

# ClearClock™ Oscillator Family | Low Jitter | 2.5x2.0mm XO

AK2

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ESD Sensitive



2.50 x 2.0 x 1.0 mm

RoHS/RoHS II Compliant

MSL Level = N/A

## Features

- Based on 3rd Overtone, Quartz Crystal Technology
- Ultra-low rms jitter; < 120fs typical @ 156.25MHz
- Lowest in-class power consumption (15mA max with LVDS)
- $\pm 25$ ppm max &  $\pm 30$ ppm max stability over -20°C to +70°C and -40°C to +85°C respectively
- 3.3V, 2.5V & 1.8V supply voltage options
- LVPECL, LVDS and HCSL differential output options
- Output enabled (Active High standard default)

## Key Electrical Specifications

## Applications

- Optical Transceivers
- Optical Modules
- Networking and communications
- Gigabit Ethernet
- Fibre Channel
- SONET/SDH
- RF systems, base stations (BTS)
- Datacenter
- PCI Express

| Parameters                                                                                                                      |        | Min.                                    | Typ.      | Max.  | Unit | Notes                                                             |
|---------------------------------------------------------------------------------------------------------------------------------|--------|-----------------------------------------|-----------|-------|------|-------------------------------------------------------------------|
| Frequency Range                                                                                                                 |        | 100                                     |           | 200   | MHz  |                                                                   |
| Standard Available Frequencies                                                                                                  |        | 100.00, 125.00, 148.50, 156.25 & 200.00 |           |       | MHz  | Contact Abracon for availability of frequencies not listed        |
| Supply Voltage (Vdd) <sup>[Note 1]</sup>                                                                                        |        | 2.97                                    | 3.3       | 3.63  | V    | Option "A"                                                        |
|                                                                                                                                 |        | 2.37                                    | 2.5       | 2.62  |      | Option "B"                                                        |
|                                                                                                                                 |        | 1.71                                    | 1.8       | 1.89  |      | Option "C"                                                        |
| Supply Current (Idd)                                                                                                            | LVPECL |                                         | 30        | 50    | mA   | @ 200MHz; @ Vdd=3.3V                                              |
|                                                                                                                                 | LVDS   |                                         | 10        | 15    |      | @ 200MHz; @ Vdd=3.3V                                              |
|                                                                                                                                 | HCSL   |                                         | 22        | 30    |      | @ 200MHz; @ Vdd=3.3V                                              |
| Operating Temperature Range                                                                                                     |        | -20                                     |           | 70    | °C   | Option "D"                                                        |
|                                                                                                                                 |        | -40                                     |           | 85    |      | Option "F"                                                        |
| Storage Temperature                                                                                                             |        | -55                                     |           | 150   | °C   |                                                                   |
| Frequency Accuracy (Initial Set-Tolerance, as received stand-alone measured frequency) at time of shipment (Pre-Reflow) @ +25°C |        | -10                                     | < $\pm 5$ | +10   | ppm  | Relative to carrier frequency                                     |
| Frequency Shift through Reflow                                                                                                  |        | -2.00                                   |           | +2.00 | ppm  | Relative to as received frequency                                 |
| Frequency Stability over Operating Temperature Range <sup>[Note 2]</sup>                                                        |        | -25                                     |           | 25    | ppm  | Option "D" (-20°C to +70°C)                                       |
|                                                                                                                                 |        | -30                                     |           | 30    |      | Option "F" (-40°C to +85°C)                                       |
| First Year Aging                                                                                                                |        | -3.00                                   |           | +3.00 | ppm  | Maximum first year aging, $\pm 2.00$ ppm max. per year thereafter |
| Aging over 20 Year Product Life <sup>[Note 3]</sup>                                                                             |        | -15                                     |           | +15   | ppm  |                                                                   |
| All-Inclusive Frequency Accuracy (Total Stability) over 20 Year Product Life <sup>[Notes 4]</sup>                               |        | -52                                     |           | 52    | ppm  | Option "D" (-20°C to +70°C)                                       |
|                                                                                                                                 |        | -57                                     |           | 57    |      | Option "F" (-40°C to +85°C)                                       |
| Rise (Tr) / Fall (Tf) Time 20% to 80% Vpeak to peak                                                                             | LVPECL |                                         | 0.3       | 0.6   | ns   | @ Vdd=3.3V, RL=50 $\Omega$                                        |
|                                                                                                                                 | LVDS   |                                         | 0.3       | 0.5   |      | @ Vdd=3.3V, RL=100 $\Omega$                                       |
|                                                                                                                                 | HCSL   |                                         | 0.3       | 0.6   |      | @ Vdd=3.3V, RL=50 $\Omega$ to GND                                 |
| Duty Cycle                                                                                                                      |        | 45                                      |           | 55    | %    |                                                                   |
| Start-up Time                                                                                                                   |        |                                         | < 2       | 5     | ms   |                                                                   |



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RoHS/RoHS II Compliant  
MSL Level = N/A

| Parameters                                                            |        |                 | Min.                   | Typ.   | Max.                   | Unit | Notes                                               |                                              |
|-----------------------------------------------------------------------|--------|-----------------|------------------------|--------|------------------------|------|-----------------------------------------------------|----------------------------------------------|
| Differential<br>Output High Voltage (VOH)<br>Output Low Voltage (VOL) | LVPECL | V <sub>OH</sub> | V <sub>dd</sub> -1.03  |        | V <sub>dd</sub> -0.88  | V    | R <sub>L</sub> =50Ω to V <sub>dd</sub> -2.0V        |                                              |
|                                                                       |        | V <sub>OL</sub> | V <sub>dd</sub> -1.85  |        | V <sub>dd</sub> -1.60  |      |                                                     |                                              |
|                                                                       | LVDS   | V <sub>OH</sub> |                        | 1.40   | 1.60                   |      | R <sub>L</sub> =100Ω between both outputs           |                                              |
|                                                                       |        | V <sub>OL</sub> | 0.90                   | 1.10   |                        |      |                                                     |                                              |
|                                                                       | HCSL   | V <sub>OH</sub> | 0.40                   | 0.74   | 0.85                   |      |                                                     | R <sub>L</sub> =50Ω to ground on each output |
|                                                                       |        | V <sub>OL</sub> | -0.15                  | 0.00   | 0.15                   |      |                                                     |                                              |
| Output Voltage Swing                                                  |        |                 | 0.50                   |        |                        | V    | LVPECL                                              |                                              |
|                                                                       |        |                 | 0.250                  | 0.350  | 0.450                  |      | LVDS                                                |                                              |
|                                                                       |        |                 | 0.50                   |        |                        |      | HCSL                                                |                                              |
| Output Enable & Disable Control                                       |        |                 | 0.7*(V <sub>dd</sub> ) |        |                        | V    | Output Enable or No Connect                         |                                              |
|                                                                       |        |                 |                        |        | 0.3*(V <sub>dd</sub> ) |      | Output Disable (High Impedance)                     |                                              |
| Output Enable Time                                                    |        |                 |                        | < 2.00 | 5.00                   | ms   |                                                     |                                              |
| Output Disable Time                                                   |        |                 |                        |        | 0.2                    | μs   |                                                     |                                              |
| Output Disable Current Consumption                                    |        |                 |                        |        | < 10                   | μA   | OE ≤ 0.3V                                           |                                              |
| rms phase jitter (12kHz to 20MHz from Carrier)                        |        |                 |                        | < 200  | 500                    | fs   | Vdd, RF output type and Carrier frequency dependent |                                              |
|                                                                       |        |                 |                        | <150   | 200                    | fs   | @ 156.25MHz                                         |                                              |

Note 1: Supply voltage (V<sub>dd</sub>) = 1.8V option not available with LVPECL output.

Note 2: Relative to initial measured frequency @ +25°C, pre-reflow.

Note 3: Relative to post-reflow frequency.

Note 4: Includes post reflow frequency accuracy, temperature stability, load pulling, power supply variation, and 20-year aging.



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## Phase Noise Test Setup

- Keysight E5052B Signal Source Analyzer
- Integration Bandwidth = 12kHz to 20MHz
- Spurious Activity (entire plot trace) = Not omitted (Normalized in dBc/Hz)
- Specified Spur Omission Function = Not enabled
- IF Gain = 20dB
- Correlation = 5
- Average = 3

## Typical Values measured at 25°C ± 3°

| Frequency (MHz)                        |        | 100.00MHz |         |         |         |         |         |         | 156.25MHz |         |         |
|----------------------------------------|--------|-----------|---------|---------|---------|---------|---------|---------|-----------|---------|---------|
| V <sub>DD</sub>                        |        | 1.8V      |         | 2.5V    |         |         | 3.3V    |         |           | 1.8V    | 2.5V    |
| RF Output                              |        | LVDS      | HCSL    | LVDS    | HCSL    | LVPECL  | LVDS    | HCSL    | LVPECL    | LVDS    |         |
| rms Phase Jitter (fsec)<br>12kHz-20MHz |        | 385.27    | 147.12  | 207.96  | 117.86  | 131.63  | 255.13  | 195.68  | 123.73    | 139.49  | 107.18  |
| Phase Noise<br>(dB <sub>C</sub> /Hz)   | 100Hz  | -104.49   | -86.91  | -80.88  | -75.50  | -99.17  | -87.89  | -105.15 | -102.40   | -93.43  | -93.21  |
|                                        | 1KHz   | -125.64   | -120.54 | -115.99 | -115.89 | -129.38 | -120.80 | -132.38 | -132.55   | -123.45 | -125.31 |
|                                        | 10KHz  | -134.97   | -144.63 | -140.15 | -147.34 | -145.94 | -143.61 | -144.58 | -146.61   | -136.98 | -139.61 |
|                                        | 100KHz | -140.45   | -152.42 | -149.52 | -457.05 | -153.02 | -146.87 | -150.96 | -152.79   | -140.93 | -149.12 |
|                                        | 1MHz   | -147.69   | -155.94 | -153.49 | -153.53 | -156.87 | -148.30 | -150.70 | -156.98   | -150.53 | -154.70 |
|                                        | 10MHz  | -149.67   | -157.06 | -153.53 | -159.42 | -157.87 | -153.04 | -154.78 | -158.59   | -155.31 | -156.40 |

Note 5: Guaranteed by characterization; rms Phase Jitter specifications are inclusive of any spurs

Note 6: Phase jitter measured with Keysight E5052B Signal Source Analyzer at 25°C±3°C

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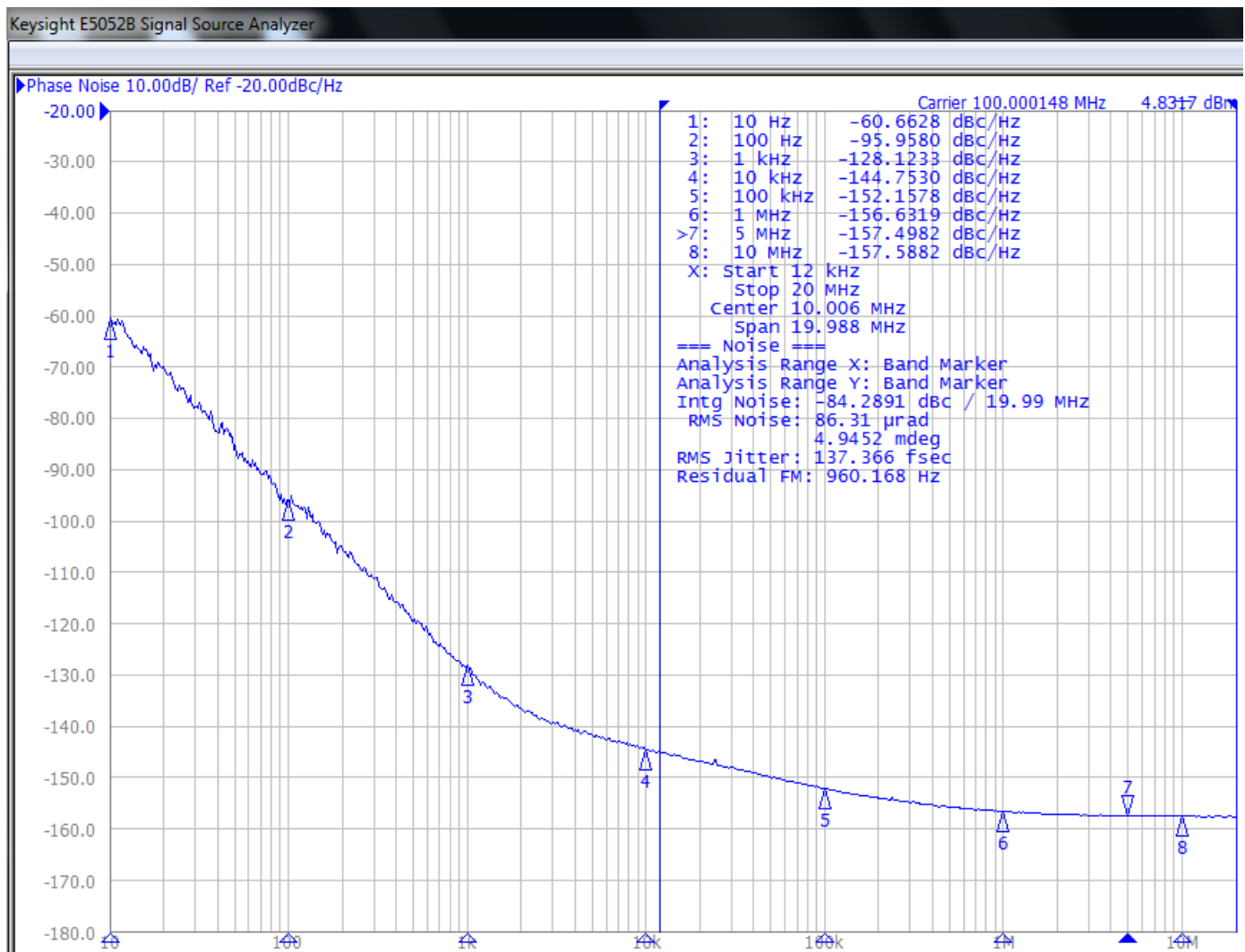
2.50 x 2.0 x 1.0 mm

RoHS/RoHS II Compliant

MSL Level = N/A

## Representative Phase Noise Plots @ +25°C [Note 7]

Frequency = 100.00MHz  
Vdd = 2.50V  
RF Output = LVPECL  
rms Phase Jitter = 137 fs



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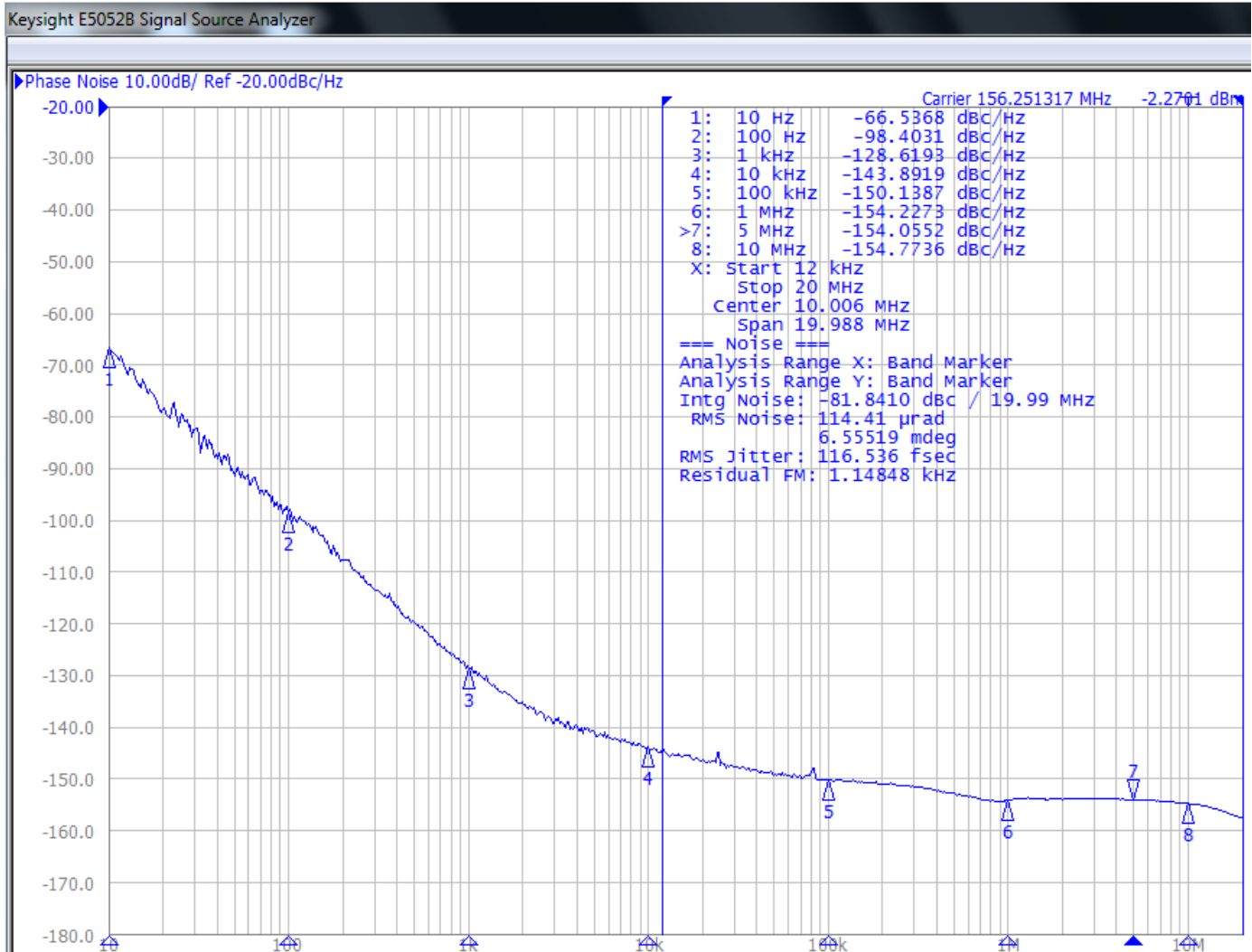


2.50 x 2.0 x 1.0 mm

RoHS/RoHS II Compliant

MSL Level = N/A

Frequency = 156.2500MHz  
Vdd = 2.50V  
RF Output = LVDS  
rms Phase Jitter = 117 fs



Note 7: Contact Abracon for phase noise plots at alternative supply voltage ( $V_{dd}$ ) & differential output formats



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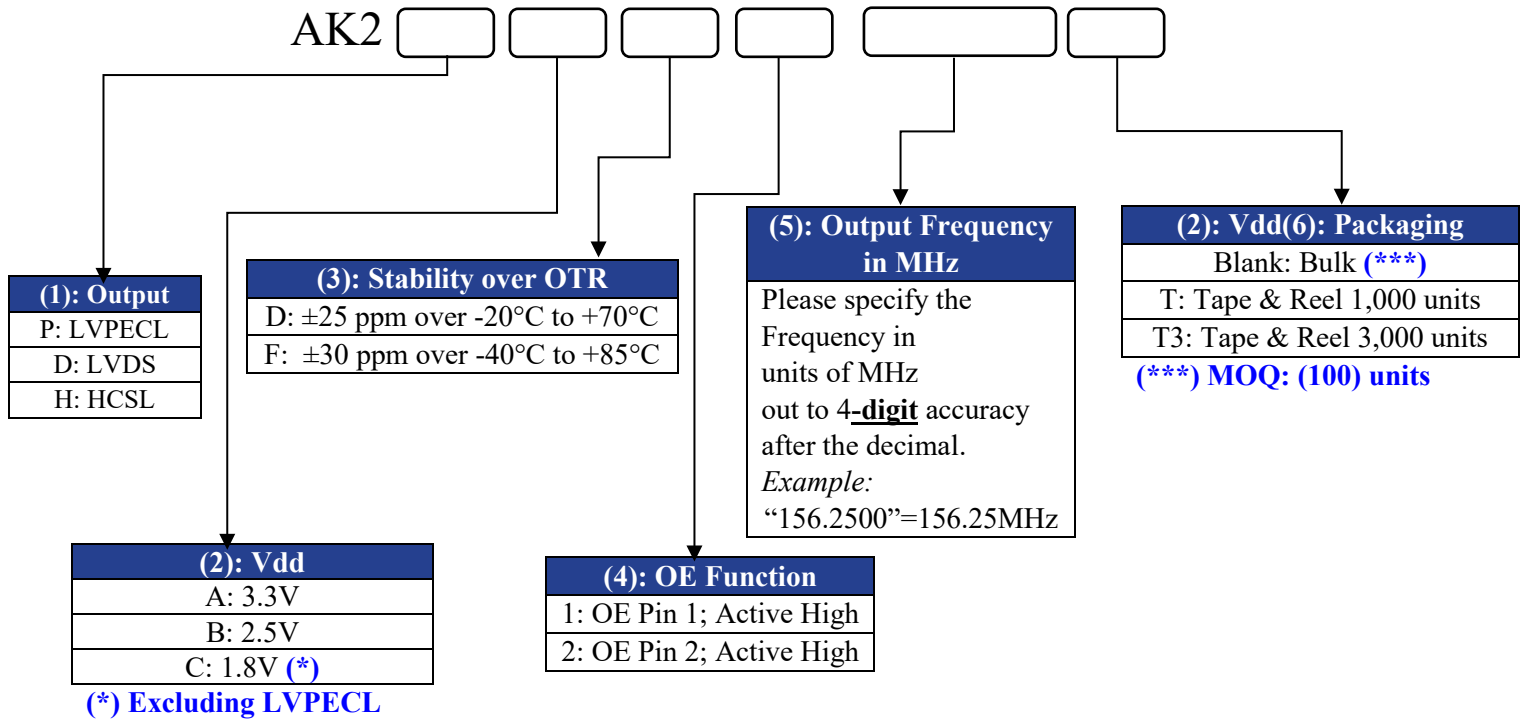


2.50 x 2.0 x 1.0 mm

RoHS/RoHS II Compliant

MSL Level = N/A

## Options and Part Identification [\[Note 8\]](#)



### Part Number Example

AK2PAF1-156.2500 [(100) units in Bulk]

AK2PAF1-156.2500T [(1k) units on Tape & Reel]

AK2PAF1-156.2500T3 [(3k) units on Tape & Reel]

Note 8: Contact Abracon for non-standard part number configurations and/or requests with carrier frequency callouts up to 5 & 6 digit accuracy after the decimal

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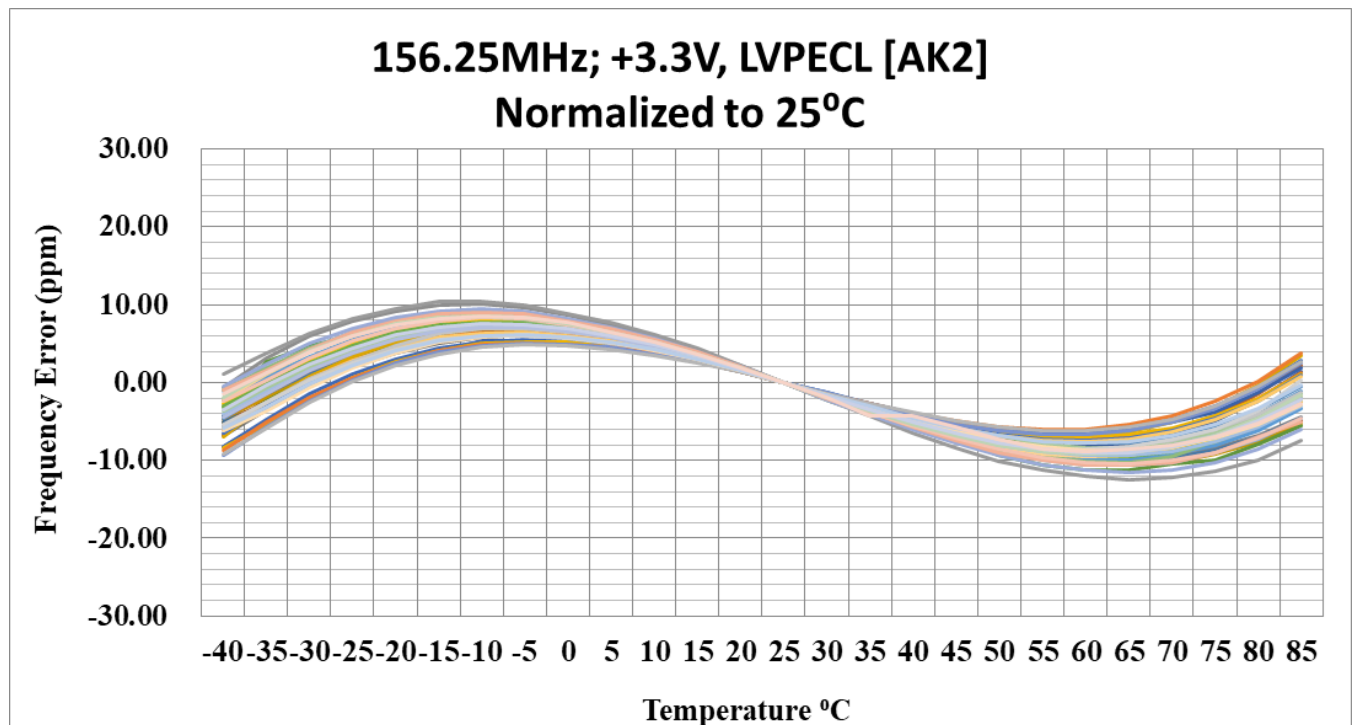
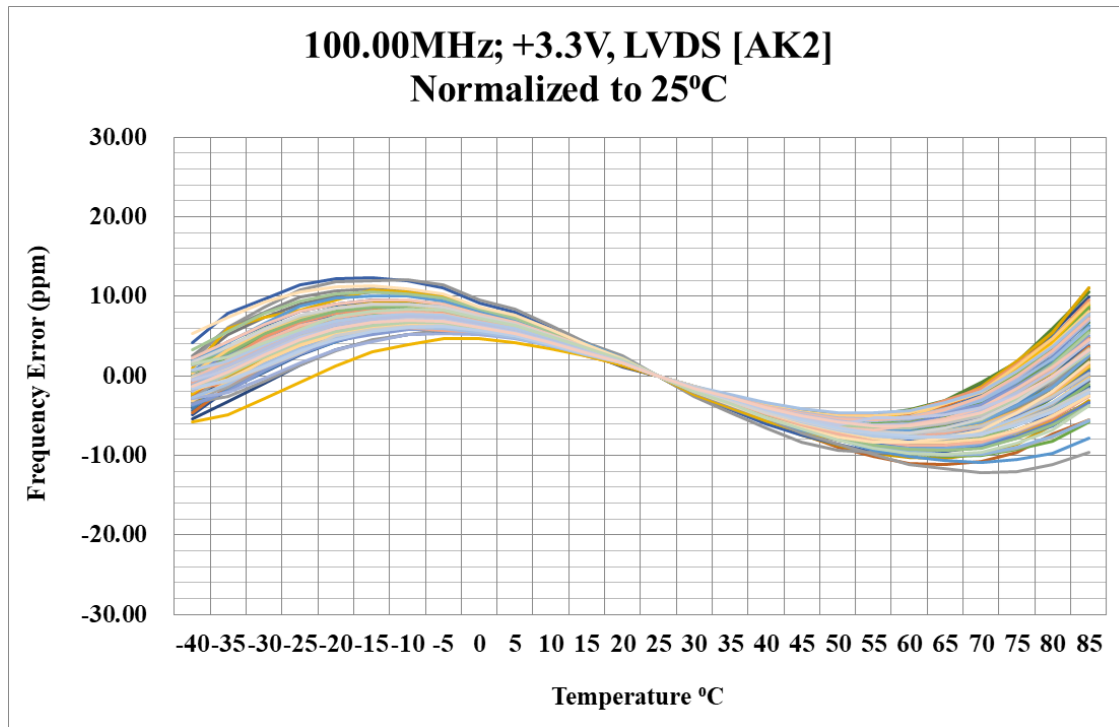


2.50 x 2.0 x 1.0 mm

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## Typical Frequency vs. Temperature Characteristics



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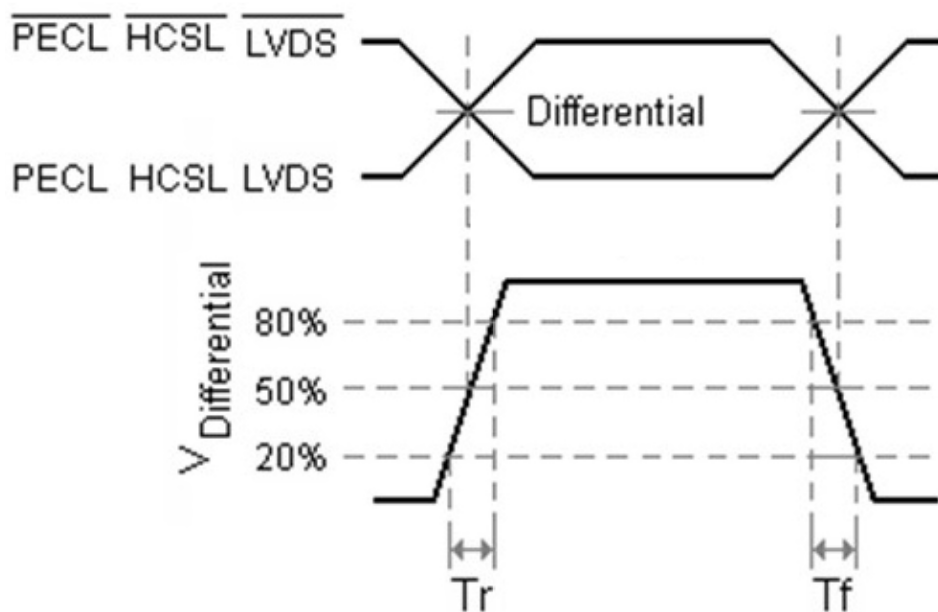
2.50 x 2.0 x 1.0 mm

RoHS/RoHS II Compliant

MSL Level = N/A

## Differential Output Waveform

### LVPECL, LVDS and HCSL Output Waveforms





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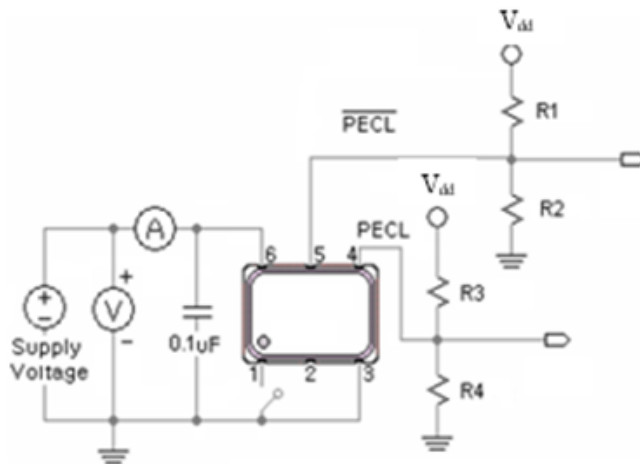
2.50 x 2.0 x 1.0 mm

RoHS/RoHS II Compliant

MSL Level = N/A

## Recommended Test Circuit [\[Note 9\]](#)

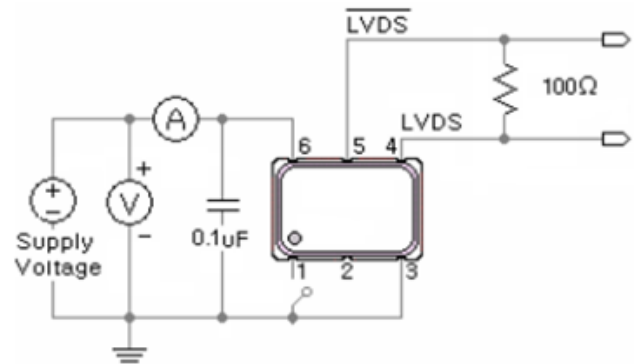
### LVPECL



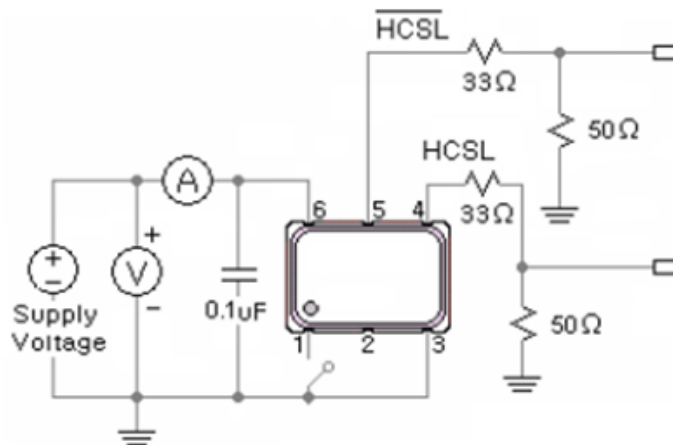
V<sub>dd</sub>= 3.3V: R1=R3=127Ω; R2=R4=82.5Ω

V<sub>dd</sub>= 2.5V: R1=R3=250Ω; R2=R4=62.5Ω

### LVDS



### HCSL



Note 9: Recommended test circuit images are representative of when the OE Function is located on Pin 1; when the OE Function is located on Pin 2, then Pin 1=No Connect & Pin 2=OE or No Connect.

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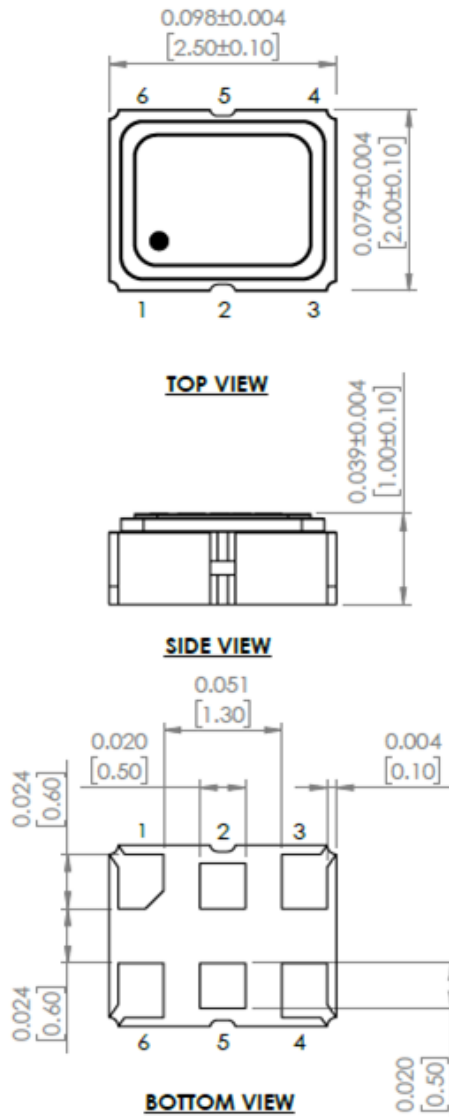


2.50 x 2.0 x 1.0 mm

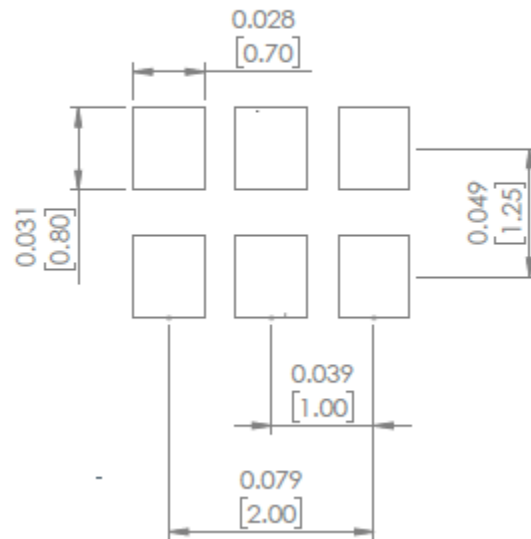
RoHS/RoHS II Compliant

MSL Level = N/A

## Mechanical Dimensions



## Recommended Land Pattern



| Case 1<br>Pin #1=Output Enable/Disable<br>Function<br>where OE is Active HIGH |                                         | Case 2<br>Pin #2=Output<br>Enable/Disable Function<br>where OE is Active HIGH |                                         |
|-------------------------------------------------------------------------------|-----------------------------------------|-------------------------------------------------------------------------------|-----------------------------------------|
| Pin                                                                           | Description                             | Pin                                                                           | Description                             |
| # 1                                                                           | Output Enable =<br>Logic High, "1", Vdd | # 1                                                                           | No Connect                              |
|                                                                               | Output Disable =<br>Logic Low, "0", GND | # 2                                                                           | Output Enable =<br>Logic High, "1", Vdd |
| # 2                                                                           | No Connect                              |                                                                               | Output Enable =<br>Logic Low, "0", GND  |
| # 3                                                                           | GND                                     | # 3                                                                           | GND                                     |
| # 4                                                                           | Output                                  | # 4                                                                           | Output                                  |
| # 5                                                                           | Complementary output                    | # 5                                                                           | Complementary output                    |
| # 6                                                                           | Supply Voltage (Vdd)                    | # 6                                                                           | Supply Voltage (Vdd)                    |

Dimensions: inches [mm]

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## Reflow Profile [JEDEC J-STD-020]

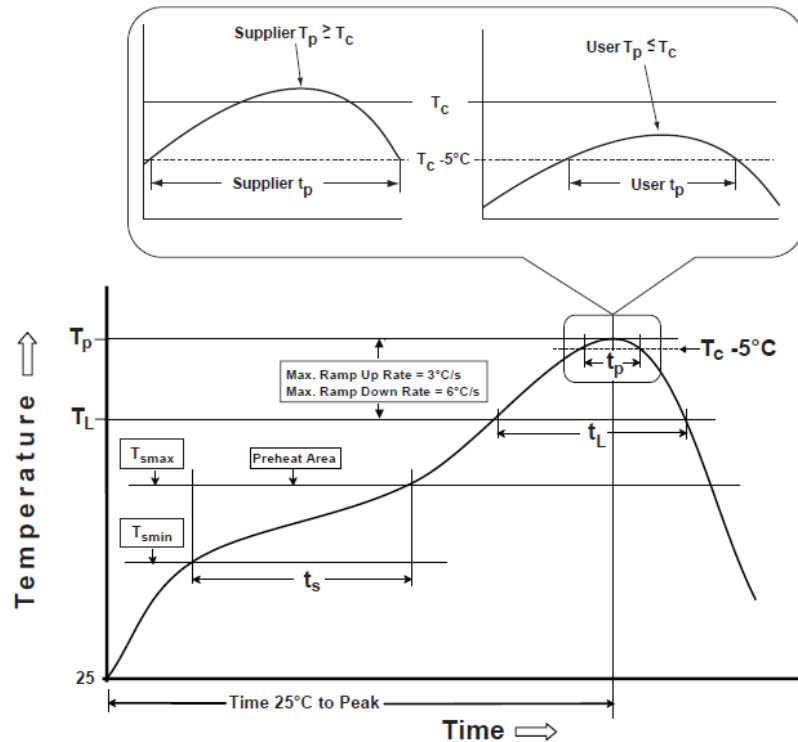


Table 1

### SnPb Eutectic Process

#### Classification Temperatures ( $T_c$ )

| Package Thickness | Volume mm <sup>3</sup> <350 | Volume mm <sup>3</sup> ≥350 |
|-------------------|-----------------------------|-----------------------------|
| <2.5 mm           | 235 °C                      | 220 °C                      |
| ≥2.5 mm           | 220 °C                      | 220 °C                      |

Table 2

### Pb-Free Process

#### Classification Temperatures ( $T_c$ )

| Package Thickness | Volume mm <sup>3</sup> <350 | Volume mm <sup>3</sup> 350-2000 | Volume mm <sup>3</sup> >2000 |
|-------------------|-----------------------------|---------------------------------|------------------------------|
| <1.6 mm           | 260 °C                      | 260 °C                          | 260 °C                       |
| 1.6 mm - 2.5 mm   | 260 °C                      | 250 °C                          | 245 °C                       |
| >2.5 mm           | 250 °C                      | 245 °C                          | 245 °C                       |

| Profile Feature                                                                   | Sn-Pb Eutectic Assembly | Pb-Free Assembly |
|-----------------------------------------------------------------------------------|-------------------------|------------------|
| Preheat / soak                                                                    |                         |                  |
| Temperature minimum ( $T_{smin}$ )                                                | 100°C                   | 150°C            |
| Temperature maximum ( $T_{smax}$ )                                                | 150°C                   | 200°C            |
| Time ( $T_{smin}$ to $T_{smax}$ ) ( $t_s$ )                                       | 60 - 120 sec.           | 60 - 120 sec.    |
| Average ramp-up rate ( $T_{smax}$ to $T_p$ )                                      | 3°C/sec. max            | 3°C/sec. max     |
| Liquidous temperature ( $T_L$ )                                                   | 183°C                   | 217°C            |
| Time at liquidous ( $t_L$ )                                                       | 60 - 150 sec.           | 60 - 150 sec.    |
| Peak package body temperature ( $T_p$ )*                                          | see Table 1             | see Table 2      |
| Time ( $t_p$ )** within 5°C of the specified classification temperature ( $T_c$ ) | 20 sec.                 | 30 sec.          |
| Ramp-down rate ( $T_p$ to $T_{smax}$ )                                            | 6°C/sec. max            | 6°C/sec. max     |
| Time 25°C to peak temperature                                                     | 6 min. max              | 8 min. max       |
| Reflow cycles                                                                     | 2 max                   | 2 max            |

\*Tolerance for peak profile temperature ( $T_p$ ) is defined as a supplier minimum and a user maximum.

\*\*Tolerance for time at peak profile temperature ( $t_p$ ) is defined as supplier minimum and a user maximum.

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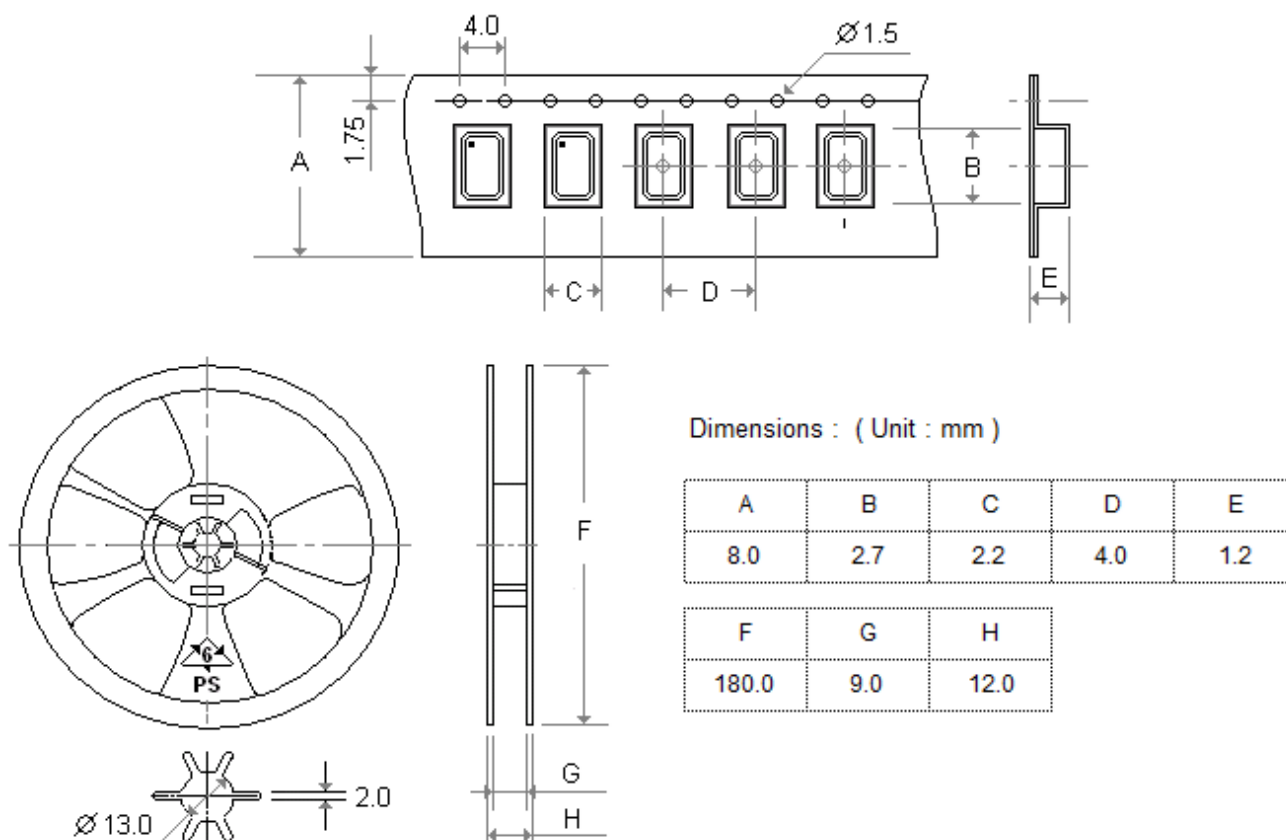
## Packaging

Blank = Bulk (MOQ=100 units)

T = Tape & Reel 1,000 units/reel

T3= Tape & Reel 3,000 units/reel

Feeding (PULL) Direction →



- (10) sprocket hold pitch cumulative tolerance is  $\pm 0.10$  mm
- "E" measured from a place on the inside bottom of the pocket to the top surface of the carrier

## Dimensions: mm

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[AK2DCD2-125.00000T](#) [AK2DCD2-125.0000T3](#) [AK2DCD1-156.25000](#) [AK2DCD1-156.25000T](#) [AK2DCD1-156.2500T3](#)  
[AK2DCD1-200.00000](#) [AK2DCD1-200.00000T](#) [AK2DCD1-200.0000T3](#) [AK2DCD1-125.00000](#) [AK2DCD1-125.00000T](#)  
[AK2DCD1-125.0000T3](#) [AK2DCD1-148.50000](#) [AK2DCD1-148.50000T](#) [AK2DCD1-148.5000T3](#) [AK2DBF2-200.00000](#)  
[AK2DBF2-200.00000T](#) [AK2DBF2-200.0000T3](#) [AK2DCD1-100.00000](#) [AK2DCD1-100.00000T](#) [AK2DCD1-100.0000T3](#)  
[AK2DBF2-148.50000](#) [AK2DBF2-148.50000T](#) [AK2DBF2-148.5000T3](#) [AK2DBF2-156.25000](#) [AK2DBF2-156.25000T](#)  
[AK2DBF2-156.2500T3](#) [AK2DBF2-100.00000](#) [AK2DBF2-100.00000T](#) [AK2DBF2-100.0000T3](#) [AK2DBF2-125.00000](#)  
[AK2DBF2-125.00000T](#) [AK2DBF2-125.0000T3](#) [AK2DBF1-156.25000](#) [AK2DBF1-156.25000T](#) [AK2DBF1-156.2500T3](#)  
[AK2DBF1-200.00000](#) [AK2DBF1-200.00000T](#) [AK2DBF1-200.0000T3](#) [AK2DBF1-125.00000](#) [AK2DBF1-125.00000T](#)  
[AK2DBF1-125.0000T3](#) [AK2DBF1-148.50000](#) [AK2DBF1-148.50000T](#) [AK2DBF1-148.5000T3](#) [AK2DBD2-200.00000](#)