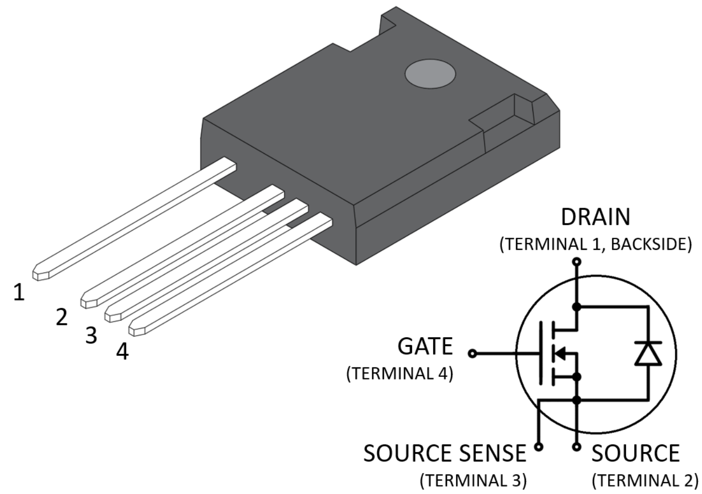
MSC060SMA070B4 Silicon Carbide N-Channel Power MOSFET

1 Product Overview

The silicon carbide (SiC) power MOSFET product line from Microsemi increases the performance over silicon MOSFET and silicon IGBT solutions while lowering the total cost of ownership for high-voltage applications. The MSC060SMA070B4 device is a 700 V, 60 mΩ SiC MOSFET in a TO-247 4-lead package with a source sense.



1.1 Features

The following are key features of the MSC060SMA070B4 device:

- Low capacitances and low gate charge
- Fast switching speed due to low internal gate resistance (ESR)
- Stable operation at high junction temperature, $T_{J(max)}$ = 175 °C
- Fast and reliable body diode
- Superior avalanche ruggedness
- RoHS compliant

1.2 Benefits

The following are benefits of the MSC060SMA070B4 device:

- High efficiency to enable lighter, more compact system
- Simple to drive and easy to parallel
- Improved thermal capabilities and lower switching losses
- Eliminates the need for external freewheeling diode
- Lower system cost of ownership

1.3 Applications

The MSC060SMA070B4 device is designed for the following applications:

- PV inverter, converter, and industrial motor drives
- Smart grid transmission and distribution
- Induction heating and welding
- H/EV powertrain and EV charger
- Power supply and distribution

2 Device Specifications

This section shows the specifications for the MSC060SMA070B4 device.

2.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings for the MSC060SMA070B4 device.

Table 1 • Absolute Maximum Ratings

Symbol	Characteristic	Ratings	Unit
V_{DSS}	Drain source voltage	700	V
I_D	Continuous drain current at T_C = 25 °C	39	A
	Continuous drain current at T_C = 100 °C	28	
I_{DM}	Pulsed drain current[1]	100	
V_{GS}	Gate-source voltage	23 to –10	V
P_D	Total power dissipation at T_C = 25 °C	143	W
	Linear derating factor	0.94	W/°C

Note:

1. Repetitive rating: pulse width and case temperature limited by maximum junction temperature.

The following table shows the thermal and mechanical characteristics for the MSC060SMA070B4 device.

Table 2 • Thermal and Mechanical Characteristics

Symbol	Characteristic	Min	Typ	Max	Unit
$R_{θJC}$	Junction-to-case thermal resistance		0.70	1.05	°C/W
T_J	Operating junction temperature	–55		175	°C
T_{STG}	Storage temperature	–55		150	
T_L	Soldering temperature for 10 seconds (1.6 mm from case)			260	
	Mounting torque, 6-32 or M3 screw			10	lbf-in
				1.1	N-m
Wt	Package weight		0.22		oz
			6.2		g

2.2 Electrical Performance

The following table shows the static characteristics for the MSC060SMA070B4 device. T_J = 25 °C unless otherwise specified.

Table 3 • Static Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	V_{GS} = 0 V, I_D = 100 µA	700			V
$R_{DS(on)}$	Drain-source on resistance [1]	V_{GS} = 20 V, I_D = 20 A		60	75	mΩ
$V_{GS(th)}$	Gate-source threshold voltage	V_{GS} = V_{DS}, I_D = 1 mA	1.9	2.4		V
$\Delta V_{GS(th)}/\Delta T_J$	Threshold voltage coefficient	V_{GS} = V_{DS}, I_D = 1 mA		–3.4		mV/°C
I_{DSS}	Zero gate voltage drain current	V_{DS}, = 700 V, V_{GS} = 0 V			100	µA
		V_{DS} = 700 V, V_{GS} = 0 V T_J = 125 °C			500	
I_{GSS}	Gate-source leakage current	V_{GS} = 20 V/–10 V			±100	nA

Notes:

1. Pulse test: pulse width < 380 µs, duty cycle < 2%.

The following table shows the dynamic characteristics for the MSC060SMA070B4 device. T_J = 25 °C unless otherwise specified.

Table 4 • Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
C_{iss}	Input capacitance	V_{GS} = 0 V, V_{DD} = 700 V, V_{AC} = 25 mV, ƒ = 1 MHz		1175		pF
C_{rss}	Reverse transfer capacitance			8		
C_{oss}	Output capacitance			130		
Q_g	Total gate charge	V_{GS} = –5 V/20 V, V_{DD} = 470 V I_D = 20 A		56		nC
Q_{gs}	Gate-source charge			15		
Q_{gd}	Gate-drain charge			9		
$t_{d(on)}$	Turn-on delay time	V_{DD} = 470 V, V_{GS} = –5 V/20 V, I_D = 20 A $R_{G(ext)}$ = 4 Ω[1], Freewheeling diode = MSC060SMA070B4 (V_{GS} = –5 V)		18		ns
t_r	Current rise time			7		
$t_{d(off)}$	Turn-off delay time			26		
t_f	Current fall time			7		
E_{on}	Turn-on switching energy [2]			125		µJ
E_{off}	Turn-off switching energy			19		
$t_{d(on)}$	Turn-on delay time	V_{DD} = 470 V, V_{GS} = –5 V/20 V, I_D = 20 A $R_{G(ext)}$ = 4 Ω[1] Freewheeling diode = MSC030SDA070B		20		ns
t_r	Current rise time			9		
$t_{d(off)}$	Turn-off delay time			25		
t_f	Current fall time			10		
E_{on}	Turn-on switching energy [2]			108		µJ
E_{off}	Turn-off switching energy			16		
ESR	Equivalent series resistance	f = 1 MHz, 25 mV, drain short		2.6		Ω
SCWT	Short circuit withstand time	V_{DS} = 560 V, V_{GS} = 20 V		3		µs

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
E_{AS}	Avalanche energy, single pulse	V_{DS} = 150 V, I_D = 20 A		1150		mJ

Notes:

1. R_G is total gate resistance excluding internal gate driver impedance.
2. E_{on} includes energy of freewheeling diode.

The following table shows the body diode characteristics for the MSC060SMA070B4 device. T_J = 25 °C unless otherwise specified.

Table 5 • Body Diode Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
V_{SD}	Diode forward voltage	I_{SD} = 20 A, V_{GS} = 0 V		4.0		V
		I_{SD} = 20 A, V_{GS} = –5 V		4.2		V
t_{rr}	Reverse recovery time	I_{SD} = 20 A, V_{GS} = –5 V V_{DD} = 470 V dI/dt = –1500 A/µs		25		ns
Q_{rr}	Reverse recovery charge			170		nC
I_{RRM}	Reverse recovery current			10		A

2.3 Typical Performance Curves

This section shows the typical performance curves for the MSC060SMA070B4 device.

Figure 1 • Drain Current vs. Drain-to-Source Voltage

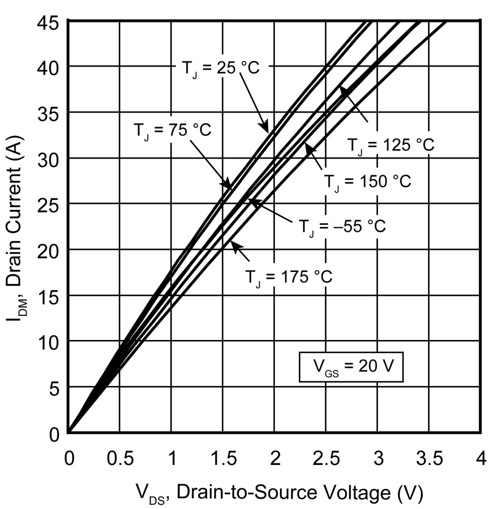


Figure 2 • Drain Current vs. Drain-to-Source Voltage

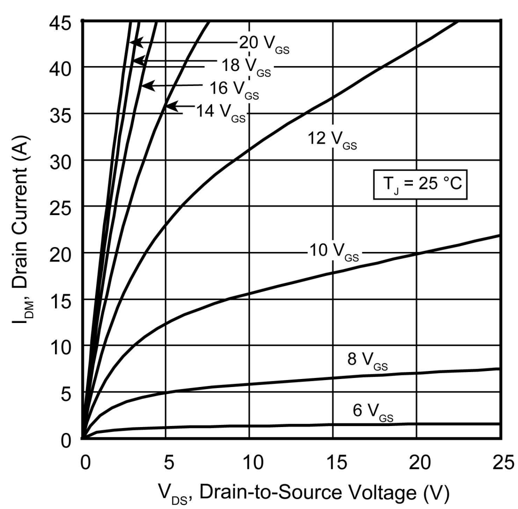


Figure 3 • Drain Current vs. Drain-to-Source Voltage

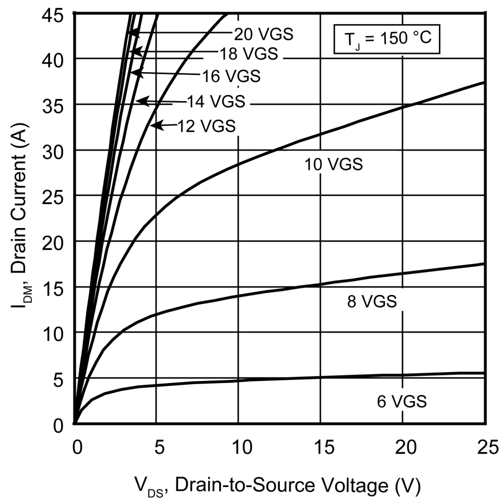


Figure 4 • Drain Current vs. Drain-to-Source Voltage

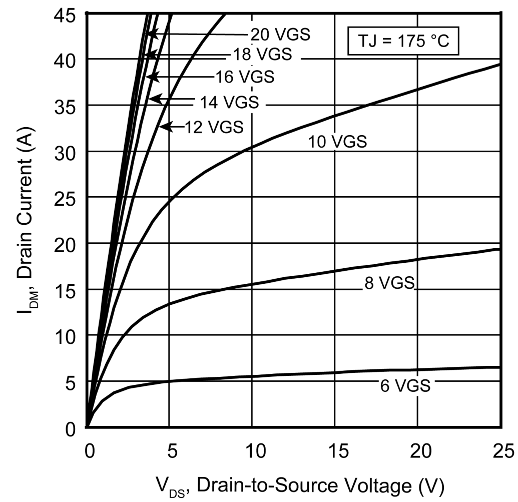


Figure 5 • RDS(on) vs. Junction Temperature

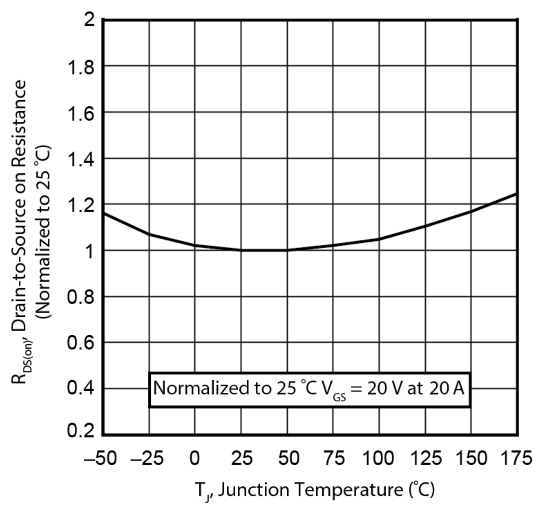


Figure 6 • Gate Charge Characteristics

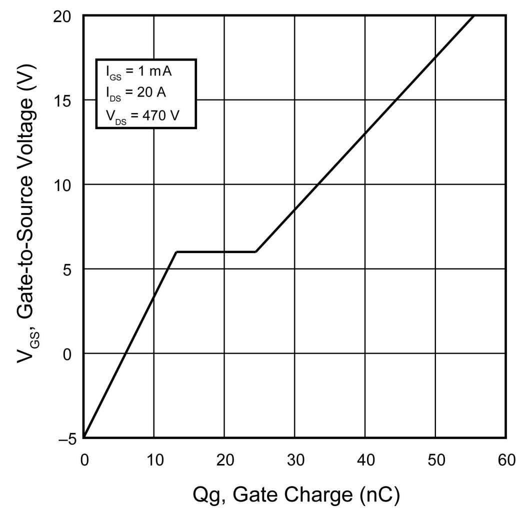


Figure 7 • Capacitance vs. Drain-to-Source Voltage

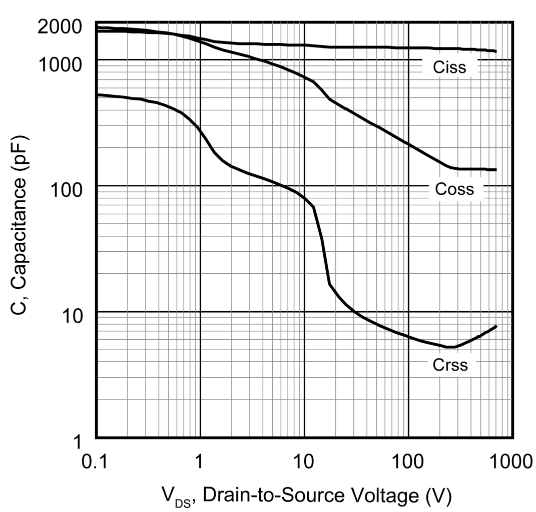


Figure 8 • IDM vs. Gate-to-Source Voltage

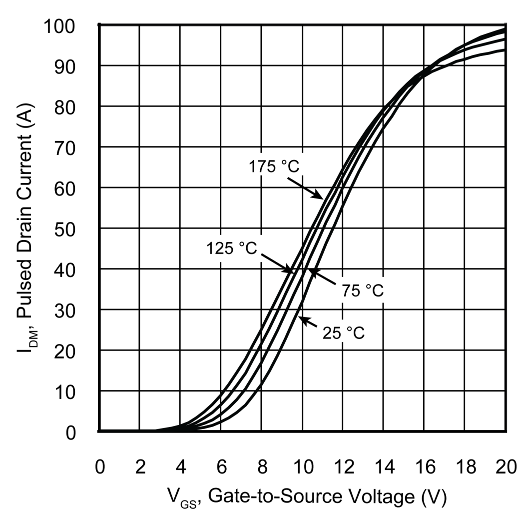


Figure 9 • IDM vs. VDS Third Quadrant Conduction

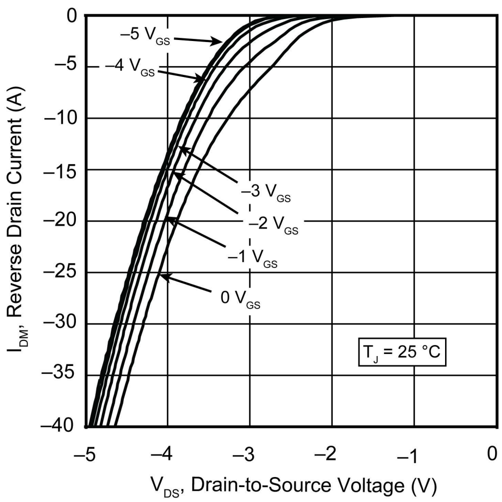


Figure 10 • IDM vs. VDS Third Quadrant Conduction

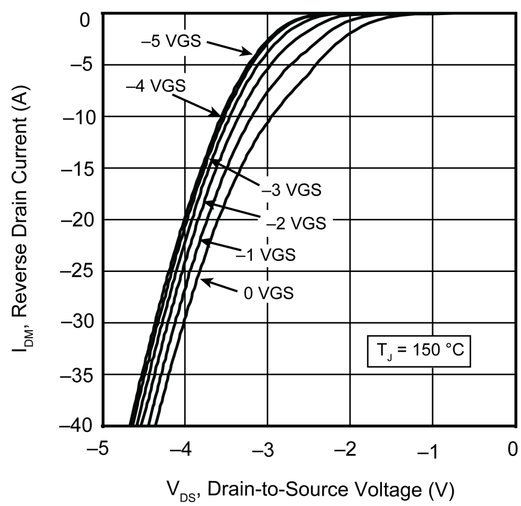


Figure 11 • VGS(th) vs. Junction Temp.

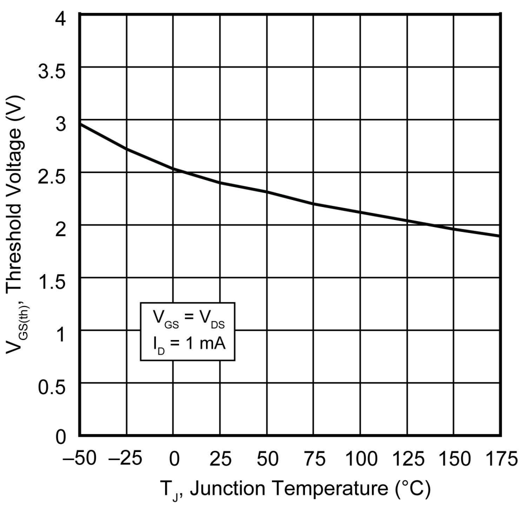


Figure 12 • Forward Safe Operating Area

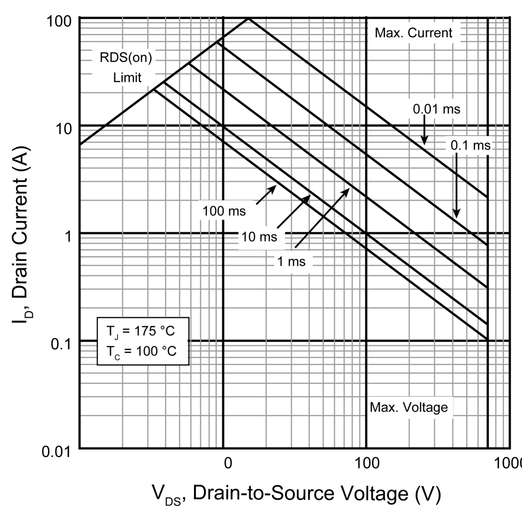
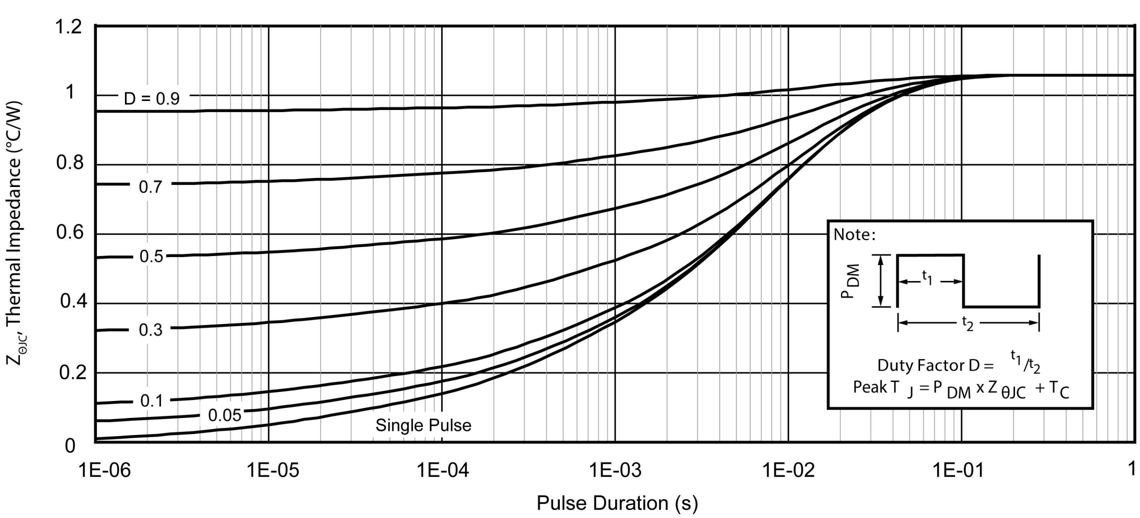


Figure 13 • Maximum Transient Thermal Impedance



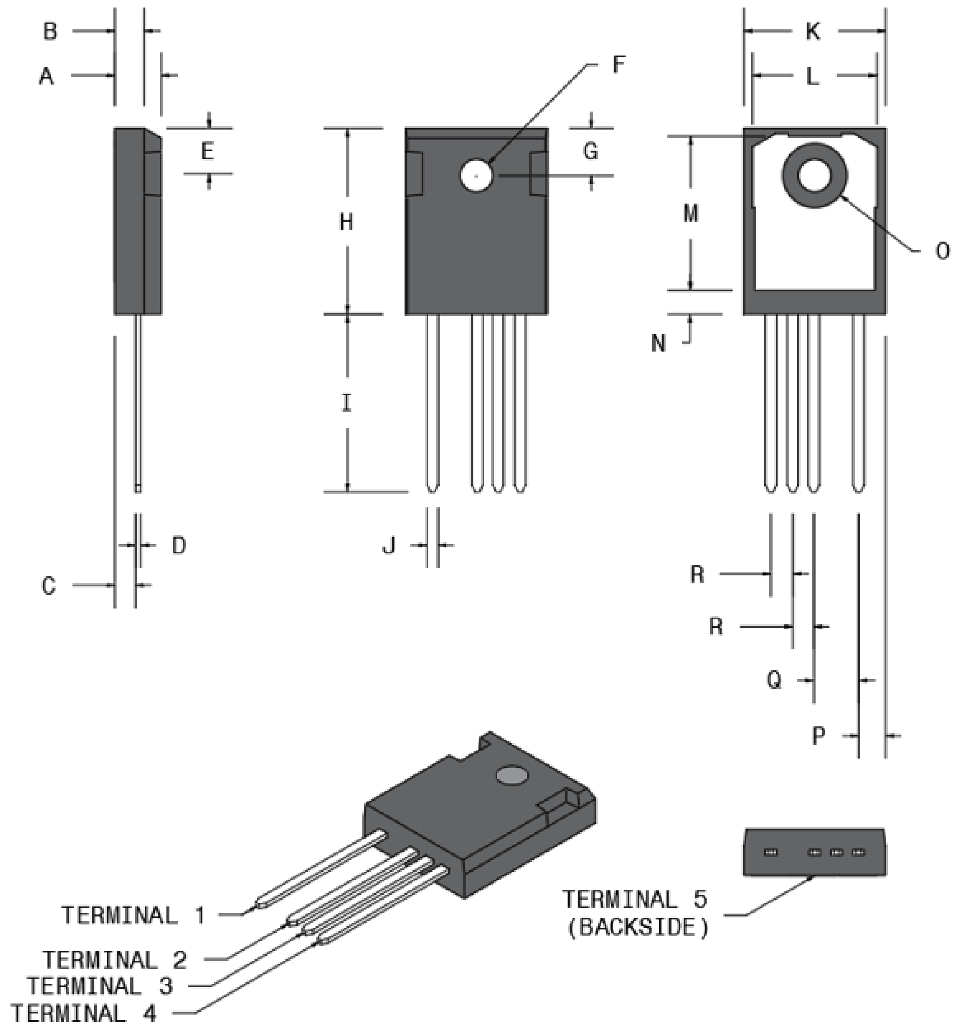
3 Package Specification

This section shows the package specification for the MSC060SMA070B4 device.

3.1 Package Outline Drawing

The following figure illustrates the TO-247 4-lead package drawing for the MSC060SMA070B4 device. The dimensions in the figure below are in millimeters and (inches).

Figure 14 • Package Outline Drawing



The following table shows the TO-247 4-lead dimensions and should be used in conjunction with the package outline drawing.

Table 6 • TO-247-4L Dimensions

Symbol	Min (mm)	Max (mm)	Min (in.)	Max (in.)
A	4.90	5.17	0.193	0.204
B	1.85	2.11	0.073	0.083
C	2.25	2.51	0.089	0.099
D	0.55	0.68	0.022	0.027
E	5.49	5.74	0.216	0.226
F	3.56	3.66	0.140	0.144
G	6.15 BSC		0.242 BSC	
H	20.83	21.08	0.820	0.830
I	19.81	20.32	0.780	0.800
J	1.07	1.33	0.042	0.052
K	15.77	16.03	0.621	0.631
L	13.89	14.15	0.547	0.557
M	16.25	16.85	0.640	0.663
N	2.00	2.75	0.079	0.108
O	7.10	7.50	0.280	0.295
P	2.87 BSC		0.113 BSC	
Q	5.08 BSC		0.200 BSC	
R	2.54 BSC		0.100 BSC	
Terminal 1	Drain			
Terminal 2	Source			
Terminal 3	Source sense			
Terminal 4	Gate			
Terminal 5	Drain			

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