PM75RL1B060

**FEATURE**
Inverter + Brake + Drive & Protection IC

a) Adopting new 5th generation Full-Gate CSTBTM chip
b) The over-temperature protection which detects the chip surface temperature of CSTBTM is adopted.
c) Error output signal is possible from all each protection upper and lower arm of IPM.
d) Compatible L-series package.

- 3φ 75A, 600V Current-sense and temperature sense IGBT type inverter
- Monolithic gate drive & protection logic
- Detection, protection & status indication circuits for, short-circuit, over-temperature & under-voltage (P-Fo available from upper arm devices)
- UL Recognized

**APPLICATION**
General purpose inverter, servo drives and other motor controls

**PACKAGE OUTLINES**
Dimensions in mm
MITSUBISHI <INTELLIGENT POWER MODULES>
PM75RL1B060
FLAT-BASE TYPE
INSULATED PACKAGE

INTERNAL FUNCTIONS BLOCK DIAGRAM

MAXIMUM RATINGS ( TJ = 25 °C, unless otherwise noted)

**INVERTER PART**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Condition</th>
<th>Ratings</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCES</td>
<td>Collector-Emitter Voltage</td>
<td>VD = 15V, VCIN = 15V</td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>IC</td>
<td>Collector Current</td>
<td>TC = 25 °C</td>
<td>75</td>
<td>A</td>
</tr>
<tr>
<td>ICP</td>
<td>Collector Current (Peak)</td>
<td>TC = 25 °C</td>
<td>150</td>
<td>A</td>
</tr>
<tr>
<td>PC</td>
<td>Collector Dissipation</td>
<td>TC = 25 °C (Note-1)</td>
<td>337</td>
<td>W</td>
</tr>
<tr>
<td>TJ</td>
<td>Junction Temperature</td>
<td></td>
<td>−20 ~ +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

* TJ measurement point is just under the chip.

**BRAKE PART**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Condition</th>
<th>Ratings</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCES</td>
<td>Collector-Emitter Voltage</td>
<td>VD = 15V, VCIN = 15V</td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>IC</td>
<td>Collector Current</td>
<td>TC = 25 °C</td>
<td>50</td>
<td>A</td>
</tr>
<tr>
<td>ICP</td>
<td>Collector Current (Peak)</td>
<td>TC = 25 °C</td>
<td>100</td>
<td>A</td>
</tr>
<tr>
<td>PC</td>
<td>Collector Dissipation</td>
<td>TC = 25 °C (Note-1)</td>
<td>284</td>
<td>W</td>
</tr>
<tr>
<td>V(RDC)</td>
<td>FWDi Rated DC Reverse Voltage</td>
<td>TC = 25 °C</td>
<td>50</td>
<td>A</td>
</tr>
<tr>
<td>TJ</td>
<td>Junction Temperature</td>
<td></td>
<td>−20 ~ +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

**CONTROL PART**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Condition</th>
<th>Ratings</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VD</td>
<td>Supply Voltage</td>
<td>Applied between : VUP1-VUPC, VVP1-VVPC</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>VCIN</td>
<td>Input Voltage</td>
<td>Applied between : UP-VUPC, VP-VVPC, WP-VVPC</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>VFO</td>
<td>Fault Output Supply Voltage</td>
<td>Applied between : UFO-VUPC, VFO-VVPC, WFG-VVPC</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>IFO</td>
<td>Fault Output Current</td>
<td>Sink current at UFO, VFO, WFO, FO terminals</td>
<td>20</td>
<td>mA</td>
</tr>
</tbody>
</table>

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TOTAL SYSTEM

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Condition</th>
<th>Ratings</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCC(Prot)</td>
<td>Supply Voltage Protected by SC</td>
<td>V₀ = 13.5 ~ 16.5V, Inverter Part, Tj = +125°C Start</td>
<td>400</td>
<td>V</td>
</tr>
<tr>
<td>VCC(surge)</td>
<td>Supply Voltage (Surge)</td>
<td>Applied between : P-N, Surge value</td>
<td>500</td>
<td>V</td>
</tr>
<tr>
<td>Tstg</td>
<td>Storage Temperature</td>
<td></td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Viso</td>
<td>Isolation Voltage</td>
<td></td>
<td>2500</td>
<td>Vrms</td>
</tr>
</tbody>
</table>

THERMAL RESISTANCES

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Condition</th>
<th>Limits</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rθ(j-c)</td>
<td>Junction to case Thermal Resistances</td>
<td>Inverter IGBT part (per 1 element)</td>
<td>Min.</td>
<td>°C/W</td>
</tr>
<tr>
<td>Rθ(c-f)</td>
<td>Contact Thermal Resistance</td>
<td>Case to fin, (per 1 module)</td>
<td>Typ.</td>
<td></td>
</tr>
<tr>
<td>Rθ(f-a)</td>
<td>Contact Thermal Resistance</td>
<td>Thermal grease applied</td>
<td>Max.</td>
<td></td>
</tr>
</tbody>
</table>

*If you use this value, Rθ(f-a) should be measured just under the chips.

(Note-1) Tc (under the chip) measurement point is below.

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise noted)

INVERTER PART

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Condition</th>
<th>Limits</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCE(sat)</td>
<td>Collector-Emitter Saturation Voltage</td>
<td>V₀ = 15V, IC = 75A, VCC = 0V, Pulsed (Fig. 1)</td>
<td>Min.</td>
<td>V</td>
</tr>
<tr>
<td>Vce</td>
<td>FWDi Forward Voltage</td>
<td>−IC = 75A, V₀ = 15V, VCC = 15V (Fig. 2)</td>
<td>Typ.</td>
<td></td>
</tr>
<tr>
<td>ton</td>
<td>Switching Time</td>
<td></td>
<td>Max.</td>
<td></td>
</tr>
<tr>
<td>tbc</td>
<td>Switching Time</td>
<td></td>
<td>Min.</td>
<td>µs</td>
</tr>
<tr>
<td>tc(spi)</td>
<td>Switching Time</td>
<td></td>
<td>Typ.</td>
<td></td>
</tr>
<tr>
<td>toff</td>
<td>Switching Time</td>
<td></td>
<td>Max.</td>
<td></td>
</tr>
<tr>
<td>ICES</td>
<td>Collector-Emitter Cutoff Current</td>
<td>VCE = VCES, V₀ = 15V</td>
<td>Min.</td>
<td>mA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>arm</th>
<th>Parameter</th>
<th>Condition</th>
<th>Limits</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>IGBT, FWDi</td>
<td></td>
<td>Min.</td>
<td>°C/W</td>
</tr>
<tr>
<td>Y</td>
<td>−6.2, 0.2</td>
<td></td>
<td>Typ.</td>
<td></td>
</tr>
</tbody>
</table>

Bottom view

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## BRAKE PART

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Condition</th>
<th>Limits</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCE(sat)</td>
<td>Collector-Emitter Saturation Voltage</td>
<td>$V_D = 15V, I_C = 50A$</td>
<td>$T_J = 25^\circ C$</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CIN} = 0V$, Pulsed</td>
<td>$T_J = 125^\circ C$</td>
<td>—</td>
</tr>
<tr>
<td>VEC</td>
<td>Forward Voltage</td>
<td>$-I_C = 50A$, $V_{CIN} = 15V$, $V_D = 15V$</td>
<td>$T_J = 25^\circ C$</td>
<td>—</td>
</tr>
<tr>
<td>ICES</td>
<td>Collector-Emitter Cutoff Current</td>
<td>$V_{CE} = V_{CES}, V_D = 15V$</td>
<td>$T_J = 125^\circ C$</td>
<td>—</td>
</tr>
</tbody>
</table>

## CONTROL PART

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Condition</th>
<th>Limits</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_D</td>
<td>Circuit Current</td>
<td>$V_D = 15V, V_{CIN} = 15V$</td>
<td>$V_{N1-VNC}$</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_{P1-VPC}$</td>
<td>—</td>
</tr>
<tr>
<td>V_{P(ON)}</td>
<td>Input ON Threshold Voltage</td>
<td>Applied between : $U_{P1-VUPC}, V_{P-VVPC}, W_{P-VWPC}$</td>
<td>1.2</td>
<td>1.5</td>
</tr>
<tr>
<td>V_{P(OFF)}</td>
<td>Input OFF Threshold Voltage</td>
<td>$U_{N1-VN}, W_{N-B-VNC}$</td>
<td>1.7</td>
<td>2.0</td>
</tr>
<tr>
<td>SC</td>
<td>Short Circuit Trip Level</td>
<td>$-20 \leq T_J \leq 125^\circ C$, $V_D = 15V$</td>
<td>Inverter part</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Brake part</td>
<td>100</td>
</tr>
<tr>
<td>t_{off(SC)}</td>
<td>Short Circuit Current Delay Time</td>
<td>$V_D = 15V$</td>
<td>(Fig. 3.6)</td>
<td>—</td>
</tr>
<tr>
<td>OT</td>
<td>Over Temperature Protection</td>
<td>Detect Temperature of IGBT Chip</td>
<td>Trip level</td>
<td>135</td>
</tr>
<tr>
<td>OT(hys)</td>
<td>Hysteresis</td>
<td></td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>UV</td>
<td>Supply Circuit Under-Voltage Protection</td>
<td>$-20 \leq T_J \leq 125^\circ C$</td>
<td>Trip level</td>
<td>11.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reset level</td>
<td>—</td>
</tr>
<tr>
<td>IFO(H)</td>
<td>Fault Output Current</td>
<td>$V_D = 15V$, $V_{CIN} = 15V$</td>
<td>(Note-2)</td>
<td>—</td>
</tr>
<tr>
<td>IFO(L)</td>
<td>Minimum Fault Output Pulse Width</td>
<td>$V_D = 15V$</td>
<td>(Note-2)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

(Note-2) Fault output is given only when the internal SC, OT & UV protections schemes of either upper or lower arm device operate to protect it.

## MECHANICAL RATINGS AND CHARACTERISTICS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Condition</th>
<th>Limits</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>—</td>
<td>Mounting torque</td>
<td>Mounting part</td>
<td>screw : M5</td>
<td>2.5</td>
</tr>
<tr>
<td>—</td>
<td>Weight</td>
<td>—</td>
<td>—</td>
<td>340</td>
</tr>
</tbody>
</table>

## RECOMMENDED CONDITIONS FOR USE

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Condition</th>
<th>Recommended value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCC</td>
<td>Supply Voltage</td>
<td>Applied across P-N terminals</td>
<td>$\leq 400$</td>
<td>V</td>
</tr>
<tr>
<td>V_D</td>
<td>Control Supply Voltage</td>
<td>Applied between : $U_{P1-VUPC}, V_{P1-VVPC}$, $V_{P1-VVPC}, V_{N1-VNC}$</td>
<td>$15.0 \pm 1.5$</td>
<td>V</td>
</tr>
<tr>
<td>V_{CIN(ON)}</td>
<td>Input ON Voltage</td>
<td>Applied between : $U_{P1-VUPC}, V_{P-VVPC}, W_{P-VWPC}$</td>
<td>$\leq 0.8$</td>
<td>V</td>
</tr>
<tr>
<td>V_{CIN(OFF)}</td>
<td>Input OFF Voltage</td>
<td>$U_{N1-VN}, W_{N-B-VNC}$</td>
<td>$\geq 9.0$</td>
<td>V</td>
</tr>
<tr>
<td>fPWM</td>
<td>PWM Input Frequency</td>
<td>Using Application Circuit of Fig. 8</td>
<td>$\leq 20$</td>
<td>kHz</td>
</tr>
<tr>
<td>t_{dead}</td>
<td>Arm Shoot-through Blocking Time</td>
<td>For IPM’s each input signals</td>
<td>(Fig. 7)</td>
<td>$\geq 2.0$</td>
</tr>
</tbody>
</table>

(Note-3) With ripple satisfying the following conditions: $dv/dt$ swing $\leq \pm 5V/\mu s$, Variation $\leq 2V$ peak to peak
PRECAUTIONS FOR TESTING

1. Before applying any control supply voltage (V_D), the input terminals should be pulled up by resistors, etc. to their corresponding supply voltage and each input signal should be kept off state.

   After this, the specified ON and OFF level setting for each input signal should be done.

2. When performing “SC” tests, the turn-off surge voltage spike at the corresponding protection operation should not be allowed to rise above V_CES rating of the device. (These tests should not be done by using a curve tracer or its equivalent.)

Fig. 1  V_CES Test

Fig. 2  V_CES (VFM) Test

Fig. 3  Switching time and SC test circuit

Fig. 4  Switching time test waveform

Fig. 5  I_CES Test

Fig. 6  SC test waveform

Fig. 7  Dead time measurement point example

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1.5V: Input on threshold voltage Vth(on) typical value, 2V: Input off threshold voltage Vth(off) typical value.
NOTES FOR STABLE AND SAFE OPERATION:

- Design the PCB pattern to minimize wiring length between opto-coupler and IPM's input terminal, and also to minimize the stray capacity between the input and output wirings of opto-coupler.
- Connect low impedance capacitor between the Vcc and GND terminal of each fast switching opto-coupler.
- Fast switching opto-couplers: tPLH, tPHL \( \leq 0.8 \mu s \), Use High CMR type.
- Slow switching opto-coupler: CTR > 100%
- Use 4 isolated control power supplies (VD). Also, care should be taken to minimize the instantaneous voltage charge of the power supply.
- Make inductance of DC bus line as small as possible, and minimize surge voltage using snubber capacitor between P and N terminal.
- Use line noise filter capacitor (ex. 4.7nF) between each input AC line and ground to reject common-mode noise from AC line and improve noise immunity of the system.

Fig. 8 Application Example Circuit
PERFORMANCE CURVES
(Inverter Part)

OUTPUT CHARACTERISTICS
(TYPICAL)

COLLECTOR CURRENT $I_C$ (A)

COLLECTOR-EMITTER VOLTAGE $V_{CE}$ (V)

COLLECTOR-EMITTER SATURATION
VOLTAGE (VS. $I_C$) CHARACTERISTICS
(TYPICAL)

COLLECTOR-EMITTER SATURATION
VOLTAGE (VS. $V_D$) CHARACTERISTICS
(TYPICAL)

DIODE FORWARD CHARACTERISTICS
(TYPICAL)

SWITCHING TIME ($t_{on}$, $t_{off}$) CHARACTERISTICS
(TYPICAL)

SWITCHING TIME ($t_{con}$, $t_{conf}$) CHARACTERISTICS
(TYPICAL)
SWITCHING LOSS CHARACTERISTICS
(TYPICAL)

Collector Current (IC) vs. Switching Loss (Eon, Eoff)

Collector Reverse Current (IC) vs. Switching Recovery Loss (Er)

Collector Reverse Current (IC) vs. UV Trip Level (UVt, UVr)

Collector Reverse Current (IC) vs. SC Trip Level (SC)

DIODE REVERSE RECOVERY CHARACTERISTICS
(TYPICAL)

Collector Reverse Current (IC) vs. Reverse Recovery Time (trr)

Collector Reverse Current (IC) vs. Reverse Recovery Current (Ir)

Collector Reverse Current (IC) vs. UV Trip Level (UVt, UVr)

Collector Reverse Current (IC) vs. SC Trip Level (SC)

May 2009
**MITSUBISHI INTELLIGENT POWER MODULES**

**PM75RL1B060**

**FLAT-BASE TYPE INSULATED PACKAGE**

**May 2009**

**TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (TYPICAL)**

![Graph showing transient thermal impedance characteristics](image)

**NORMALIZED TRANSIENT THERMAL IMPEDANCE**

- **Single Pulse**: IGBT part; Per unit base = $R_{th(j-c)}Q = 0.37^\circ C/W$
- **FWDi part**: Per unit base = $R_{th(j-c)}F = 0.63^\circ C/W$

**TIME** $t$ (sec)

**COEFFICIENT**

- $10^{-1}$
- $10^{-2}$
- $10^{-3}$
- $10^{-4}$

**OUTLET CHARACTERISTICS**

- **$T_j = 25^\circ C$**
- **$V_0 = 17V$**
- **$13V$**

**DIODE FORWARD CHARACTERISTICS (TYPICAL)**

- **$V_0 = 15V$**

**COLLECTOR CURRENT** $I_c$ (A)

- $T_j = 25^\circ C$
- $T_j = 125^\circ C$

**COEFFICIENT**

- $10^{-1}$
- $10^{-2}$
- $10^{-3}$
- $10^{-4}$

**TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (TYPICAL)**

![Graph showing transient thermal impedance characteristics](image)

**NORMALIZED TRANSIENT THERMAL IMPEDANCE**

- **Single Pulse**: IGBT part; Per unit base = $R_{th(j-c)}Q = 0.44^\circ C/W$
- **FWDi part**: Per unit base = $R_{th(j-c)}F = 0.75^\circ C/W$

**TIME** $t$ (sec)

**COEFFICIENT**

- $10^{-1}$
- $10^{-2}$
- $10^{-3}$
- $10^{-4}$

**CONTROL VOLTAGE** $V_D$ (V)

- $10$V
- $12V$
- $13V$
- $14V$
- $15V$
- $16V$
- $17V$
- $18V$

**TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (TYPICAL)**

![Graph showing transient thermal impedance characteristics](image)

**NORMALIZED TRANSIENT THERMAL IMPEDANCE**

- **Single Pulse**: IGBT part; Per unit base = $R_{th(j-c)}Q = 0.44^\circ C/W$
- **FWDi part**: Per unit base = $R_{th(j-c)}F = 0.75^\circ C/W$

**TIME** $t$ (sec)

**COEFFICIENT**

- $10^{-1}$
- $10^{-2}$
- $10^{-3}$
- $10^{-4}$

**CONTROL VOLTAGE** $V_D$ (V)

- $10$V
- $12V$
- $13V$
- $14V$
- $15V$
- $16V$
- $17V$
- $18V$

**COLLECTOR-EMITTER SATURATION VOLTAGE** $V_{CE(sat)}$ (V)

**COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)**

- **$T_j = 25^\circ C$**
- **$T_j = 125^\circ C$**

**COEFFICIENT**

- $10^{-1}$
- $10^{-2}$
- $10^{-3}$
- $10^{-4}$

**COLLECTOR CURRENT** $I_c$ (A)

- $0$
- $1$
- $2$
- $3$
- $4$
- $5$
- $6$
- $7$

**OUTPUT CHARACTERISTICS (TYPICAL)**

- **$T_j = 25^\circ C$**
- **$V_0 = 17V$**
- **$13V$**

**COLLECTOR-EMITTER SATURATION VOLTAGE (VS. $I_c$) CHARACTERISTICS (TYPICAL)**

- **$T_j = 25^\circ C$**
- **$T_j = 125^\circ C$**

**COEFFICIENT**

- $10^{-1}$
- $10^{-2}$
- $10^{-3}$
- $10^{-4}$

**CONTROL VOLTAGE** $V_D$ (V)

- $10$V
- $12V$
- $13V$
- $14V$
- $15V$
- $16V$
- $17V$
- $18V$

**TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (TYPICAL)**

![Graph showing transient thermal impedance characteristics](image)

**NORMALIZED TRANSIENT THERMAL IMPEDANCE**

- **Single Pulse**: IGBT part; Per unit base = $R_{th(j-c)}Q = 0.44^\circ C/W$
- **FWDi part**: Per unit base = $R_{th(j-c)}F = 0.75^\circ C/W$

**TIME** $t$ (sec)

**COEFFICIENT**

- $10^{-1}$
- $10^{-2}$
- $10^{-3}$
- $10^{-4}$

**CONTROL VOLTAGE** $V_D$ (V)

- $10$V
- $12V$
- $13V$
- $14V$
- $15V$
- $16V$
- $17V$
- $18V$

**COLLECTOR EMISSION SATURATION VOLTAGE** $V_{CE(sat)}$ (V)

**COLLECTOR EMISSION SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)**

- **$T_j = 25^\circ C$**
- **$T_j = 125^\circ C$**

**COEFFICIENT**

- $10^{-1}$
- $10^{-2}$
- $10^{-3}$
- $10^{-4}$

**CONTROL VOLTAGE** $V_D$ (V)

- $10$V
- $12V$
- $13V$
- $14V$
- $15V$
- $16V$
- $17V$
- $18V$

**COLLECTOR RECOVERY CURRENT** $I_{c(r)}$ (A)

**DIODE FORWARD CHARACTERISTICS (TYPICAL)**

- **$V_0 = 15V$**

**COEFFICIENT**

- $10^{-1}$
- $10^{-2}$
- $10^{-3}$
- $10^{-4}$

**EMITTER-COLLECTOR VOLTAGE** $V_{EC(c)}$ (V)

- $0$
- $1$
- $2$
- $3$
- $4$
- $5$
- $6$
- $7$

**EMITTER-COLLECTOR VOLTAGE CHARACTERISTICS (TYPICAL)**

- **$T_j = 25^\circ C$**
- **$T_j = 125^\circ C$**

**COEFFICIENT**

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- $10^{-2}$
- $10^{-3}$
- $10^{-4}$

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