



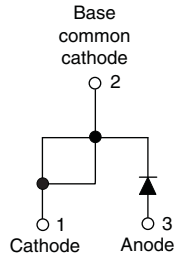
Ultrafast Soft Recovery Diode, 60 A FRED Pt®



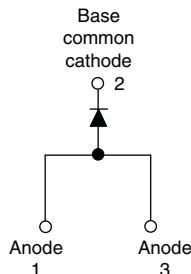
TO-247AC modified



TO-247AC



VS-60EPU02PbF
VS-60EPU02-N3



VS-60APU02PbF
VS-60APU02-N3

FEATURES

- Ultrafast recovery time
- Low forward voltage drop
- 175 °C operating junction temperature
- Output rectification
- Compliant to RoHS Directive 2002/95/EC
- Designed and qualified according to JEDEC-JESD47
- Halogen-free according to IEC 61249-2-21 definition (-N3 only)



BENEFITS

- Reduced RFI and EMI
- Higher frequency operation
- Reduced snubbing
- Reduced parts count

DESCRIPTION/APPLICATIONS

These diodes are optimized to reduce losses and EMI/RFI in high frequency power conditioning systems. The softness of the recovery eliminates the need for a snubber in most applications. These devices are ideally suited for HF welding, power converters and other applications where switching losses are not significant portion of the total losses.

| PRODUCT SUMMARY | |
|-----------------|--------------------------------------|
| Package | TO-247AC, TO-247AC modified (2 pins) |
| $I_{F(AV)}$ | 60 A |
| V_R | 200 V |
| V_F at I_F | 1.08 V |
| t_{rr} typ. | See Recovery table |
| T_J max. | 175 °C |
| Diode variation | Single die |

| ABSOLUTE MAXIMUM RATINGS | | | | | |
|---|----------------|-----------------------|-------------|-------|--|
| PARAMETER | SYMBOL | TEST CONDITIONS | VALUES | UNITS | |
| Cathode to anode voltage | V_R | | 200 | V | |
| Continuous forward current | $I_{F(AV)}$ | $T_C = 127\text{ °C}$ | 60 | A | |
| Single pulse forward current | I_{FSM} | $T_C = 25\text{ °C}$ | 800 | | |
| Maximum repetitive forward current | I_{FRM} | Square wave, 20 kHz | 120 | | |
| Operating junction and storage temperatures | T_J, T_{Stg} | | - 55 to 175 | °C | |

| ELECTRICAL SPECIFICATIONS ($T_J = 25\text{ °C}$ unless otherwise specified) | | | | | | |
|--|---------------|---|------|--------------|--------------|---------------------|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNITS |
| Breakdown voltage, blocking voltage | V_{BR}, V_R | $I_R = 100\text{ }\mu\text{A}$ | 200 | - | - | V |
| Forward voltage | V_F | $I_F = 60\text{ A}$ $I_F = 60\text{ A}, T_J = 175\text{ °C}$ | - | 0.98 0.81 | 1.08 0.88 | |
| Reverse leakage current | I_R | $V_R = V_R$ rated $T_J = 150\text{ °C}, V_R = V_R$ rated | - | - | 50 2 | μA mA |
| Junction capacitance | C_T | $V_R = 200\text{ V}$ | - | 87 | - | pF |
| Series inductance | L_S | Measured lead to lead 5 mm from package body | - | 8.0 | - | nH |



| DYNAMIC RECOVERY CHARACTERISTICS ($T_C = 25\text{ }^\circ\text{C}$ unless otherwise specified) | | | | | | |
|--|-----------|---|------|------|------|-------|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNITS |
| Reverse recovery time | t_{rr} | $I_F = 1.0\text{ A}$, $dI_F/dt = 200\text{ A}/\mu\text{s}$, $V_R = 30\text{ V}$ | - | - | 35 | ns |
| | | $T_J = 25\text{ }^\circ\text{C}$ | - | 28 | - | |
| | | $T_J = 125\text{ }^\circ\text{C}$ | - | 50 | - | |
| Peak recovery current | I_{RRM} | $T_J = 25\text{ }^\circ\text{C}$ | - | 4 | - | A |
| | | $T_J = 125\text{ }^\circ\text{C}$ | - | 8 | - | |
| Reverse recovery charge | Q_{rr} | $T_J = 25\text{ }^\circ\text{C}$ | - | 59 | - | nC |
| | | $T_J = 125\text{ }^\circ\text{C}$ | - | 220 | - | |

| THERMAL - MECHANICAL SPECIFICATIONS | | | | | | |
|--|------------|--|---------|------|------|-------|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNITS |
| Thermal resistance, junction to case | R_{thJC} | | - | - | 0.70 | K/W |
| Thermal resistance, case to heatsink | R_{thCS} | Mounting surface, flat, smooth and greased | - | 0.2 | - | |
| Weight | | | - | 5.5 | - | g |
| | | | - | 0.2 | - | oz. |
| Mounting torque | | | - | - | 1.2 | N · m |
| Marking device | | Case style TO-247AC modified | 60EPU02 | | | |
| | | Case style TO-247AC | 60APU02 | | | |

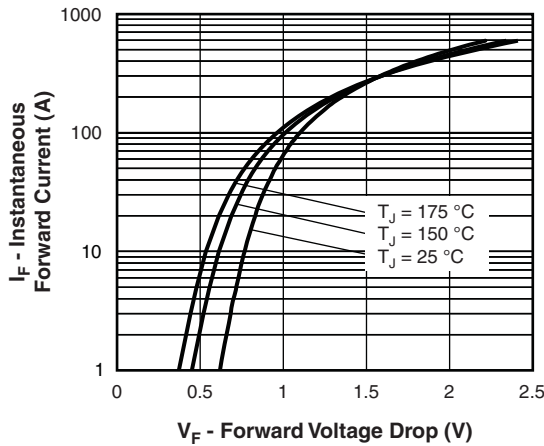


Fig. 1 - Typical Forward Voltage Drop Characteristics

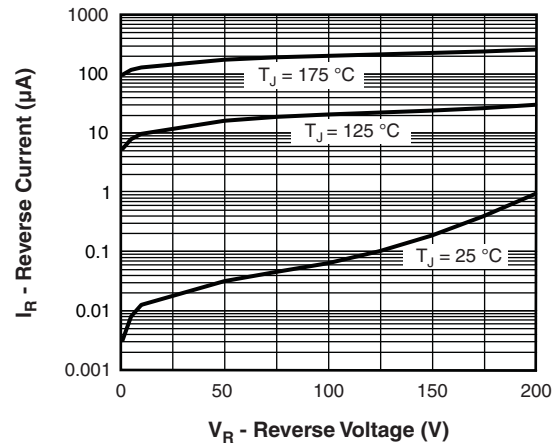


Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

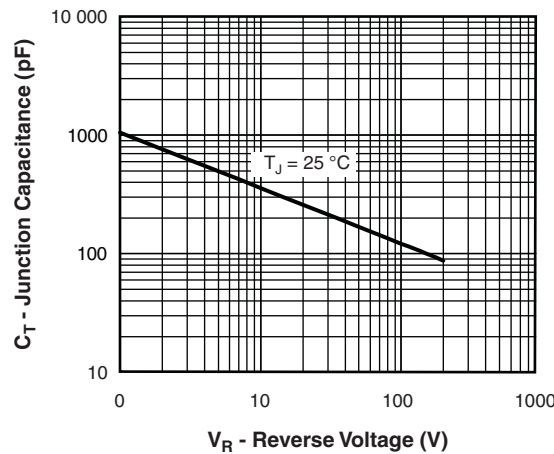


Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage

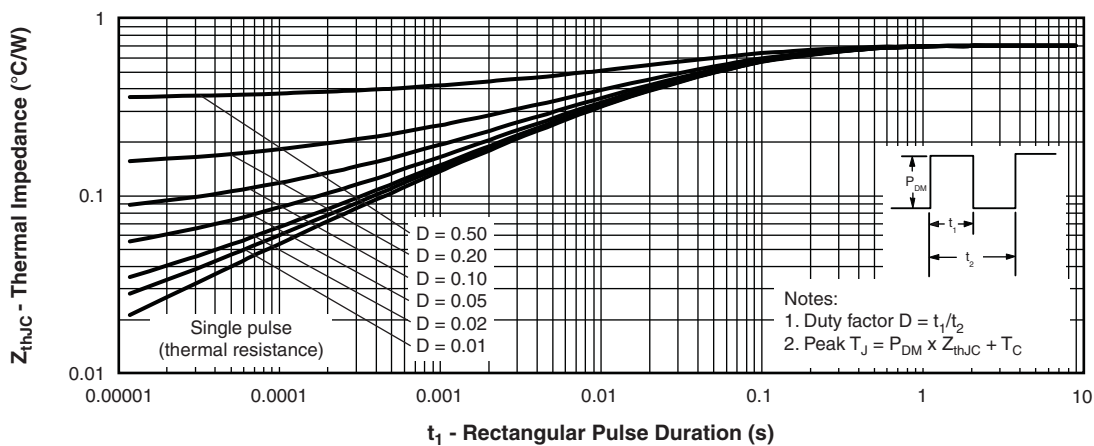


Fig. 4 - Maximum Thermal Impedance Z_{thJC} Characteristics

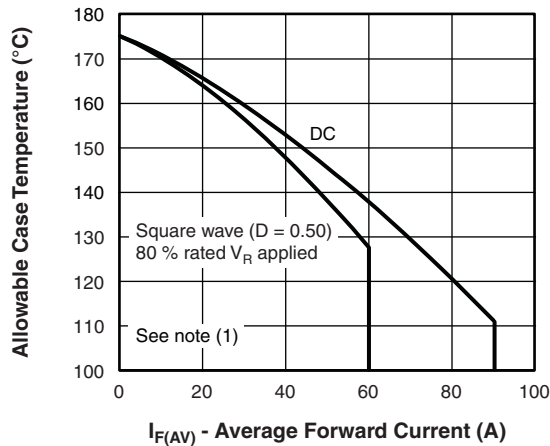


Fig. 5 - Maximum Allowable Case Temperature vs. Average Forward Current

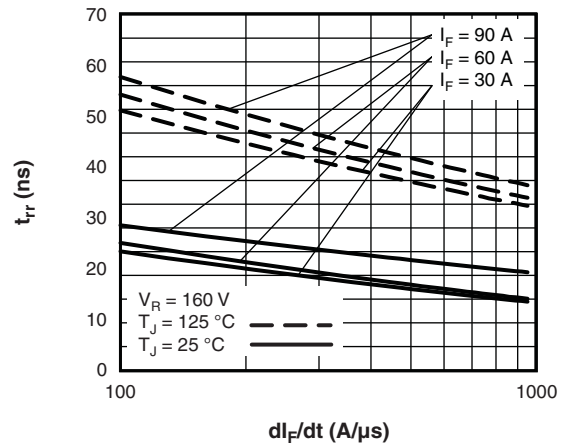


Fig. 7 - Typical Reverse Recovery Time vs. dI_F/dt

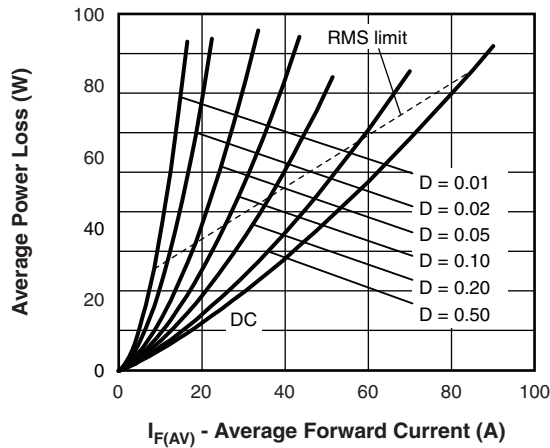


Fig. 6 - Forward Power Loss Characteristics

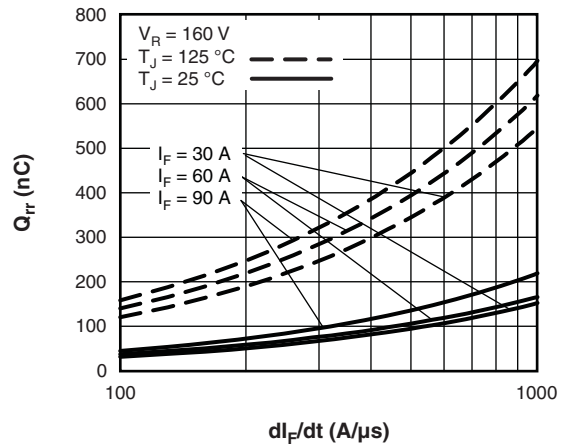


Fig. 8 - Typical Stored Charge vs. dI_F/dt

Note

- (1) Formula used: $T_C = T_J - (P_d + P_{d_{REV}}) \times R_{thJC}$;
- P_d = Forward power loss = $I_{F(AV)} \times V_{FM}$ at $(I_{F(AV)}/D)$ (see fig. 6);
- $P_{d_{REV}}$ = Inverse power loss = $V_{R1} \times I_R (1 - D)$; I_R at $V_{R1} = 80\%$ rated V_R

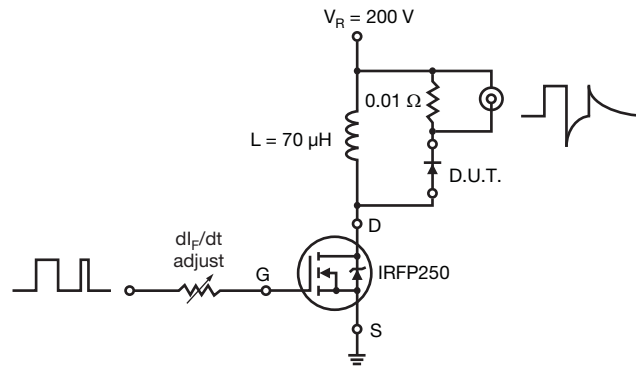
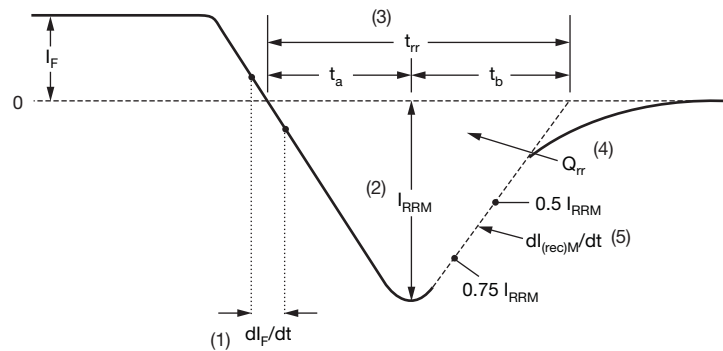


Fig. 9 - Reverse Recovery Parameter Test Circuit



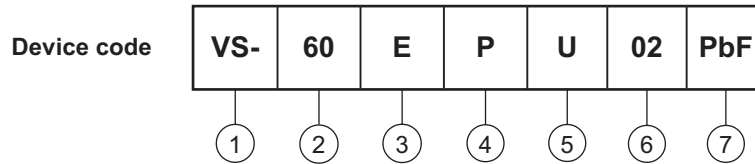
- (1) di_F/dt - rate of change of current through zero crossing
- (2) I_{RRM} - peak reverse recovery current
- (3) t_{rr} - reverse recovery time measured from zero crossing point of negative going I_F to point where a line passing through $0.75 I_{RRM}$ and $0.50 I_{RRM}$ extrapolated to zero current.
- (4) Q_{rr} - area under curve defined by t_{rr} and I_{RRM}
- (5) $di_{(rec)M}/dt$ - peak rate of change of current during t_b portion of t_{rr}

$$Q_{rr} = \frac{t_{rr} \times I_{RRM}}{2}$$

Fig. 10 - Reverse Recovery Waveform and Definitions



ORDERING INFORMATION TABLE



- 1** - Vishay Semiconductors product
- 2** - Current rating (60 = 60 A)
- 3** - Circuit configuration:
 - E = Single diode
 - A = Single diode, 3 pins
- 4** - Package:
 - P = TO-247AC (modified)
- 5** - Type of silicon:
 - U = Ultrafast recovery
- 6** - Voltage rating (02 = 200 V)
- 7** - Environmental digit:
 - PbF = Lead (Pb)-free and RoHS compliant
 - N3 = Halogen-free, RoHS compliant and totally lead (Pb)-free

| ORDERING INFORMATION (Example) | | | |
|--------------------------------|------------------|------------------------|-------------------------|
| PREFERRED P/N | QUANTITY PER T/R | MINIMUM ORDER QUANTITY | PACKAGING DESCRIPTION |
| VS-60EPU02PbF | 25 | 500 | Antistatic plastic tube |
| VS-60EPU02-N3 | 25 | 500 | Antistatic plastic tube |
| VS-60APU02PbF | 25 | 500 | Antistatic plastic tube |
| VS-60APU02-N3 | 25 | 500 | Antistatic plastic tube |

| LINKS TO RELATED DOCUMENTS | | |
|----------------------------|-----------------------|--|
| Dimensions | TO-247AC modified | www.vishay.com/doc?95253 |
| | TO-247AC | www.vishay.com/doc?95223 |
| Part marking information | TO-247AC modified PbF | www.vishay.com/doc?95255 |
| | TO-247AC modified -N3 | www.vishay.com/doc?95442 |
| | TO-247ACPbF | www.vishay.com/doc?95226 |
| | TO-247AC-N3 | www.vishay.com/doc?95007 |
| SPIICE model | | www.vishay.com/doc?95416 |



DIMENSIONS in millimeters and inches



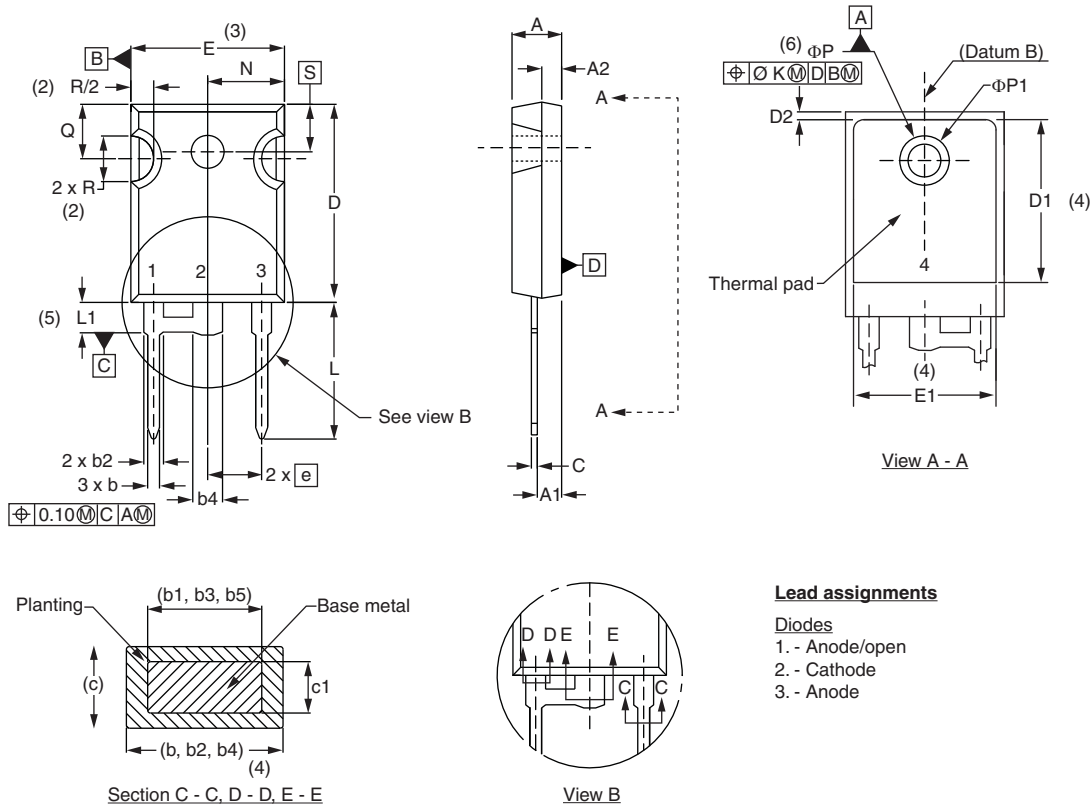
| SYMBOL | MILLIMETERS | | INCHES | | NOTES | SYMBOL | MILLIMETERS | | INCHES | | NOTES |
|--------|-------------|-------|--------|-------|-------|--------|-------------|-------|-----------|-------|-------|
| | MIN. | MAX. | MIN. | MAX. | | | MIN. | MAX. | MIN. | MAX. | |
| A | 4.65 | 5.31 | 0.183 | 0.209 | | D2 | 0.51 | 1.30 | 0.020 | 0.051 | |
| A1 | 2.21 | 2.59 | 0.087 | 0.102 | | E | 15.29 | 15.87 | 0.602 | 0.625 | 3 |
| A2 | 1.50 | 2.49 | 0.059 | 0.098 | | E1 | 13.72 | - | 0.540 | - | |
| b | 0.99 | 1.40 | 0.039 | 0.055 | | e | 5.46 BSC | | 0.215 BSC | | |
| b1 | 0.99 | 1.35 | 0.039 | 0.053 | | FK | 2.54 | | 0.010 | | |
| b2 | 1.65 | 2.39 | 0.065 | 0.094 | | L | 14.20 | 16.10 | 0.559 | 0.634 | |
| b3 | 1.65 | 2.37 | 0.065 | 0.094 | | L1 | 3.71 | 4.29 | 0.146 | 0.169 | |
| b4 | 2.59 | 3.43 | 0.102 | 0.135 | | N | 7.62 BSC | | 0.3 | | |
| b5 | 2.59 | 3.38 | 0.102 | 0.133 | | φP | 3.56 | 3.66 | 0.14 | 0.144 | |
| c | 0.38 | 0.86 | 0.015 | 0.034 | | φP1 | - | 6.98 | - | 0.275 | |
| c1 | 0.38 | 0.76 | 0.015 | 0.030 | | Q | 5.31 | 5.69 | 0.209 | 0.224 | |
| D | 19.71 | 20.70 | 0.776 | 0.815 | 3 | R | 4.52 | 5.49 | 1.78 | 0.216 | |
| D1 | 13.08 | - | 0.515 | - | 4 | S | 5.51 BSC | | 0.217 BSC | | |

Notes

- (1) Dimensioning and tolerancing per ASME Y14.5M-1994
- (2) Contour of slot optional
- (3) Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm (0.005") per side. These dimensions are measured at the outermost extremes of the plastic body
- (4) Thermal pad contour optional with dimensions D1 and E1
- (5) Lead finish uncontrolled in L1
- (6) φ P to have a maximum draft angle of 1.5 to the top of the part with a maximum hole diameter of 3.91 mm (0.154")
- (7) Outline conforms to JEDEC outline TO-247 with exception of dimension c



DIMENSIONS in millimeters and inches



| SYMBOL | MILLIMETERS | | INCHES | | NOTES |
|--------|-------------|-------|--------|-------|-------|
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.65 | 5.31 | 0.183 | 0.209 | |
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|--------|-------------|-------|-----------|-------|-------|
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| D2 | 0.51 | 1.30 | 0.020 | 0.051 | |
| E | 15.29 | 15.87 | 0.602 | 0.625 | 3 |
| E1 | 13.72 | - | 0.540 | - | |
| e | 5.46 BSC | | 0.215 BSC | | |
| ΦK | 2.54 | | 0.010 | | |
| L | 14.20 | 16.10 | 0.559 | 0.634 | |
| L1 | 3.71 | 4.29 | 0.146 | 0.169 | |
| N | 7.62 BSC | | 0.3 | | |
| ΦP | 3.56 | 3.66 | 0.14 | 0.144 | |
| ΦP1 | - | 6.98 | - | 0.275 | |
| Q | 5.31 | 5.69 | 0.209 | 0.224 | |
| R | 4.52 | 5.49 | 1.78 | 0.216 | |
| S | 5.51 BSC | | 0.217 BSC | | |

Notes

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