

650V, 20A N-Channel MOSFET

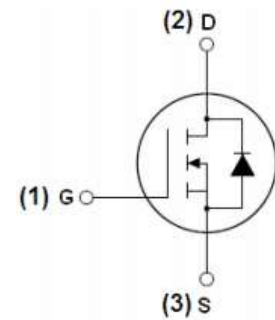
Features

- * $V_{DS} = 650V$, $I_D = 20A$
 $R_{DS(ON)} = 350m\Omega$ (Typ.) @ $V_{GS} = 10V$
- * Low on-resistance and low C_{rss} (Typical 20pF)
- * Fast switching characteristics
- * Good stability and improved dv/dt capability
- * Low gate charge
- * Lead free available (RoHS compliant)
- * TO-220F, TO-220AB package for good heat dissipation

Applications

- High efficiency Switched Mode Power Supplies
- Electronic Ballast
- LED Power Supply

Pin Description and Schematic



N-Channel MOSFET

Package Marking And Ordering Information

Device	Marking ^[1]	Device Package	Quantity
HCR20N65FT2FBP	HCR20N65F xx	TO-220F	1000pcs / Box
HCR20N65PT22BP	HCR20N65P xx	TO-220AB	1000pcs / Box

Note 1. "HCR20N65F" and "HCR20N65P" identify the product; "xx" is the date code.

650V, 20A N-Channel MOSFET
Absolute Maximum Ratings
 $T_C = 25^{\circ}\text{C}$, unless otherwise noted

Parameter	Symbol	HCR20N65F	HCR20N65P	Unit
Drain-source voltage ($V_{GS} = 0V$)	V_{DS}	650		V
Gate-source voltage ($V_{DS} = 0V$), AC ($f > 1\text{Hz}$)	V_{GS}	± 30		V
Continuous drain current, $T_J = 25^{\circ}\text{C}$	I_D	20 (Note 1)	20	A
Continuous drain current, $T_J = 100^{\circ}\text{C}$	I_D	14 (Note 1)	14	A
Pulsed drain current (Note 1)	I_{DM}	80		A
Maximum power dissipation	P_D	62	185	W
Derate above 25°C	P_D	0.5	0.68	W/ $^{\circ}\text{C}$
Single pulsed avalanche energy (Note 2)	E_{AS}	550		mJ
Avalanche current (Note 2)	I_{AR}	3.2		A
Repetitive avalanche current (Note 1)	E_{AR}	50		mJ
Peak diode recovery dv/dt (Note 3)	dv/dt	5.0		V/ns
Maximum lead temperature for soldering	T_L	300		$^{\circ}\text{C}$
Operating junction and storage temperature range	T_J, T_{stg}	-55 to 150		$^{\circ}\text{C}$

Note 1. Pulse width is limited by maximum junction temperature.

Note 2. $L = 10\text{mH}$, $I_{AS} = 10.5\text{A}$, $V_{DD} = 48\text{V}$, $R_G = 25\Omega$; starting $T_J = 25^{\circ}\text{C}$.

Note 3. $I_{SD} \leq 20\text{A}$, $di/dt \leq 100\text{A}/\mu\text{s}$, $V_{DD} \leq BV_{DSS}$; starting $T_J = 25^{\circ}\text{C}$.

Thermal Characteristics

Parameter	Symbol	HCR20N65F	HCR20N65P	Unit
Thermal resistance, junction to case (maximum)	$R_{\theta JC}$	1.47	0.5	$^{\circ}\text{C}/\text{W}$
Thermal resistance, junction to ambient (maximum)	$R_{\theta JA}$	62.5	62.5	$^{\circ}\text{C}/\text{W}$

650V, 20A N-Channel MOSFET
Electrical Characteristics
 $T_A = 25^\circ\text{C}$, unless otherwise noted

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
On/Off States						
Drain-source breakdown voltage	BV_{DSS}	$V_{GS} = 0V, I_D = 250\mu A$	650	-	-	V
Breakdown voltage temperature coefficient	$\Delta BV_{DSS}/\Delta T_J$	$I_D = 250\mu A$, referenced to 25°C	-	0.65	-	V/ $^\circ\text{C}$
Zero gate voltage drain current	I_{DSS}	$V_{DS} = 650V, V_{GS} = 0V$, $T_C = 25^\circ\text{C}$	-	0.05	1.0	μA
Zero gate voltage drain current	I_{DSS}	$V_{DS} = 520V, V_{GS} = 0V$, $T_C = 125^\circ\text{C}$	-	-	100	μA
Gate-body leakage current	I_{GSS}	$V_{DS} = 0V, V_{GS} = \pm 30V$	-	-	± 100	nA
Gate-threshold voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}, I_D = 250\mu A$	2.0	3.0	4.0	V
Drain-source on-resistance	$R_{DS(on)}$	$V_{GS} = 10V, I_D = 10A$	-	320	400	m Ω

Dynamic Characteristics

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Input capacitance	C_{iss}	$V_{DS} = 25V, V_{GS} = 0V$, $f = 1\text{MHz}$	-	2847	-	pF
Output capacitance	C_{oss}		-	252	-	pF
Reverse transfer capacitance	C_{rss}		-	20	-	pF

Gate Charge Characteristics

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Total gate charge	Q_g	$V_{DS} = 325V, I_D = 20A$, $V_{GS} = 10V$ (Notes 4, 5)	-	60	-	nC
Gate-source charge	Q_{gs}		-	14	-	nC
Gate-drain charge	Q_{gd}		-	24	-	nC

Notes 4 and 5: see the following page.

650V, 20A N-Channel MOSFET
Electrical Characteristics (Continued)

$T_A = 25^\circ\text{C}$, unless otherwise noted

Switching Characteristics

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Turn-on delay time	$t_{d(on)}$	$V_{DS} = 325\text{V}$, $I_D = 20\text{A}$, $R_G = 25\Omega$ (Notes 4, 5)	-	36	-	ns
Rise time	t_r		-	73	-	ns
Turn-off delay time	$t_{d(off)}$		-	166	-	ns
Fall time	t_f		-	73	-	ns

Drain-Source Diode Characteristics

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Source-drain current (body diode)	I_{SD}	$T_C = 25^\circ\text{C}$	-	-	20	A
Pulsed source-drain current (body diode)	I_{SDM}		-	-	80	A
Forward on voltage	V_{SD}	$T_J = 25^\circ\text{C}$, $V_{GS} = 0\text{V}$, $I_{SD} = 20\text{A}$	-	-	1.5	V
Reverse recovery time	t_{rr}	$V_{GS} = 0\text{V}$, $I_S = 20\text{A}$, $di/dt = 100\text{A}/\mu\text{s}$ (Note 4)	-	425	-	ns
Reverse recovery charge	Q_{rr}		-	3.7	-	μC

Note 4. Pulse test: pulse width $\leq 300\mu\text{s}$, duty cycle $\leq 2\%$.

Note 5. Essentially independent of operating temperature.

650V, 20A N-Channel MOSFET

Typical Characteristics

$T_J = 25^\circ\text{C}$, unless otherwise noted

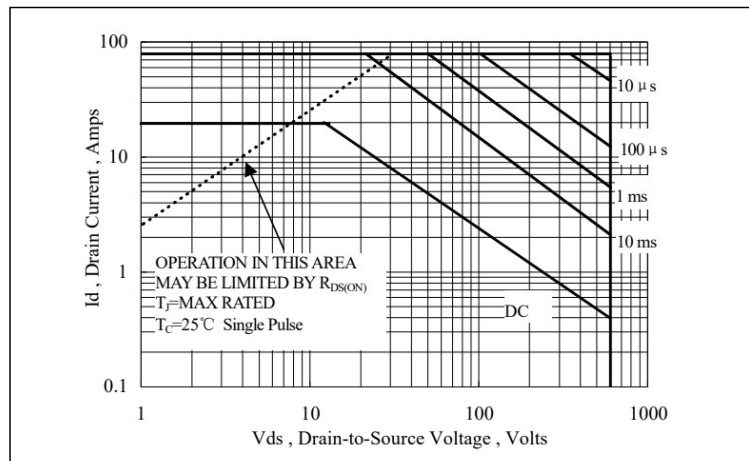


Figure 1. Maximum Forward Bias Safe Operating Area

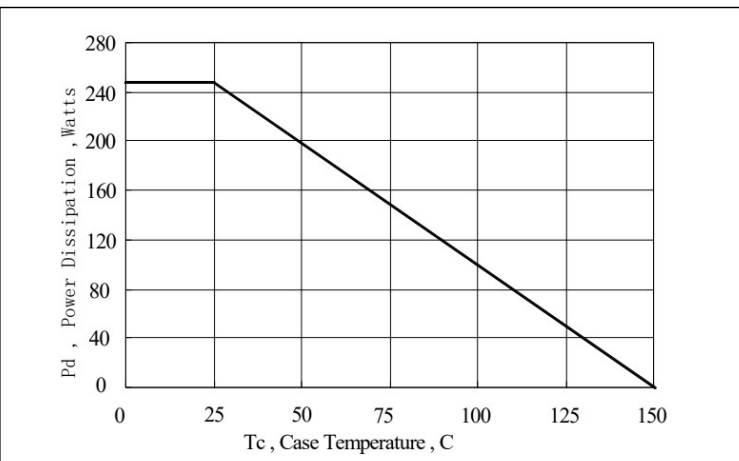


Figure 2. Maximum Power Dissipation vs. Case Temperature

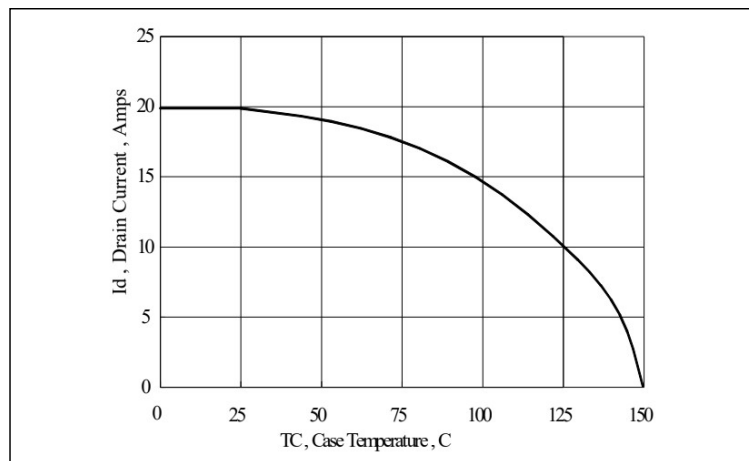


Figure 3. Maximum Continuous Drain Current vs. Case Temperature

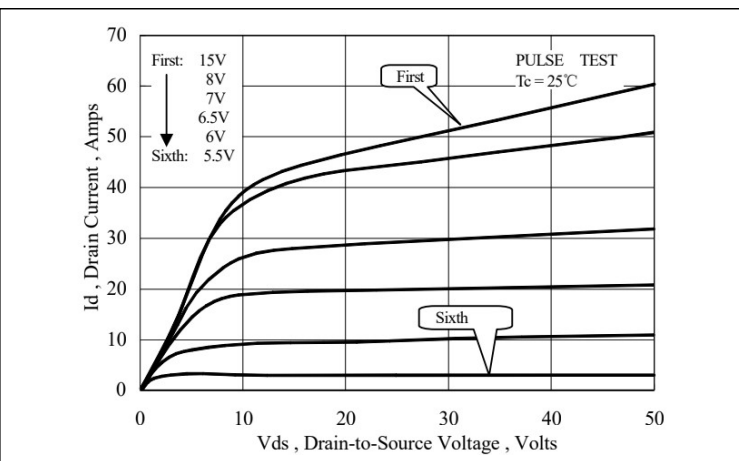


Figure 4. Typical Output Characteristics

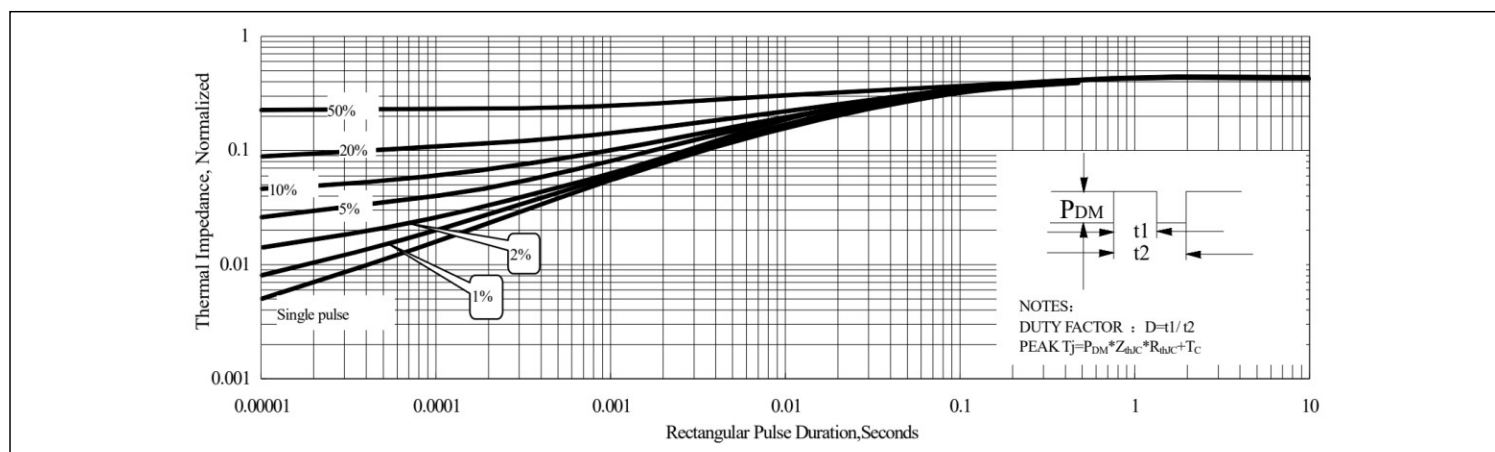


Figure 5. Maximum Effective Thermal Impedance, Junction to Case

650V, 20A N-Channel MOSFET

Typical Characteristics (Continued)

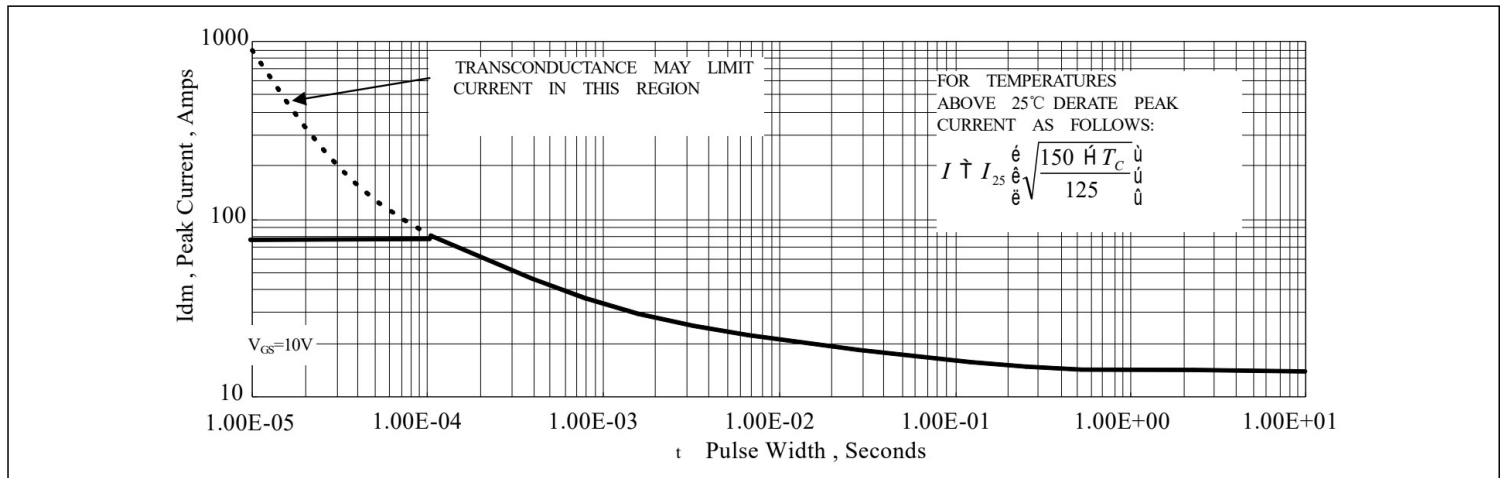


Figure 6. Maximum Peak Current Capability

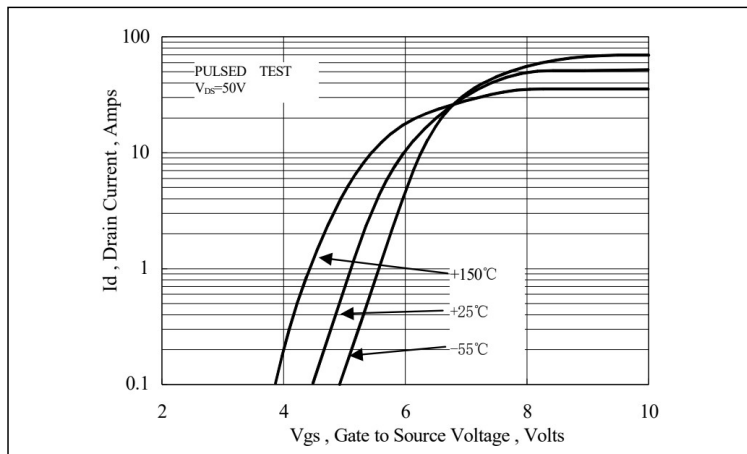


Figure 7. Typical Transfer Characteristics

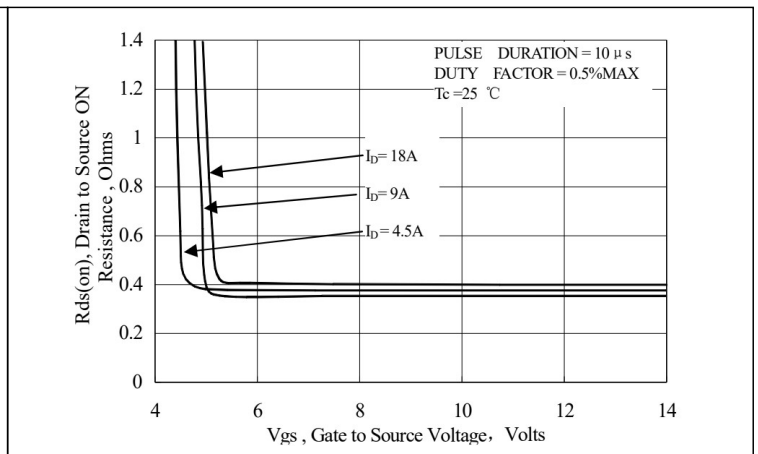


Figure 8. Typical Drain-to-Source On-Resistance vs. Gate Voltage and Drain Current

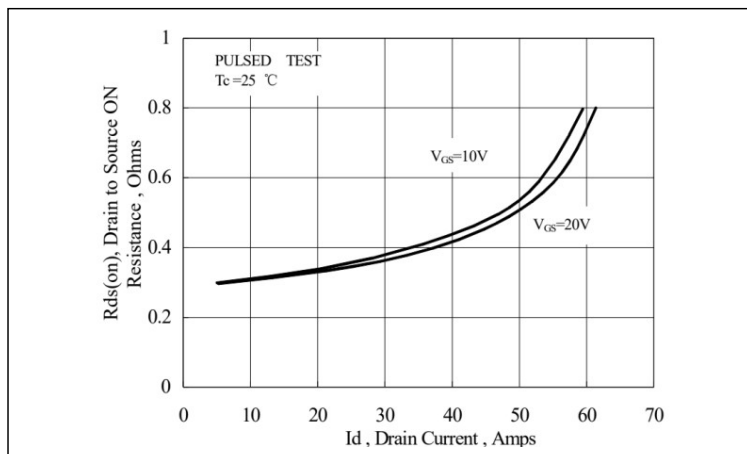


Figure 9. Typical Drain-to-Source On-Resistance vs. Drain Current

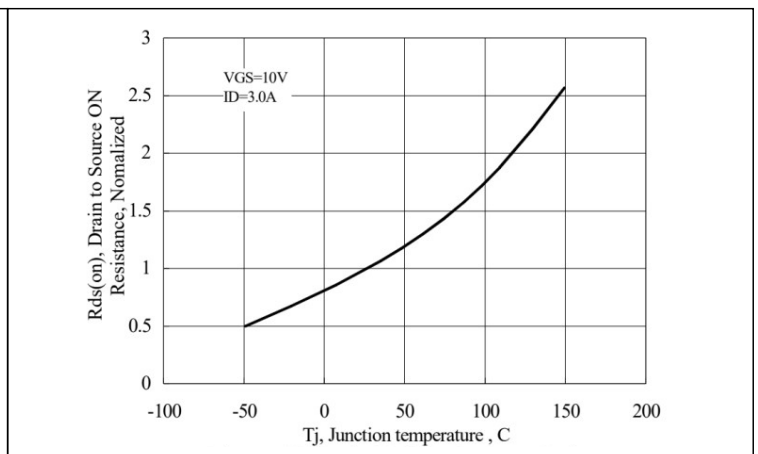


Figure 10. Typical Drain-to-Source On-Resistance vs. Junction Temperature

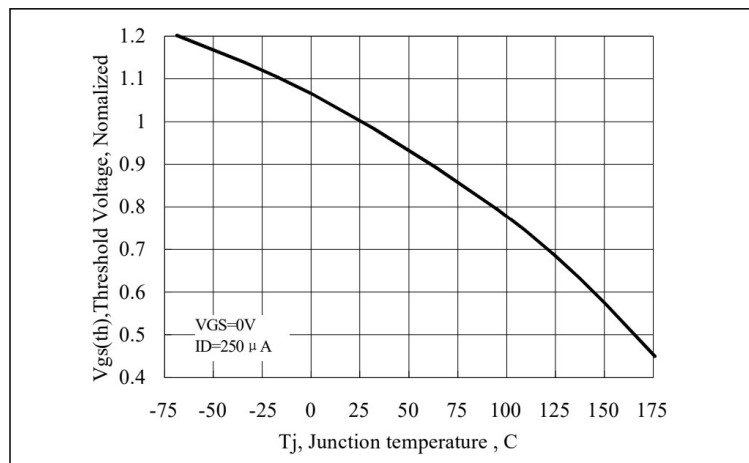
650V, 20A N-Channel MOSFET
Typical Characteristics (Continued)


Figure 11. Typical Threshold Voltage vs. Junction Temperature

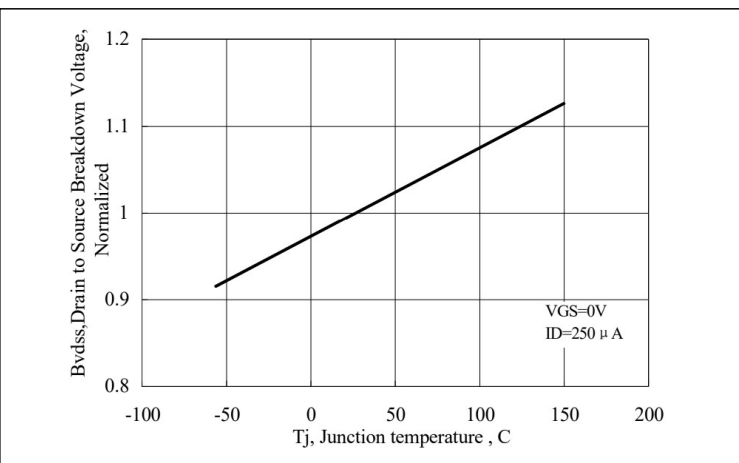


Figure 12. Typical Breakdown Voltage vs. Junction Temperature and Drain Current

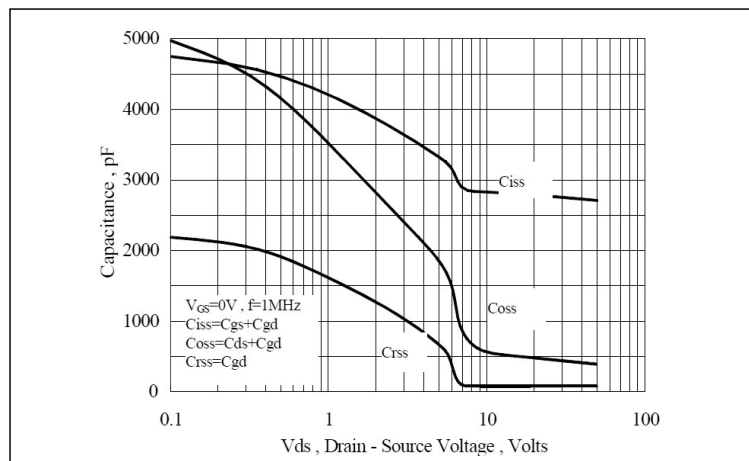


Figure 13. Typical Capacitance vs. Drain-to-Source Voltage

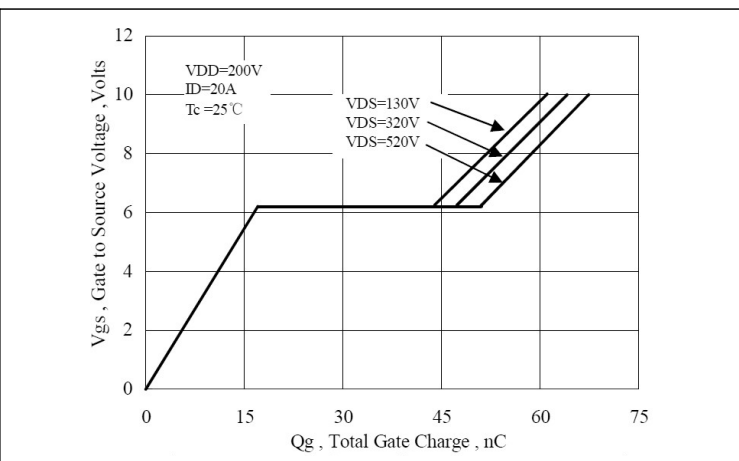


Figure 14. Typical Gate Charge vs. Gate-to-Source Voltage

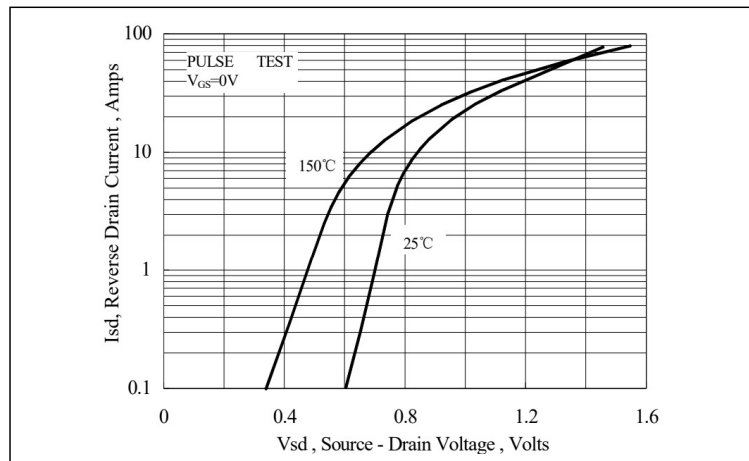


Figure 15. Typical Body Diode Transfer Characteristics

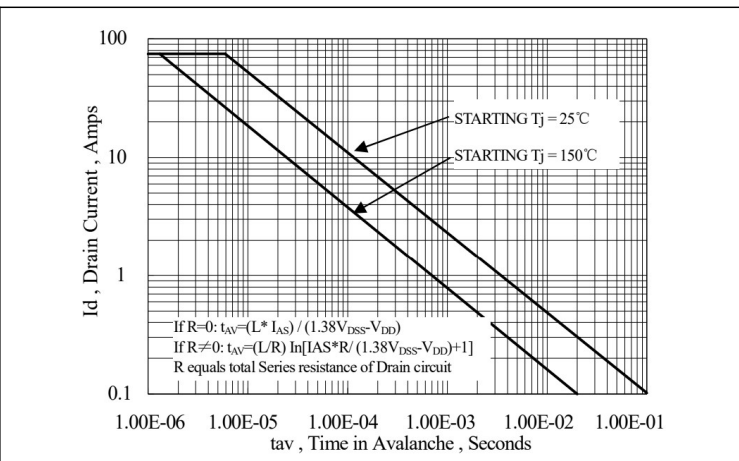
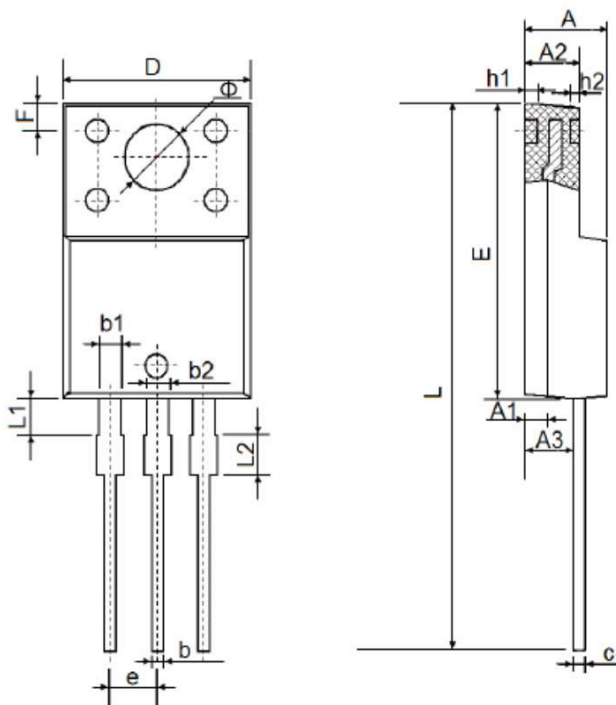


Figure 16. Unclamped Inductive Switching Capability

Package Dimensions

HCR20N65F - TO-220F Package

Unit: mm

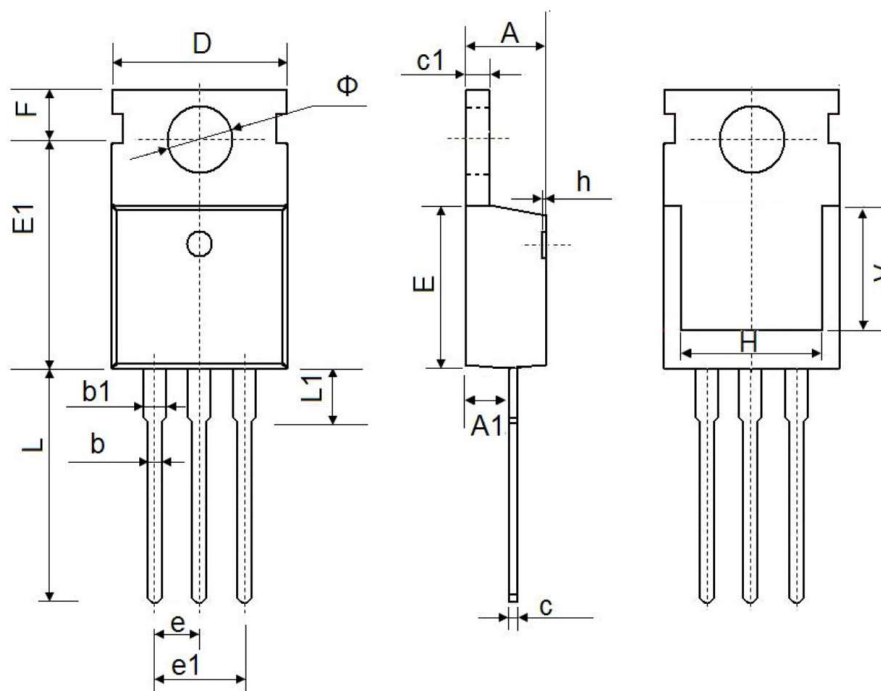


Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min.	Max.	Min.	Max.
A	4.300	4.700	0.169	0.185
A1	1.300REF		0.051REF	
A2	2.800	3.200	0.110	0.126
A3	2.500	2.900	0.098	0.114
b	0.500	0.750	0.020	0.030
b1	1.100	1.350	0.043	0.053
b2	1.500	1.750	0.059	0.069
c	0.500	0.750	0.020	0.030
D	9.960	10.360	0.392	0.408
E	14.800	15.200	0.583	0.598
e	2.540TYP.		0.100TYP	
F	2.700REF		0.106REF	
Φ	3.500REF		0.138REF	
h1	0.800REF		0.031REF	
h2	0.500REF		0.020REF	
L	28.000	28.400	1.102	1.118
L1	1.700	1.900	0.067	0.075
L2	1.900	2.100	0.075	0.083

Package Dimensions

HCR20N65P - TO-220AB Package

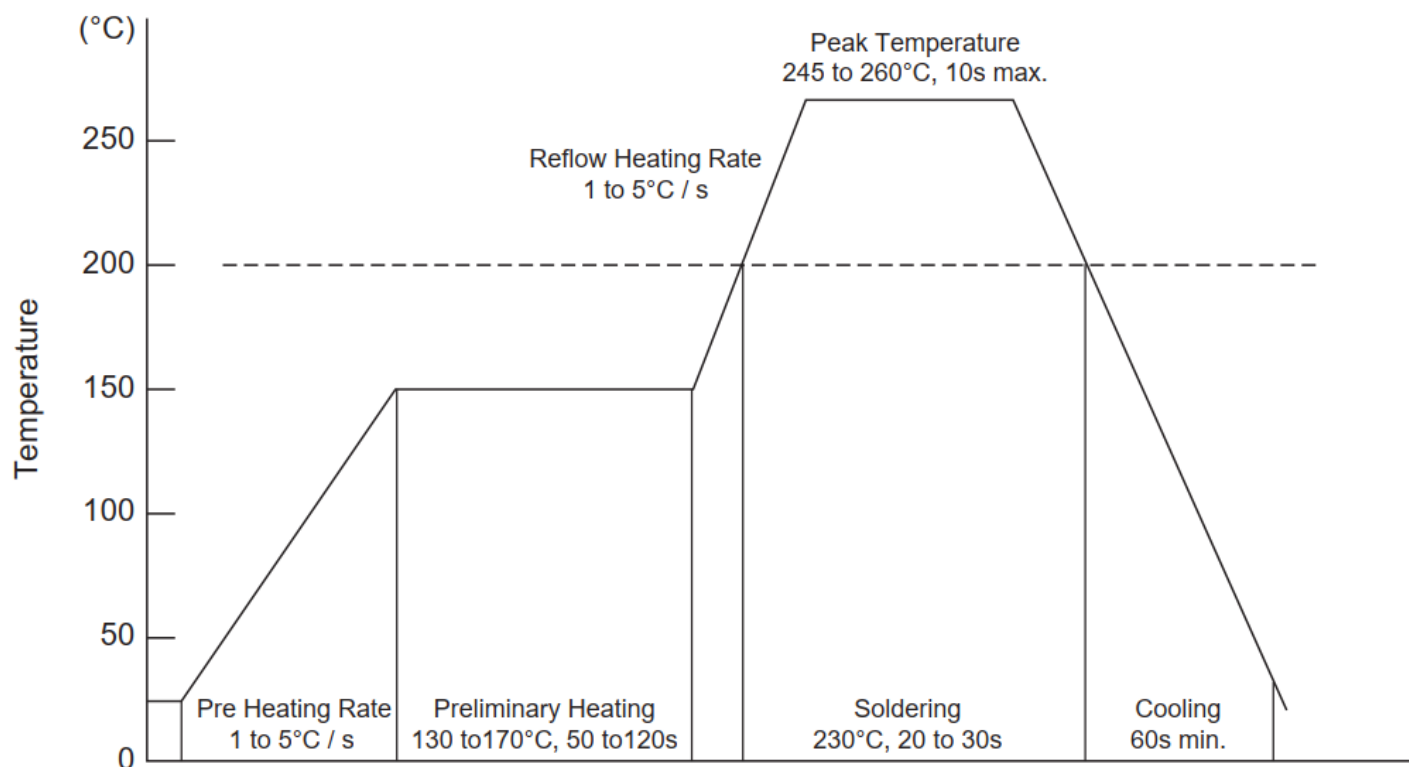
Unit: mm



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min.	Max.	Min.	Max.
A	4.400	4.600	0.173	0.181
A1	2.250	2.550	0.089	0.100
b	0.710	0.910	0.028	0.036
b1	1.170	1.370	0.046	0.054
c	0.330	0.650	0.013	0.026
c1	1.200	1.400	0.047	0.055
D	9.910	10.250	0.390	0.404
E	8.9500	9.750	0.352	0.384
E1	12.650	12.950	0.498	0.510
e	2.540 TYP.		0.100 TYP.	
e1	4.980	5.180	0.196	0.204
F	2.650	2.950	0.104	0.116
H	7.900	8.100	0.311	0.319
h	0.000	0.300	0.000	0.012
L	12.900	13.400	0.508	0.528
L1	2.850	3.250	0.112	0.128
V	7.500 REF.		0.295 REF.	
Φ	3.400	3.800	0.134	0.150

Conditions of Soldering and Storage

Recommended condition of reflow soldering



Recommended peak temperature is over 245°C. If peak temperature is below 245°C, you may adjust the following parameters:

- Time length of peak temperature (longer)
- Time length of soldering (longer)
- Thickness of solder paste (thicker)

Conditions of hand soldering

- Temperature: 300°C
- Time: 3s max
- Times: one time

Storage conditions

- Temperature: 5 to 40°C
- Humidity: 30 to 80% RH
- Recommended period: One year after manufacturing