

**Preliminary**

TOSHIBA INTELLIGENT POWER MODULE

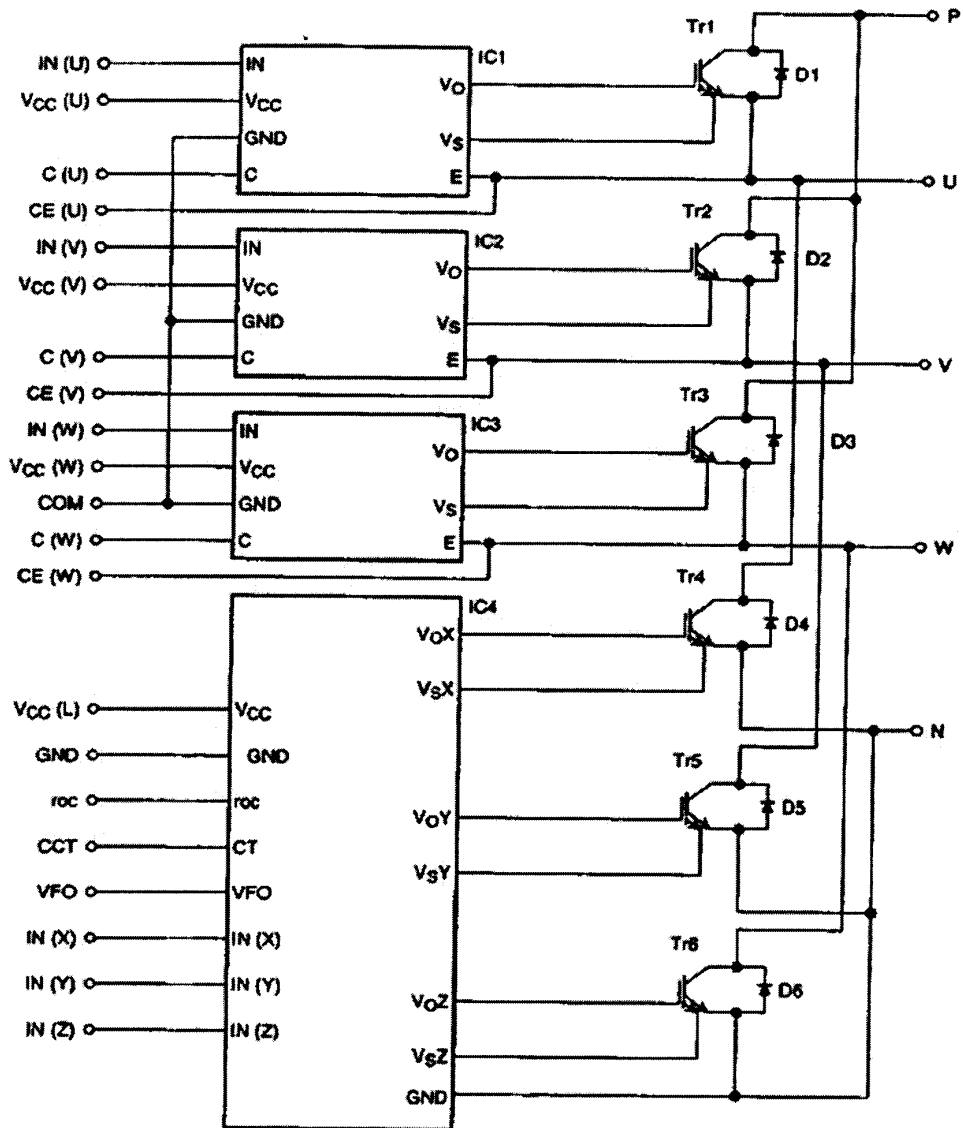
**MIG30J502H****FEATURES**

- (1) **Maximum Rating**  
VCEX = 600 V, IC = 30 A
- (2) **Control IC**
  - High voltage IC × 3 + low voltage IC × 1
  - 5-V system CMOS/correspond to TTL
  - Single power supply driving bootstrap circuit
- (3) **Functions**
  - Over current protection: only low-side arm
  - Short circuit protection: only low-side arm
  - RTC: high and low-side arms
  - Over temperature protection: only low-side arm
  - Power supply under voltage protection: high and low-side arms
  - Fault signal output: In case of abnormal status of low-side arm
- (4) **Applications**
  - High power switching applications
  - Motor control applications
  - PWM carrier frequency 20kHz

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Equivalent Circuit



**Maximum Ratings (Unless otherwise specified,  $T_j = 25^\circ\text{C}$ )**

**Inverter**

| Item                        | Symbol           | Test Condition           | Rating | Unit             |
|-----------------------------|------------------|--------------------------|--------|------------------|
| Supply Voltage              | $V_{CC}$         | P-N                      | 450    | V                |
| Supply Voltage (Surge)      | $V_{CC}$ (surge) | P-N                      | 500    | V                |
| Collector Emitter Voltage   | $V_{CES}$        | —                        | 600    | V                |
| Collector Current           | $\pm I_C$        | $T_c = 25^\circ\text{C}$ | 30     | A                |
| Collector Current (Peak)    | $\pm I_{CP}$     | $T_c = 25^\circ\text{C}$ | 60     | A                |
| Collector Power Dissipation | $P_C$            | $T_c = 25^\circ\text{C}$ | 50     | W                |
| Junction Temperature        | $T_j$            | —                        | 150    | $^\circ\text{C}$ |

**Control (protection)**

| Item                                   | Symbol    | Test Condition                                      | Rating              | Unit |
|--|-----------|---|---------------------|------|
| Supply Voltage                         | $V_D$     | $V_{CC}$ (U), (V), (W) – COM,<br>$V_{CC}$ (L) – GND | 20                  | V    |
| Supply Voltage                         | $V_{DB}$  | C (U), (V), (W) – CE (U), (V), (W)                  | 20                  | V    |
| Input Voltage                          | $V_{IN}$  | IN (U), (V), (W) – COM,<br>IN (X), (Y), (Z) – GND   | -0.5 to $V_D + 0.5$ | V    |
| Fault Output Voltage                   | $V_{FO}$  | VFO – GND   | -0.5 to $V_D + 0.5$ | V    |
| Fault Output Current                   | $I_{FO}$  | Sink current rating of VFO                          | 10                  | mA   |
| Overcurrent Protection Set-up Terminal | $I_{roc}$ | roc – GND   | 3                   | mA   |

**General**

| Item   | Symbol         | Test Condition  | Rating      | Unit             |
|--|----------------|---|-------------|------------------|
| Power Supply Voltage Self-protection Range (Short) | $V_{CC(Prot)}$ | $V_D = 13.5\text{V to }16.5\text{V}$<br>Inverter: $T_j = 125^\circ\text{C}$<br>Non Repetitive | 400         | V                |
| Operating Module Frame Temperature                 | $T_c$          | -   | -20 to +100 | $^\circ\text{C}$ |
| Storage Temperature                                | $T_{stg}$      | -   | -40 to +125 | $^\circ\text{C}$ |
| Isolation Voltage                                  | $V_{iso}$      | Sine wave 60Hz, AC 1 minute,<br>Fin-terminal  | 2500        | Vrms             |

**Thermal resistance**

| Item                                | Symbol        | Test Condition            | Min | Typ. | Max | Unit               |
|-------------------------------------|---------------|---------------------------|-----|------|-----|--------------------|
| Junction to Case Thermal Resistance | $R_{th(j-c)}$ | Inverter IGBT             | —   | —    | 2.5 | $^\circ\text{C/W}$ |
|                                     | $R_{th(j-c)}$ | Inverter FRD              | —   | —    | 4.5 |                    |
| Case to Fin Thermal Resistance      | $R_{th(c-f)}$ | Case-Fin (coating grease) | —   | —    | 0.4 |                    |

**Electrical Characteristics (Unless otherwise specified,  $T_j = 25^\circ\text{C}$ )**

**Inverter**

| Item                                 | Symbol        | Test Condition  | Min | Typ. | Max       | Unit |
|--------------------------------------|---------------|---|-----|------|-----------|------|
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $V_D = V_{DB} = 15V$<br>Input = ON  | -   | 2.1  | 2.7       | V    |
| Forward Voltage                      | $V_F$         | $I_C = 30A$ , Input = OFF   | -   | 2.2  | 2.9       | V    |
| Switching Time                       | $t_{on}(H)$   | $V_{CC} = 300V, V_D = 15V, I_C = 30A$<br>Inductance Load<br>(high and Low-side arms)<br>Input = ON<br>(Note1) | -   | 1.4  | 2.1       | i s  |
|                                      | $t_{on}(L)$   |   | -   | 1.2  | 1.6       |      |
|                                      | $t_r$         |   | -   | 0.2  | -         |      |
|                                      | $t_{off}(H)$  |   | -   | 1.5  | 2.4       |      |
|                                      | $t_{off}(L)$  |   | -   | 1.5  | 2.4       |      |
|                                      | $t_f$         |   | -   | 0.15 | 0.3       |      |
|                                      | $t_{rr}$      |   | -   | 0.1  | -         |      |
| Collector Cut-off Current            | $I_{CES}$     | $V_{CE} = 600V$<br>$T_j = 25^\circ\text{C}$<br>$T_j = 125^\circ\text{C}$                                      | -   | -    | 1.0<br>10 | mA   |

**Control (protection)**

| Item  | Symbol        | Test Condition   | Min        | Typ. | Max  | Unit             |   |
|---|---------------|--|------------|------|------|------------------|---|
| Control Power Supply Voltage                  | $V_D$         | $V_{CC(U),(V),(W)-COM}$ ,<br>$V_{CC(L)-GND}$   | 13.5       | 15.0 | 16.5 | V                |   |
| Circuit Current                               | $I_D$         | $V_D = 15V$ ,<br>Input = OFF,<br>$V_{DB} = 15V$ ,<br>Input = OFF   | -          | 6    | -    | mA               |   |
|   |               | $V_{CC(L)-GND}$ ,<br>$C(U)-CE(U)$ ,<br>$C(V)-CE(V)$ ,<br>$C(W)-CE(W)$  | -          | 1.5  | -    | mA               |   |
| Fault Output Voltage                          | $V_{FOH}$     | $V_D = 15V, R_{oc} = 1.55k\Omega$ ,<br>$FO = 10k\Omega$ 5V pullup  | 4.9        | -    | -    | V                |   |
|   | $V_{FOL}$     | $V_D = 10V, R_{oc} = 1.55k\Omega, I_{FO} = 5mA$  | -          | 0.8  | 1.2  | V                |   |
| High-and Low-Side Arm Dead Time               | $t_{dead}$    | Correspond to each arm input<br>$V_D = 15V$<br>$-20 \leq T_j \leq 100^\circ\text{C}$   | 3.0        | -    | -    | i s              |   |
| Over Current Protection Trip Level            | $I_{oc}$      | $V_D = 15V, R_{oc} = 1.55k\Omega \pm 0.5\%$<br>$I_{oc} = 1.86k \times \text{current (rating)} (30A)$<br>$/R_{oc}$<br>(Note1) | 30         | 36   | 43   | A                |   |
| Control Power Supply Under Voltage Protection | $UV_{DBH}$    | $T_j \leq 125^\circ\text{C}$<br>Filtering time<br>min 5 is   | Trip level | 10   | 10.5 | 11.3             | V |
|   | $UV_{DBHys}$  |  | Hysteresis | 0.4  | 0.55 | 0.7              | V |
|   | $UV_{DL}$     |  | Trip level | 10.5 | 11.5 | 12.5             | V |
|   | $UV_{DLHys}$  |  | Hysteresis | 0.3  | 0.5  | 0.7              | V |
| Over Temperature Protection ( $T_j$ )         | OT            | Trip level   | -          | 170  | -    | $^\circ\text{C}$ |   |
|   | $OT_{Hys}$    | Hysteresis   | -          | 15   | -    | $^\circ\text{C}$ |   |
| Fault Outout Pulse Width                      | $t_{FO}$      | $V_D = 15V, C_{EO} = 22nF$<br>(Note3)  | 2.6        | 4.4  | -    | ms               |   |
| Input ON-Threshold Voltage (H side)           | $V_{IN(ON)}$  | $I_N(U),(V),(W)-COM$   | 1.5        | -    | 2.5  | V                |   |
| Input OFF-Threshold Voltage (H side)          | $V_{IN(OFF)}$ | $V_D = 15V$  | 2.5        | -    | 3.5  | V                |   |
| Input ON-Threshold Voltage (L side)           | $V_{IN(ON)}$  | $I_N(U),(V),(W)-COM$   | 1.5        | -    | 2.5  | V                |   |
| Input OFF-Threshold Voltage (L side)          | $V_{IN(OFF)}$ | $V_D = 15V$  | 2.5        | -    | 3.5  | V                |   |

Note 1: Can set overcurrent protection only at low-side arm.

Note 2:  $T_j$  specifies junction temperature for low-side control IC.

Note 3: When low-side arm trips caused by over/short current protection or under voltage protection or over temperature protection, fault pulse outputs.

Pulse width,  $t_{FO}$ , can be derived from the following equation:

$$t_{FO} (\text{ms}) = 200 \times \text{external capacitance} (\mu\text{F})$$

## Mechanical Test and Characteristics

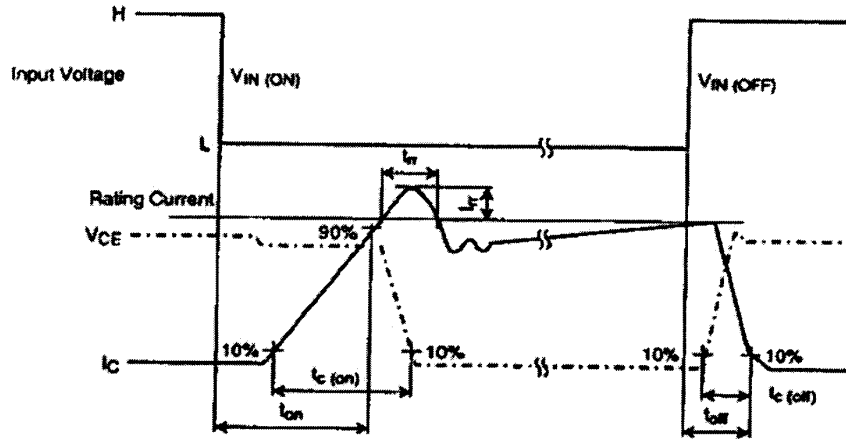
| Item                    | Symbol | Test Condition  | Applicable Standard          | Min | Typ. | Max | Unit   |       |
|-------------------------|--------|---|------------------------------|-----|------|-----|--------|-------|
| Screw Tightening Torque | —      | Screws M4   | Recommended rating: 12 kg·cm | —   | 10   | —   | 15     | kg·cm |
|                         |        |   | Recommended rating: 1.18 N·m | —   | 0.98 | —   | 1.47   | N/M   |
| Pin Straining Strength  | —      | Load 4.5 kg/44.1 N<br>(P, N, U, V, W pins)                    | JIS C7021                    | 30  | —    | —   | s      |       |
|                         |        | Load 1.0 kg/9.8 N<br>(except P, N, U, V, W pins)              |                              |     |      |     |        |       |
| Pin Bending Strength    | —      | Load 1.5 kg/14.7 N<br>/bend 90°<br>(P, N, U, V, W pins)       | JIS C7021                    | 2   | —    | —   | cycles |       |
|                         |        | Load 0.5 kg/4.9 N<br>/bend 90°<br>(except P, N, U, V, W pins) |                              |     |      |     |        |       |
| Weight                  | —      | —   | —                            | —   | 52   | —   | g      |       |

## Recommended Usage Condition

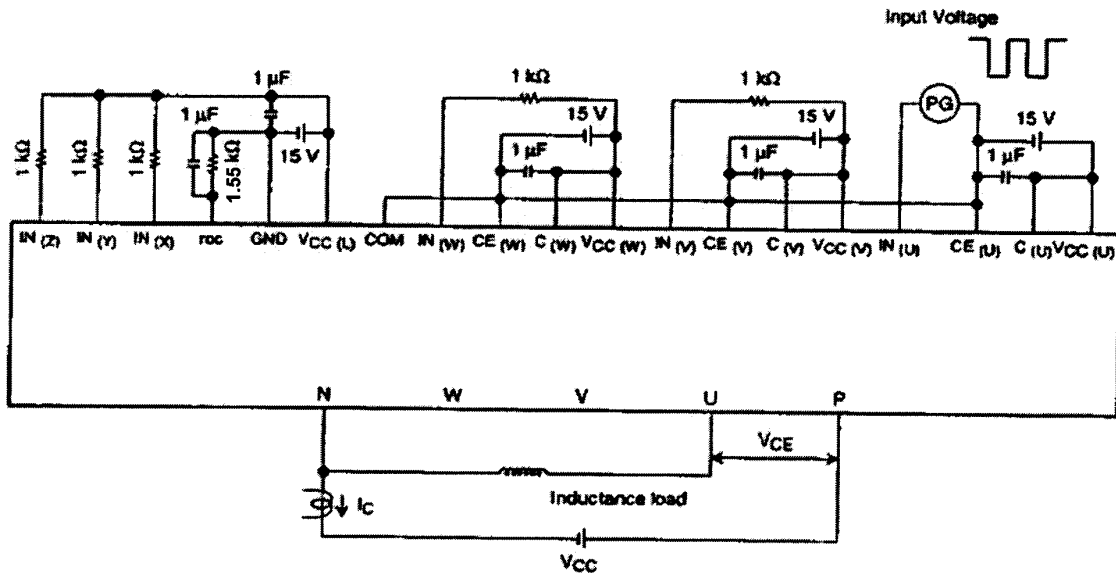
| Item                             | Symbol                | Test Condition  | Recommended Rating |      |      | Unit |
|----------------------------------|-----------------------|---|--------------------|------|------|------|
|                                  |                       |   | Min                | Typ. | Max  |      |
| Power Supply Voltage             | V <sub>CC</sub>       | P - N   | 200                | 300  | 400  | V    |
| Control Power Supply Voltage     | V <sub>D</sub>        | V <sub>CC</sub> (U), (V), (W) - COM,<br>V <sub>CC</sub> (L) - GND | 13.5               | 15.0 | 16.5 | V    |
| Control Power Supply Voltage     | V <sub>DB</sub>       | C (U), (V), (W) - CE (U), (V), (W)                                | 13.5               | 15.0 | 16.5 | V    |
| PWM Carrier Frequency            | f <sub>c</sub>        | —   | —                  | 20   | —    | kHz  |
| High and Low-side Arms Dead Time | t <sub>dead</sub>     | Correspond to each arm input                                      | 3.0                | —    | —    | μs   |
| Input ON-Threshold Voltage       | V <sub>IN (ON)</sub>  | IN (U), (V), (W) - COM  | 0 to 0.65          |      |      | V    |
| Input OFF-Threshold Voltage      | V <sub>IN (OFF)</sub> | IN (X), (Y), (Z) - GND  | 4.0 to 5.5         |      |      | V    |
| Minimum input pulse width        | t <sub>min</sub>      | Acceptable minimum input pulse width                              | 1.0                |      |      | μs   |

**NOTE 1 Switching Waveform**

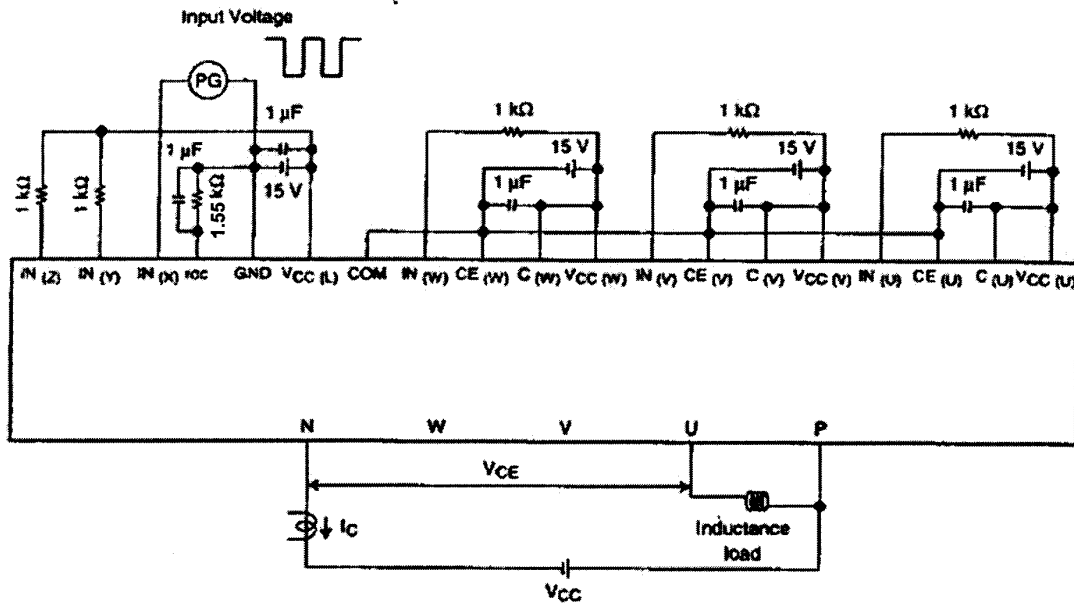
ton(H): high-side arms "ton"  
 ton(L): low-side arms "ton"  
 toff(H): high-side arms "toff"  
 toff(L): low-side arms "toff"



**Switching Time Test Circuit of High Side**



**Switching Time Test Circuit of Low Side**



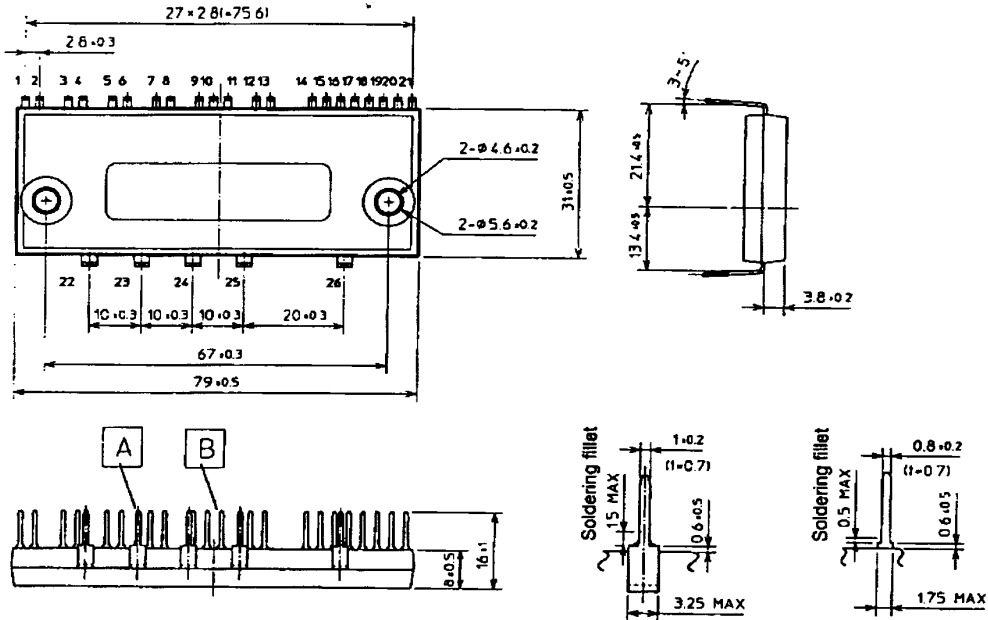
**NOTE 2 Details in protection function against overcurrent**

- (1) **OC (overcurrent) protection**  
Protection function against overcurrent during the normal operation. This function is set to only a low-side circuit. Diagnosis is also output.
- (2) **SC (short-circuit) protection**  
Protection function against overcurrent during abnormal operation such as a twisted wiring on a circuit board. This function is set to only a low-side circuit. Diagnosis is also output.
- (3) **RTC (real time control) protection**  
SC protection circuit has mask time period for about 2.0 μs to protect malfunction against noise. RTC protection is designed to protect IGBT from overcurrent and limit current flow during this mask time period. OC and SC protection functions cut off their operations, but RTC function just control current peak. Diagnosis function is not applied to this protection.

| Protection | Arm       | Set Up Level         | Error Signal |
|------------|-----------|----------------------|--------------|
| OC         | Low Side  | 120 % that of rating | ○            |
|            | High Side | Non                  | —            |
| SC         | Low Side  | 180 % that of rating | ○            |
|            | High Side | Non                  | Non          |
| RTC        | Low Side  | 400% that of rating  | Non          |
|            | High Side | 400% that of rating  | Non          |

R<sub>proc</sub> = 1.55 kΩ

**Package Dimension/Pin Assignment**



Enlarged part A (5 parts)    Enlarged part B (21 parts)

**Pin Names**

- |             |             |
|-------------|-------------|
| 1. IN (U)   | 14. VCC (L) |
| 2. VCC (U)  | 15. GND     |
| 3. C (U)    | 16. roc     |
| 4. CE (U)   | 17. CCT     |
| 5. IN (V)   | 18. VFO     |
| 6. VCC (V)  | 19. IN (X)  |
| 7. C (V)    | 20. IN (Y)  |
| 8. CE (V)   | 21. IN (Z)  |
| 9. IN (W)   | 22. P       |
| 10. VCC (W) | 23. U       |
| 11. COM     | 24. V       |
| 12. C (W)   | 25. W       |
| 13. CE (W)  | 26. N       |