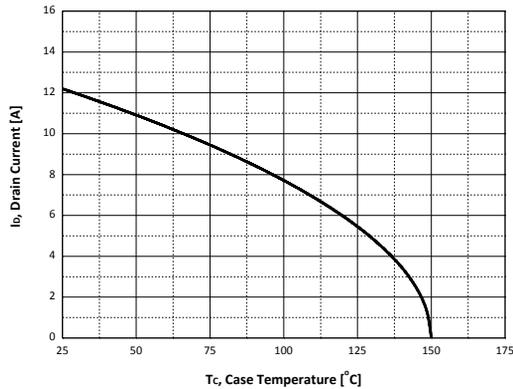for PFF12N65E**

**Figure 10. Maximum Drain Current
vs. Case Temperature**

Typical Characteristics   (continued)

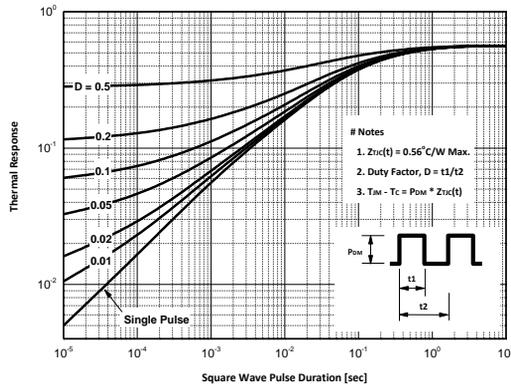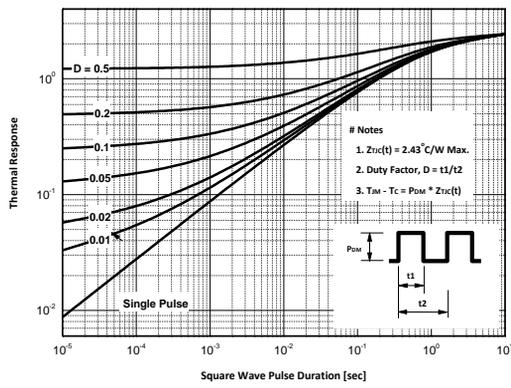**Figure 11-1. Transient Thermal Response Curve
for PFP12N65E**

Notes
1. $Z_{TJC}(t) = 0.56^\circ C/W$ Max.
2. Duty Factor, $D = t1/t2$
3. $T_{JM} - T_C = P_{DM} * Z_{TJC}(t)$

**Figure 11-2. Transient Thermal Response Curve
for PFF12N65E**

Notes
1. $Z_{TJC}(t) = 2.43^\circ C/W$ Max.
2. Duty Factor, $D = t1/t2$
3. $T_{JM} - T_C = P_{DM} * Z_{TJC}(t)$

Characteristics Test Circuit & Waveform

V_{DS} R_L

V_{DD}
(0.5 rated V_{DS})

R_G

10V

DUT

V_{DS}

90%

V_{in}

10%

$t_{d(on)}$ t_r

t_{on}

$t_{d(off)}$ t_f

t_{off}
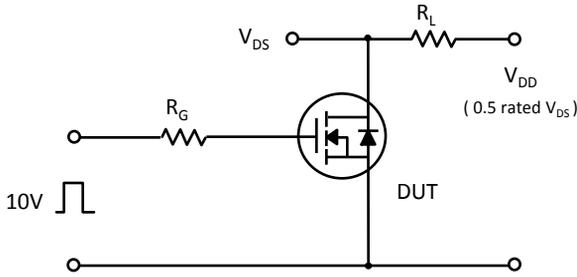
Fig 14. Resistive Switching Test Circuit & Waveforms

Same Type
as DUT

12V 200nF 50KΩ 300nF

V_{GS}

DUT

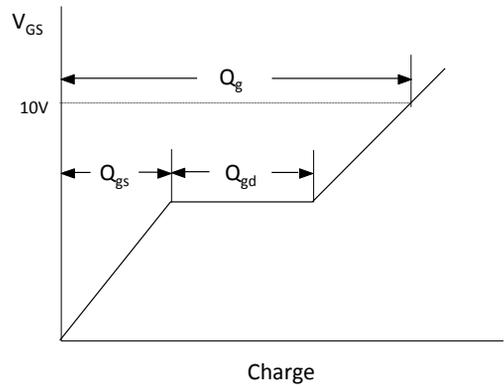3mA

V_{DS}

V_{GS}

Q_g

10V

Q_{gs} Q_{gd}
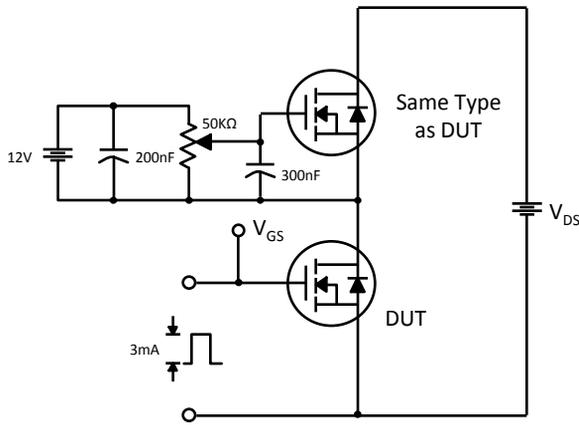
Charge

Fig 15. Gate Charge Test Circuit & Waveform

V_{DS} L

V_{DD}

I_D

R_G

10V

DUT

$$E_{AS} = \frac{1}{2} \, L_L \, I_{AS}{}^2 \, \frac{BV_{DSS}}{BV_{DSS} -- V_{DD}}$$

BV_{DSS}

I_{AS}

$I_D(t)$

V_{DD}

$V_{DS}(t)$

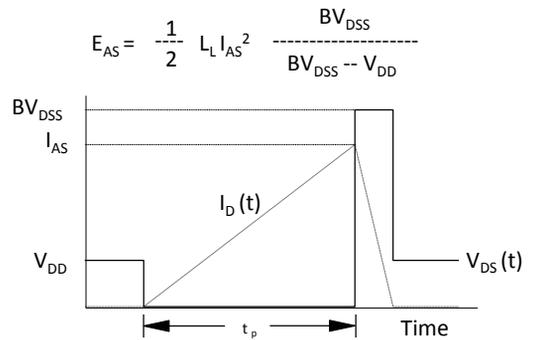t_p Time

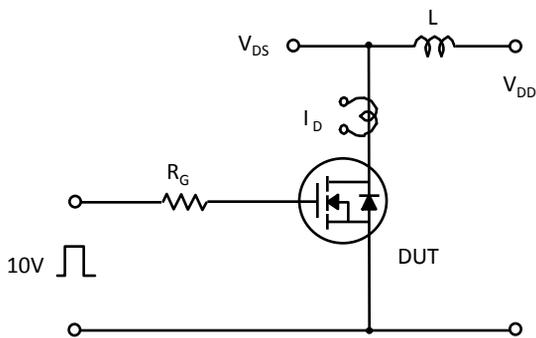**Fig 16. Unclamped Inductive Switching Test Circuit & Waveforms**

Characteristics Test Circuit & Waveform (continued)

DUT

+

V_{DS}

−

I_S

L

Driver

R_G

Same Type
as DUT

V_{DD}

V_{GS}

• dv/dt controlled by R_G
• I_S controlled by pulse period

V_{GS}
(Driver)

$D = \dfrac{\text{Gate Pulse Width}}{\text{Gate Pulse Period}}$

10V

I_S
(DUT)

I_{FM} , Body Diode Forward Current

di/dt

I_{RM}

Body Diode Reverse Current

V_{DS}
(DUT)

Body Diode Recovery dv/dt
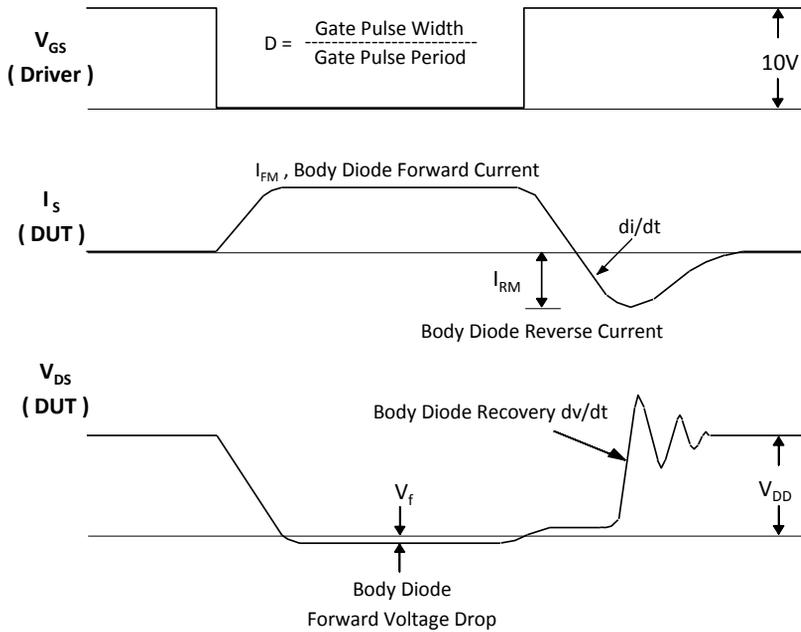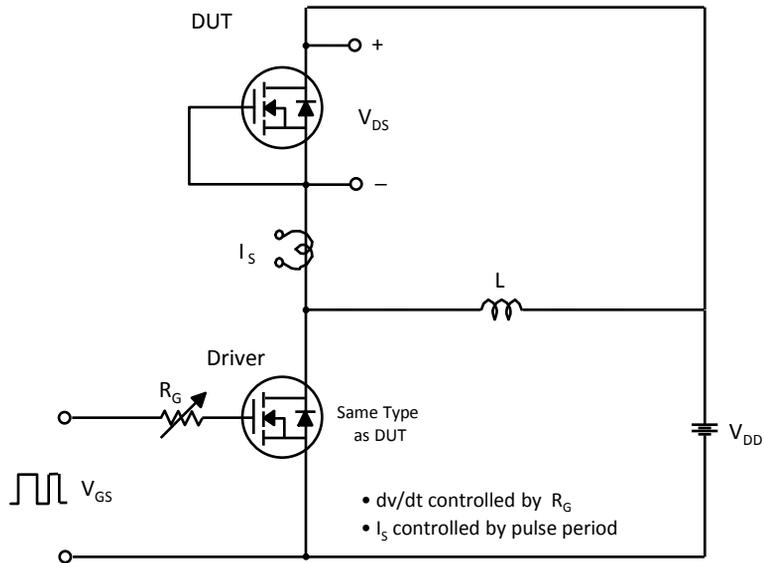
V_f

V_{DD}

Body Diode
Forward Voltage Drop

Fig 17. Peak Diode Recovery dv/dt Test Circuit & Waveforms

Package Dimension

TO-220

Package Dimension

TO-220F (type1)

Package Dimension

TO-220F (type2)