P-Ch 60V Fast Switching MOSFETs

General Description

The QL6013D is the highest performance trench P-ch MOSFETs with extreme high cell density , which provide excellent RDSON and gate charge for most of the synchronous buck converter applications .

The QL6013D meet the RoHS and Green Product requirement , 100% EAS guaranteed with full function reliability approved.

Features

- Advanced high cell density Trench technology
- Super Low Gate Charge
- Excellent CdV/dt effect decline
- 100% EAS Guaranteed
- Green Device Available

Product Summery

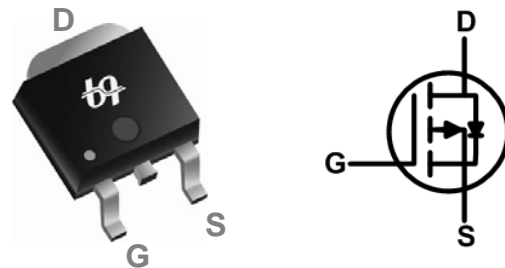| BVDSS	RDSON	ID
-60V	85mΩ	-13A

Applications

- High Frequency Point-of-Load Synchronous Buck Converter for MB/NB/UMPC/VGA
- Networking DC-DC Power System
- CCFL Back-light Inverter

TO252 Pin Configuration

Absolute Maximum Ratings

Symbol	Parameter	Rating	Units
V_{DS}	Drain-Source Voltage	-60	V
V_{GS}	Gate-Source Voltage	±20	V
$I_D@T_C=25℃$	Continuous Drain Current, V_{GS} @ -10V[1]	-13	A
$I_D@T_C=100℃$	Continuous Drain Current, V_{GS} @ -10V[1]	-8.3	A
$I_D@T_A=25℃$	Continuous Drain Current, V_{GS} @ -10V[1]	-3.3	A
$I_D@T_A=70℃$	Continuous Drain Current, V_{GS} @ -10V[1]	-2.7	A
I_{DM}	Pulsed Drain Current[2]	-26	A
EAS	Single Pulse Avalanche Energy[3]	44	mJ
I_{AS}	Avalanche Current	24.4	A
$P_D@T_C=25℃$	Total Power Dissipation[4]	31.3	W
$P_D@T_A=25℃$	Total Power Dissipation[4]	2	W
T_{STG}	Storage Temperature Range	-55 to 150	℃
T_J	Operating Junction Temperature Range	-55 to 150	℃

Thermal Data

Symbol	Parameter	Typ.	Max.	Unit
$R_{θJA}$	Thermal Resistance Junction-Ambient [1]	---	62	℃/W
$R_{θJC}$	Thermal Resistance Junction-Case[1]	---	4	℃/W

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P-Channel Electrical Characteristics (T_J=25 ℃, unless otherwise noted)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
BV_{DSS}	Drain-Source Breakdown Voltage	V_{GS}=0V , I_D=-250uA	-60	---	---	V
$\triangle BV_{DSS}/\triangle T_J$	BV_{DSS} Temperature Coefficient	Reference to 25℃ , I_D=-1mA	---	-0.023	---	V/℃
$R_{DS(ON)}$	Static Drain-Source On-Resistance[2]	V_{GS}=-10V , I_D=-10A	---	70	85	mΩ
		V_{GS}=-4.5V , I_D=-5A	---	85	105	
$V_{GS(th)}$	Gate Threshold Voltage	V_{GS}=V_{DS} , I_D =-250uA	-1.0	-1.6	-2.5	V
$\triangle V_{GS(th)}$	$V_{GS(th)}$ Temperature Coefficient		---	4.65	---	mV/℃
I_{DSS}	Drain-Source Leakage Current	V_{DS}=-48V , V_{GS}=0V , T_J=25℃	---	---	1	uA
		V_{DS}=-48V , V_{GS}=0V , T_J=55℃	---	---	5	
I_{GSS}	Gate-Source Leakage Current	V_{GS}=±20V , V_{DS}=0V	---	---	±100	nA
gfs	Forward Transconductance	V_{DS}=-5V , I_D=-4A	---	8.7	---	S
R_g	Gate Resistance	V_{DS}=0V , V_{GS}=0V , f=1MHz	---	15	30	Ω
Q_g	Total Gate Charge (-4.5V)	V_{DS}=-12V , V_{GS}=-4.5V , I_D=-6A	---	11.8	---	nC
Q_{gs}	Gate-Source Charge		---	1.9	---	
Q_{gd}	Gate-Drain Charge		---	6.5	---	
$T_{d(on)}$	Turn-On Delay Time	V_{DD}=-15V , V_{GS}=-10V , R_G=3.3Ω, I_D=-1A	---	8.8	---	ns
T_r	Rise Time		---	19.6	---	
$T_{d(off)}$	Turn-Off Delay Time		---	47.2	---	
T_f	Fall Time		---	9.6	---	
C_{iss}	Input Capacitance	V_{DS}=-15V , V_{GS}=0V , f=1MHz	---	1080	---	pF
C_{oss}	Output Capacitance		---	73	---	
C_{rss}	Reverse Transfer Capacitance		---	50	---	

Guaranteed Avalanche Characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
EAS	Single Pulse Avalanche Energy[5]	V_{DD}=-25V , L=0.1mH , I_{AS}=-15A	17	---	---	mJ

Diode Characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
I_S	Continuous Source Current[1,6]	V_G=V_D=0V , Force Current	---	---	-13	A
I_{SM}	Pulsed Source Current[2,6]		---	---	-26	A
V_{SD}	Diode Forward Voltage[2]	V_{GS}=0V , I_S=-1A , T_J=25℃	---	---	-1	V

Note :
1.The data tested by surface mounted on a 1 inch[2] FR-4 board with 2OZ copper.
2.The data tested by pulsed , pulse width ≦ 300us , duty cycle ≦ 2%
3.The EAS data shows Max. rating . The test condition is V_{DD}=-25V,V_{GS}=-10V,L=0.1mH,I_{AS}=-24.4A
4.The power dissipation is limited by 150℃ junction temperature
5.The Min. value is 100% EAS tested guarantee.
6.The data is theoretically the same as I_D and I_{DM} , in real applications , should be limited by total power dissipation.

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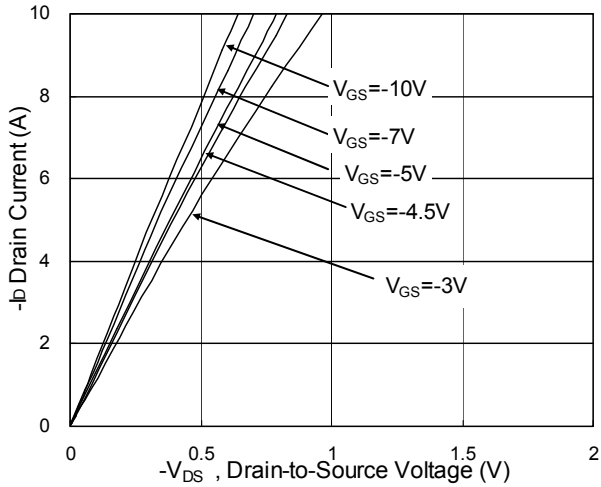
P-Channel Typical Characteristics

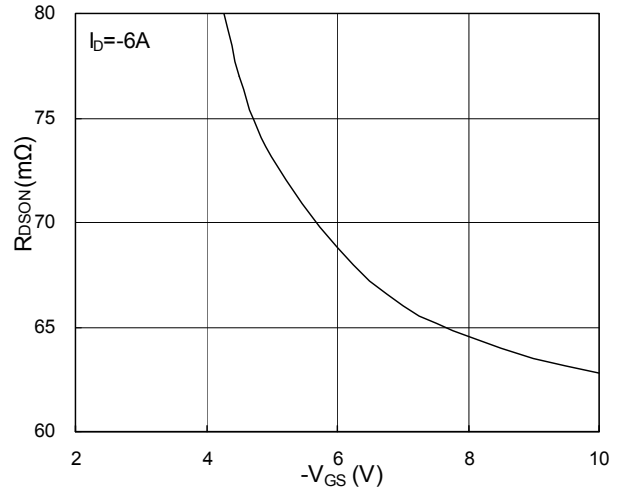Fig.1 Typical Output Characteristics

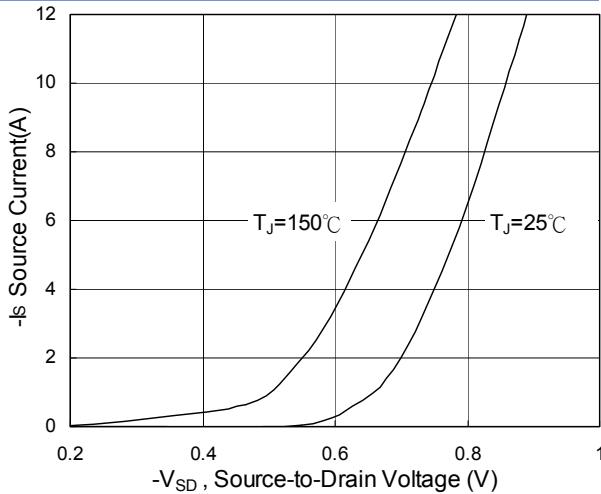Fig.2 On-Resistance v.s Gate-Source
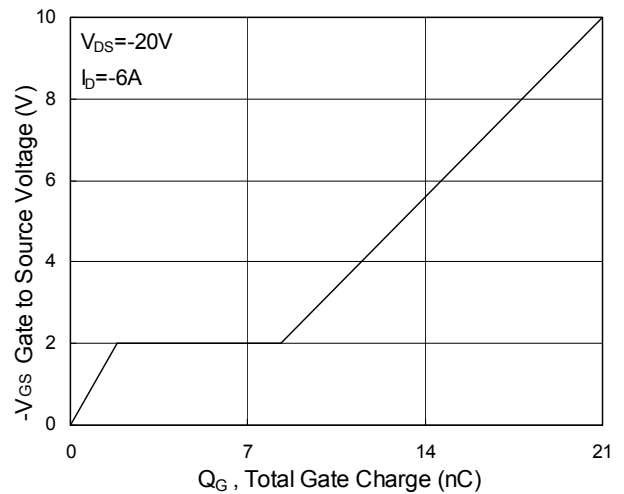

Fig.3 Forward Characteristics of Reverse
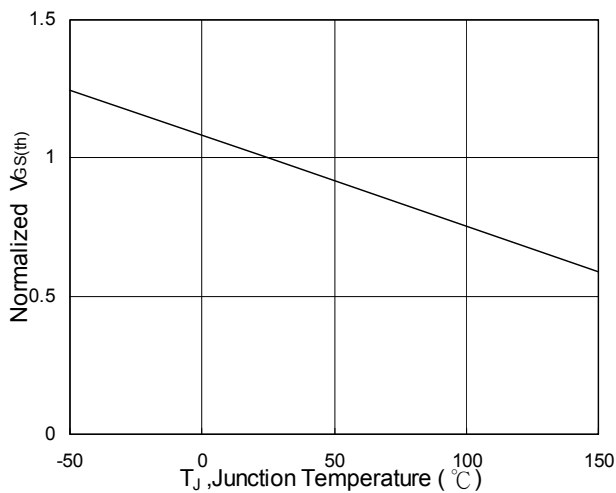

Fig.4 Gate-Charge Characteristics

Fig.5 Normalized $V_{GS(th)}$ v.s T_J

Fig.6 Normalized R_{DSON} v.s T_J
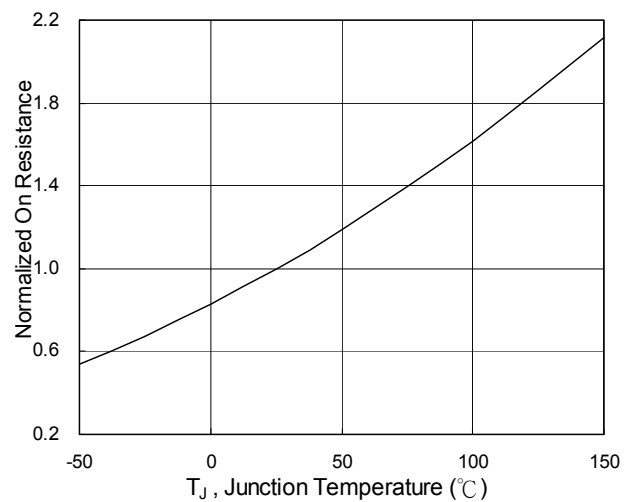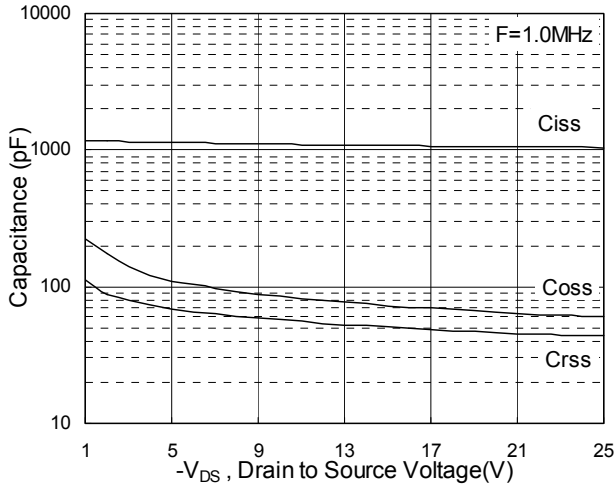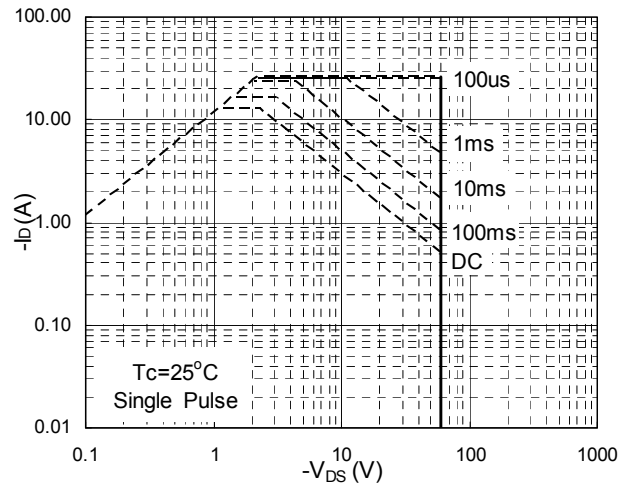
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Fig.7 Capacitance graph: Capacitance (pF) vs $-V_{DS}$, Drain to Source Voltage(V), F=1.0MHz, showing Ciss, Coss, Crss

Fig.7 Capacitance

Fig.8 graph: $-I_D$(A) vs $-V_{DS}$(V), with curves 100us, 1ms, 10ms, 100ms, DC; Tc=25°C Single Pulse

Fig.8 Safe Operating Area

Fig.9 graph: Normalized Thermal Response ($R_{\theta JC}$) vs t, Pulse Width (s), with DUTY=0.5, 0.2, 0.1, 0.05, 0.02, 0.01, SINGLE PULSE

$$D = T_{ON}/T$$

$$T_J peak = T_C + P_{DM} \times R_{\theta JC}$$

Fig.9 Normalized Maximum Transient Thermal Impedance

Fig.10: Switching time waveform showing $-V_{DS}$, $-V_{GS}$, 90%, 10%, $T_{d(on)}$, T_r, T_{on}, $T_{d(off)}$, T_f, T_{off}

Fig.10 Switching Time Waveform

$$EAS = \frac{1}{2} L \times (-I_{AS}^2) \times \frac{-BV_{DSS}}{-BV_{DSS}-(-V_{DD})}$$
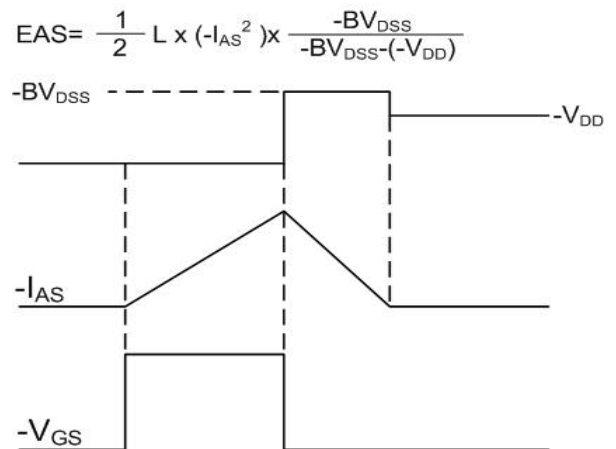
Fig.11: waveform showing $-BV_{DSS}$, $-V_{DD}$, $-I_{AS}$, $-V_{GS}$

Fig.11 Unclamped Inductive Switching Waveform