Field Effect Transistor Silicon P Channel MOS Type

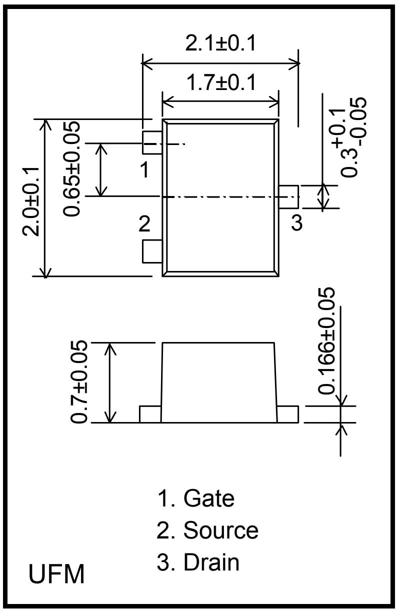
# HB60P20W

## ○ Power Management Switch Applications
## ○ High-Current Switching Applications

- 1.5 V drive
- Low on-resistance

  $R_{on}$ = 140 mΩ (max) (@$V_{GS}$ = -1.5 V)
  $R_{on}$ = 78 mΩ (max) (@$V_{GS}$ = -1.8 V)
  $R_{on}$ = 49 mΩ (max) (@$V_{GS}$ = -2.5 V)
  $R_{on}$ = 38 mΩ (max) (@$V_{GS}$ = -4.0 V)

Unit: mm




Weight: 6.6mg (typ.)

## Absolute Maximum Ratings (Ta = 25°C)

| Characteristics | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Drain-Source voltage | | $V_{DS}$ | -20 | V |
| Gate-Source voltage | | $V_{GSS}$ | ± 8 | V |
| Drain current | DC | $I_D$ | -4.0 | A |
| | Pulse | $I_{DP}$ | -8.0 | |
| Drain power dissipation | | $P_D$ (Note 1) | 800 | mW |
| | | $P_D$ (Note 2) | 500 | |
| Channel temperature | | $T_{ch}$ | 150 | °C |
| Storage temperature | | $T_{stg}$ | −55~150 | °C |

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.

Note 1 : Mounted on ceramic board (25.4 mm × 25.4 mm × 0.8 t, Cu Pad: 645 $mm^2$)

Note 2 : Mounted on FR4 board (25.4 mm × 25.4 mm × 1.6 t, Cu Pad: 645 $mm^2$)

## Electrical Characteristics (Ta = 25°C)

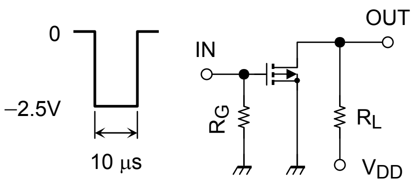
| Characteristics | | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Drain-Source breakdown voltage | | $V_{(BR)DSS}$ | $I_D$ = −1 mA, $V_{GS}$ = 0 | −20 | — | — | V |
| | | $V_{(BR)DSX}$ | $I_D$ = −1 mA, $V_{GS}$ = +8 V | −12 | — | — | |
| Drain cut-off current | | $I_{DSS}$ | $V_{DS}$ = −20 V, $V_{GS}$ = 0 | — | — | −10 | μA |
| Gate leakage current | | $I_{GSS}$ | $V_{GS}$ = ±8 V, $V_{DS}$ = 0 | — | — | ±1 | μA |
| Gate threshold voltage | | $V_{th}$ | $V_{DS}$ = −3 V, $I_D$ = −1 mA | −0.3 | — | −1.0 | V |
| Forward transfer admittance | | $\|Y_{fs}\|$ | $V_{DS}$ = -3 V, $I_D$ = -2.0 A (Note 3) | 6.1 | 12.1 | — | S |
| Drain-Source ON-resistance | | $R_{DS(ON)}$ | $I_D$ = -3.0 A, $V_{GS}$ = -4.0 V (Note 3) | — | 28 | 38 | mΩ |
| | | | $I_D$ = -2.0 A, $V_{GS}$ = -2.5 V (Note 3) | — | 34 | 49 | |
| | | | $I_D$ = -1.0 A, $V_{GS}$ = -1.8 V (Note 3) | — | 47 | 78 | |
| | | | $I_D$ = -0.3 A, $V_{GS}$ = -1.5 V (Note 3) | — | 60 | 140 | |
| Input capacitance | | $C_{iss}$ | $V_{DS}$ = −10 V, $V_{GS}$ = 0<br>f = 1 MHz | — | 1484 | — | pF |
| Output capacitance | | $C_{oss}$ | | — | 185 | — | pF |
| Reverse transfer capacitance | | $C_{rss}$ | | — | 169 | — | pF |
| Switching time | Turn-on time | $t_{on}$ | $V_{DD}$ = −10 V, $I_D$ = −2.0 A<br>$V_{GS}$ = 0 ~ −2.5 V, $R_G$ = 4.7 Ω | — | 67 | — | ns |
| | Turn-off time | $t_{off}$ | | — | 92 | — | |

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Total gate charge | $Q_g$ | $V_{DS}$ = –16 V, $I_{DS}$ = –4.0 A, $V_{GS}$ = –4.0 V, | — | 22.3 | — | nC |
| Gate-Source charge | $Q_{gs}$ | | — | 14.9 | — | |
| Gate-Drain charge | $Q_{gd}$ | | — | 7.3 | — | |
| Drain-Source forward voltage | $V_{DSF}$ | $I_D$ = 4.0 A, $V_{GS}$ = 0 (Note 3) | — | 0.8 | 1.2 | V |

Note 3: Pulse test

## Switching Time Test Circuit

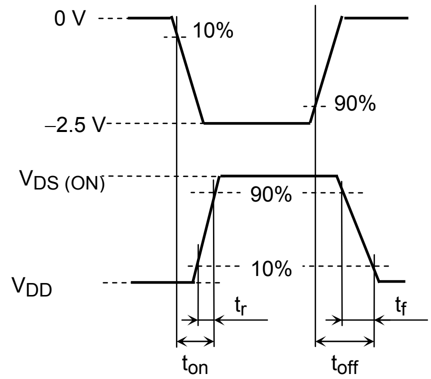
### (a) Test Circuit



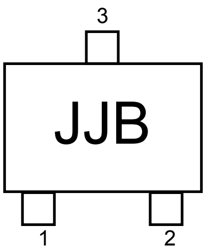

$V_{DD}$ = -10 V
$R_G$ = 4.7 Ω
D.U. ≦ 1%
$V_{IN}$: $t_r$, $t_f$ < 5 ns
Common Source
Ta = 25 °C

### (b) $V_{IN}$

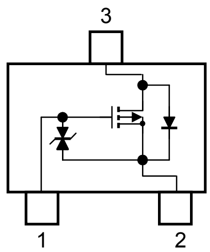
### (c) $V_{OUT}$




## Marking




## Equivalent Circuit (top view)



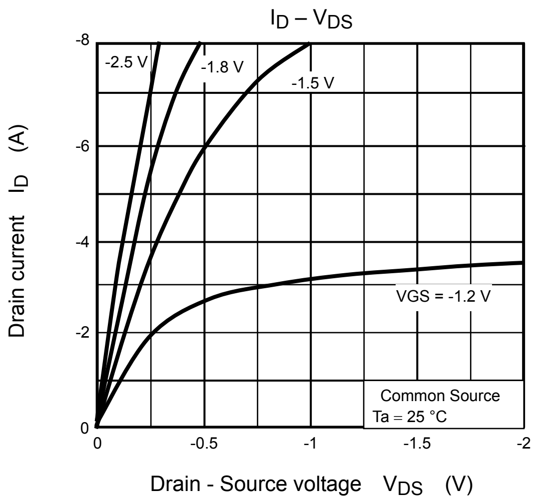

## Precaution

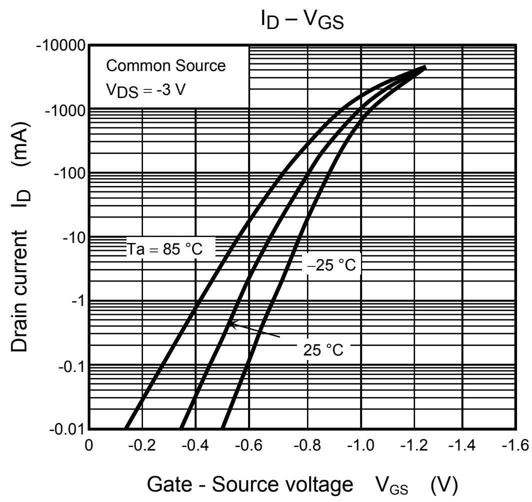
$V_{th}$ can be expressed as the voltage between the gate and source when the low operating current value is $I_D$ = -1mA for this product. For normal switching operation, $V_{GS\ (on)}$ requires a higher voltage than $V_{th}$ and $V_{GS\ (off)}$ requires a lower voltage than $V_{th}$. (The relationship can be established as follows: $V_{GS\ (off)} < V_{th} < V_{GS\ (on)}$.)

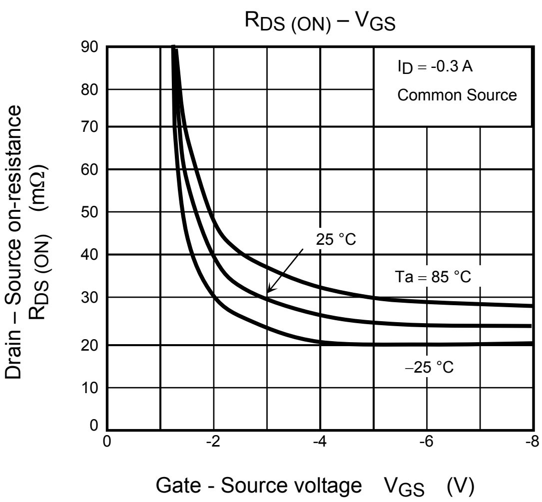
Be sure to take this into consideration when using the device.

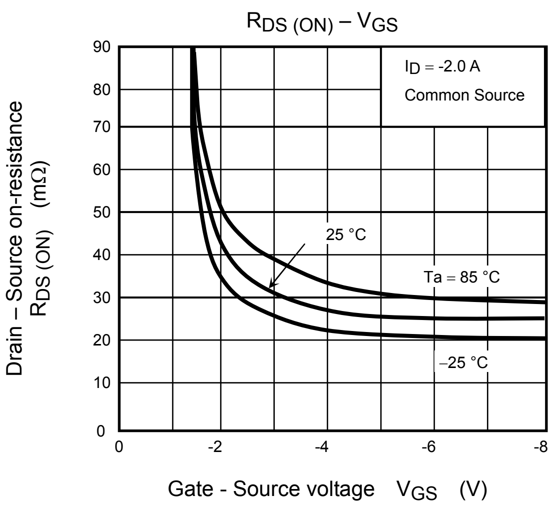
## Handling Precaution

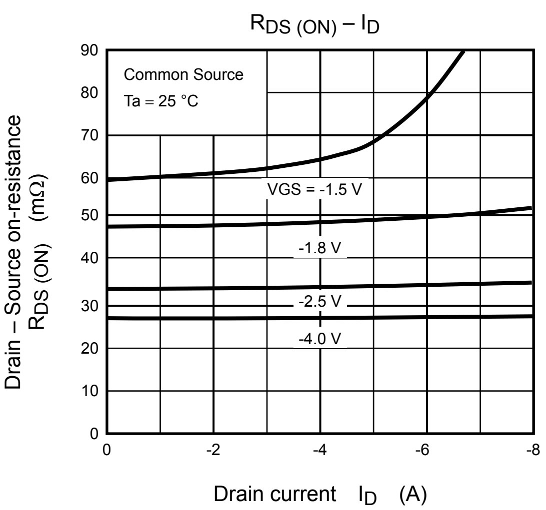
When handling individual devices (which are not yet mounted on a circuit board), ensure that the environment is protected against static electricity. Operators should wear anti-static clothing, and containers and other objects that come into direct contact with devices should be made of anti-static materials.

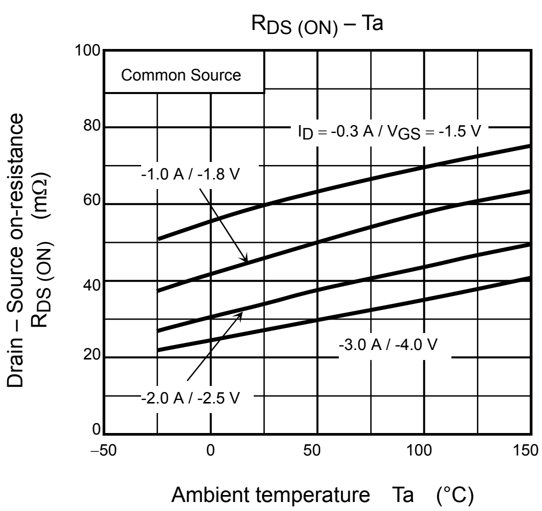

ID – VDS
-2.5 V
-1.8 V
-1.5 V
VGS = -1.2 V
Common Source
Ta = 25 °C
Drain current ID (A)
-8
-6
-4
-2
0
0
-0.5
-1
-1.5
-2
Drain - Source voltage VDS (V)

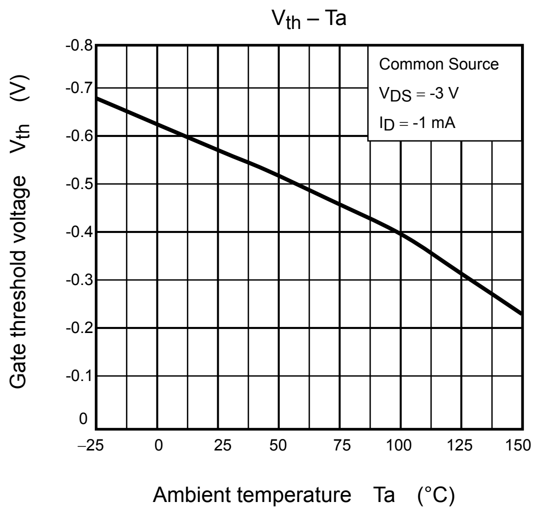

ID – VGS
Common Source
VDS = -3 V
Ta = 85 °C
–25 °C
25 °C
Drain current ID (mA)
-10000
-1000
-100
-10
-1
-0.1
-0.01
0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
Gate - Source voltage VGS (V)

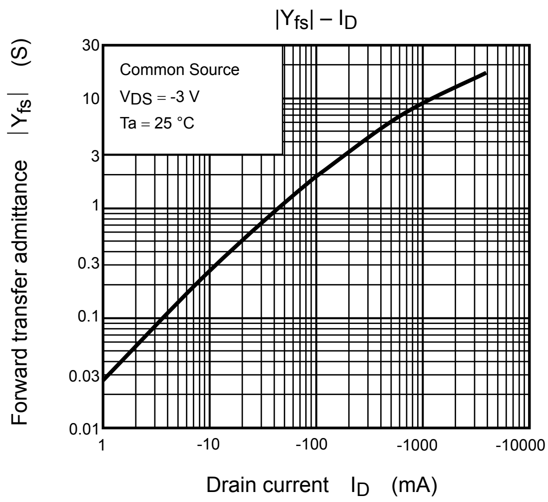

RDS (ON) – VGS
ID = -0.3 A
Common Source
25 °C
Ta = 85 °C
–25 °C
Drain – Source on-resistance RDS (ON) (mΩ)
90
80
70
60
50
40
30
20
10
0
0
-2
-4
-6
-8
Gate - Source voltage VGS (V)

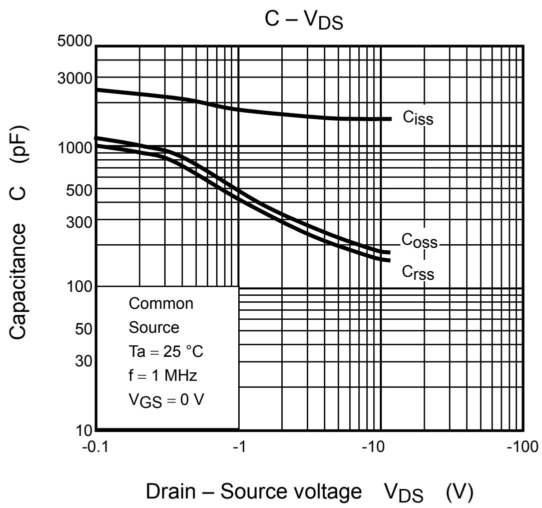

RDS (ON) – VGS
ID = -2.0 A
Common Source
25 °C
Ta = 85 °C
–25 °C
Drain – Source on-resistance RDS (ON) (mΩ)
90
80
70
60
50
40
30
20
10
0
0
-2
-4
-6
-8
Gate - Source voltage VGS (V)

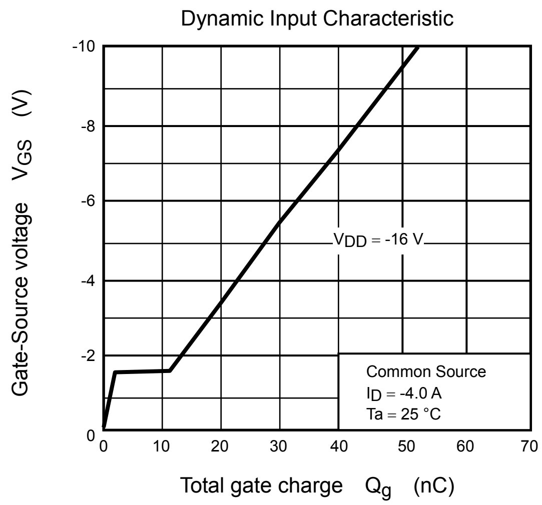

RDS (ON) – ID
Common Source
Ta = 25 °C
VGS = -1.5 V
-1.8 V
-2.5 V
-4.0 V
Drain – Source on-resistance RDS (ON) (mΩ)
90
80
70
60
50
40
30
20
10
0
0
-2
-4
-6
-8
Drain current ID (A)

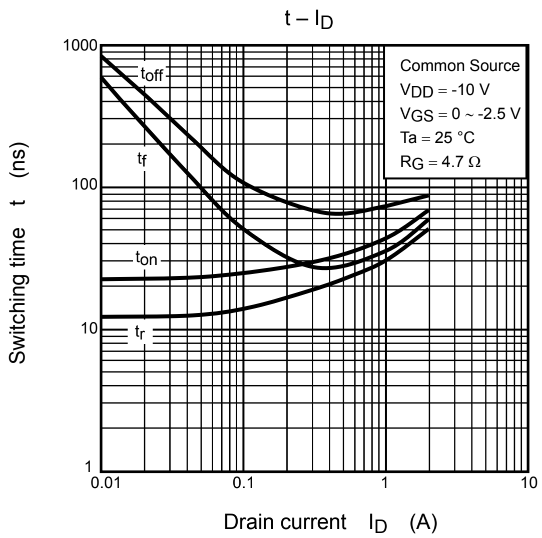

RDS (ON) – Ta
Common Source
ID = -0.3 A / VGS = -1.5 V
-1.0 A / -1.8 V
-3.0 A / -4.0 V
-2.0 A / -2.5 V
Drain – Source on-resistance RDS (ON) (mΩ)
100
80
60
40
20
0
–50
0
50
100
150
Ambient temperature Ta (°C)

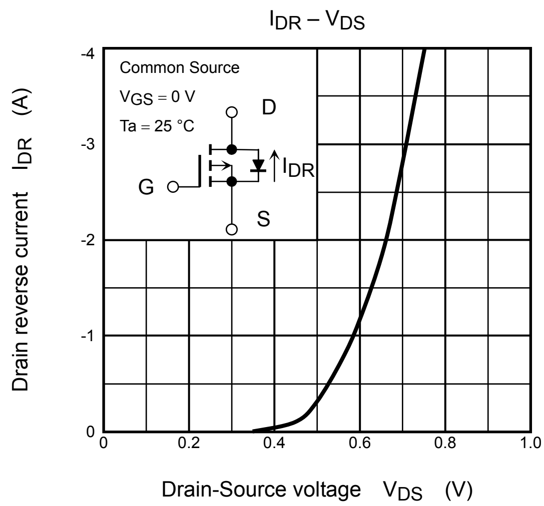

Vth – Ta
Common Source
VDS = -3 V
ID = -1 mA
Gate threshold voltage Vth (V)
Ambient temperature Ta (°C)

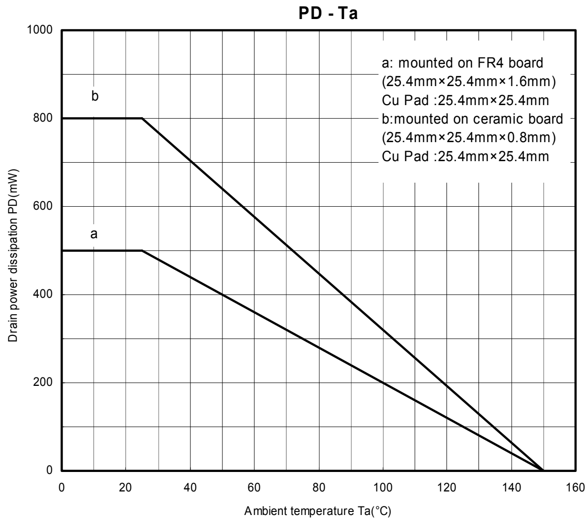

|Yfs| – ID
Common Source
VDS = -3 V
Ta = 25 °C
Forward transfer admittance |Yfs| (S)
Drain current ID (mA)

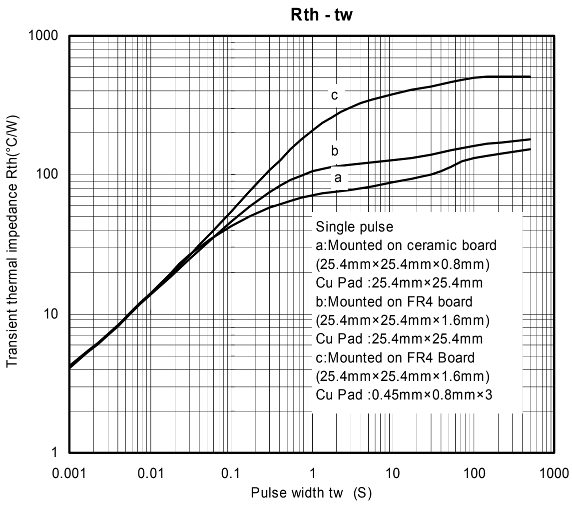

C – VDS
Ciss
Coss
Crss
Common Source
Ta = 25 °C
f = 1 MHz
VGS = 0 V
Capacitance C (pF)
Drain – Source voltage VDS (V)


Dynamic Input Characteristic
VDD = -16 V
Common Source
ID = -4.0 A
Ta = 25 °C
Gate-Source voltage VGS (V)
Total gate charge Qg (nC)


t – ID
Common Source
VDD = -10 V
VGS = 0 ~ -2.5 V
Ta = 25 °C
RG = 4.7 Ω
toff
tf
ton
tr
Switching time t (ns)
Drain current ID (A)


IDR – VDS
Common Source
VGS = 0 V
Ta = 25 °C
D
G
S
IDR
Drain reverse current IDR (A)
Drain-Source voltage VDS (V)


PD - Ta
1000
800
600
400
200
0
0
20
40
60
80
100
120
140
160
Drain power dissipation PD(mW)
Ambient temperature Ta(°C)
b
a
a: mounted on FR4 board
(25.4mm×25.4mm×1.6mm)
Cu Pad :25.4mm×25.4mm
b:mounted on ceramic board
(25.4mm×25.4mm×0.8mm)
Cu Pad :25.4mm×25.4mm


Rth - tw
1000
100
10
1
0.001
0.01
0.1
1
10
100
1000
Transient thermal impedance Rth(°C/W)
Pulse width tw (S)
c
b
a
Single pulse
a:Mounted on ceramic board
(25.4mm×25.4mm×0.8mm)
Cu Pad :25.4mm×25.4mm
b:Mounted on FR4 board
(25.4mm×25.4mm×1.6mm)
Cu Pad :25.4mm×25.4mm
c:Mounted on FR4 Board
(25.4mm×25.4mm×1.6mm)
Cu Pad :0.45mm×0.8mm×3