

# High Efficiency Thyristor

$$V_{RRM} = 1200 \text{ V}$$

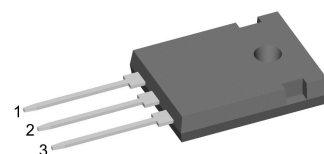
$$I_{TAV} = 40 \text{ A}$$

$$V_T = 1.44 \text{ V}$$

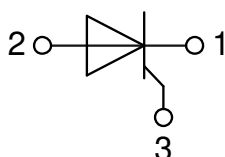
SemiFast  
Single Thyristor

Part number

**CLE40E1200HB**



Backside: anode



## Features / Advantages:

- Thyristor for line and moderate frequencies
- Short turn-off time
- Planar passivated chip
- Long-term stability

## Applications:

- Softstart AC motor control
- Power converter
- AC power control
- Lighting and temperature control

## Package: TO-247

- Industry standard outline
- RoHS compliant
- Epoxy meets UL 94V-0

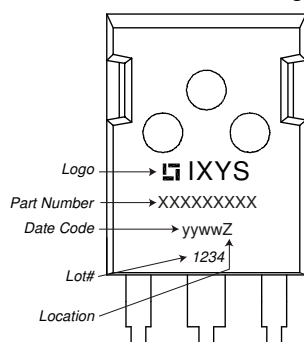
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| Thyristor      |                                                      |                                                                                                                                                                                                       |                                | Ratings |      |      |                   |
|----------------|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------|------|------|-------------------|
| Symbol         | Definition                                           | Conditions                                                                                                                                                                                            |                                | min.    | typ. | max. | Unit              |
| $V_{RSM/DSM}$  | max. non-repetitive reverse/forward blocking voltage | $T_{VJ} = 25^{\circ}\text{C}$                                                                                                                                                                         |                                |         |      | 1300 | V                 |
| $V_{RRM/DRM}$  | max. repetitive reverse/forward blocking voltage     | $T_{VJ} = 25^{\circ}\text{C}$                                                                                                                                                                         |                                |         |      | 1200 | V                 |
| $I_{R/D}$      | reverse current, drain current                       | $V_{R/D} = 1200\text{ V}$                                                                                                                                                                             | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 50   | $\mu\text{A}$     |
|                |                                                      | $V_{R/D} = 1200\text{ V}$                                                                                                                                                                             | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 4    | mA                |
| $V_T$          | forward voltage drop                                 | $I_T = 40\text{ A}$                                                                                                                                                                                   | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1.47 | V                 |
|                |                                                      | $I_T = 80\text{ A}$                                                                                                                                                                                   |                                |         |      | 1.76 | V                 |
|                |                                                      | $I_T = 40\text{ A}$                                                                                                                                                                                   | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 1.44 | V                 |
|                |                                                      | $I_T = 80\text{ A}$                                                                                                                                                                                   |                                |         |      | 1.80 | V                 |
| $I_{TAV}$      | average forward current                              | $T_C = 130^{\circ}\text{C}$                                                                                                                                                                           | $T_{VJ} = 150^{\circ}\text{C}$ |         |      | 40   | A                 |
| $I_{T(RMS)}$   | RMS forward current                                  | 180° sine                                                                                                                                                                                             |                                |         |      | 63   | A                 |
| $V_{T0}$       | threshold voltage                                    | } for power loss calculation only                                                                                                                                                                     | $T_{VJ} = 150^{\circ}\text{C}$ |         |      | 1.06 | V                 |
| $r_T$          | slope resistance                                     |                                                                                                                                                                                                       |                                |         |      | 9.1  | m $\Omega$        |
| $R_{thJC}$     | thermal resistance junction to case                  |                                                                                                                                                                                                       |                                |         |      | 0.25 | K/W               |
| $R_{thCH}$     | thermal resistance case to heatsink                  |                                                                                                                                                                                                       |                                |         | 0.3  |      | K/W               |
| $P_{tot}$      | total power dissipation                              |                                                                                                                                                                                                       | $T_C = 25^{\circ}\text{C}$     |         |      | 500  | W                 |
| $I_{TSM}$      | max. forward surge current                           | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                                                      | $T_{VJ} = 45^{\circ}\text{C}$  |         |      | 600  | A                 |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                                                     | $V_R = 0\text{ V}$             |         |      | 650  | A                 |
|                |                                                      | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                                                      | $T_{VJ} = 150^{\circ}\text{C}$ |         |      | 510  | A                 |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                                                     | $V_R = 0\text{ V}$             |         |      | 550  | A                 |
| $I^2t$         | value for fusing                                     | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                                                      | $T_{VJ} = 45^{\circ}\text{C}$  |         |      | 1.80 | kA <sup>2</sup> s |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                                                     | $V_R = 0\text{ V}$             |         |      | 1.76 | kA <sup>2</sup> s |
|                |                                                      | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                                                      | $T_{VJ} = 150^{\circ}\text{C}$ |         |      | 1.30 | kA <sup>2</sup> s |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                                                     | $V_R = 0\text{ V}$             |         |      | 1.26 | kA <sup>2</sup> s |
| $C_J$          | junction capacitance                                 | $V_R = 400\text{ V}$ $f = 1\text{ MHz}$                                                                                                                                                               | $T_{VJ} = 25^{\circ}\text{C}$  |         | 25   |      | pF                |
| $P_{GM}$       | max. gate power dissipation                          | $t_p = 30\text{ }\mu\text{s}$                                                                                                                                                                         | $T_C = 150^{\circ}\text{C}$    |         |      | 10   | W                 |
|                |                                                      | $t_p = 300\text{ }\mu\text{s}$                                                                                                                                                                        |                                |         |      | 5    | W                 |
| $P_{GAV}$      | average gate power dissipation                       |                                                                                                                                                                                                       |                                |         |      | 0.5  | W                 |
| $(di/dt)_{cr}$ | critical rate of rise of current                     | $T_{VJ} = 150^{\circ}\text{C}; f = 50\text{ Hz}$ repetitive, $I_T = 120\text{ A}$                                                                                                                     |                                |         |      | 150  | A/ $\mu\text{s}$  |
|                |                                                      | $t_p = 200\text{ }\mu\text{s}; di_G/dt = 0.3\text{ A}/\mu\text{s};$<br>$I_G = 0.3\text{ A}; V = \frac{2}{3} V_{DRM}$ non-repet., $I_T = 40\text{ A}$                                                  |                                |         |      | 500  | A/ $\mu\text{s}$  |
| $(dv/dt)_{cr}$ | critical rate of rise of voltage                     | $V = \frac{2}{3} V_{DRM}$                                                                                                                                                                             | $T_{VJ} = 150^{\circ}\text{C}$ |         |      | 1000 | V/ $\mu\text{s}$  |
|                |                                                      | $R_{GK} = \infty$ ; method 1 (linear voltage rise)                                                                                                                                                    |                                |         |      |      |                   |
| $V_{GT}$       | gate trigger voltage                                 | $V_D = 6\text{ V}$                                                                                                                                                                                    | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1.5  | V                 |
|                |                                                      |                                                                                                                                                                                                       | $T_{VJ} = -40^{\circ}\text{C}$ |         |      | 1.6  | V                 |
| $I_{GT}$       | gate trigger current                                 | $V_D = 6\text{ V}$                                                                                                                                                                                    | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 50   | mA                |
|                |                                                      |                                                                                                                                                                                                       | $T_{VJ} = -40^{\circ}\text{C}$ |         |      | 80   | mA                |
| $V_{GD}$       | gate non-trigger voltage                             | $V_D = \frac{2}{3} V_{DRM}$                                                                                                                                                                           | $T_{VJ} = 150^{\circ}\text{C}$ |         |      | 0.2  | V                 |
| $I_{GD}$       | gate non-trigger current                             |                                                                                                                                                                                                       |                                |         |      | 3    | mA                |
| $I_L$          | latching current                                     | $t_p = 10\text{ }\mu\text{s}$                                                                                                                                                                         | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 125  | mA                |
|                |                                                      | $I_G = 0.3\text{ A}; di_G/dt = 0.3\text{ A}/\mu\text{s}$                                                                                                                                              |                                |         |      |      |                   |
| $I_H$          | holding current                                      | $V_D = 6\text{ V}$ $R_{GK} = \infty$                                                                                                                                                                  | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 120  | mA                |
| $t_{gd}$       | gate controlled delay time                           | $V_D = \frac{1}{2} V_{DRM}$                                                                                                                                                                           | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 2    | $\mu\text{s}$     |
|                |                                                      | $I_G = 0.3\text{ A}; di_G/dt = 0.3\text{ A}/\mu\text{s}$                                                                                                                                              |                                |         |      |      |                   |
| $t_q$          | turn-off time                                        | $V_R = 100\text{ V}; I_T = 40\text{ A}; V = \frac{2}{3} V_{DRM}$ $T_{VJ} = 125^{\circ}\text{C}$<br>$di/dt = 10\text{ A}/\mu\text{s}$ $dv/dt = 20\text{ V}/\mu\text{s}$ $t_p = 200\text{ }\mu\text{s}$ |                                |         | 80   |      | $\mu\text{s}$     |

| Package TO-247 |                              |              | Ratings |      |      |      |
|----------------|------------------------------|--------------|---------|------|------|------|
| Symbol         | Definition                   | Conditions   | min.    | typ. | max. | Unit |
| $I_{RMS}$      | RMS current                  | per terminal |         |      | 70   | A    |
| $T_{VJ}$       | virtual junction temperature |              | -55     |      | 150  | °C   |
| $T_{op}$       | operation temperature        |              | -55     |      | 125  | °C   |
| $T_{stg}$      | storage temperature          |              | -55     |      | 150  | °C   |
| <b>Weight</b>  |                              |              |         | 6    |      | g    |
| $M_D$          | mounting torque              |              | 0.8     |      | 1.2  | Nm   |
| $F_C$          | mounting force with clip     |              | 20      |      | 120  | N    |

### Product Marking



### Part description

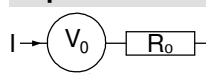
C = Thyristor (SCR)  
 L = High Efficiency Thyristor  
 E = Semifast (up to 1200V)  
 40 = Current Rating [A]  
 E = Single Thyristor  
 1200 = Reverse Voltage [V]  
 HB = TO-247AD (3)

| Ordering | Ordering Number | Marking on Product | Delivery Mode | Quantity | Code No. |
|----------|-----------------|--------------------|---------------|----------|----------|
| Standard | CLE40E1200HB    | CLE40E1200HB       | Tube          | 30       | 517588   |

### Equivalent Circuits for Simulation

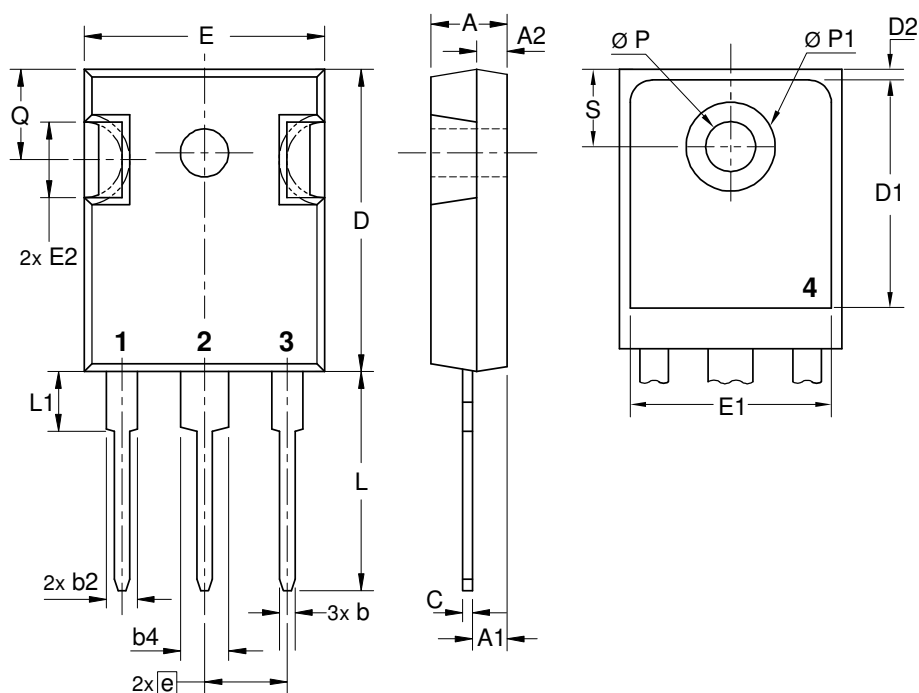
\* on die level

$T_{VJ} = 150^{\circ}\text{C}$

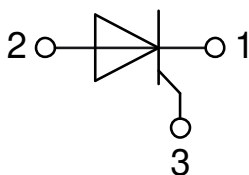


Thyristor

|             |                    |      |    |
|-------------|--------------------|------|----|
| $V_{0\max}$ | threshold voltage  | 1.06 | V  |
| $R_{0\max}$ | slope resistance * | 5.8  | mΩ |

**Outlines TO-247**


| Sym. | Inches |       | Millimeter |       |
|------|--------|-------|------------|-------|
|      | min.   | max.  | min.       | max.  |
| A    | 0.185  | 0.209 | 4.70       | 5.30  |
| A1   | 0.087  | 0.102 | 2.21       | 2.59  |
| A2   | 0.059  | 0.098 | 1.50       | 2.49  |
| D    | 0.819  | 0.845 | 20.79      | 21.45 |
| E    | 0.610  | 0.640 | 15.48      | 16.24 |
| E2   | 0.170  | 0.216 | 4.31       | 5.48  |
| e    | 0.215  | BSC   | 5.46       | BSC   |
| L    | 0.780  | 0.800 | 19.80      | 20.30 |
| L1   | -      | 0.177 | -          | 4.49  |
| Ø P  | 0.140  | 0.144 | 3.55       | 3.65  |
| Q    | 0.212  | 0.244 | 5.38       | 6.19  |
| S    | 0.242  | BSC   | 6.14       | BSC   |
| b    | 0.039  | 0.055 | 0.99       | 1.40  |
| b2   | 0.065  | 0.094 | 1.65       | 2.39  |
| b4   | 0.102  | 0.135 | 2.59       | 3.43  |
| c    | 0.015  | 0.035 | 0.38       | 0.89  |
| D1   | 0.515  | -     | 13.07      | -     |
| D2   | 0.020  | 0.053 | 0.51       | 1.35  |
| E1   | 0.530  | -     | 13.45      | -     |
| Ø P1 | -      | 0.29  | -          | 7.39  |



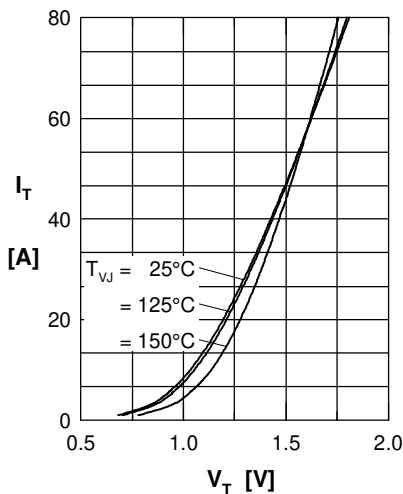
**Thyristor**


Fig. 1 Forward characteristics

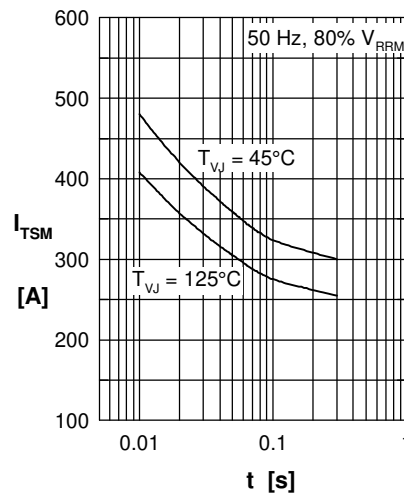
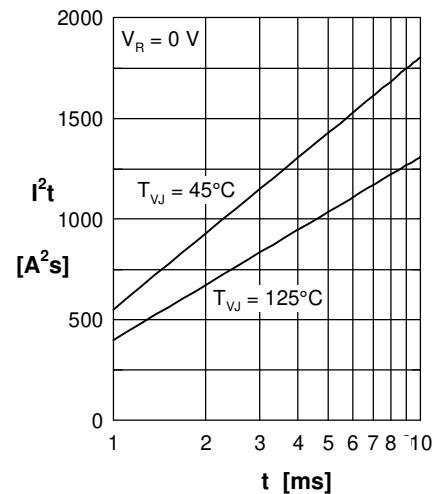
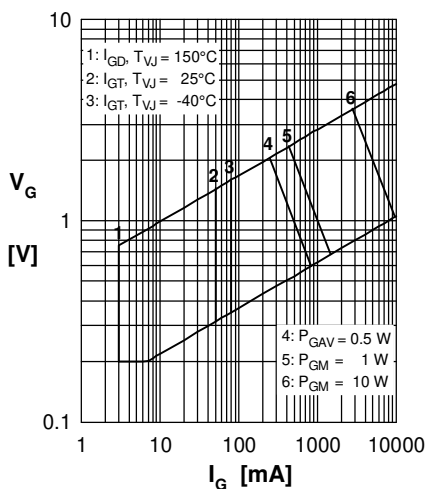

 Fig. 2 Surge overload current  
 $I_{TSM}$ : crest value,  $t$ : duration

 Fig. 3  $I^2t$  versus time (1-10 s)


Fig. 4 Gate voltage &amp; gate current

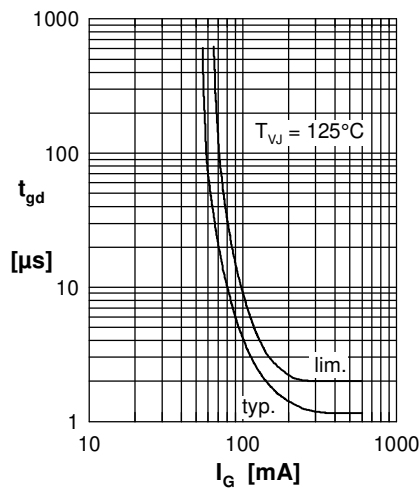
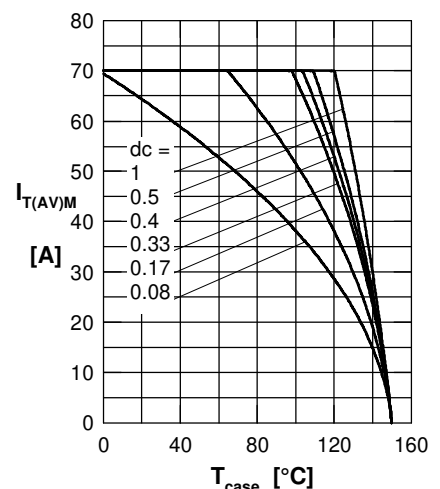

 Fig. 5 Gate controlled delay time  $t_{gd}$ 


Fig. 6 Max. forward current at case temperature

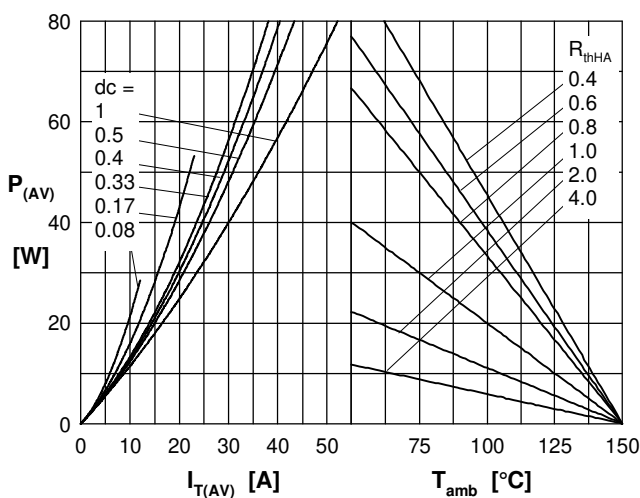
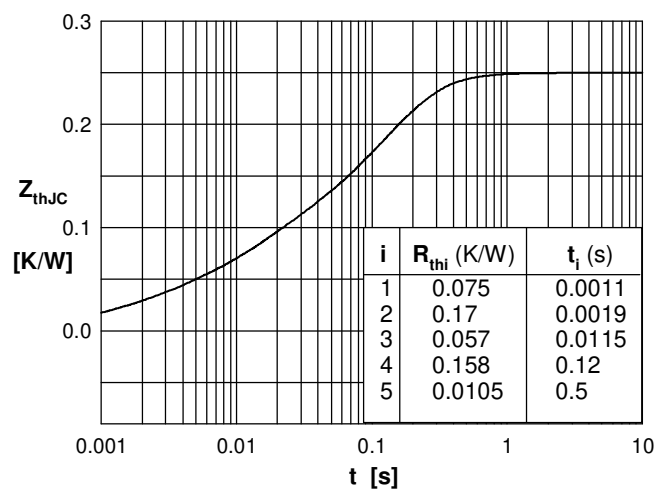

 Fig. 7a Power dissipation versus direct output current  
 Fig. 7b and ambient temperature


Fig. 7 Transient thermal impedance junction to case