GPT65C0WMA

650V ▲ 230mΩ ▲ GaN FET

GALLIUM NITRIDE GaN FET ▲ THT type
Normally off device
Easy to drive with standard MOSFET driver
TO-220AB package
Very low switching losses
Ultra-low Q_{RR} and very robust design

SPECIFICATION

Item (T_C = 25°C, unless otherwise noted)		Characteristics
Operating Temperature Range	T_J	-55°C to +150°C
Storage Temperature Range	T_S	-55°C to +150°C
Drain-Source Voltage	V_{DSS}	650V
Transient Drain-Source Voltage Note 1	$V_{TR(DSS)}$	800V
Drain-Source On-State Resistance Note 2	$R_{DS(ON)TYP}$	230mΩ
Typical Recovered Charge Note 3	Q_{RR}	18.6nC
Typical Total Gate Charge	Q_G	16nC

Notes

1: **Spike duty cycle DC < 0.01, spike duration time < 20µs during off-state mode**

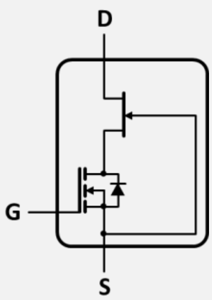
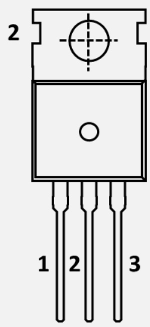
2: **V_{GS} = 10V, I_{DS} = 6A**

3: **See diode reverse recovery test circuit and waveform, Fig. 15, and Fig. 16**

APPLICATIONS

Battery Chargers	Power Adapters	LED Lighting	Wireless Power	AC/DC Converter	DC/DC Converter	Class D Audio Amplifiers

PIN DESCRIPTION

Circuit Diagram	Outline ▪ Front View	Pin No.	Symbol	Description
		1 2 3	G S D	Gate Source Drain

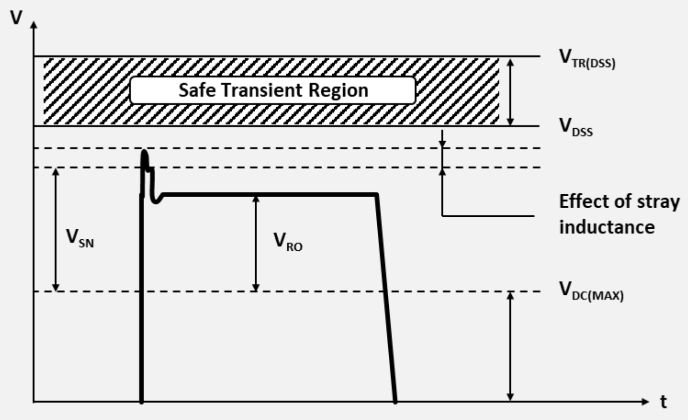
ABSOLUT MAXIMUM RATINGS ▲ T_C = 25°C, unless otherwise noted

Item	Condition	Symbol		Unit
Drain-Source Breakdown Voltage		V_{DSS}	650	V
Transient Drain-Source Voltage Note1		$V_{(TR)DSS}$	800	V
Gate-Source Voltage		V_{GSS}	±18	V
Continuous Drain Current	T_C = 25°C Note 2	I_D	6	A
Continuous Drain Current	T_C = 100°C Note 2	I_D	3.9	A
Pulse Drain Current	Pulse Width = 10µs	I_{DM}	27	A
Operating Temperature Range	Case	T_C	-55 to +150	°C
Operating Temperature Range	Junction	T_J	-55 to +150	°C
Storage Temperature Range		T_S	-55 to +150	°C

Note:

1: Spike duty cycle DC < 0.01, spike duration time < 20µs during off-state mode
2: See application information for increased stability at high current operation, fig. 2

Fig. 1 ▪ Voltage Stress Primary Switch with 264VAC



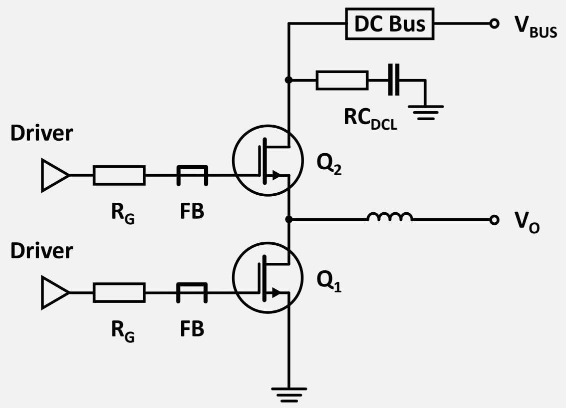
$V_{TR(DSS)}$ - V_{DSS} = Safety margin
800V - 650V = 150V
Safety margin is around 80%

$V_{DC(MAX)}$ + V_{SN} + effect of stray inductance < 560V

$V_{DC(MAX)}$	Maximum input voltage
V_{RO}	Reflected output voltage
V_{SN}	Snubber capacitor voltage
V_{DSS}	Drain-Source breakdown voltage
$V_{(TR)DSS}$	Transient Drain-source voltage

APPLICATION INFORMATION

Fig. 2 ▪ Recommended Circuit for Improved Stability at High Current Operation



A ferrite bead (FB) should be connected in series with the gate pin to dampen the resonant circuit of gate-source loop inductance and the input capacitance of the GaN-FET. The ferrite bead should be placed as close as possible to the gate pin to minimize the gate-source loop. (See figure 2). This causes fast switching stability. We recommend an impedance of 240Ω at 100MHz for the ferrite bead. In addition, a series resistance (R_G) of 10 to 15Ω should be provided.

Furthermore, a DC-link snubber should always be used to eliminate instability of the GaN-FET. In the simplest case, an RC combination is connected in parallel to the DC link bus, which significantly reduces the Q factor of any resonance in the bus. We recommend an MLCC between 4.7 and 10nF and an SMD resistor with 5.1Ω as well-suited values.

THERMAL CHARACTERISTIC RATINGS

Items		Typ.
Thermal Resistance Junction to Ambient Note 1	R_{thJA}	53°C/W
Thermal Resistance Junction to Case	R_{thJC}	1°C/W

Note:

1: Device on one layer epoxy PCB for drain connection (vertical and without air stream cooling, with 6cm^2 copper and 70µm thickness

ELECTRICAL CHARACTERISTICS ▲ T_C = 25°C, unless otherwise noted

Item	Condition	Symbol	Min.	Typ.	Max.	Unit
Static Characteristics						
Drain-Source Breakdown Voltage	V_{GS} = 0V	V_{DSS}	650			V
Gate-Source Threshold Voltage	V_{GS} = V_{DS}, I_D = 500µA	V_{GSth}	1	1.7	2.5	V
Gate-Source Leakage Current	V_{GS} = 18V, V_{DS} = 0V	I_{GSS}			100	nA
Gate-Source Leakage Current	V_{GS} = -18V, V_{DS} = 0V	I_{GSS}			-100	nA
Drain-Source Leakage Current	V_{DS} = 650V, V_{GS} = 0V	I_{DSS}		5	10	µA
Drain-Source Leakage Current	V_{DS} = 650V, V_{GS} = 0V, T_J = 150°C	I_{DSS}		15		µA
Drain-Source On-State Resistance	V_{GS} = 10V, I_{DS} = 6A	$R_{DS(ON)}$		230	300	mΩ
Drain-Source On-State Resistance	V_{GS} = 10V, I_{DS} = 6A, T_J = 150°C	$R_{DS(ON)}$		405		mΩ

Item	Condition	Symbol	Min.	Typ.	Max.	Unit
Dynamic Characteristics						
Input Capacitance	V_{DS} = 400V, V_{GS} = 0V, f = 1MHz	C_{ISS}		400		pF
Output Capacitance	V_{DS} = 400V, V_{GS} = 0V, f = 1MHz	C_{OSS}		40		pF
Reverse Transfer Capacitance	V_{DS} = 400V, V_{GS} = 0V, f = 1MHz	C_{RSS}		8		pF
Effective Output Capacitance, Energy Related Note 1	V_{DS} = 0 to 400V, V_{GS} = 0V	$C_{O(ER)}$		175		pF
Effective Output Capacitance, Time Related Note 2	V_{DS} = 0 to 400V, V_{GS} = 0V	$C_{O(TR)}$		116		pF
Total Gate Charge	V_{DS} = 400V, V_{GS} = 0 to 8V, I_D = 4A	Q_G		16		nC
Gate-Source Charge	V_{DS} = 400V, V_{GS} = 0 to 8V, I_D = 4A	Q_{GS}		2.8		nC
Gate-Drain Charge	V_{DS} = 400V, V_{GS} = 0 to 8V, I_D = 4A	Q_{GD}		4.1		nC
Output Charge	V_{DS} = 0 ~ 400V, V_{GS} = 0V	Q_{OSS}		46		nC
Turn-On Delay	V_{DS} = 400V, V_{GS} = 0 to 8V, I_D = 6A, R_G = 30Ω	$t_{D(ON)}$		8		ns
Rise Time	V_{DS} = 400V, V_{GS} = 0 to 8V, I_D = 6A, R_G = 30Ω	t_R		4		ns
Turn-Off Delay	V_{DS} = 400V, V_{GS} = 0 to 8V, I_D = 6A, R_G = 30Ω	$t_{D(OFF)}$		17		ns
Fall Time	V_{DS} = 400V, V_{GS} = 0 to 8V, I_D = 6A, R_G = 30Ω	t_F		8		ns

Item	Condition	Symbol	Min.	Typ.	Max.	Unit
Source-Drain Diode						
Reverse Current	V_{GS} = 0V	I_S			6	A
Source-Drain Voltage	I_S = 3A, V_{GS} = 0V	V_{SD}		1.4		V
	I_S = 6A, V_{GS} = 0V			2.4		V
Reverse Recovery Time Note 3	I_S = 4A, V_{DS} = 400V, di/dt = 200A/µs	t_{RR}		11		ns
Recovered Charge Note 4	I_S = 4A, V_{DS} = 400V, di/dt = 200A/µs	Q_{RR}		18.6		nC

Notes:

1: Equivalent capacitance to give same stored energy from 0V to the stated V_{DS}
2: Equivalent capacitance to give same charging time from 0V to the stated V_{DS}
3: See diode reverse recovery test circuit and waveform, fig. 15 and fig 16
4: See diode reverse recovery test circuit and waveform, fig 15 and fig. 16

REFERENCE DATA

Fig. 3 ▪ Typ. Output Characteristics I_D vs. V_{DS}, T_J = 25°C

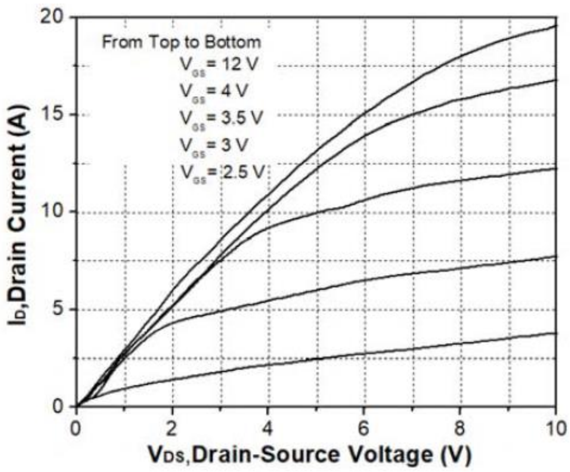


Fig. 4 ▪ Typ. Output Characteristics I_D vs. V_{DS}, T_J = 150°C

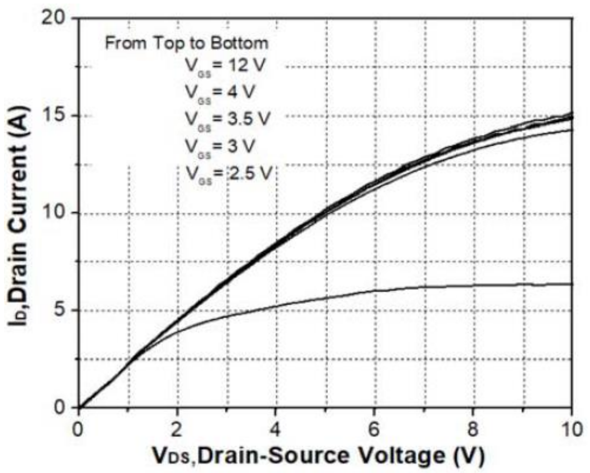


Fig. 5 ▪ Typ. Transfer Characteristics I_D vs. V_{GS}, V_{DS} = 10V

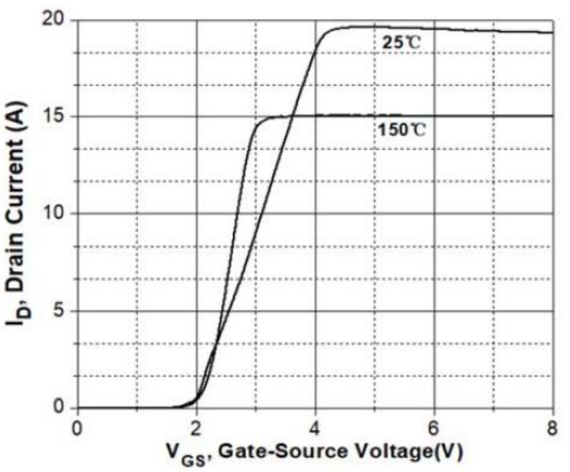


Fig. 6 ▪ Normalized $R_{DS(ON)}$ Characteristics, I_D = 6A, V_{GS} = 10V

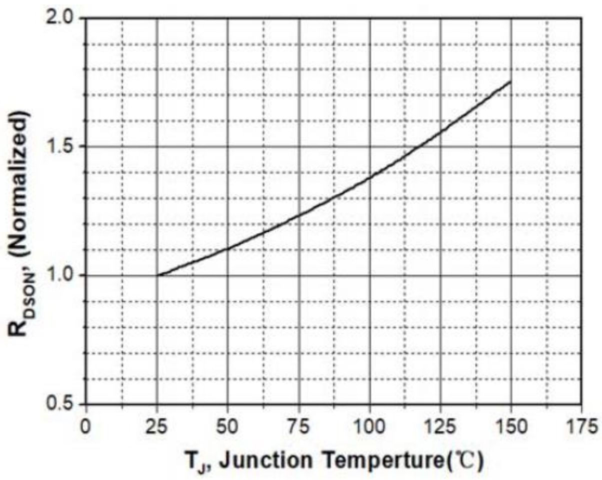


Fig. 7 ▪ Typ. Capacitance Characteristics, V_{GS} = 0V, f = 1MHz

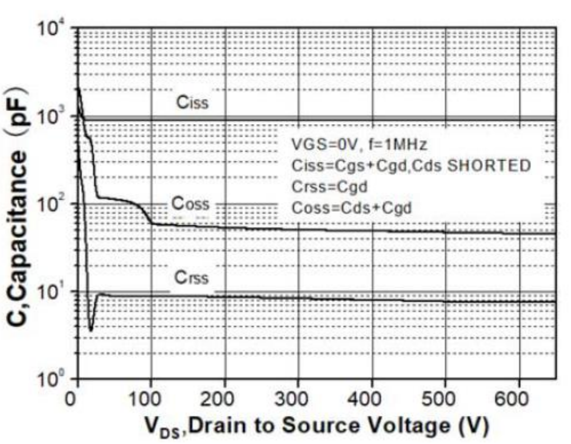
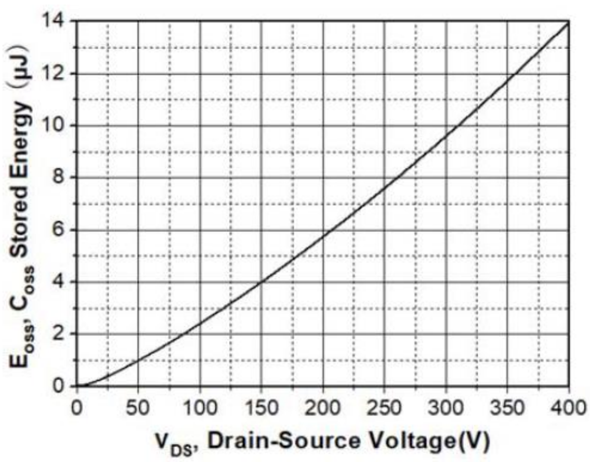


Fig. 8 ▪ Typ. Stored Energy Characteristics C_{OSS}



REFERENCE DATA

Fig. 9 ▪ Typ. Capacitance Charge Characteristics

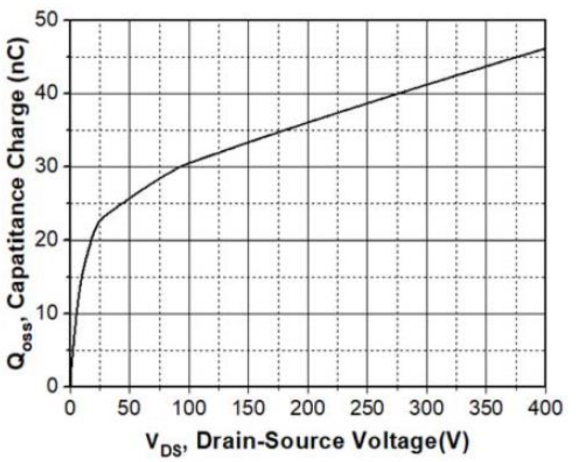


Fig. 10 ▪ Typ. Gate Charge Characteristics, I_D = 4A, V_{DS} = 400V

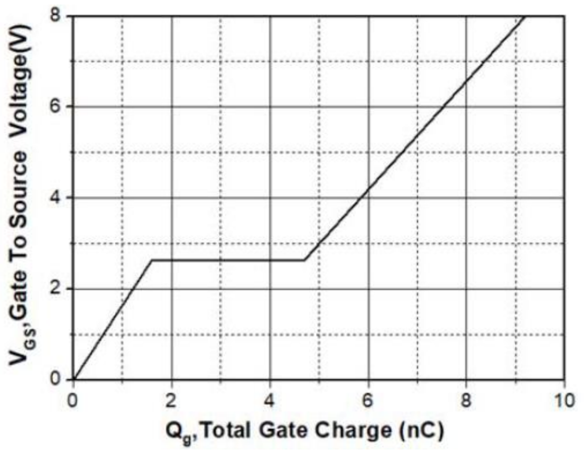


Fig. 11 ▪ Forward Characteristics of Reverse Diode $I_S = f(V_{SD})$

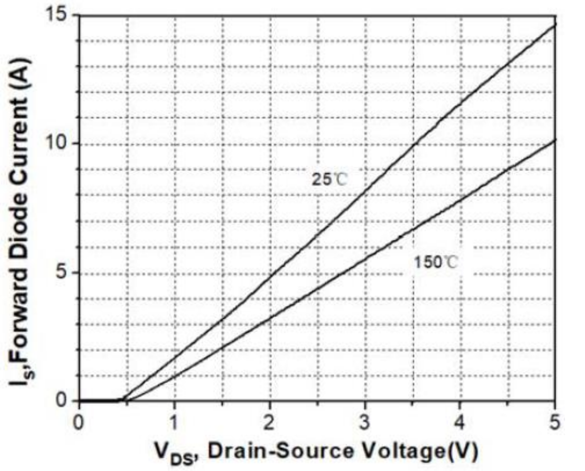


Fig. 12 ▪ Safe Operating Area, T_C = 25°C (calculated based on thermal limit)

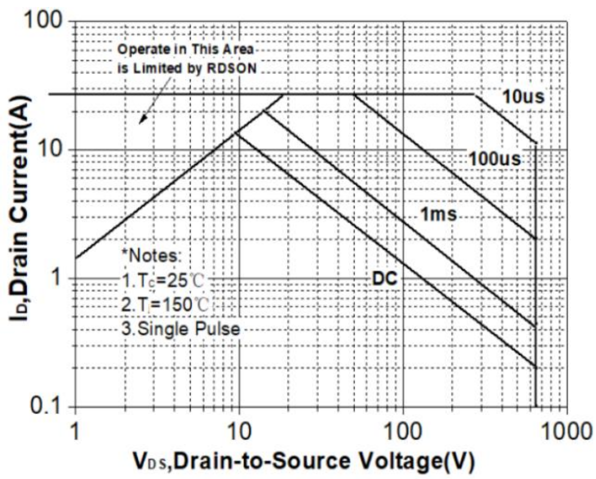


Fig. 13 ▪ Power Dissipation vs. Case Temperature T_C

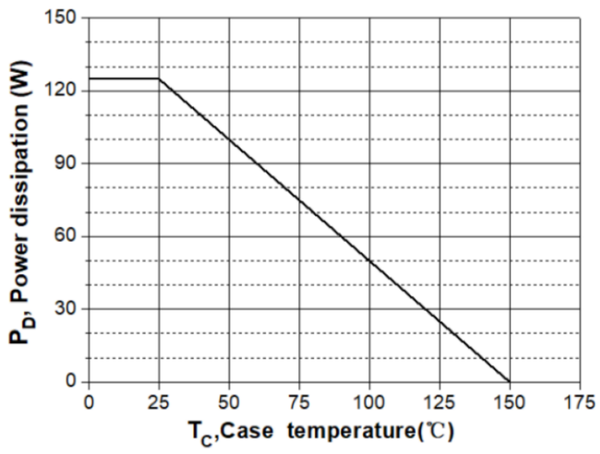
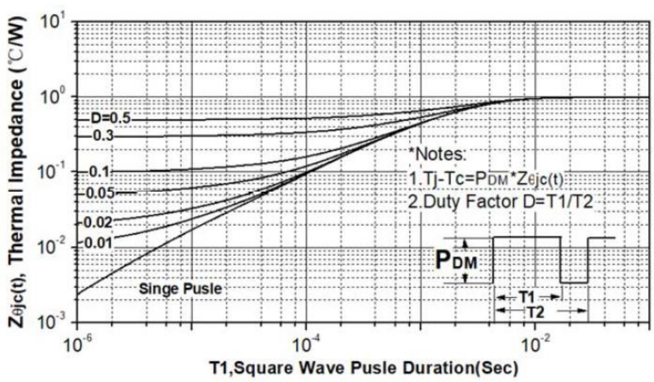


Fig. 14 ▪ Transient thermal impedance R_{thJC}



TEST CIRCUITS AND WAVEFORMS

Fig. 15 ▪ Diode reverse recovery test circuit

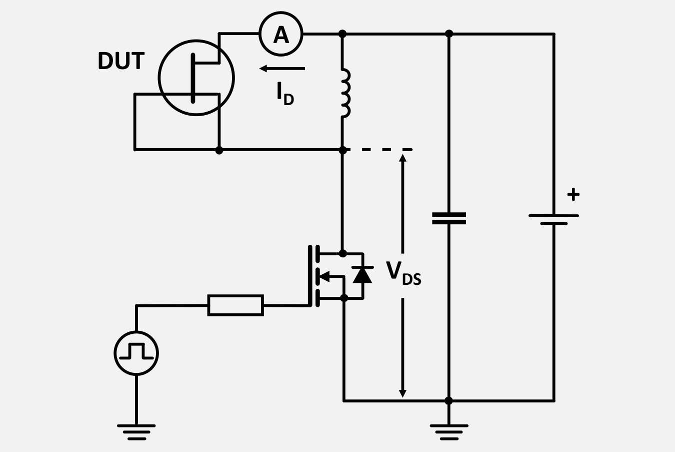


Fig. 16 ▪ Diode reverse recovery waveform

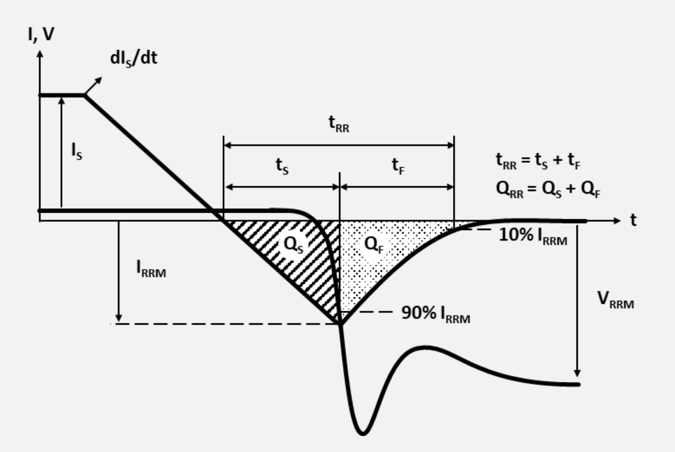


Fig. 17 ▪ Switching time test circuit

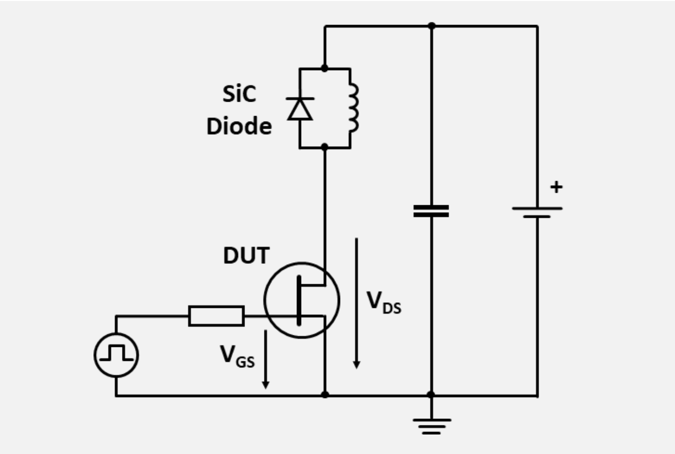


Fig. 18 ▪ Switching time waveform

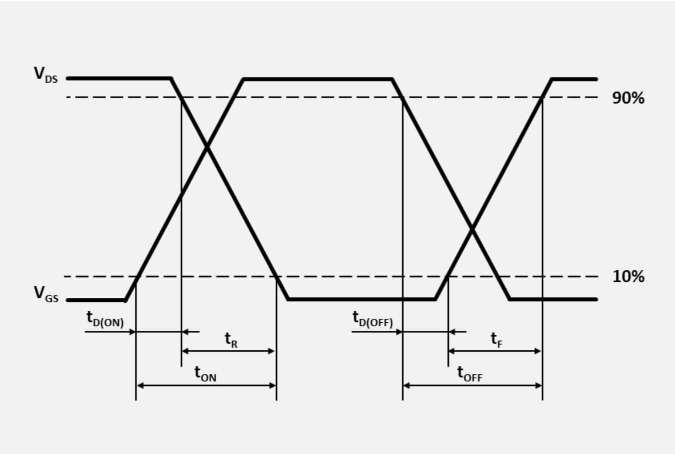


Fig. 19 ▪ Dynamic $R_{DS(ON)eff}$ test circuit

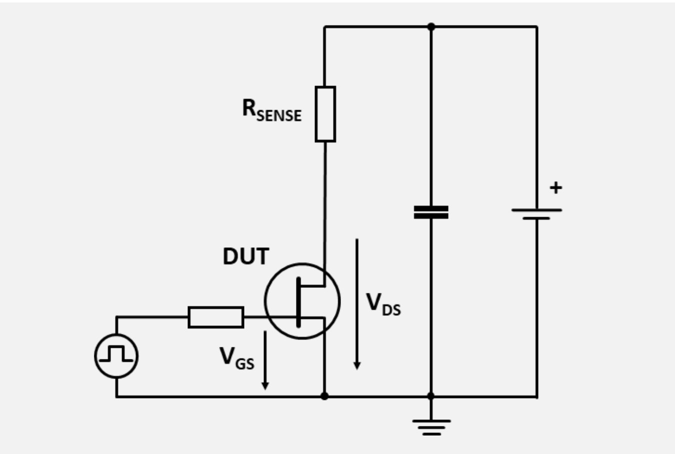
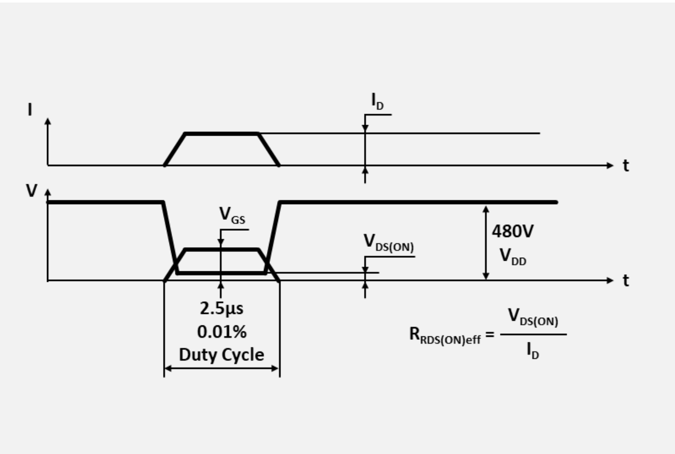
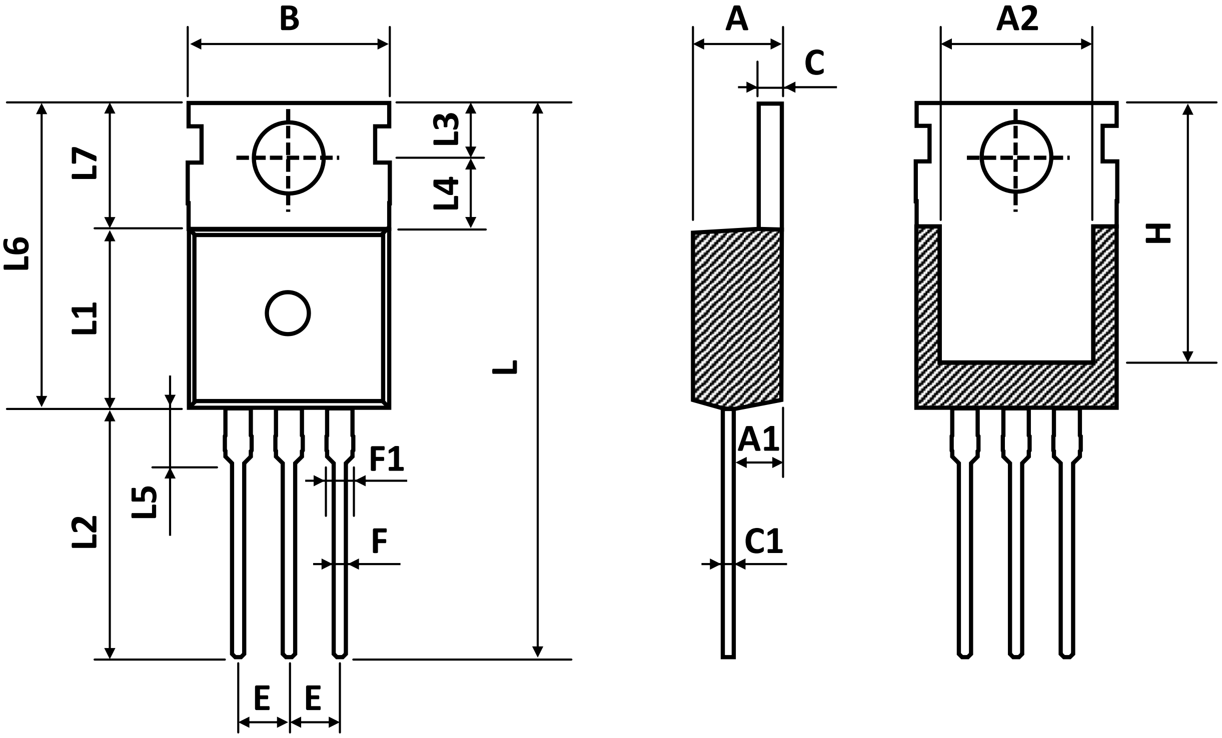


Fig. 20 ▪ Dynamic $R_{DS(ON)eff}$ waveform



PACKAGE OUTLINE



Sym	Millimeters (Min.)	Millimeters (Typ.)	Millimeters (Max.)
A	4.43	4.53	4.63
A1	2.30	2.40	2.50
A2	7.70	7.90	8.10
B	9.80	10.00	10.20
C	1.25	1.30	1.40
C1	0.45	0.50	0.60
D	3.45	3.60	3.70
E	2.45	2.54	2.60
F	0.70	0.80	0.95
F1	1.15	1.33	1.50
L	26.80	28.80	30.80
L1	9.20	9.30	9.40
L2	12.80	13.10	13.40
L3	2.70	2.80	2.90
L4	3.50	3.70	3.80
L5	2.60	2.90	3.20
L6	15.40	15.80	16.20
L7	6.20	6.50	6.80
H	12.95	13.25	13.55

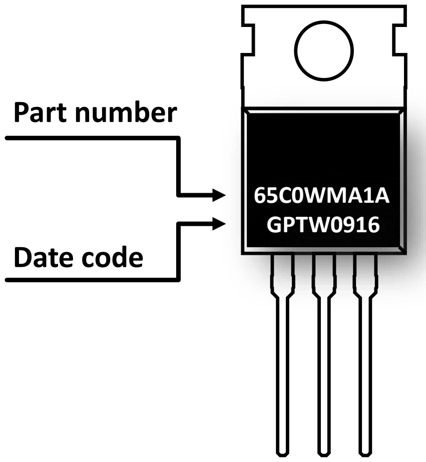
ORDERING INFORMATION

Part Number	Package	Packing	Tube Qty.	Inner Box Qty.	Outer Box Qty.
GPT65C0WMA	TO-220AB	Tube	50pcs	1,000pcs	5,000pcs

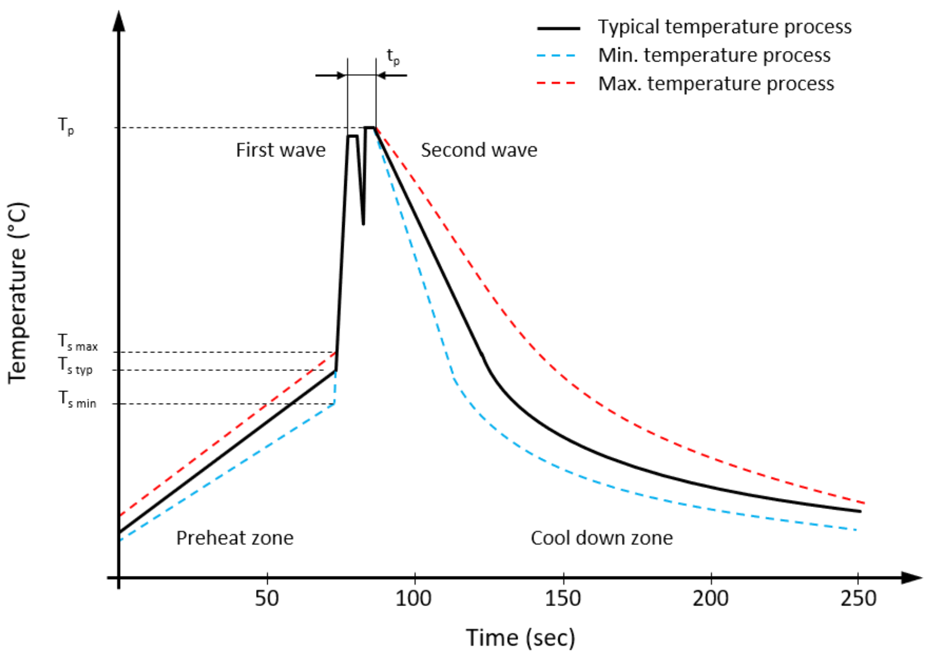
DATE CODE AND PART MARKING

Example: **0916**

09		16	
Week of the Month		Year	
		16	2022
01	1st	17	2023
02	2nd	18	2024
03	3rd	19	2025
04	4th	1A	2026
...	...	1B	2026
52	52nd	...	...
		1F	2031



RECOMMENDED WAVE SOLDERING PROFILE ▲ THT PACKAGE



Classification wave soldering profile ▲ Refer to EN 61760-1: 2006

Profile Features		Value ▲ Sn-Pb Assembly	Value ▲ Pb-free Assembly
Preheat temperature min.	$T_{s\,min}$	100 °C	100 °C
Preheat temperature typical	$T_{s\,typ}$	120 °C	120 °C
Preheat temperature max.	$T_{s\,max}$	130 °C	130 °C
Preheat time t_s from $T_{s\,min}$ to $T_{s\,max}$	t_s	70 seconds	70 seconds
Peak temperature	T_p	235 °C to 260 °C	245 °C to 260 °C
Time of actual peak temperature	t_p	Max. 10 seconds Max. 5 second each wave	Max. 10 seconds Max. 5 second each wave
Ramp-down date min.		~ 2 °C/second	~ 2 °C/second
Ramp-down rate typical		~ 3.5 °C/second	~ 3.5 °C/second
Ramp-down rate max.		~ 5 °C/second	~ 5 °C/second
Time 25°C to 25°C		4 minutes	4 minutes

REVISION TABLE

Revision	Date	Status	Notes
001	01/04/2022	Initial release	Initial publication
002	15/05/2022	Second release	Part number marking

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