# Phase Control Thyristors (Hockey PUK Version), 410 A

TO-200AB (A-PUK)

## FEATURES

- Center amplifying gate
- Metal case with ceramic insulator
- International standard case TO-200AB (A-PUK)
- Designed and qualified for industrial level
- Material categorization: For definitions of compliance please see www.vishay.com/doc?99912

Pb-free RoHS COMPLIANT

## TYPICAL APPLICATIONS

- DC motor controls
- Controlled DC power supplies
- AC controllers

| PRODUCT SUMMARY | |
|---|---|
| Package | TO-200AB (A-PUK) |
| Diode variation | Single SCR |
| $I_{T(AV)}$ | 410 A |
| $V_{DRM}/V_{RRM}$ | 400 V, 800 V, 1200 V, 1400 V, 1600 V, 1800 V, 2000 V |
| $V_{TM}$ | 1.69 V |
| $I_{GT}$ | 90 mA |
| $T_J$ | -40 °C to 125 °C |

| MAJOR RATINGS AND CHARACTERISTICS | | | |
|---|---|---|---|
| PARAMETER | TEST CONDITIONS | VALUES | UNITS |
| $I_{T(AV)}$ | | 410 | A |
| | $T_{hs}$ | 55 | °C |
| $I_{T(RMS)}$ | | 780 | A |
| | $T_{hs}$ | 25 | °C |
| $I_{TSM}$ | 50 Hz | 5700 | A |
| | 60 Hz | 5970 | |
| $I^2t$ | 50 Hz | 163 | $kA^2s$ |
| | 60 Hz | 149 | |
| $V_{DRM}/V_{RRM}$ | | 400 to 2000 | V |
| $t_q$ | Typical | 100 | µs |
| $T_J$ | | -40 to 125 | °C |

## ELECTRICAL SPECIFICATIONS

| VOLTAGE RATINGS | | | | |
|---|---|---|---|---|
| TYPE NUMBER | VOLTAGE CODE | $V_{DRM}/V_{RRM}$, MAXIMUM REPETITIVE PEAK AND OFF-STATE VOLTAGE V | $V_{RSM}$, MAXIMUM NON-REPETITIVE PEAK VOLTAGE V | $I_{DRM}/I_{RRM}$, MAXIMUM AT $T_J = T_J$ MAXIMUM mA |
| VS-ST230C..C | 04 | 400 | 500 | 30 |
| | 08 | 800 | 900 | |
| | 12 | 1200 | 1300 | |
| | 14 | 1400 | 1500 | |
| | 16 | 1600 | 1700 | |
| | 18 | 1800 | 1900 | |
| | 20 | 2000 | 2100 | |

| ABSOLUTE MAXIMUM RATINGS | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | | | **VALUES** | **UNITS** |
| Maximum average on-state current at heatsink temperature | $I_{T(AV)}$ | 180° conduction, half sine wave double side (single side) cooled | | | 410 (165) | A |
| | | | | | 55 (85) | °C |
| Maximum RMS on-state current | $I_{T(RMS)}$ | DC at 25 °C heatsink temperature double side cooled | | | 780 | A |
| Maximum peak, one-cycle non-repetitive surge current | $I_{TSM}$ | t = 10 ms | No voltage reapplied | Sinusoidal half wave, initial $T_J = T_J$ maximum | 5700 | |
| | | t = 8.3 ms | | | 5970 | |
| | | t = 10 ms | 100 % $V_{RRM}$ reapplied | | 4800 | |
| | | t = 8.3 ms | | | 5000 | |
| Maximum $I^2t$ for fusing | $I^2t$ | t = 10 ms | No voltage reapplied | | 163 | $kA^2s$ |
| | | t = 8.3 ms | | | 148 | |
| | | t = 10 ms | 100 % $V_{RRM}$ reapplied | | 115 | |
| | | t = 8.3 ms | | | 105 | |
| Maximum $I^2\sqrt{t}$ for fusing | $I^2\sqrt{t}$ | t = 0.1 to 10 ms, no voltage reapplied | | | 1630 | $kA^2\sqrt{s}$ |
| Low level value of threshold voltage | $V_{T(TO)1}$ | (16.7 % x π x $I_{T(AV)}$ < I < π x $I_{T(AV)}$), $T_J = T_J$ maximum | | | 0.92 | V |
| High level value of threshold voltage | $V_{T(TO)2}$ | (I > π x $I_{T(AV)}$), $T_J = T_J$ maximum | | | 0.98 | |
| Low level value of on-state slope resistance | $r_{t1}$ | (16.7 % x π x $I_{T(AV)}$ < I < π x $I_{T(AV)}$), $T_J = T_J$ maximum | | | 0.88 | mΩ |
| High level value of on-state slope resistance | $r_{t2}$ | (I > π x $I_{T(AV)}$), $T_J = T_J$ maximum | | | 0.81 | |
| Maximum on-state voltage | $V_{TM}$ | $I_{pk}$ = 880 A, $T_J = T_J$ maximum, $t_p$ = 10 ms sine pulse | | | 1.69 | V |
| Maximum holding current | $I_H$ | $T_J$ = 25 °C, anode supply 12 V resistive load | | | 600 | mA |
| Maximum (typical) latching current | $I_L$ | | | | 1000 (300) | |

| SWITCHING | | | | |
|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **VALUES** | **UNITS** |
| Maximum non-repetitive rate of rise of turned-on current | dI/dt | Gate drive 20 V, 20 Ω, $t_r \leq 1$ µs<br>$T_J = T_J$ maximum, anode voltage ≤ 80 % $V_{DRM}$ | 1000 | A/µs |
| Typical delay time | $t_d$ | Gate current 1 A, $dI_g/dt$ = 1 A/µs<br>$V_d$ = 0.67 % $V_{DRM}$, $T_J$ = 25 °C | 1.0 | µs |
| Typical turn-off time | $t_q$ | $I_{TM}$ = 300 A, $T_J = T_J$ maximum, dI/dt = 20 A/µs,<br>$V_R$ = 50 V, dV/dt = 20 V/µs, gate 0 V 100 Ω, $t_p$ = 500 µs | 100 | |

| BLOCKING | | | | |
|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **VALUES** | **UNITS** |
| Maximum critical rate of rise of off-state voltage | dV/dt | $T_J = T_J$ maximum linear to 80 % rated $V_{DRM}$ | 500 | V/µs |
| Maximum peak reverse and off-state leakage current | $I_{RRM}$, $I_{DRM}$ | $T_J = T_J$ maximum, rated $V_{DRM}/V_{RRM}$ applied | 30 | mA |

| TRIGGERING | | | | | | |
|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | | VALUES TYP. | VALUES MAX. | UNITS |
| Maximum peak gate power | $P_{GM}$ | $T_J = T_J$ maximum, $t_p \leq 5$ ms | | 10.0 | | W |
| Maximum average gate power | $P_{G(AV)}$ | $T_J = T_J$ maximum, f = 50 Hz, d% = 50 | | 2.0 | | W |
| Maximum peak positive gate current | $I_{GM}$ | $T_J = T_J$ maximum, $t_p \leq 5$ ms | | 3.0 | | A |
| Maximum peak positive gate voltage | + $V_{GM}$ | $T_J = T_J$ maximum, $t_p \leq 5$ ms | | 20 | | V |
| Maximum peak negative gate voltage | - $V_{GM}$ | | | 5.0 | | V |
| DC gate current required to trigger | $I_{GT}$ | $T_J$ = - 40 °C | Maximum required gate trigger/ current/voltage are the lowest value which will trigger all units 12 V anode to cathode applied | 180 | - | mA |
| | | $T_J$ = 25 °C | | 90 | 150 | mA |
| | | $T_J$ = 125 °C | | 40 | - | mA |
| DC gate voltage required to trigger | $V_{GT}$ | $T_J$ = - 40 °C | | 2.9 | - | V |
| | | $T_J$ = 25 °C | | 1.8 | 3.0 | V |
| | | $T_J$ = 125 °C | | 1.2 | - | V |
| DC gate current not to trigger | $I_{GD}$ | $T_J = T_J$ maximum | Maximum gate current/voltage not to trigger is the maximum value which will not trigger any unit with rated $V_{DRM}$ anode to cathode applied | 10 | | mA |
| DC gate voltage not to trigger | $V_{GD}$ | | | 0.25 | | V |

| THERMAL AND MECHANICAL SPECIFICATIONS | | | | |
|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | VALUES | UNITS |
| Maximum operating temperature range | $T_J$ | | - 40 to 125 | °C |
| Maximum storage temperature range | $T_{Stg}$ | | - 40 to 150 | °C |
| Maximum thermal resistance, junction to heatsink | $R_{thJ-hs}$ | DC operation single side cooled | 0.17 | K/W |
| | | DC operation double side cooled | 0.08 | K/W |
| Maximum thermal resistance, case to heatsink | $R_{thC-hs}$ | DC operation single side cooled | 0.033 | K/W |
| | | DC operation double side cooled | 0.017 | K/W |
| Mounting force, ± 10 % | | | 4900 (500) | N (kg) |
| Approximate weight | | | 50 | g |
| Case style | | See dimensions - link at the end of datasheet | TO-200AB (A-PUK) | |

| $\Delta R_{thJC}$ CONDUCTION | | | | | | |
|---|---|---|---|---|---|---|
| CONDUCTION ANGLE | SINUSOIDAL CONDUCTION | | RECTANGULAR CONDUCTION | | TEST CONDITIONS | UNITS |
| | SINGLE SIDE | DOUBLE SIDE | SINGLE SIDE | DOUBLE SIDE | | |
| 180° | 0.015 | 0.017 | 0.011 | 0.011 | $T_J = T_J$ maximum | K/W |
| 120° | 0.018 | 0.019 | 0.019 | 0.019 | | |
| 90° | 0.024 | 0.024 | 0.026 | 0.026 | | |
| 60° | 0.035 | 0.035 | 0.036 | 0.036 | | |
| 30° | 0.060 | 0.060 | 0.060 | 0.061 | | |

**Note**

- The table above shows the increment of thermal resistance $R_{thJC}$ when devices operate at different conduction angles than DC

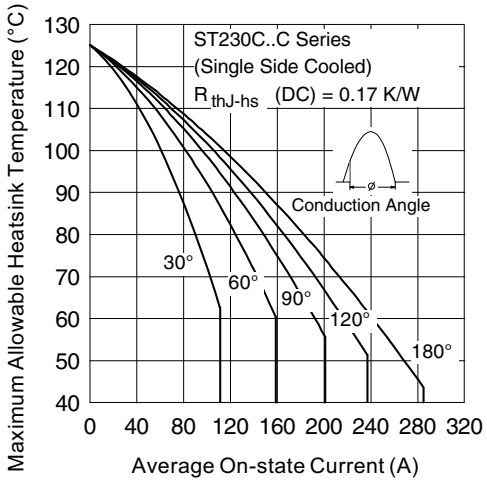



Fig. 1 - Current Ratings Characteristics

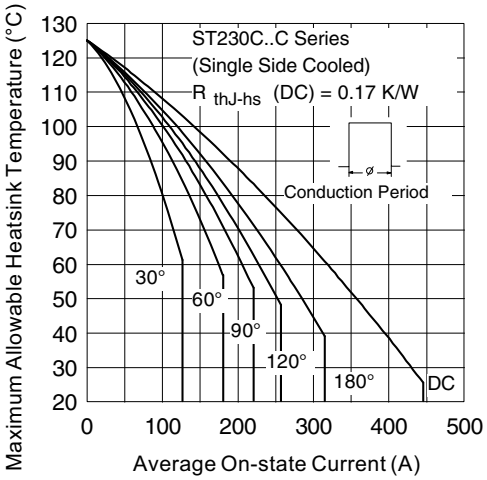



Fig. 2 - Current Ratings Characteristics

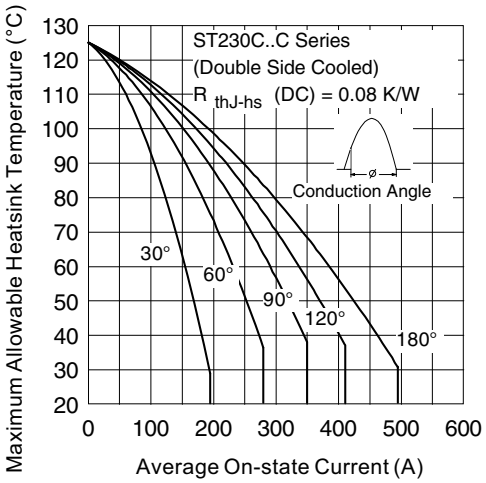



Fig. 3 - Current Ratings Characteristics

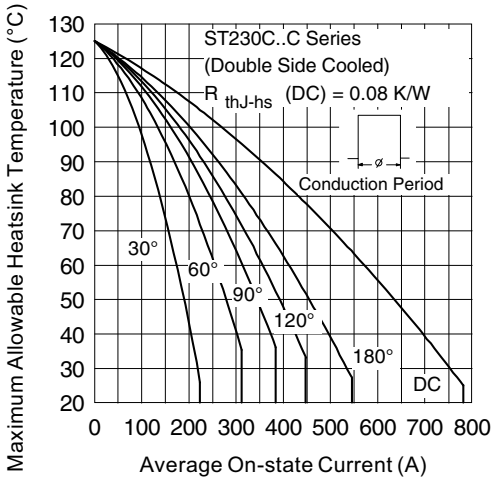



Fig. 4 - Current Ratings Characteristics

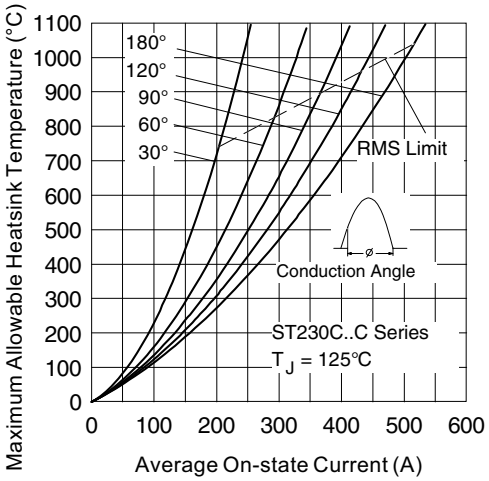



Fig. 5 - On-State Power Loss Characteristics

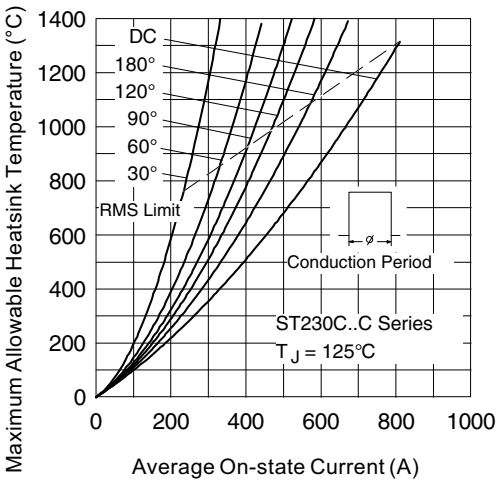



Fig. 6 - On-State Power Loss Characteristics

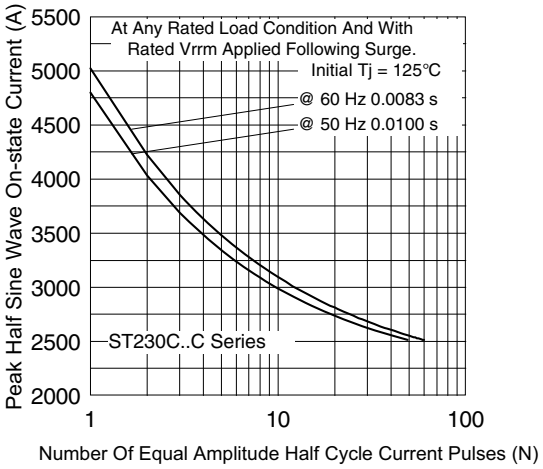



Fig. 7 - Maximum Non-Repetitive Surge Current
Single and Double Side Cooled

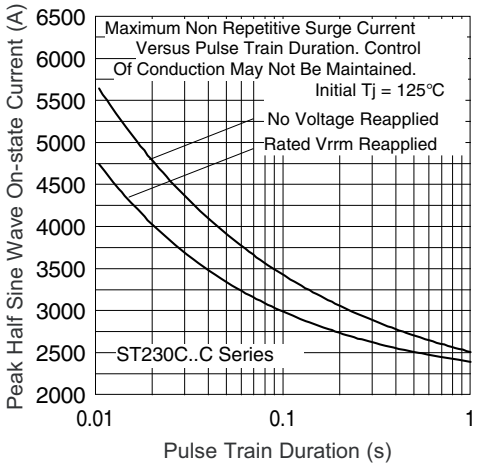



Fig. 8 - Maximum Non-Repetitive Surge Current
Single and Double Side Cooled

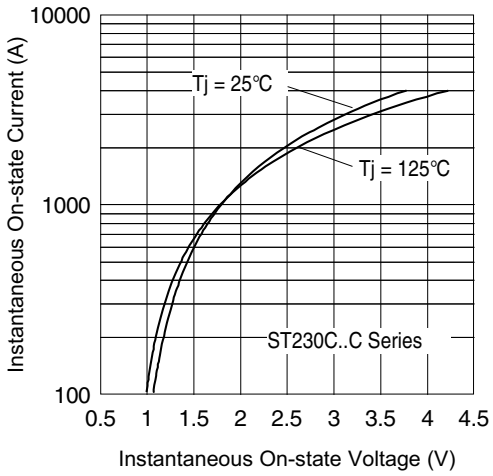



Fig. 9 - On-State Voltage Drop Characteristics

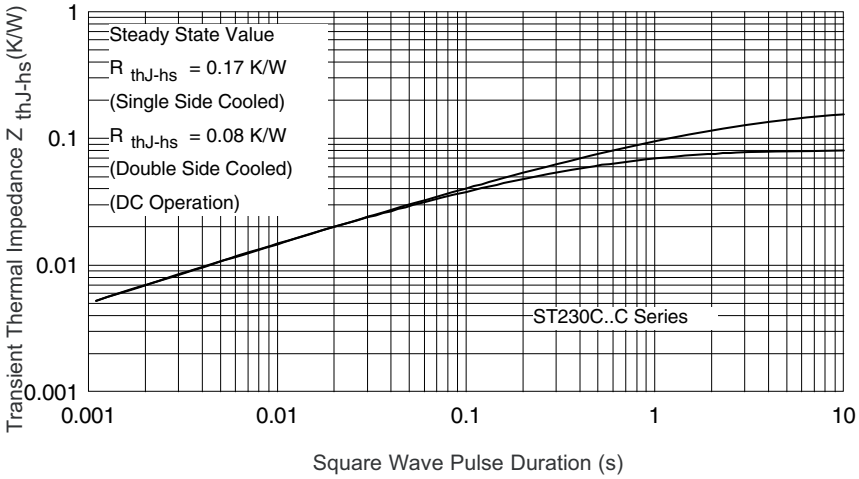



Fig. 10 - Thermal Impedance $Z_{thJ\text{-}hs}$ Characteristics

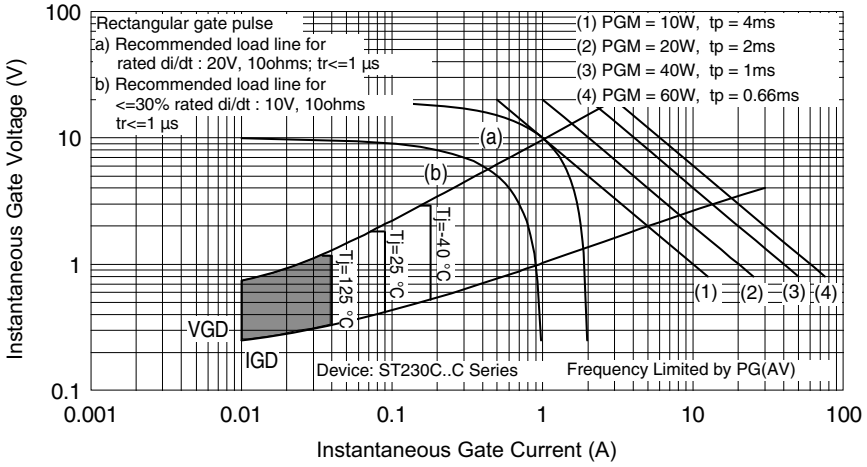



Fig. 11 - Gate Characteristics

## ORDERING INFORMATION TABLE

**Device code**

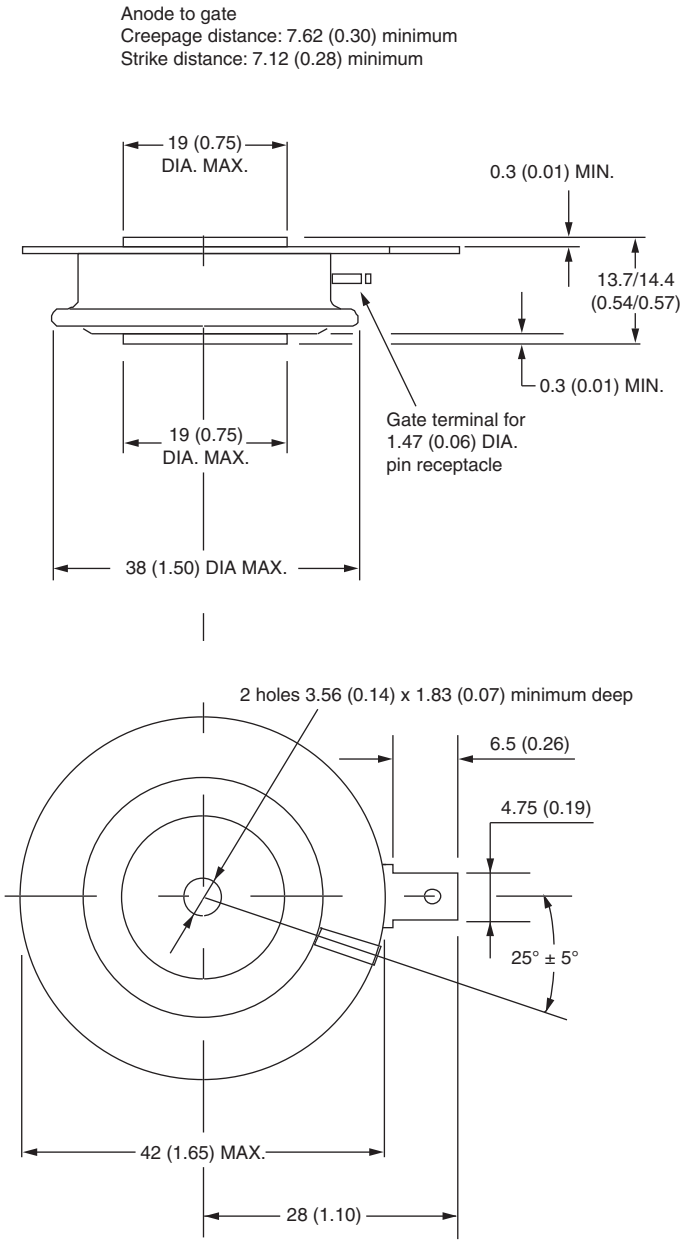
| VS- | ST | 23 | 0 | C | 20 | C | 1 | - |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

- 1 - Vishay Semiconductors product
- 2 - Thyristor
- 3 - Essential part number
- 4 - 0 = Converter grade
- 5 - C = Ceramic PUK
- 6 - Voltage code x 100 = $V_{RRM}$ (see Voltage Ratings table)
- 7 - C = PUK case TO-200AB (A-PUK)
- 8 - 0 = Eyelet terminals (gate and auxiliary cathode unsoldered leads)
  1 = Fast-on terminals (gate and auxiliary cathode unsoldered leads)
  2 = Eyelet terminals (gate and auxiliary cathode soldered leads)
  3 = Fast-on terminals (gate and auxiliary cathode soldered leads)
- 9 - Critical dV/dt: • None = 500 V/µs (Standard selection)
  • L = 1000 V/µs (Special selection)

| LINKS TO RELATED DOCUMENTS | |
|---|---|
| Dimensions | www.vishay.com/doc?95074 |

# TO-200AB (A-PUK)

**DIMENSIONS** in millimeters (inches)




Quote between upper and lower pole pieces has to be considered after application of mounting force (see thermal and mechanical specification)

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