**PM100RL1A120**

**FEATURE**

Inverter + Brake + Drive & Protection IC

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

- 3Ø 100A, 1200V 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
### Maximum Ratings ($T_j = 25^\circ C$, 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>$V_CES$</td>
<td>Collector-Emitter Voltage</td>
<td>$V_D = 15V, V_{CIN} = 15V$</td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>$T_c = 25^\circ C$</td>
<td>100</td>
<td>A</td>
</tr>
<tr>
<td>$I_{CP}$</td>
<td>Collector Current (Peak)</td>
<td>$T_c = 25^\circ C$</td>
<td>200</td>
<td>A</td>
</tr>
<tr>
<td>$P_C$</td>
<td>Collector Dissipation</td>
<td>$T_c = 25^\circ C$</td>
<td>657</td>
<td>W</td>
</tr>
<tr>
<td>$T_J$</td>
<td>Junction Temperature</td>
<td>$-20 \rightarrow +150$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*: $T_c$ 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>$V_CES$</td>
<td>Collector-Emitter Voltage</td>
<td>$V_D = 15V, V_{CIN} = 15V$</td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current</td>
<td>$T_c = 25^\circ C$</td>
<td>50</td>
<td>A</td>
</tr>
<tr>
<td>$I_{CP}$</td>
<td>Collector Current (Peak)</td>
<td>$T_c = 25^\circ C$</td>
<td>100</td>
<td>A</td>
</tr>
<tr>
<td>$P_C$</td>
<td>Collector Dissipation</td>
<td>$T_c = 25^\circ C$</td>
<td>446</td>
<td>W</td>
</tr>
<tr>
<td>$I_F$</td>
<td>FWDi Forward Current</td>
<td>$T_c = 25^\circ C$</td>
<td>50</td>
<td>A</td>
</tr>
<tr>
<td>$V_{R(DC)}$</td>
<td>FWDi Rated DC Reverse Voltage</td>
<td>$T_c = 25^\circ C$</td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>$T_J$</td>
<td>Junction Temperature</td>
<td>$-20 \rightarrow +150$</td>
<td></td>
<td></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>$V_D$</td>
<td>Supply Voltage</td>
<td>Applied between : $V_{UP1-VUPC}, V_{VP1-VVPC}$, $V_{WP1-VWPC}, V_{VNC}$</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CIN}$</td>
<td>Input Voltage</td>
<td>Applied between : $U_{P-VUPC}, V_{P-VVPC}, W_{P-VWPC}$, $U_N \cdot V_N \cdot W_N \cdot B_{-VNC}$</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>$V_{FO}$</td>
<td>Fault Output Supply Voltage</td>
<td>Applied between : $U_{FO-VUPC}, V_{FO-VVPC}, W_{FO-VWPC}$, $F_{-VNC}$</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>$I_{FO}$</td>
<td>Fault Output Current</td>
<td>Sink current at $U_{FO}, V_{FO}, W_{FO}, F_{-FO}$ 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>V_{D} = 13.5 ~ 16.5V Inverter Part, T_{J} = +125°C Start</td>
<td>800</td>
<td>V</td>
</tr>
<tr>
<td>VCC (Surge)</td>
<td>Supply Voltage (Surge)</td>
<td>Applied between : P-N, Surge value</td>
<td>1000</td>
<td>V</td>
</tr>
<tr>
<td>Tstg</td>
<td>Storage Temperature</td>
<td>–40 ~ +125°C</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Viso</td>
<td>Isolation Voltage</td>
<td>60Hz, Sinusoidal, Charged part to Base, AC 1 min.</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>Rnj(c-o)</td>
<td>Junction to case Thermal Resists</td>
<td>Inverter IGBT part (per 1 element) (Note-1)</td>
<td>Min.</td>
<td>CW/W</td>
</tr>
<tr>
<td>Rnj(c-f)</td>
<td></td>
<td>Inverter FWDi part (per 1 element) (Note-1)</td>
<td>Typ.</td>
<td></td>
</tr>
<tr>
<td>Rnj(o-o)</td>
<td></td>
<td>Brake IGBT part (Note-1)</td>
<td>Max.</td>
<td></td>
</tr>
<tr>
<td>Rnj(f-f)</td>
<td></td>
<td>Brake FWDi upper part (Note-1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rnf(c-f)</td>
<td>Contact Thermal Resistance</td>
<td>Case to fin, (per 1 module) Thermal grease applied (Note-1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

(Note-1) T_{C} (under the chip) measurement point is below.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Condition</th>
<th>Limit (unit: °C/W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCE(sat)</td>
<td></td>
<td>Min.</td>
</tr>
<tr>
<td></td>
<td>IGBT</td>
<td>24.5</td>
</tr>
<tr>
<td></td>
<td>FWDi</td>
<td>24.5</td>
</tr>
<tr>
<td></td>
<td>UP</td>
<td>125°C</td>
</tr>
<tr>
<td></td>
<td>VP</td>
<td>100A</td>
</tr>
<tr>
<td></td>
<td>UN</td>
<td>0V</td>
</tr>
<tr>
<td>FWDi</td>
<td>VP</td>
<td>100A</td>
</tr>
<tr>
<td>FWDi</td>
<td>UN</td>
<td>0V</td>
</tr>
<tr>
<td></td>
<td>VN</td>
<td>0V</td>
</tr>
<tr>
<td></td>
<td>WN</td>
<td>0V</td>
</tr>
<tr>
<td></td>
<td>BR</td>
<td>0V</td>
</tr>
</tbody>
</table>

ELECTRICAL CHARACTERISTICS (T_{J} = 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</td>
<td>V_{D} = 15V, IC = 100A V_{CIN} = 0V, Pulsed (Fig. 1)</td>
<td>Min.</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Voltage</td>
<td>T_{J} = 25°C</td>
<td>Typ.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>T_{J} = 125°C</td>
<td>Max.</td>
<td></td>
</tr>
<tr>
<td>VEC</td>
<td>FWDi Forward Voltage</td>
<td>–IC = 100A, V_{D} = 15V, V_{CIN} = 15V (Fig. 2)</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Ion</td>
<td>Switching Time</td>
<td>V_{D} = 15V, V_{CIN} = 0V→15V</td>
<td>0.3</td>
<td>µs</td>
</tr>
<tr>
<td>ftr</td>
<td></td>
<td>V_{CC} = 600V, IC = 100A</td>
<td>0.3</td>
<td>0.8</td>
</tr>
<tr>
<td>ts(on)</td>
<td></td>
<td>T_{J} = 125°C</td>
<td>0.4</td>
<td>1.0</td>
</tr>
<tr>
<td>tsoff</td>
<td>Inductive Load</td>
<td>(Fig. 3, 4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ices</td>
<td>Collector-Emitter Cutoff Current</td>
<td>V_{CE} = V_{CES}, V_{D} = 15V (Fig. 5)</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T_{J} = 25°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>T_{J} = 125°C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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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 VD = 15V, IC = 50A</td>
<td>Tj = 25°C (Fig. 1)</td>
<td>—</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>VCE = VCES, VD = 15V</td>
<td></td>
<td>—</td>
<td>mA</td>
</tr>
<tr>
<td>VEC</td>
<td>FWDI Forward Voltage —IC = 50A, VCIN = 15V, VD = 15V</td>
<td>Tj = 125°C (Fig. 2)</td>
<td>—</td>
<td>V</td>
</tr>
<tr>
<td>ICES</td>
<td>Collector-Emitter Cutoff Current VCE = VCES, VD = 15V</td>
<td>Tj = 25°C (Fig. 5)</td>
<td>—</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>

**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>—</td>
<td>Mounting torque</td>
<td>screw : M5</td>
<td>N • m</td>
</tr>
<tr>
<td></td>
<td>—</td>
<td>Main terminal part</td>
<td>screw : M5</td>
<td>N • m</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>≤ 800</td>
<td>V</td>
</tr>
<tr>
<td>Vd</td>
<td>Control Supply Voltage</td>
<td>Applied between : VUP1-VUPC, VVP1-VVPC, VWP1-VWPC</td>
<td>15.0 ± 1.5</td>
<td>V</td>
</tr>
<tr>
<td>VCIN(ON)</td>
<td>Input ON Voltage</td>
<td>Applied between : UIN • VV1 • WW1 • BW1-VN1</td>
<td>≤ 0.8</td>
<td>V</td>
</tr>
<tr>
<td>VCIN(OFF)</td>
<td>Input OFF Voltage</td>
<td>Applied between : UIN • VV1 • WW1 • BW1-VN1</td>
<td>≥ 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>≤ 20</td>
<td>kHz</td>
</tr>
<tr>
<td>fload</td>
<td>Arm Shoot-through Blocking Time</td>
<td>For IPM’s each input signals (Fig. 7)</td>
<td>≥ 2.5</td>
<td>µs</td>
</tr>
</tbody>
</table>

(Note-3) With ripple satisfying the following conditions: dv/dt swing ≤ ±5V/µs, Variation ≤ 2V peak to peak.
PRECAUTIONS FOR TESTING

1. Before applying any control supply voltage (Vb), the input terminals should be pulled up by resistors, etc. to their corre- 
sponding 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 al-

lowed to rise above VCES rating of the device.

(These test should not be done by using a curve tracer or its equivalent.)

![Diagram of PM100RL1A120](image)

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**Fig. 1**  VCE(sat) Test

**Fig. 2**  VEC, (VFM) Test

**Fig. 3**  Switching Time and SC Test Circuit

**Fig. 4**  Switching Time Test Waveform

**Fig. 5**  Ices Test

**Fig. 6**  SC Test Waveform

**Fig. 7**  Dead time measurement point example

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 ≤ 0.8µs, 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.
MITSUBISHI INTELLIGENT POWER MODULES

PM100RL1A120
FLAT-BASE TYPE
INSULATED PACKAGE

PERFORMANCE CURVES
(Inverter Part)

OUTPUT CHARACTERISTICS
(TYPICAL)

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

COLLECTOR CURRENT $I_C$ (A)

$T_J = 25^\circ C$, $V_D = 17V$

$T_J = 125^\circ C$, $V_D = 15V$

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

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

COLLECTOR CURRENT $I_C$ (A)

$T_J = 125^\circ C$

$T_J = 25^\circ C$

DIODE FORWARD CHARACTERISTICS
(TYPICAL)

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

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

$V_{CC} = 600V$

$V_D = 15V$

$T_J = 125^\circ C$

Inductive load

$T_J = 25^\circ C$

Inductive load

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MITSUBISHI ELECTRIC
**MITSUBISHI INTELLIGENT POWER MODULES**

**PM100RL1A120**

**FLAT-BASE TYPE INSULATED PACKAGE**

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### SWITCHING LOSS CHARACTERISTICS (TYPICAL)

- **VCC = 600V**
- **VD = 15V**
- **Tj = 25°C**
- **Tj = 125°C**

**Inductive load**

- **Con**
- **Eoff**

**Collecter Current IC (A)**

- **Eon**
- **Eoff**

---

### DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)

- **VCC = 600V**
- **VD = 15V**
- **Tj = 25°C**
- **Tj = 125°C**

**Inductive load**

- **Err**

**Collector Reverse Current –IC (A)**

- **Recovery Time trr (µs)**
- **Recovery Current lrr (A)**

---

### SWITCHING RECOVERY LOSS CHARACTERISTICS (TYPICAL)

- **VCC = 600V**
- **VD = 15V**
- **Tj = 25°C**
- **Tj = 125°C**

**Inductive load**

- **Eon**
- **Eoff**

**Collector Reverse Current –IC (A)**

- **Recovery Time trr (µs)**
- **Recovery Current lrr (A)**

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### UV TRIP LEVEL VS. Tj CHARACTERISTICS (TYPICAL)

- **UVt**
- **UVr**

**Tj (°C)**

- **SC TRIP LEVEL VS. Tj CHARACTERISTICS (TYPICAL)**

- **Vd = 15V**

**SC (°C)**

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TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (TYPICAL)

NORMALIZED TRANSIENT THERMAL IMPEDANCE $Z_{th}(j\omega)$

**Single Pulse**
- IGBT part: $R_{th(j-c)}Q = 0.19°C/W$
- FWDi part: $R_{th(j-c)}F = 0.31°C/W$

**t(sec)**

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

$V_{ce(sat)} (V)$

$V_{o} = 15V$

$T_{j} = 25°C$

$T_{j} = 125°C$

1.0

1.2

1.4

1.6

1.8

2.0

2.2

2.4

2.6

COLLECTOR CURRENT $Ic$ (A)

TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (TYPICAL)

NORMALIZED TRANSIENT THERMAL IMPEDANCE $Z_{th}(j\omega)$

**Single Pulse**
- IGBT part: $R_{th(j-c)}Q = 0.19°C/W$
- FWDi part: $R_{th(j-c)}F = 0.31°C/W$

**t(sec)**

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

DIODE FORWARD CHARACTERISTICS (TYPICAL)

$V_{o} = 15V$

$T_{j} = 25°C$

$T_{j} = 125°C$

1.0

1.2

1.4

1.6

1.8

2.0

2.2

2.4

2.6

COLLECTOR RECOVERY CURRENT $-Ic$ (A)

OUTPUT CHARACTERISTICS (TYPICAL)

COLLECTOR CURRENT $Ic$ (A)

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

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

$V_{d} = 15V$

$T_{j} = 25°C$

$T_{j} = 125°C$

1.0

1.2

1.4

1.6

1.8

2.0

2.2

2.4

2.6

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

CONTROL POWER SUPPLY VOLTAGE $Vd$ (V)

12

13

14

15

16

17

18

15V

TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (TYPICAL)

NORMALIZED TRANSIENT THERMAL IMPEDANCE $Z_{th}(j\omega)$

**Single Pulse**
- IGBT part: $R_{th(j-c)}Q = 0.19°C/W$
- FWDi part: $R_{th(j-c)}F = 0.31°C/W$

**t(sec)**

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