

NTS2216T03S4

N+P-Channel Enhancement Mode Trench Power MOSFET



Voltage: ±30 Volts

Current: +29/-24 Ampers

Package: TO-252-4L

Features

- NH'S Advanced Trench Technology
- Low Rds(on) For Low On-State Loss
- High EAS For High Reliability
- Excellent Qg*Rds(on) Product(FOM)
- Built-in ESD Protected

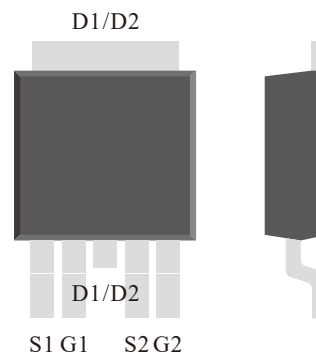
Typical Applications

- DC-DC Converter
- Battery Management System(BMS)
- Printed Circuit Board For Control Circuit
- Uninterruptible Power Supplies(UPS)

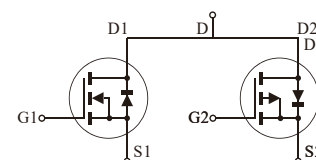
Product Summary

Types of MOS	N	P	Unit
VDS Min.@Tj	30	-30	V
N-ID Min.@Ta	29	-24	A
N-RDS(ON) Type@10V	16	22	mΩ

Diagram:



Polarity:



***100% UIS TESTED**

***100% ΔVDS TESTED**

Absolute Maximum Ratings (Ta=25°C Unless Otherwise Specified)

Parameter	Test Conditions	Symbol	N-Ch Ratings	P-Ch Ratings	Unit
Drain-Source Voltage		V_{DS}	30	-30	V
Gate-Source Voltage		V_{GS}	±20	±20	V
Continuous Drain Current (Note 1)	Ta= 25 °C	I_D	29	-24	A
	Ta= 100 °C		18	-15	
Drain Current-Pulsed (Note 1)	Tj< 150 °C	I_{DM}	114	-95	A
Maximum Power Dissipation Power	Ta= 25 °C	P_D	26.0	25.0	W
	Ta= 100 °C		10.4	10.0	
Derating Factor		D_F	0.21	0.20	W/°C
Avalanche Current,Single Pulse (Note 1)	L= 0.5 mH	I_{AS}	11.0	-10.0	A
Single Pulse Avalanche Energy (Note 1) Test Circuit & Waveform See Fig.16	L= 0.5 mH IAS= N/P A,RG= 10 Ω Starting Tj=25 °C,VG = 10 V	E_{AS}	30	25	mJ

Thermal Characteristics (Ta=25°C Unless Otherwise Specified)

Parameter	Test Conditions	Symbol	N-Ch Ratings	P-Ch Ratings	Unit
Junction Temperature		T_J	-55 to 150	-55 to 150	°C
Storage Temperature Range		T_{STD}	-55 to 150	-55 to 150	°C
Thermal Resistance Junction To Ambient With Steady-State	Still Air Environment With Ta=25°C	$R_{θJA}$	60.0	60.0	°C/W
Thermal Resistance Junction-Case With Steady-State	FALSE	$R_{θJC}$	4.8	5.0	

Notes: 1. Pulse Width Limited By Max. Junction Temperature. (See Fig. 13).

NTS2216T03S4

N+P-Channel Enhancement Mode Trench Power MOSFET


N-Channel Electrical Characteristics (Ta=25°C Unless Otherwise Specified)

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Static off Characteristics						
Drain-Source Breakdown Voltage	VGS=0V,ID=250uA	BV_{DSS}	30	--	--	V
Bvdss Temperature Coefficient	ID=250uA,Reference25℃	$\Delta BV_{DSS}/\Delta T_J$	--	0.034	--	V/℃
Drain-Source Leakage Current	VDS= 24 V,VGS=0V	I_{DSS}	--	--	1	uA
Gate-Body Leakage Current	VGS= ±20 V,VDS=0V	I_{GSS}	--	--	±100	nA
Forward Transconductance	ID= 14 A,VDS= 5 V	gfs	--	5	--	S
Static on Characteristics						
Gate Threshold Voltage	VGS= VDS ID=250uA	$V_{GS(TH)}$	1.2	1.6	2.0	V
Drain-Source On Resistance	ID= 14 A,VGS= 10 V	$R_{DS(ON)}$	--	16	21	mΩ
	ID= 14 A,VGS= 4.5 V		--	24	32	
Dynamic Characteristics						
Input Capacitance	VDS= 15 V	C_{iss}	--	650.0	--	pF
Output Capacitance	VGS= 0 V	C_{oss}	--	80.0	--	pF
Reverse Transfer Capacitance	F= 1 MHZ	C_{rss}	--	65.0	--	pF
Gate Resistance	VGS=0V,VDS=0V, Freq.=1MHz	R_g	--	1.50	--	Ω
Switching Paramters (Test Circuit & Waveform See Fig.14)						
Turn-On Delay Time	VDS= 15 V	$t_{d(on)}$	--	5.0	--	ns
Turn-On Rise Time	VGS= 10 V	t_r	--	3.0	--	ns
Turn-Off Delay Time	RG= 10 Ω	$t_{d(off)}$	--	15.0	--	ns
Turn-Off Rise Time		t_f	--	4.0	--	ns
Gate Charge Paramters (Test Circuit & Waveform See Fig.15)						
Total Gate Charge	VDS= 15 V	Q_g	--	15.0	--	nC
Gate-Source Charge	VGS= 10 V	Q_{gs}	--	2.5	--	nC
Gate-Drain Charge	ID= 14 A	Q_{gd}	--	3.5	--	nC
Drain-Source Diode Characteristics And Maximum Ratings (Test Circuit & Waveform See Fig.17)						
Max. Diode Forward Cuurent		I_S	--	--	28.5	A
Max. Pulsed Forward Cuurent		I_{SM}	--	--	100	A
Diode Forward Voltage	ID= 14 A,VGS=0V	V_{SD}	--	0.86	1.2	V
Reverse Recovery Time	ID= 14 A,di/dt= 100 A/us	t_{rr}	--	10	--	ns
Reverse Recovery Charge	VGS= 10 V,VDS= 12 V	Q_{rr}	--	5.0	--	nC
Reverse Recovery Current		I_{RRM}	--	1.0	--	A

NTS2216T03S4

N+P-Channel Enhancement Mode Trench Power MOSFET


P-Channel Electrical Characteristics (Ta=25°C Unless Otherwise Specified)

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Static off Characteristics						
Drain-Source Breakdown Voltage	VGS=0V,ID=-250uA	BV_{DSS}	-30	--	--	V
Bvdss Temperature Coefficient	ID=-250uA,Reference 25℃	$\Delta BV_{DSS}/\Delta T_J$	--	0.034	--	V/℃
Drain-Source Leakage Current	VDS= -24 V,VGS=0V	I_{DSS}	--	--	-1	uA
Gate-Body Leakage Current	VGS= ±20 V,VDS=0V	I_{GSS}	--	--	±100	nA
Forward Transconductance	ID= -12 A,VDS= -5 V	gfs	--	6.5	--	S
Static on Characteristics						
Gate Threshold Voltage	VGS= VDS ID=-250uA	$V_{GS(TH)}$	-0.7	-1.1	-1.5	V
Drain-Source On Resistance	ID= -12 A,VGS= -10 V	$R_{DS(ON)}$	--	22	30	mΩ
	ID= -12 A,VGS= -4.5 V		--	33	45	
Dynamic Characteristics						
Input Capacitance	VDS= -15 V	C_{iss}	--	600.0	--	pF
Output Capacitance	VGS= 0 V	C_{oss}	--	70.0	--	pF
Reverse Transfer Capacitance	F= 1 MHZ	C_{rss}	--	55.0	--	pF
Gate Resistance	VGS=0V,VDS=0V, Freq.=1MHz	R_g	--	4.5	--	Ω
Switching Paramters (Test Circuit & Waveform See Fig.31)						
Turn-On Delay Time	VDS= -15 V	$t_{d(on)}$	--	7.0	--	ns
Turn-On Rise Time	VGS= -10 V	t_r	--	5.0	--	ns
Turn-Off Delay Time	RG= 10 Ω	$t_{d(off)}$	--	18.0	--	ns
Turn-Off Rise Time		t_f	--	6.0	--	ns
Gate Charge Paramters (Test Circuit & Waveform See Fig.32)						
Total Gate Charge	VDS= -15 V	Q_g	--	15.0	--	nC
Gate-Source Charge	VGS= -10 V	Q_{gs}	--	1.5	--	nC
Gate-Drain Charge	ID= -12 A	Q_{gd}	--	3.5	--	nC
Drain-Source Diode Characteristics And Maximum Ratings (Test Circuit & Waveform See Fig.34)						
Max. Diode Forward Cuurent		I_S	--	--	-24	A
Max. Pulsed Forward Cuurent		I_{SM}	--	--	-83	A
Diode Forward Voltage	ID= -12 A,VGS=0V	V_{SD}	--	-0.8	-1.2	V
Reverse Recovery Time	ID= -12 A,di/dt= 100 A/us	t_{rr}	--	15	--	ns
Reverse Recovery Charge	VGS= -10 V,VDS= -12 V	Q_{rr}	--	10	--	nC
Reverse Recovery Current		I_{RRM}	--	1.0	--	A

NTS2216T03S4

N+P-Channel Enhancement Mode Trench Power MOSFET



N-Channel Typical Characteristics Curves

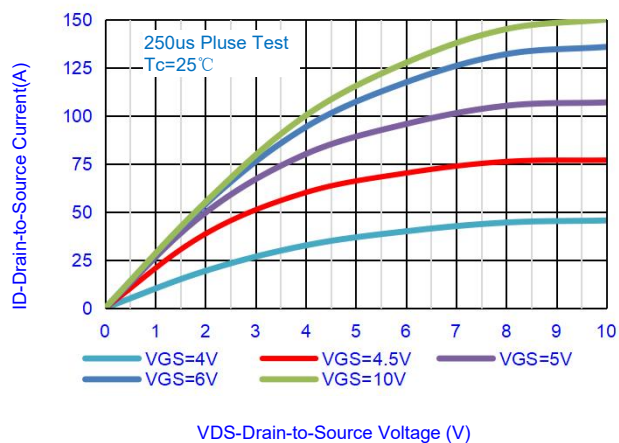


Fig.1-Output Characteristics

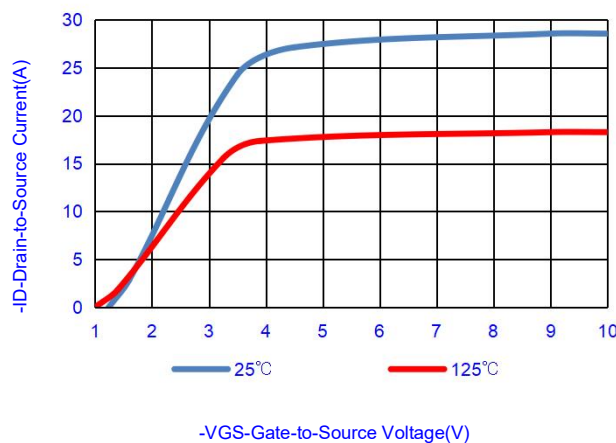


Fig.2- Transfer Characteristics

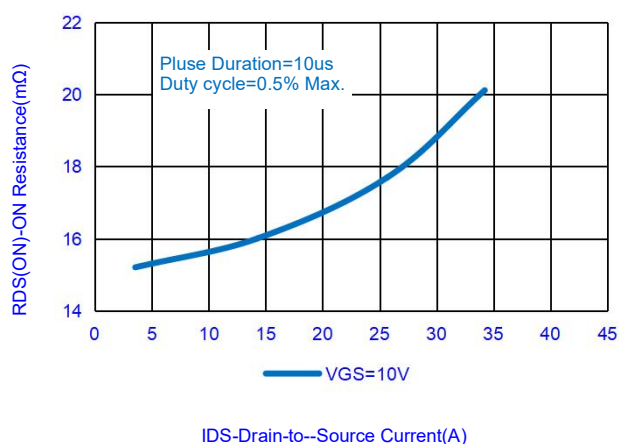


Fig.3- On Resistance vs. Drain Current

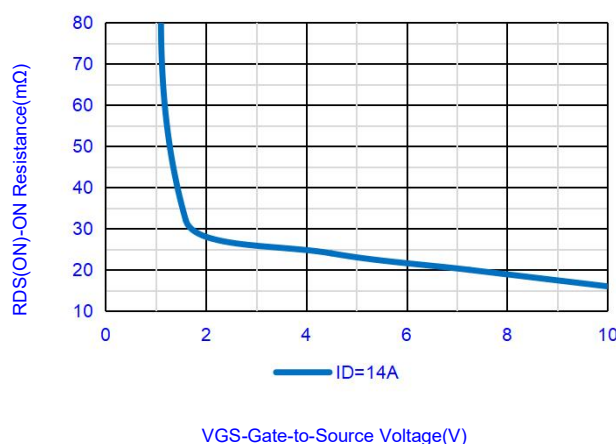


Fig.4- On Resistance vs. Gate Source Voltage

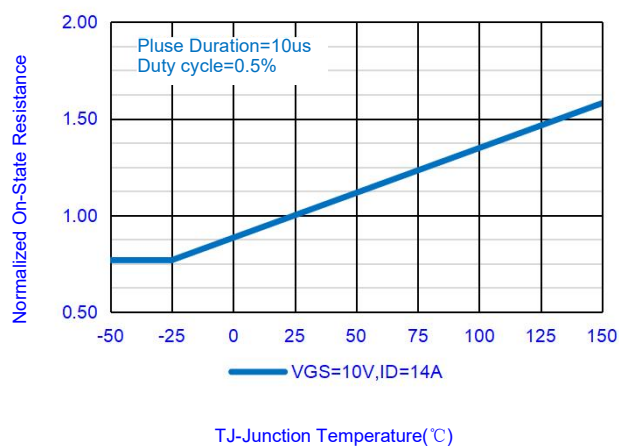


Fig.5- On Resistance vs. Junction Temperature

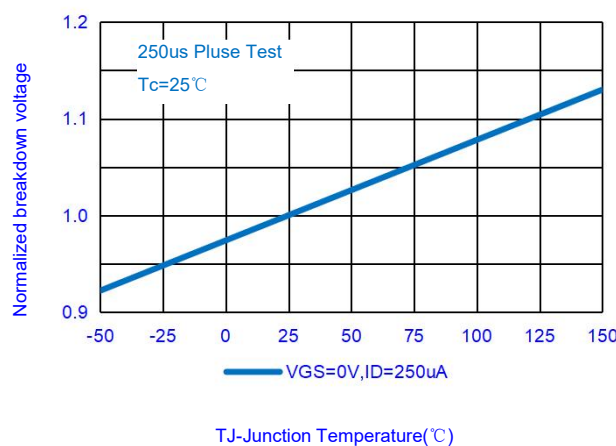


Fig.6- Breakdown Voltage vs. Junction Temperature

NTS2216T03S4

N+P-Channel Enhancement Mode Trench Power MOSFET



N-Channel Typical Characteristics Curves

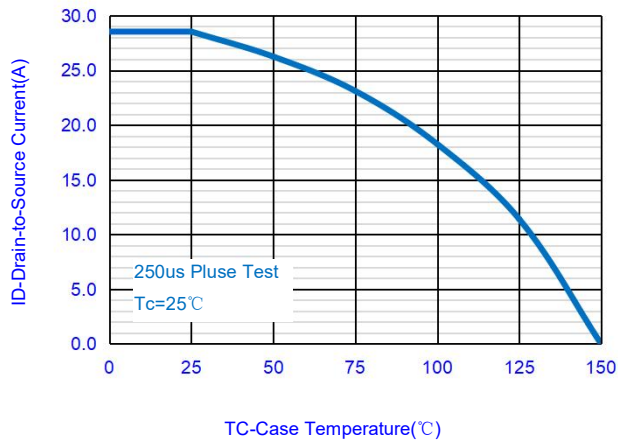


Fig.7-Maximum Continuous Drain Current vs. Case Temperature

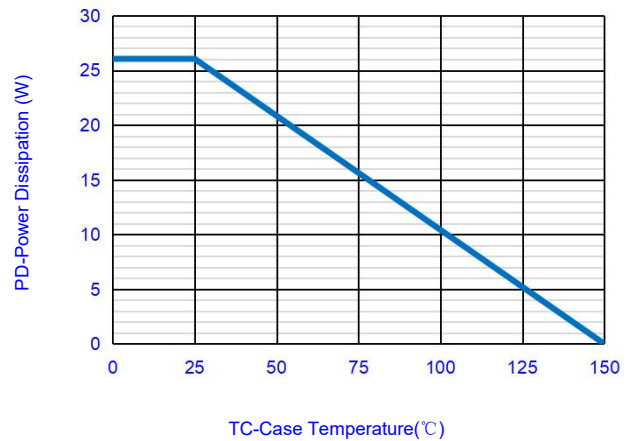


Fig.8-Maximum Power Dissipation vs. Case Temperature

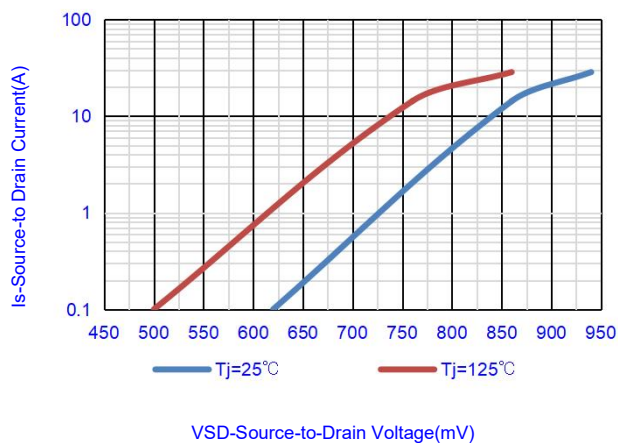


Fig.9- Source-Drain Diode Forward Voltage

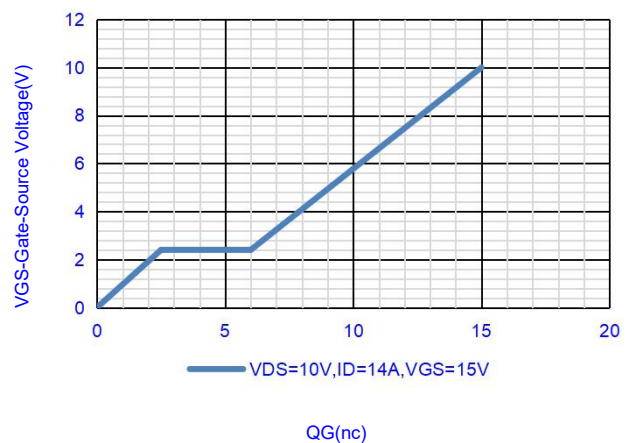


Fig.10-Gate Charge Waveform

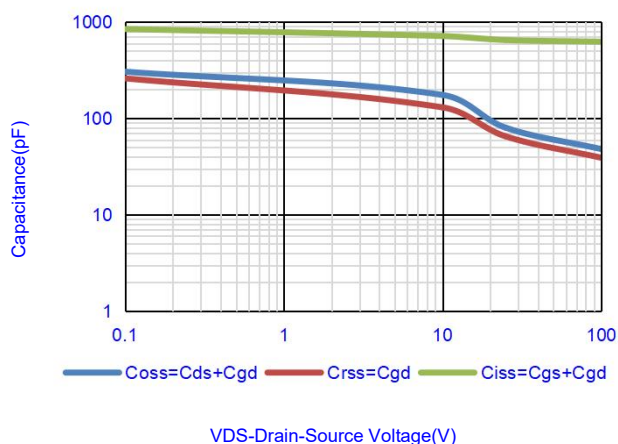


Fig.11- Gate-Source Voltage-VGS(V)

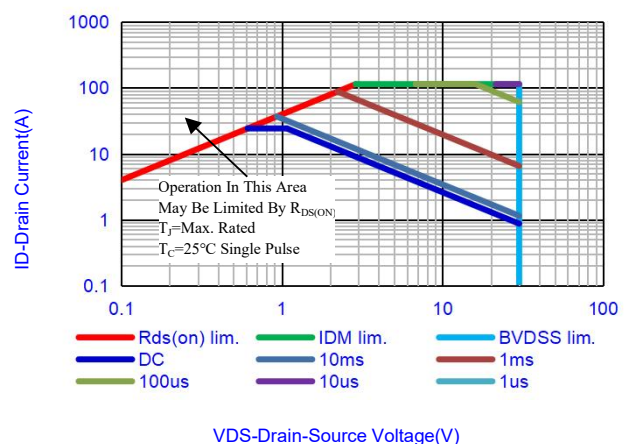


Fig.12-Maximum Safe Operating Area(SOA)

NTS2216T03S4

N+P-Channel Enhancement Mode Trench Power MOSFET



N-Channel Typical Characteristics Curves

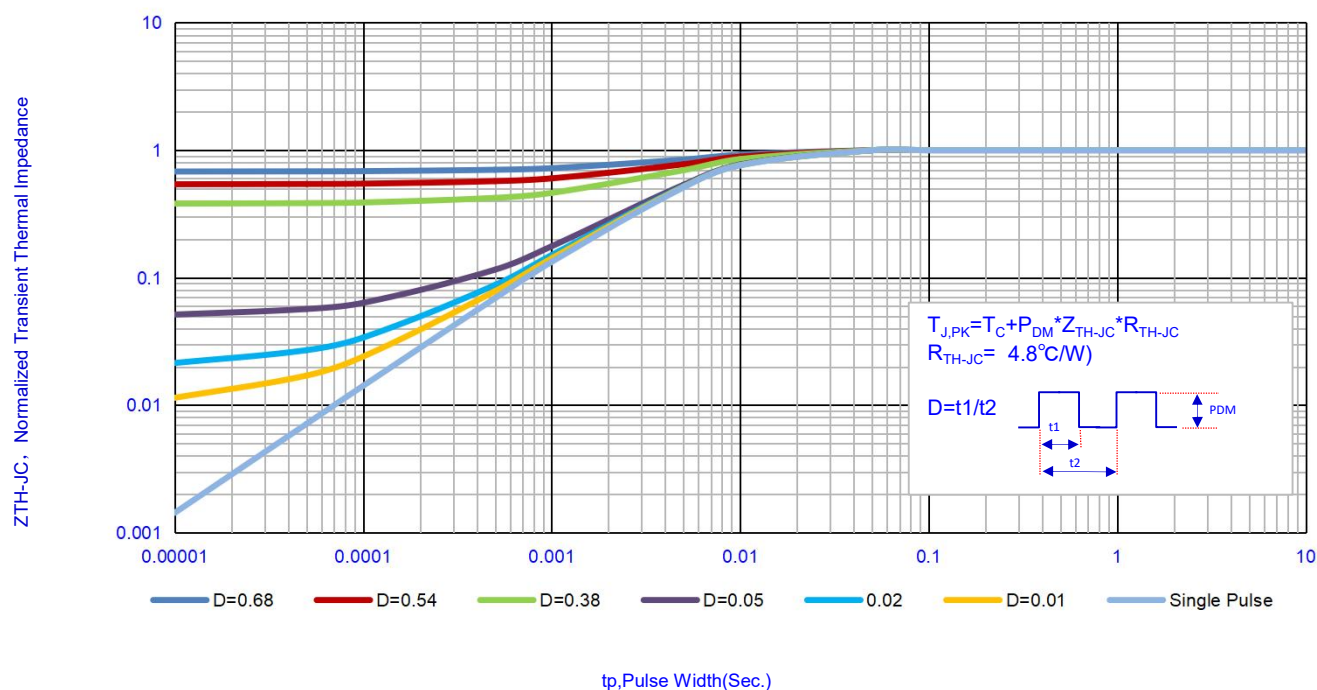


Fig.13- Normalized Maximum Transient Thermal Impedance vs. Pulse Width

N-Channel Test Circuit & Waveform

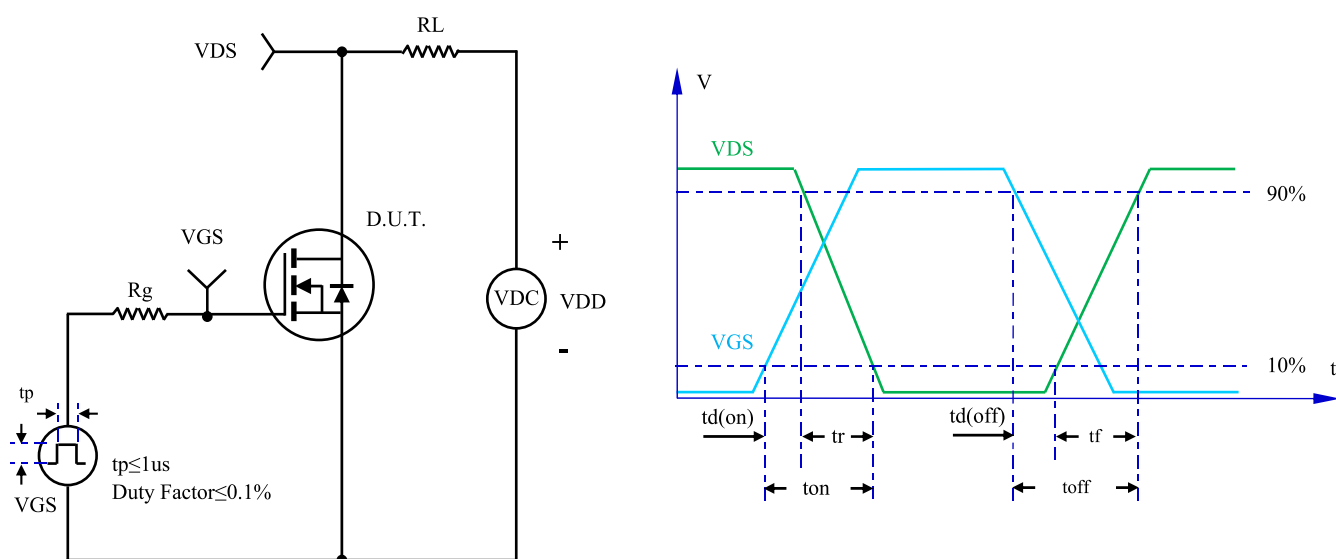


Fig.14- Resistive Switching Test Circuit & Waveform

NTS2216T03S4

N+P-Channel Enhancement Mode Trench Power MOSFET



N-Channel Test Circuit & Waveform

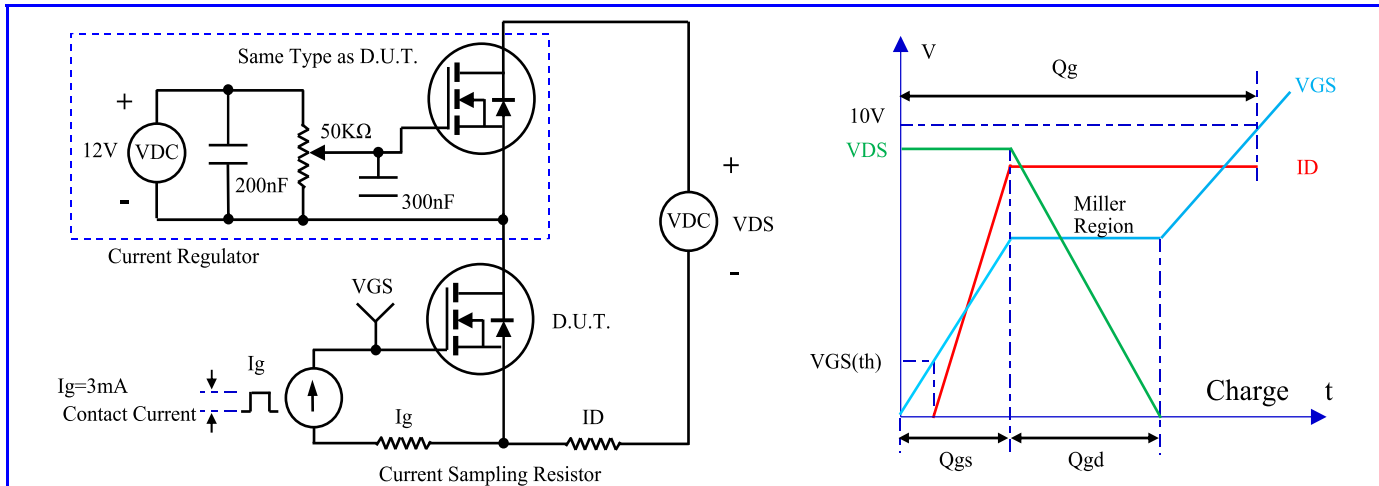


Fig.15- Gate Charge Test Circuit & Waveform

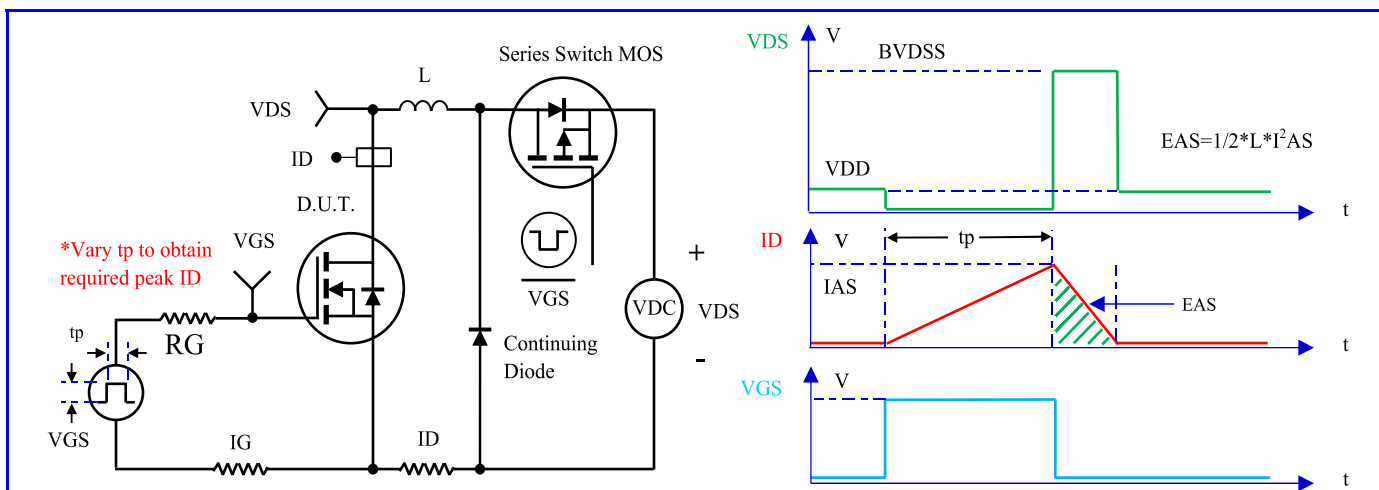


Fig.16- EAS Test Circuit & Waveform

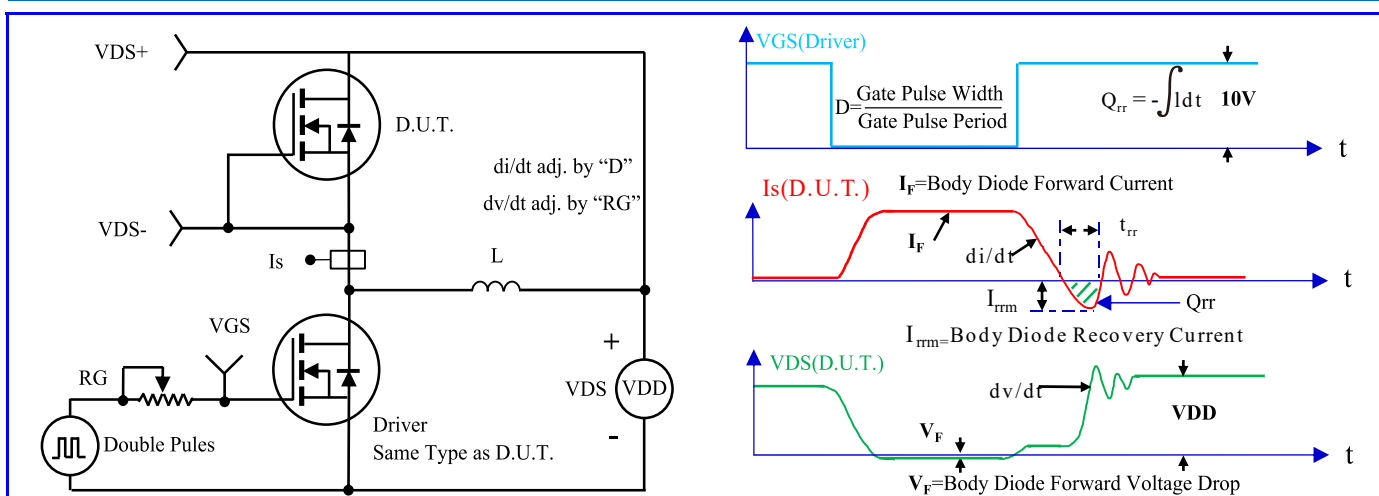


Fig.17- Diode Recovery Test Circuit & Waveform

NTS2216T03S4

N+P-Channel Enhancement Mode Trench Power MOSFET



P-Channel Typical Characteristics Curves

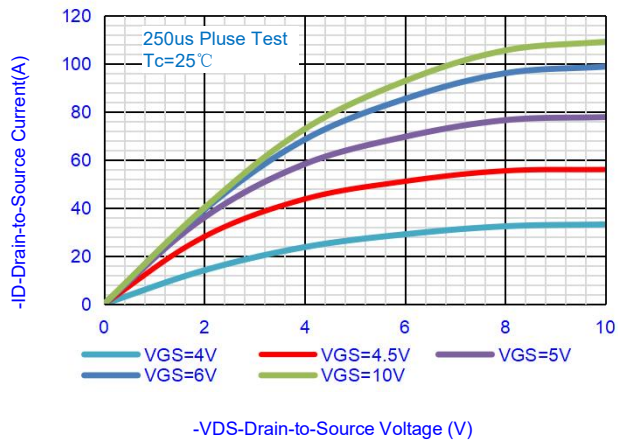


Fig.18-Output Characteristics

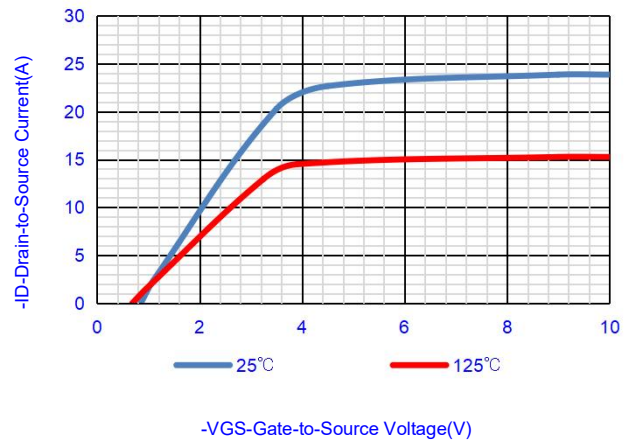


Fig.19- Transfer Characteristics

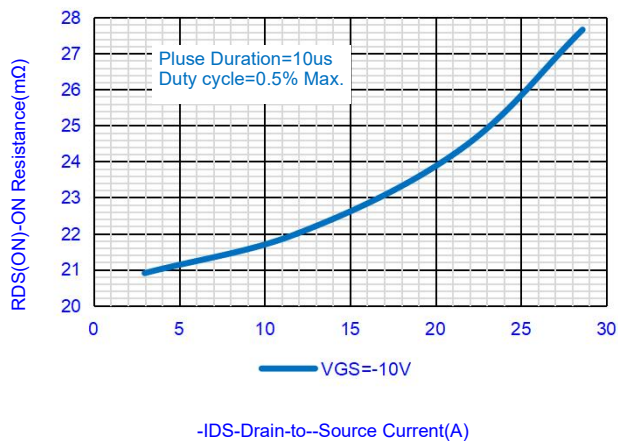


Fig.20- On Resistance vs. Drain Current

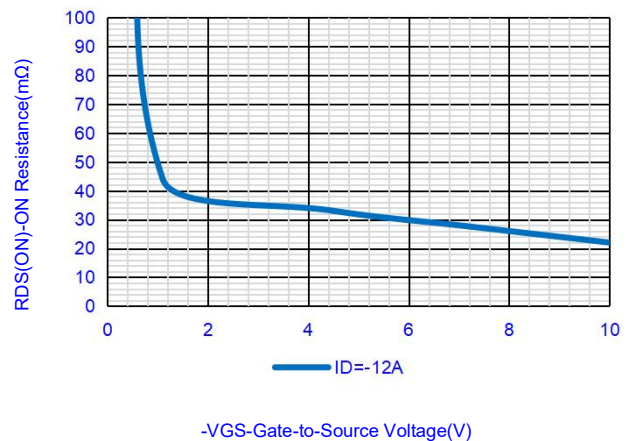


Fig.21- On Resistance vs. Gate Source Voltage

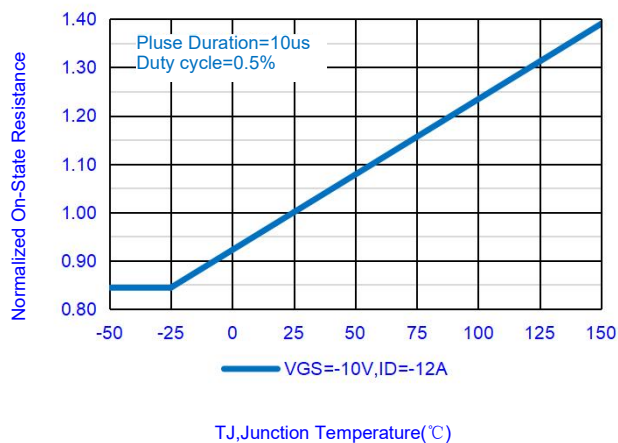


Fig.22- On Resistance vs. Junction Temperature

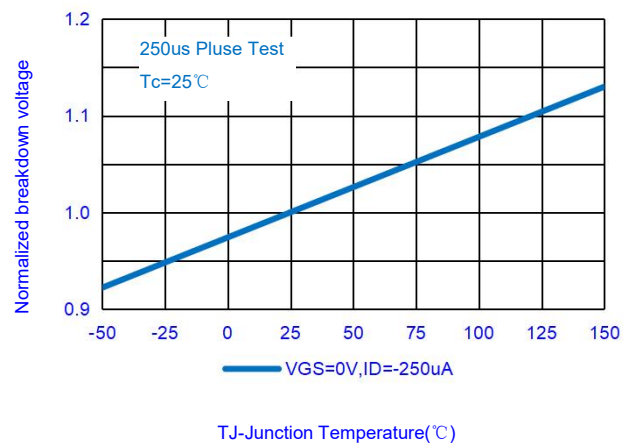


Fig.23- Breakdown Voltage vs. Junction Temperature

NTS2216T03S4

N+P-Channel Enhancement Mode Trench Power MOSFET



P-Channel Typical Characteristics Curves

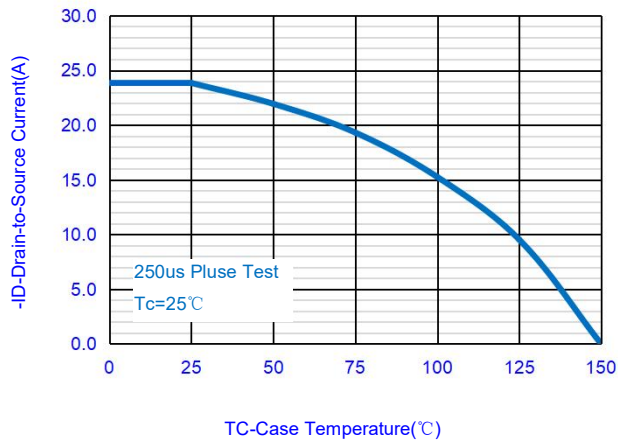


Fig.24-Maximum Continuous Drain Current vs. Case Temperature

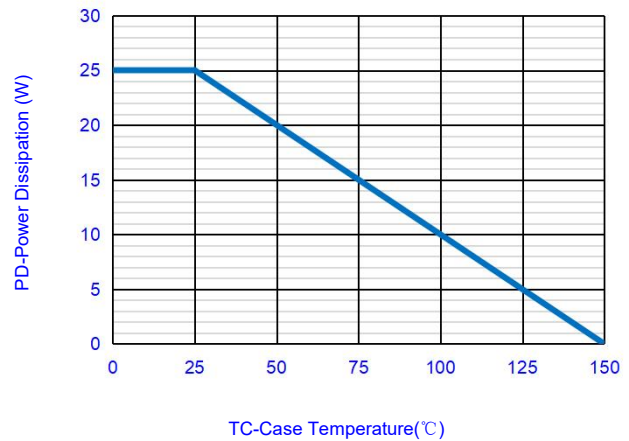


Fig.25-Maximum Power Dissipation vs. Case Temperature

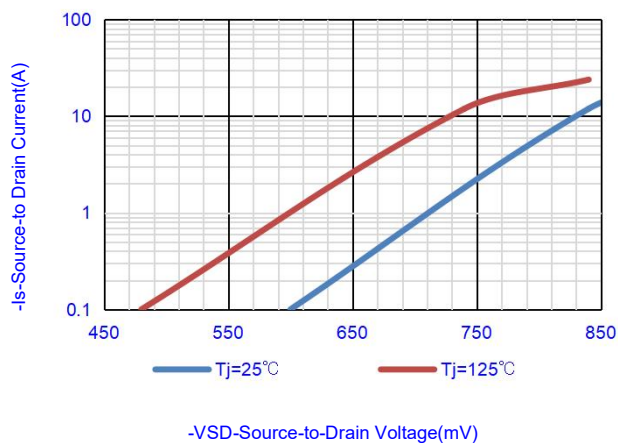


Fig.26- Source-Drain Diode Forward Voltage

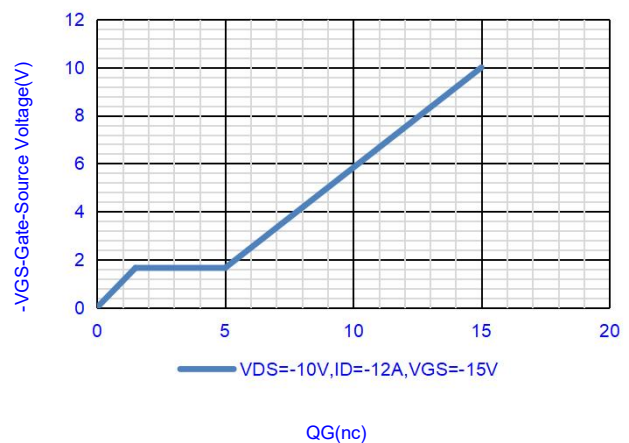


Fig.27-Gate Charge Waveform

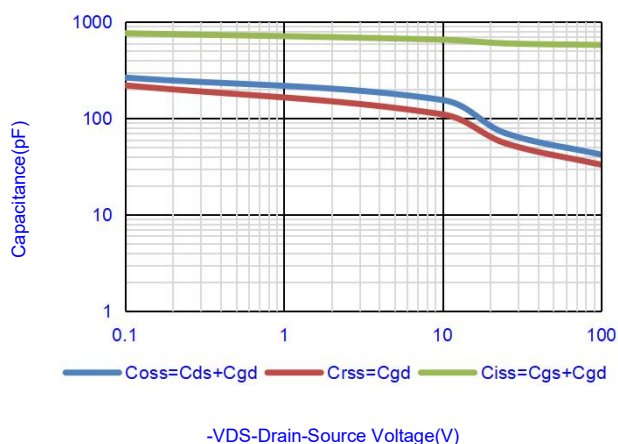


Fig.28- Gate-Source Voltage-VGS(V)

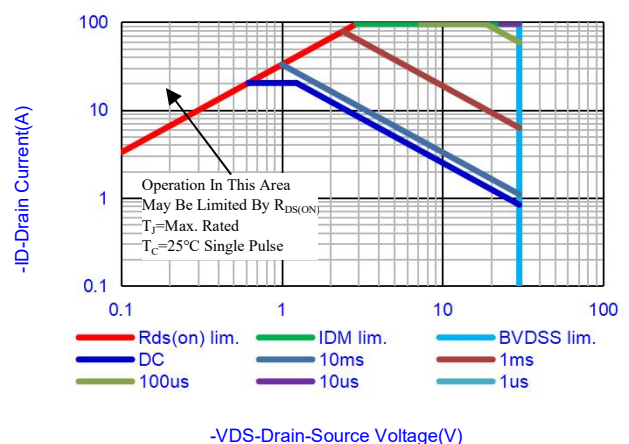


Fig.29-Maximum Safe Operating Area(SOA)

NTS2216T03S4

N+P-Channel Enhancement Mode Trench Power MOSFET



P-Channel Typical Characteristics Curves

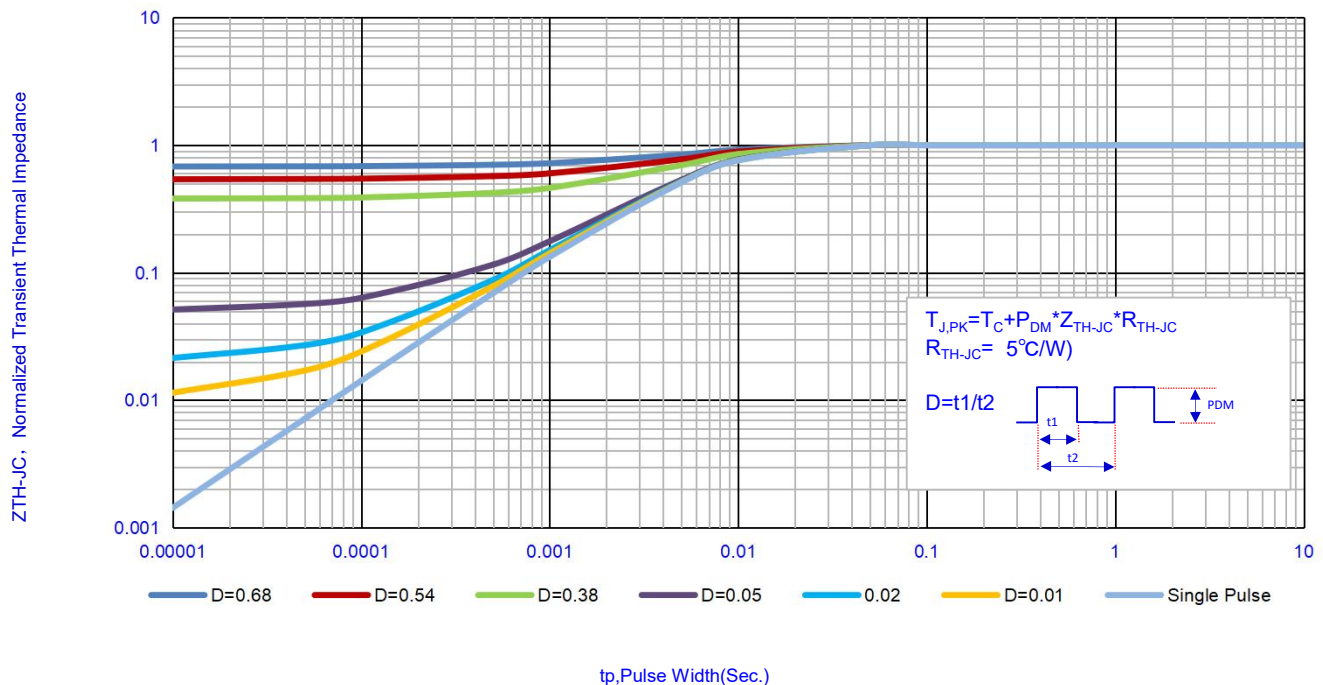


Fig.30- Normalized Maximum Transient Thermal Impedance vs.Pulse Width

P-Channel Test Circuit & Waveform

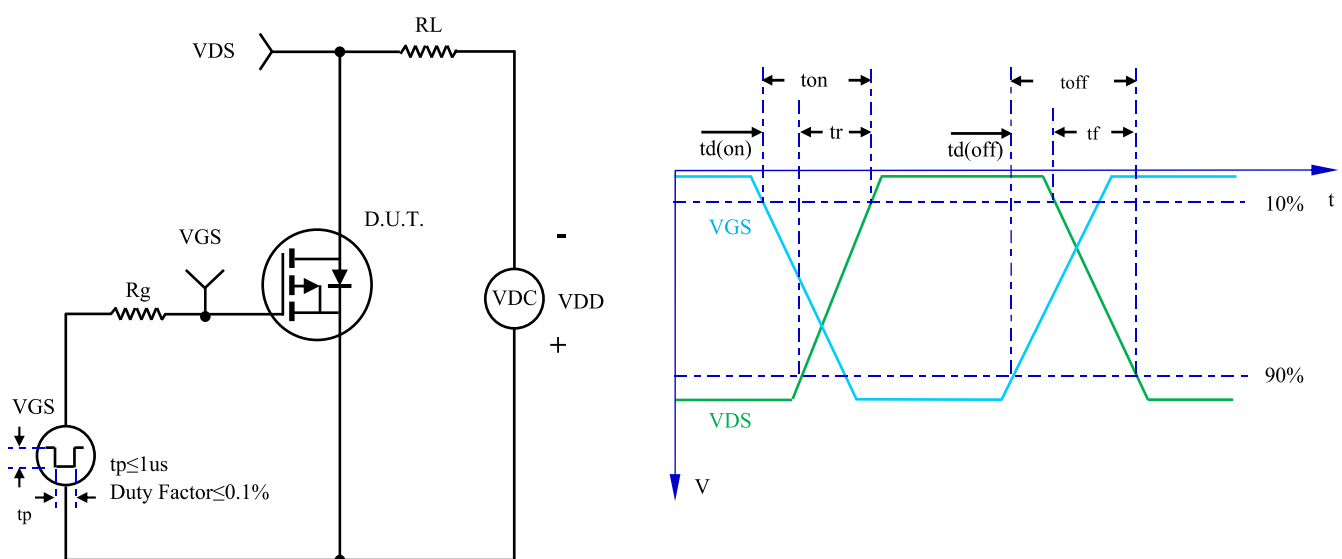


Fig.31- Resistive Switching Test Circuit & Waveform

NTS2216T03S4

N+P-Channel Enhancement Mode Trench Power MOSFET



P-Channel Test Circuit & Waveform

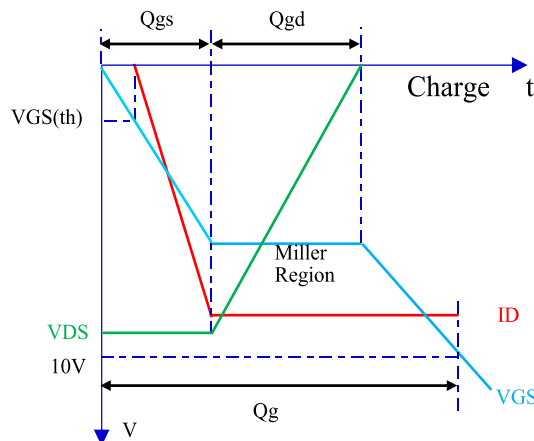
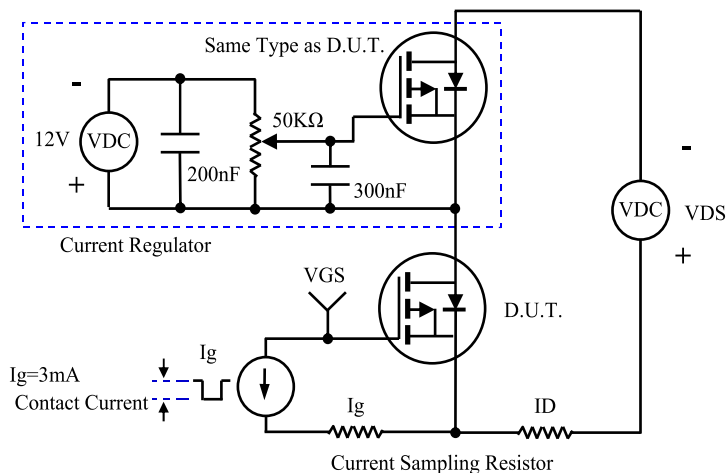


Fig.32-Gate Charge Test Circuit & Waveform

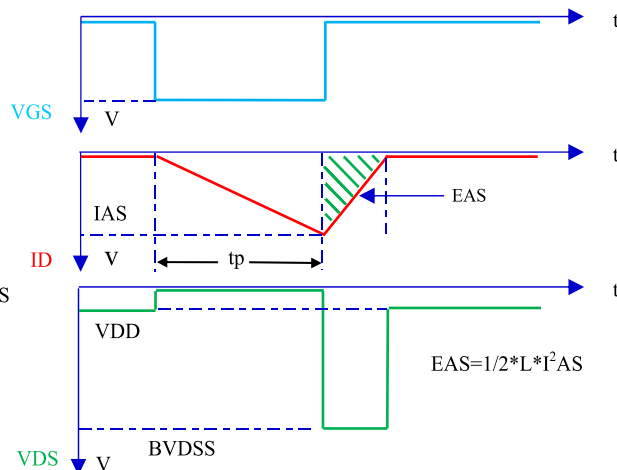
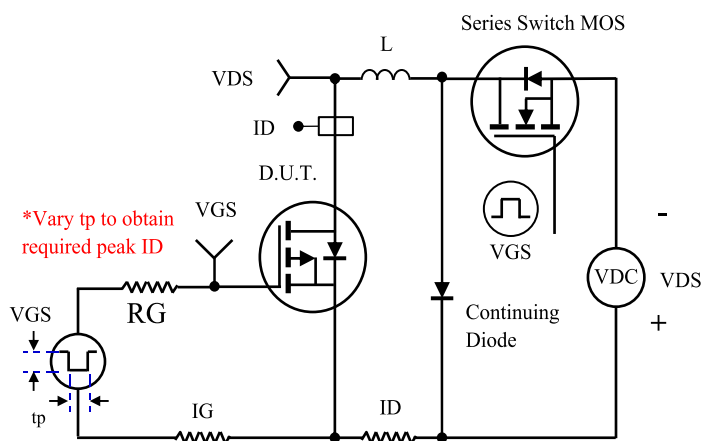


Fig.33- EAS Test Circuit & Waveform

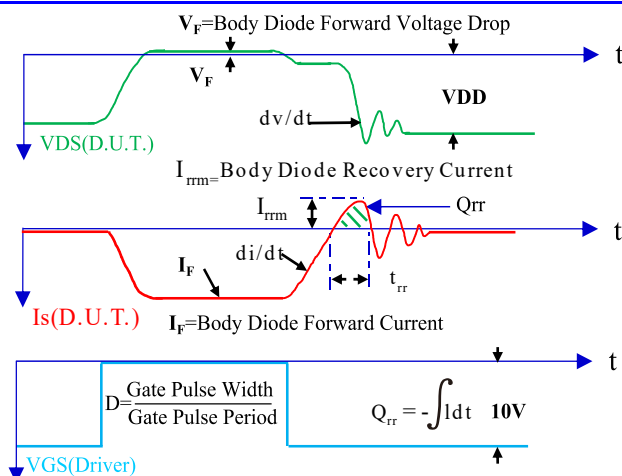
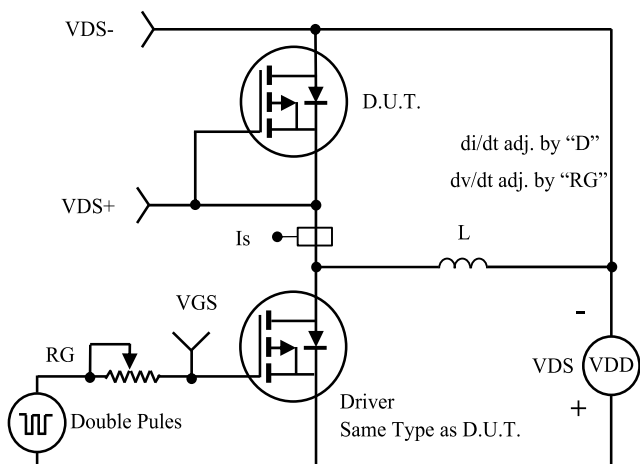


Fig.34- Diode Recovery Test Circuit & Waveform

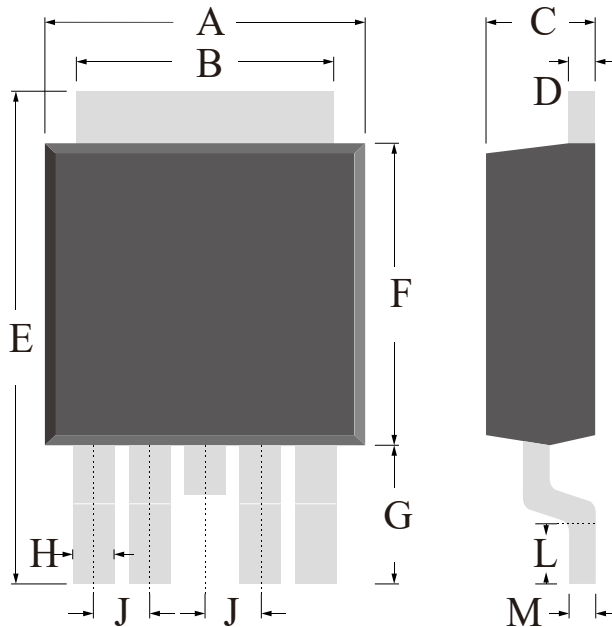
NTS2216T03S4

N+P-Channel Enhancement Mode Trench Power MOSFET



OUTLINE DRAWINGS

TO-252-4L

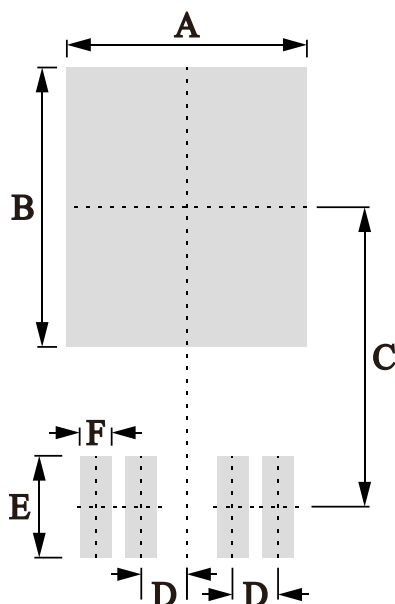


OUTLINE DIMENSIONS

Dim.	Milimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	6.10	-	7.10	0.2402	-	0.2795
B	4.80	-	5.80	0.1890	-	0.2283
C	1.95	-	2.55	0.0768	-	0.1004
D	0.35	-	0.75	0.0138	-	0.0295
E	9.25	-	10.75	0.3642	-	0.4232
F	5.60	-	6.60	0.2205	-	0.2598
G	2.50	-	3.10	0.0984	-	0.1220
H	0.65	-	1.05	0.0256	-	0.0413
J	1.00	-	1.28	0.0394	-	0.0504
L	1.00	-	1.40	0.0394	-	0.0551
M	0.35	-	0.75	0.0138	-	0.0295

RECOMMEDNED LAYOUT DRAWINGS

TO-252-4L



OUTLINE DIMENSIONS

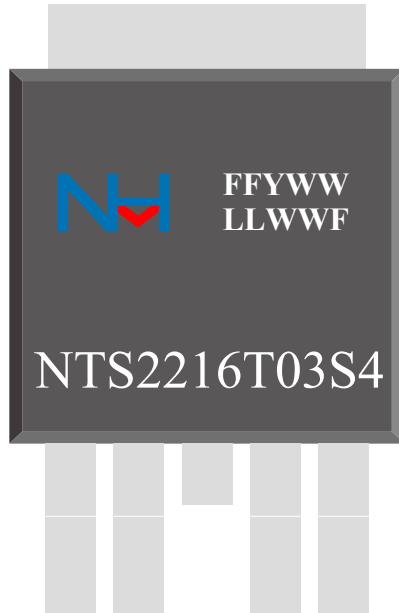
Dim.	Milimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	-	6.09	-	-	0.2398	-
B	-	7.57	-	-	0.2980	-
C	-	6.64	-	-	0.2614	-
D	-	1.14	-	-	0.0449	-
E	-	2.76	-	-	0.1087	-
F	-	0.80	-	-	0.0315	-

NTS2216T03S4

N+P-Channel Enhancement Mode Trench Power MOSFET



MARKING INFORMATION



MARKING INSTRUCTIONS

NH=Niuhang Trademark

FF=Product Line Code,According To Actual Changes

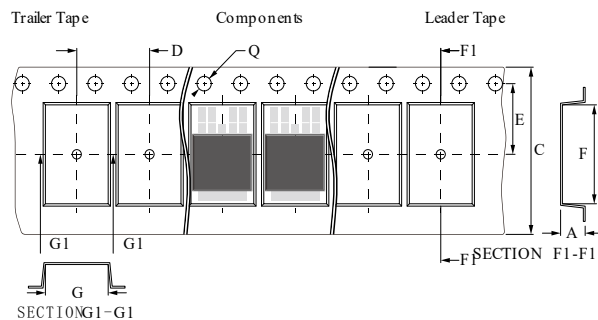
YWW=Date Code,According To Actual Changes

LLWWF=Internal Code,According To Actual Changes

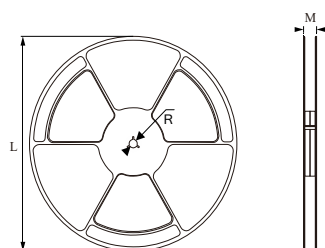
NTS2216T03S4=Model

PACKAGING

TAPE



REEL



TO-252-4L

OUTLINE DIMENSIONS

Dim.	Milimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
TAPE						
A	2.60	-	2.80	0.1024	-	0.1102
C	15.60	-	16.40	0.6142	-	0.6457
D	7.70	-	8.30	0.3031	-	0.3268
E	7.30	-	7.70	0.2874	-	0.3031
F	10.20	-	10.80	0.4016	-	0.4252
G	6.70	-	7.10	0.2638	-	0.2795
Q Φ	1.40	-	1.60	0.0551	-	0.0630
REEL						
L	328.00	-	332.00	12.913	-	13.071
R	12.00	-	14.00	0.4724	-	0.5512
M	19.40	-	23.40	0.7638	-	0.9213

PACKING INFORMATION

Package Type	Package Code	Product Weight Approx(g/Pcs)	Package Method	Quantity (Pcs/Min. Pack.)	Quantity (Pcs/Inner Box)	Quantity (Pcs/Carton)
TO-252-4L	P1	0.325	13" Reel	2500	5000	30000
TO-252-4L	P2	0.325	13" Reel	2500	2500	25000

NTS2216T03S4

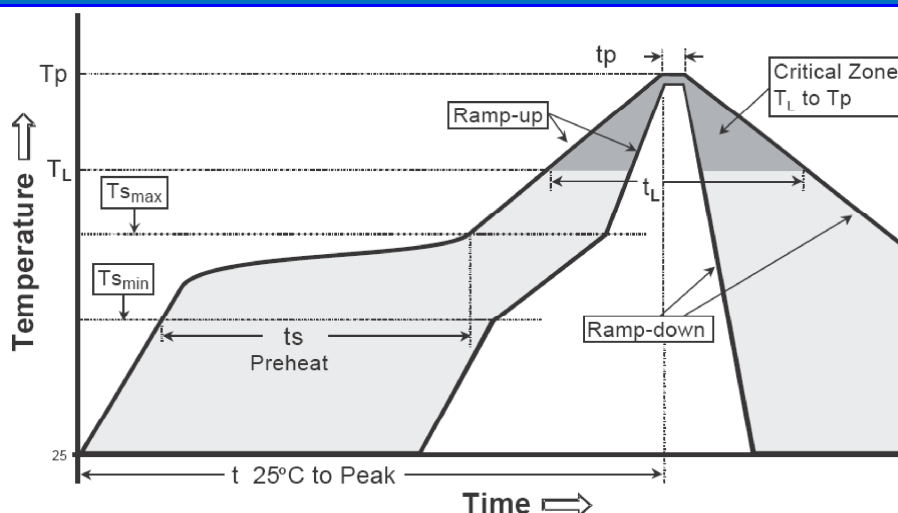
N+P-Channel Enhancement Mode Trench Power MOSFET



Recommended wave soldering condition

Product	Peak Temperature	Soldering Time
Pb-free devices	260 +0/-5 °C	5 +1/-1 seconds

Recommended temperature profile for IR reflow



Profile feature	Sn-Pb eutectic Assembly	Pb-free Assembly
Average ramp-up rate (T _{smax} to T _p)	3°C/second max.	3°C/second max.
Preheat -Temperature Min(T _s min) -Temperature Max(T _s max) -Time(t _s min to t _s max)	100°C 150°C 60-120 seconds	150°C 200°C 60-180 seconds
Time maintained above: -Temperature (T _L) - Time (t _L)	183°C 60-150 seconds	217°C 60-150 seconds
Peak Temperature(T _p)	240 +0/-5 °C	260 +0/-5 °C
Time within 5°C of actual peak temperature(t _p)	10-30 seconds	20-40 seconds
Ramp down rate	6°C/second max.	6°C/second max.
Time 25 °C to peak temperature	6 minutes max.	8 minutes max.

Note : All temperatures refer to topside of the package, measured on the package body surface.

NTS2216T03S4

N+P-Channel Enhancement Mode Trench Power MOSFET



Disclaimer

- Reproducing and modifying information of the document is prohibited without permission from niuhang Electronics co., LTD
- Niuhan Electronics co., LTD. reserves the rights to make changes of the content herein the document anytime without notification.
- Niuhan Electronics co., LTD. disclaims any and all liability arising out of the application or use of any product including damages incidentally and consequentially occurred.
- Niuhan Electronics co., LTD. does not assume any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.
- Applications shown on the herein document are examples of standard use and operation. Customers are responsible in comprehending the suitable use in particular applications. Niuhan Electronics co., LTD. makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.
- The products shown herein are not designed and authorized for equipments requiring high level of reliability or relating to human life and for any applications concerning life-saving or life-sustaining, such as medical instruments, transportation equipment, aerospace machinery et cetera. Customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Niuhan Electronics co., LTD. for any damages resulting from such improper use or sale.
- When the appearance of the product and chip size does not change, in order to product the customer quality, change the internal structure and the production process Niuhan can not notify