

## AQxx-02HTG Series 500W TVS Diode Array

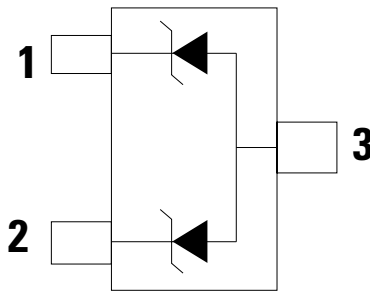


### Description

The AQxx-02HTG Series TVS Diode Array is designed to protect sensitive equipment from damage due to electrostatic discharge (ESD), electrical fast transients (EFT), and lightning induced surges.

This AQxx series can safely absorb repetitive ESD strikes of  $\pm 30$  kV (contact and air discharge as defined in IEC 61000-4-2) without any performance degradation. Additionally, the AQ05 can safely conduct a 33A 8/20 surge event as defined in IEC 61000-4-5 2<sup>nd</sup> Edition at low voltage clamping levels.

### Pinout and Functional Block Diagram



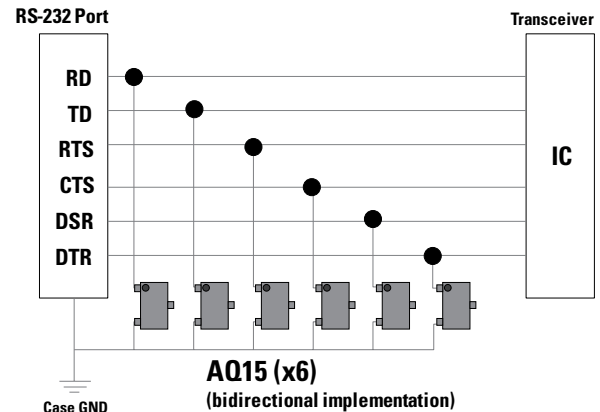
### Features

- ESD, IEC 61000-4-2,  $\pm 30$ kV contact,  $\pm 30$ kV air
- EFT, IEC 61000-4-4, 50A (5/50ns)
- Lightning, 33A (8/20 $\mu$ s as defined in IEC 61000-4-5 2<sup>nd</sup> edition) for the AQ05
- Working voltages: 5V, 12V, 15V, 24V and 36V
- ESD, ISO 10605, 330pF, 330 $\Omega$ ,  $\pm 30$ kV contact,  $\pm 30$ kV air
- Low clamping voltage
- Low leakage current
- AEC-Q101 qualified
- Moisture Sensitivity Level (MSL -1)
- Halogen free, lead free and RoHS compliant
- PPAP capable

### Applications

- Industrial Equipment
- Test and Medical Equipment
- Point-of-Sale Terminals
- Motor Controls
- Legacy Ports (RS-232, RS-485)
- Security and Alarm Systems

### RS-232 Application Example



Life Support Note:

**Not Intended for Use in Life Support or Life Saving Applications**

The products shown herein are not designed for use in life sustaining or life saving applications unless otherwise expressly indicated.

### Absolute Maximum Ratings

| Symbol     | Parameter                            | Value      | Units |
|------------|--------------------------------------|------------|-------|
| $P_{PK}$   | Peak Pulse Power ( $t_p=8/20\mu s$ ) | 500        | W     |
| $T_{OP}$   | Operating Temperature                | -40 to 150 | °C    |
| $T_{STOR}$ | Storage Temperature                  | -55 to 150 | °C    |

**CAUTION:** Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the component. This is a stress only rating and operation of the component at these or any other conditions above those indicated in the operational sections of this specification is not implied.

### AQ05 Electrical Characteristics ( $T_{OP}=25^\circ C$ )

| Parameter                          | Symbol        | Test Conditions                                       | Min      | Typ  | Max  | Units    |
|------------------------------------|---------------|---|----------|------|------|----------|
| Reverse Standoff Voltage           | $V_{RWM}$     | $I_R=1\mu A$  |          |      | 5.0  | V        |
| Breakdown Voltage                  | $V_{BR}$      | $I_R=1mA$   | 6.0      | 7.0  |      | V        |
| Reverse Leakage Current            | $I_{LEAK}$    | $V_R=5V$  |          |      | 1.0  | $\mu A$  |
| Clamp Voltage <sup>1</sup>         | $V_C$         | $I_{PP}=1A, t_p=8/20\mu s$ , Pin 1 or Pin 2 to Pin 3  |          | 8.0  | 9.8  | V        |
|                                    |               | $I_{PP}=10A, t_p=8/20\mu s$ , Pin 1 or Pin 2 to Pin 3 |          | 10.5 | 13.0 | V        |
| Dynamic Resistance <sup>2</sup>    | $R_{DYN}$     | TLP, $t_p=100ns$ , Pin 1 or Pin 2 to Pin 3            |          | 0.19 |      | $\Omega$ |
| Peak Pulse Current                 | $I_{PP}$      | $t_p=8/20\mu s$                                       |          |      | 33   | A        |
| ESD Withstand Voltage <sup>1</sup> | $V_{ESD}$     | IEC 61000-4-2 (Contact Discharge)                     | $\pm 30$ |      |      | kV       |
|                                    |               | IEC 61000-4-2 (Air Discharge)                         | $\pm 30$ |      |      | kV       |
| Diode Capacitance <sup>1</sup>     | $C_{I/O-GND}$ | Reverse Bias=0V, f=1MHz                               |          | 290  | 350  | pF       |
|                                    | $C_{I/O-I/O}$ | Reverse Bias=0V, f=1MHz                               |          | 145  | 180  | pF       |

### AQ12 Electrical Characteristics ( $T_{OP}=25^\circ C$ )

| Parameter                          | Symbol        | Test Conditions                                       | Min      | Typ  | Max  | Units    |
|------------------------------------|---------------|---|----------|------|------|----------|
| Reverse Standoff Voltage           | $V_{RWM}$     | $I_R=1\mu A$  |          |      | 12.0 | V        |
| Breakdown Voltage                  | $V_{BR}$      | $I_R=1mA$   | 13.3     | 14.2 |      | V        |
| Reverse Leakage Current            | $I_{LEAK}$    | $V_R=12V$   |          |      | 1.0  | $\mu A$  |
| Clamp Voltage <sup>1</sup>         | $V_C$         | $I_{PP}=1A, t_p=8/20\mu s$ , Pin 1 or Pin 2 to Pin 3  |          | 16.0 | 18.5 | V        |
|                                    |               | $I_{PP}=10A, t_p=8/20\mu s$ , Pin 1 or Pin 2 to Pin 3 |          | 20.0 | 22.5 | V        |
| Dynamic Resistance <sup>2</sup>    | $R_{DYN}$     | TLP, $t_p=100ns$ , Pin 1 or Pin 2 to Pin 3            |          | 0.25 |      | $\Omega$ |
| Peak Pulse Current                 | $I_{PP}$      | $t_p=8/20\mu s$                                       |          |      | 20   | A        |
| ESD Withstand Voltage <sup>1</sup> | $V_{ESD}$     | IEC 61000-4-2 (Contact Discharge)                     | $\pm 30$ |      |      | kV       |
|                                    |               | IEC 61000-4-2 (Air Discharge)                         | $\pm 30$ |      |      | kV       |
| Diode Capacitance <sup>1</sup>     | $C_{I/O-GND}$ | Reverse Bias=0V, f=1MHz                               |          | 110  | 135  | pF       |
|                                    | $C_{I/O-I/O}$ | Reverse Bias=0V, f=1MHz                               |          | 55   | 85   | pF       |

**AQ15 Electrical Characteristics (T<sub>op</sub>=25°C)**

| Parameter                          | Symbol               | Test Conditions   | Min  | Typ  | Max  | Units |
|------------------------------------|----------------------|---|------|------|------|-------|
| Reverse Standoff Voltage           | V <sub>RWM</sub>     | I <sub>R</sub> =1μA   |      |      | 15.0 | V     |
| Breakdown Voltage                  | V <sub>BR</sub>      | I <sub>R</sub> =1mA   | 16.7 | 18.5 |      | V     |
| Reverse Leakage Current            | I <sub>LEAK</sub>    | V <sub>R</sub> =15V   |      |      | 1.0  | μA    |
| Clamp Voltage <sup>1</sup>         | V <sub>C</sub>       | I <sub>pp</sub> =1A, t <sub>p</sub> =8/20μs, Pin 1 or Pin 2 to Pin 3  |      | 20.5 | 24.0 | V     |
|                                    |                      | I <sub>pp</sub> =10A, t <sub>p</sub> =8/20μs, Pin 1 or Pin 2 to Pin 3 |      | 26.6 | 30.0 | V     |
| Dynamic Resistance <sup>2</sup>    | R <sub>DYN</sub>     | TLP, t <sub>p</sub> =100ns, Pin 1 or Pin 2 to Pin 3                   |      | 0.30 |      | Ω     |
| Peak Pulse Current                 | I <sub>PP</sub>      | t <sub>p</sub> =8/20μs  |      |      | 15   | A     |
| ESD Withstand Voltage <sup>1</sup> | V <sub>ESD</sub>     | IEC 61000-4-2 (Contact Discharge)                                     | ±30  |      |      | kV    |
|                                    |                      | IEC 61000-4-2 (Air Discharge)   | ±30  |      |      | kV    |
| Diode Capacitance <sup>1</sup>     | C <sub>I/O-GND</sub> | Reverse Bias=0V, f=1MHz   |      | 85   | 100  | pF    |
|                                    | C <sub>I/O-I/O</sub> | Reverse Bias=0V, f=1MHz   |      | 45   | 75   | pF    |

**AQ24 Electrical Characteristics (T<sub>op</sub>=25°C)**

| Parameter                          | Symbol               | Test Conditions  | Min  | Typ  | Max  | Units |
|------------------------------------|----------------------|--|------|------|------|-------|
| Reverse Standoff Voltage           | V <sub>RWM</sub>     | I <sub>R</sub> =1μA  |      |      | 24.0 | V     |
| Breakdown Voltage                  | V <sub>BR</sub>      | I <sub>R</sub> =1mA  | 26.7 | 28   |      | V     |
| Reverse Leakage Current            | I <sub>LEAK</sub>    | V <sub>R</sub> =24V  |      |      | 1.0  | μA    |
| Clamp Voltage <sup>1</sup>         | V <sub>C</sub>       | I <sub>pp</sub> =1A, t <sub>p</sub> =8/20μs, Pin 1 or Pin 2 to Pin 3 |      | 30.0 | 36.0 | V     |
|                                    |                      | I <sub>pp</sub> =5A, t <sub>p</sub> =8/20μs, Pin 1 or Pin 2 to Pin 3 |      | 36.0 | 42.0 | V     |
| Dynamic Resistance <sup>2</sup>    | R <sub>DYN</sub>     | TLP, t <sub>p</sub> =100ns, Pin 1 or Pin 2 to Pin 3                  |      | 0.50 |      | Ω     |
| Peak Pulse Current                 | I <sub>PP</sub>      | t <sub>p</sub> =8/20μs   |      |      | 9    | A     |
| ESD Withstand Voltage <sup>1</sup> | V <sub>ESD</sub>     | IEC 61000-4-2 (Contact Discharge)                                    | ±30  |      |      | kV    |
|                                    |                      | IEC 61000-4-2 (Air Discharge)  | ±30  |      |      | kV    |
| Diode Capacitance <sup>1</sup>     | C <sub>I/O-GND</sub> | Reverse Bias=0V, f=1MHz  |      | 60   | 65   | pF    |
|                                    | C <sub>I/O-I/O</sub> | Reverse Bias=0V, f=1MHz  |      | 30   | 50   | pF    |

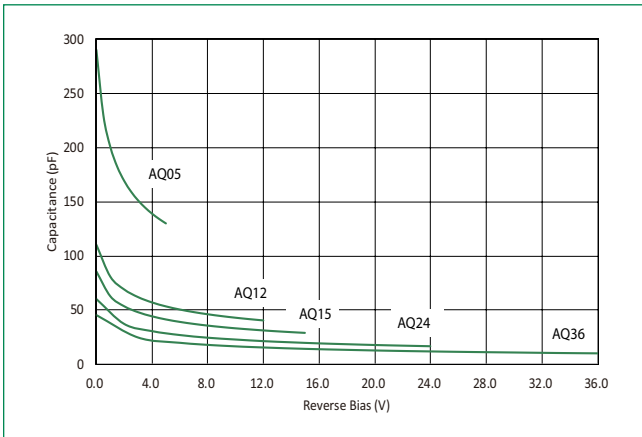
**AQ36 Electrical Characteristics (T<sub>op</sub>=25°C)**

| Parameter                          | Symbol               | Test Conditions  | Min  | Typ  | Max  | Units |
|------------------------------------|----------------------|--|------|------|------|-------|
| Reverse Standoff Voltage           | V <sub>RWM</sub>     | I <sub>R</sub> =1μA  |      |      | 36.0 | V     |
| Breakdown Voltage                  | V <sub>BR</sub>      | I <sub>R</sub> =1mA  | 40.0 | 41.8 |      | V     |
| Reverse Leakage Current            | I <sub>LEAK</sub>    | V <sub>R</sub> =36V  |      |      | 1.0  | μA    |
| Clamp Voltage <sup>1</sup>         | V <sub>C</sub>       | I <sub>pp</sub> =1A, t <sub>p</sub> =8/20μs, Pin 1 or Pin 2 to Pin 3 |      | 45.0 | 52.0 | V     |
|                                    |                      | I <sub>pp</sub> =5A, t <sub>p</sub> =8/20μs, Pin 1 or Pin 2 to Pin 3 |      | 58.5 | 62.0 | V     |
| Dynamic Resistance <sup>2</sup>    | R <sub>DYN</sub>     | TLP, t <sub>p</sub> =100ns, Pin 1 or Pin 2 to Pin 3                  |      | 0.65 |      | Ω     |
| Peak Pulse Current                 | I <sub>PP</sub>      | t <sub>p</sub> =8/20μs   |      |      | 7    | A     |
| ESD Withstand Voltage <sup>1</sup> | V <sub>ESD</sub>     | IEC 61000-4-2 (Contact Discharge)                                    | ±30  |      |      | kV    |
|                                    |                      | IEC 61000-4-2 (Air Discharge)  | ±30  |      |      | kV    |
| Diode Capacitance <sup>1</sup>     | C <sub>I/O-GND</sub> | Reverse Bias=0V, f=1MHz  |      | 45   | 50   | pF    |
|                                    | C <sub>I/O-I/O</sub> | Reverse Bias=0V, f=1MHz  |      | 25   | 40   | pF    |

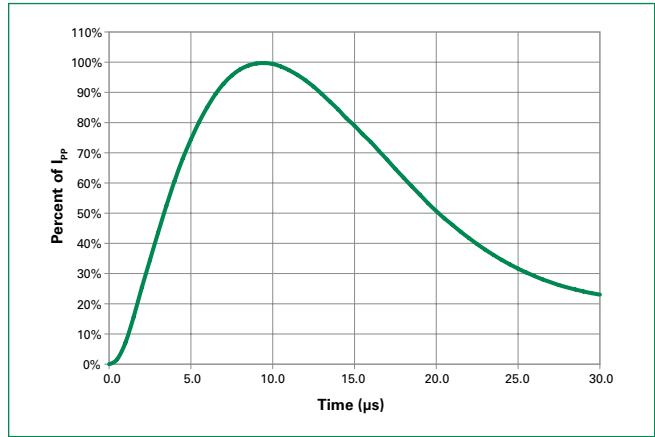
**Note:**
<sup>1</sup> Parameter is guaranteed by design and/or component characterization.

<sup>2</sup> Transmission Line Pulse (TLP) with 100ns width, 2ns rise time, and average window t1=70ns to t2= 90ns

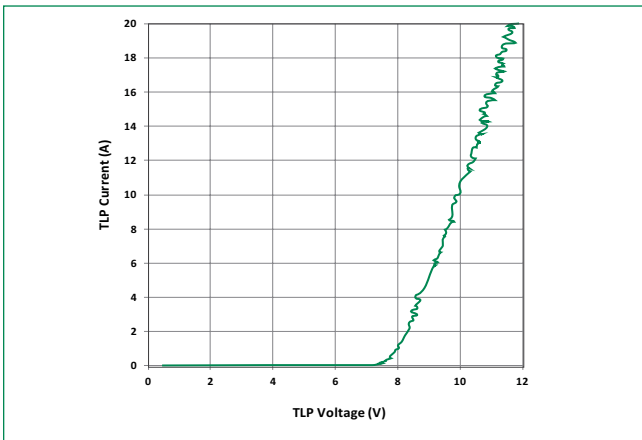
**Capacitance vs. Reverse Bias (Pin1 or Pin2 to Pin3)**



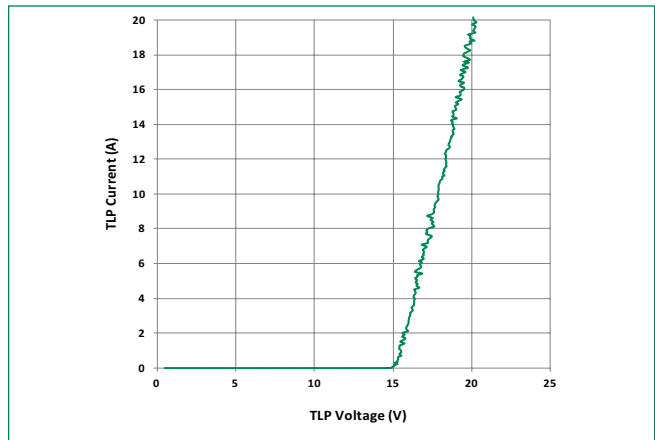
**8/20µs Pulse Waveform**



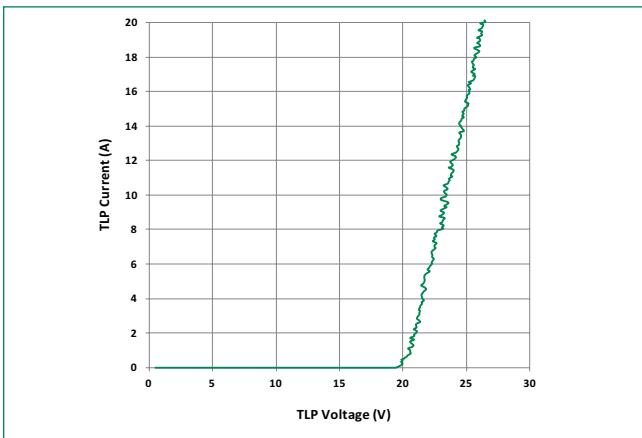
**AQ05 Transmission Line Pulsing(TLP) Plot**



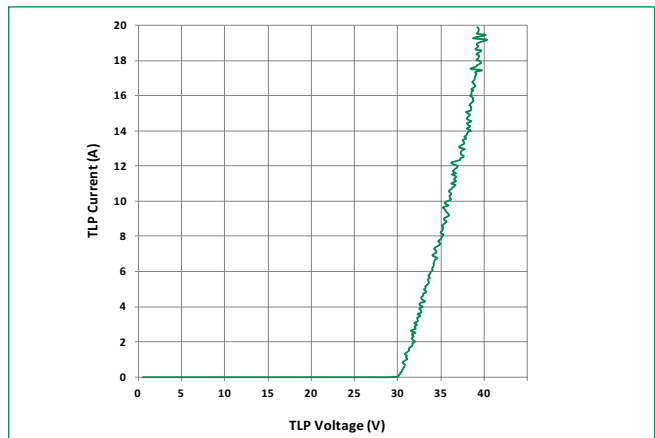
**AQ12 Transmission Line Pulsing(TLP) Plot**



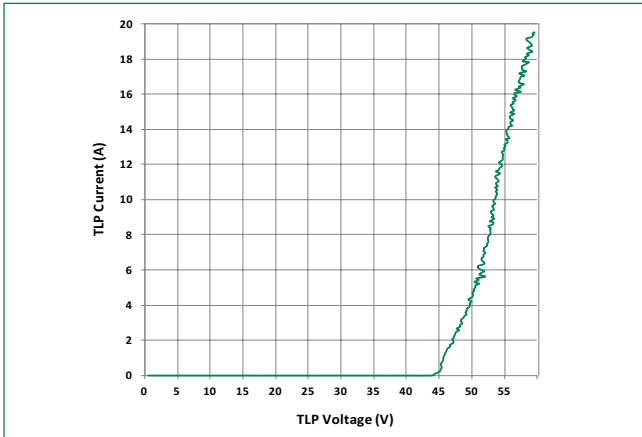
**AQ15 Transmission Line Pulsing(TLP) Plot**



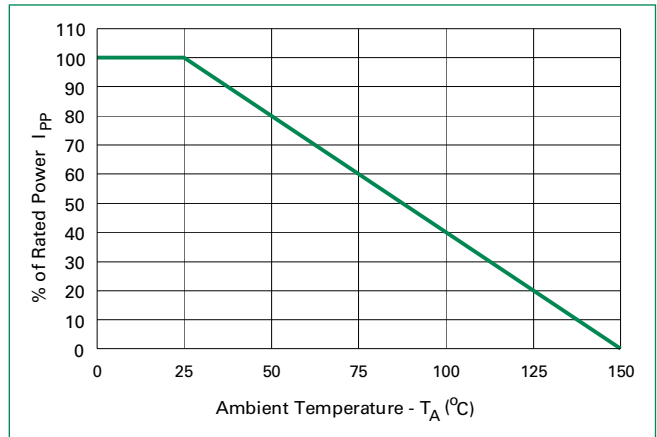
**AQ24 Transmission Line Pulsing(TLP) Plot**



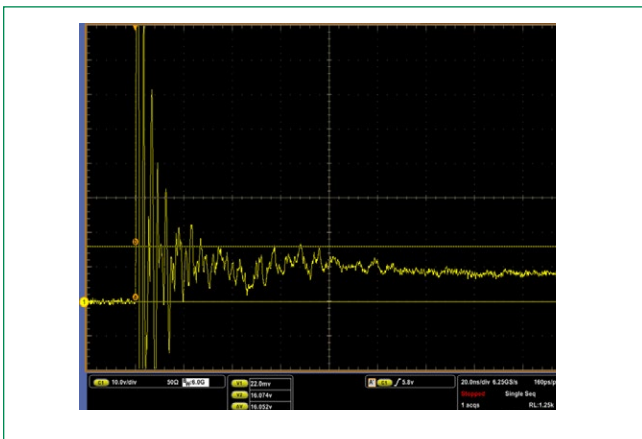
**AQ36 Transmission Line Pulsing(TLP) Plot**



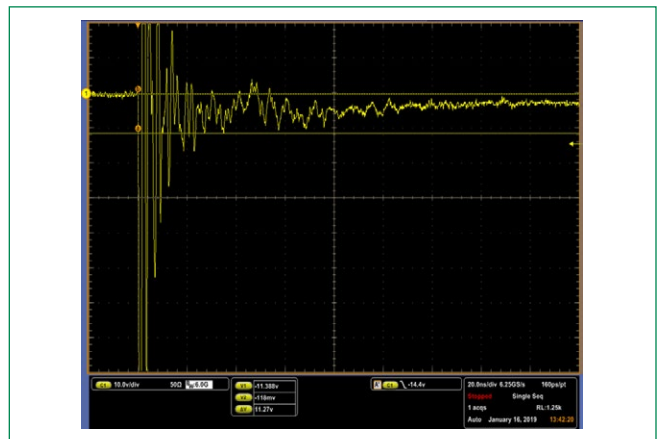
**Power Derating Curve**



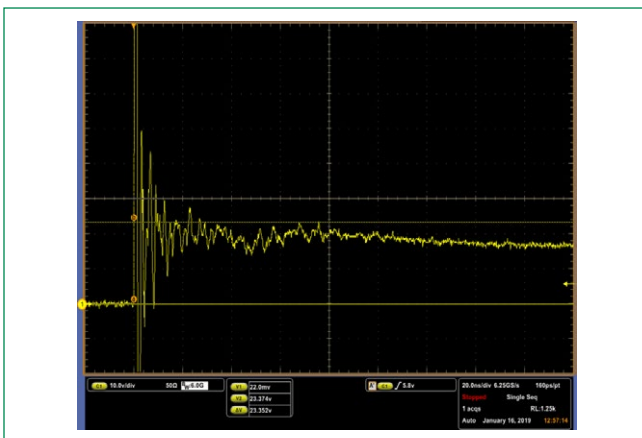
**ISO10605 (C:330pF, R:330Ω) contact discharge plot at +8KV**



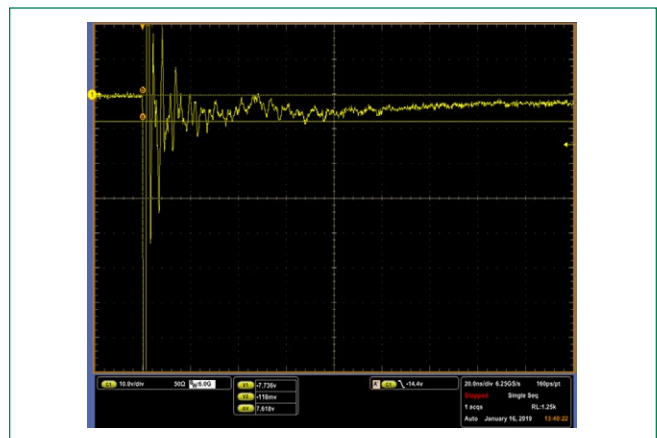
**ISO10605 (C:330pF, R:330Ω) contact discharge plot at -8KV**



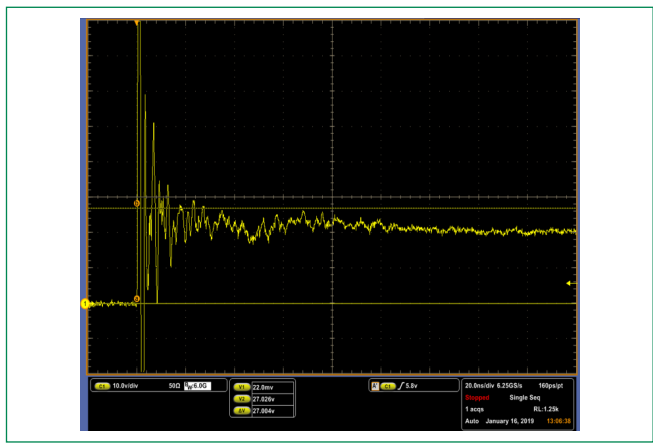
**ISO10605 (C:330pF, R:330Ω) contact discharge plot at +8KV**



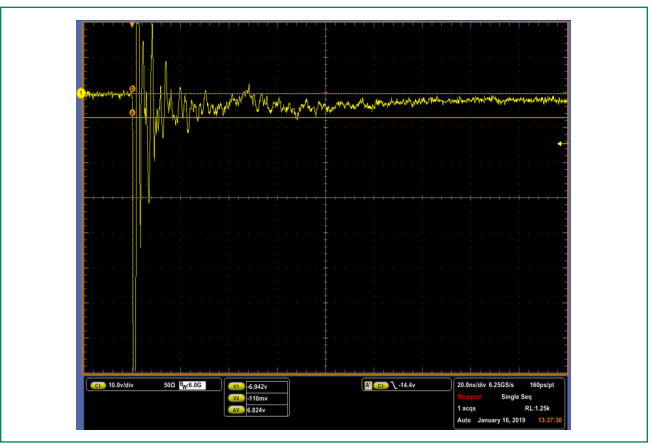
**ISO10605 (C:330pF, R:330Ω) contact discharge plot at -8KV**



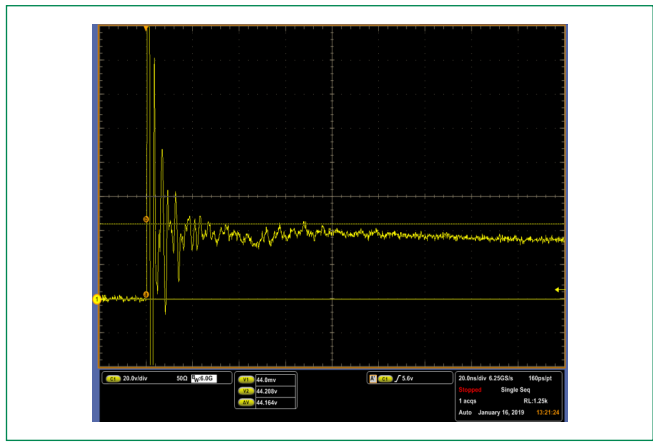
ISO10605 (C:330pF, R:330Ω) contact discharge plot at +8KV



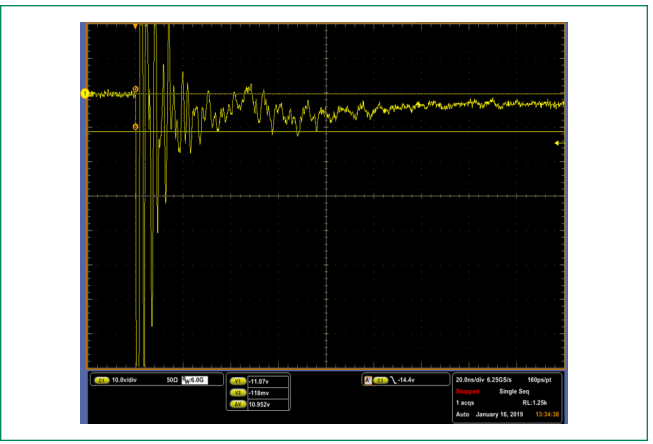
ISO10605 (C:330pF, R:330Ω) contact discharge plot at -8KV



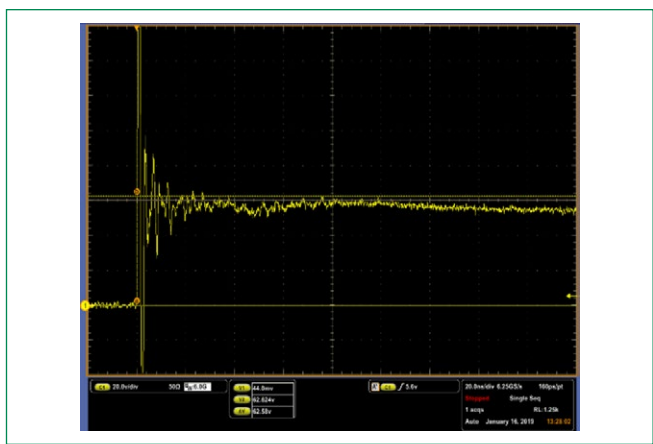
ISO10605 (C:330pF, R:330Ω) contact discharge plot at +8KV



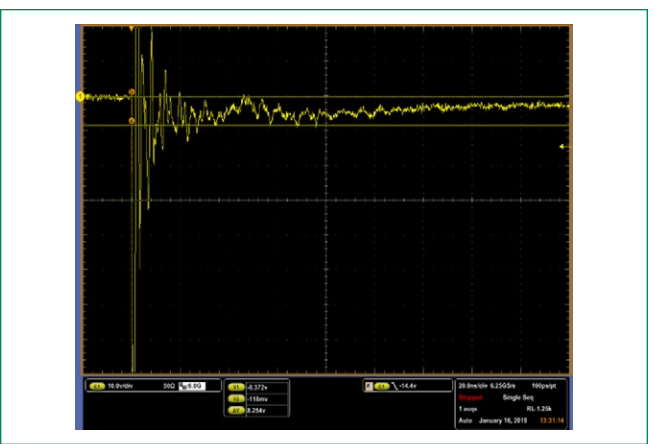
ISO10605 (C:330pF, R:330Ω) contact discharge plot at -8KV



ISO10605 (C:330pF, R:330Ω) contact discharge plot at +8KV

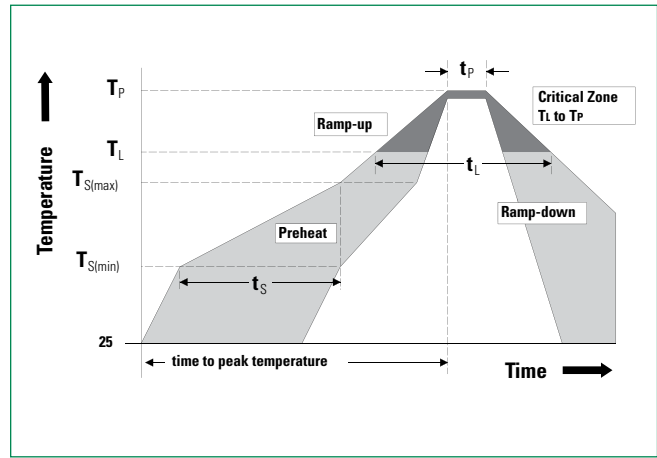


ISO10605 (C:330pF, R:330Ω) contact discharge plot at -8KV



### Soldering Parameters

|  |                                    |                         |
|--|------------------------------------|-------------------------|
| <b>Reflow Condition</b>  |                                    | Pb – Free assembly      |
| <b>Pre Heat</b>  | - Temperature Min ( $T_{s(min)}$ ) | 150°C                   |
|  | - Temperature Max ( $T_{s(max)}$ ) | 200°C                   |
|  | - Time (min to max) ( $t_p$ )      | 60 – 180 secs           |
| <b>Average ramp up rate (Liquidus) Temp (<math>T_L</math>) to peak</b> |                                    | 3°C/second max          |
| <b><math>T_{s(max)}</math> to <math>T_L</math> - Ramp-up Rate</b>      |                                    | 3°C/second max          |
| <b>Reflow</b>  | - Temperature ( $T_L$ ) (Liquidus) | 217°C                   |
|  | - Temperature ( $t_L$ )            | 60 – 150 seconds        |
| <b>Peak Temperature (<math>T_p</math>)</b>                             |                                    | 260 <sup>+0/-5</sup> °C |
| <b>Time within 5°C of actual peak Temperature (<math>t_p</math>)</b>   |                                    | 20 – 40 seconds         |
| <b>Ramp-down Rate</b>  |                                    | 6°C/second max          |
| <b>Time 25°C to peak Temperature (<math>T_p</math>)</b>                |                                    | 8 minutes Max.          |
| <b>Do not exceed</b>   |                                    | 260°C                   |



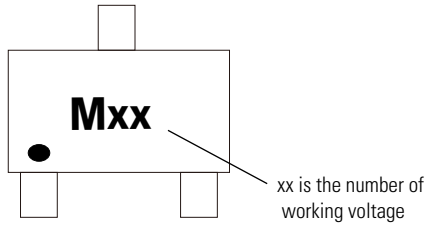
### Ordering Information

| Part Number | Package | Min. Order Qty. |
|-------------|---------|-----------------|
| AQ05-02HTG  | SOT23-3 | 3000            |
| AQ12-02HTG  | SOT23-3 | 3000            |
| AQ15-02HTG  | SOT23-3 | 3000            |
| AQ24-02HTG  | SOT23-3 | 3000            |
| AQ36-02HTG  | SOT23-3 | 3000            |

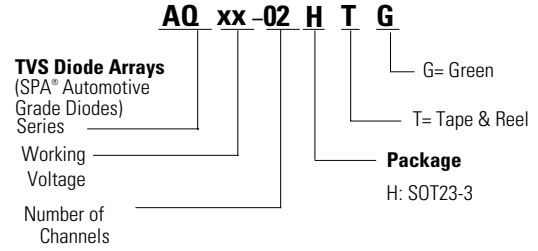
### Product Characteristics

|                           |  |
|---------------------------|--|
| <b>Lead Plating</b>       | Matte Tin  |
| <b>Lead Material</b>      | Copper Alloy   |
| <b>Lead Coplanarity</b>   | 0.004 inches(0.102mm)                                  |
| <b>Substrate Material</b> | Silicon  |
| <b>Body Material</b>      | Molded Compound  |
| <b>Flammability</b>       | UL Recognized compound meeting flammability rating V-0 |

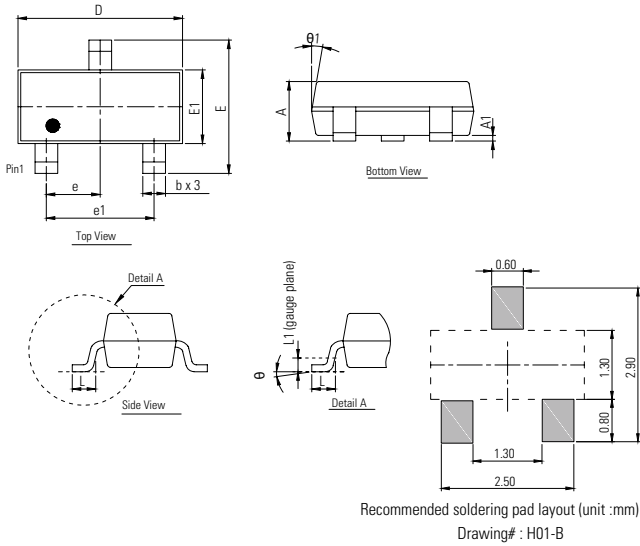
**Part Marking System**



**Part Numbering System**

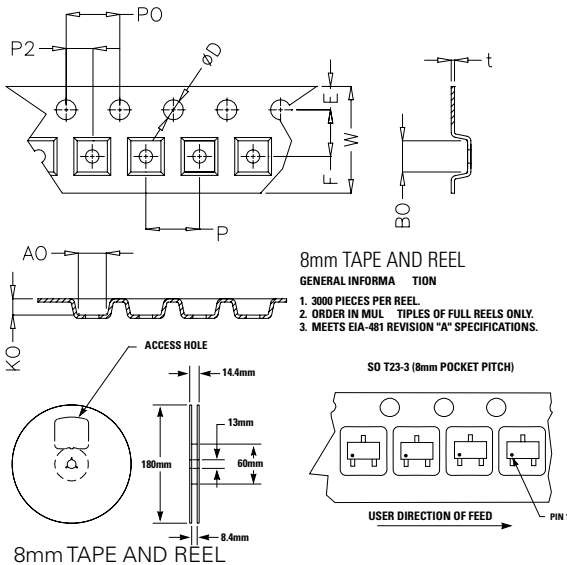


**Package Dimensions — SOT23-3**



| Symbol | Millimeters |      | Inches    |       |
|--------|-------------|------|-----------|-------|
|        | Min         | Max  | Min       | Max   |
| A      | 0.90        | 1.10 | 0.035     | 0.043 |
| A1     | 0.03        | 0.09 | 0.001     | 0.004 |
| b      | 0.37        | 0.51 | 0.015     | 0.020 |
| D      | 2.80        | 3.04 | 0.110     | 0.120 |
| E      | 2.10        | 2.64 | 0.083     | 0.104 |
| E1     | 1.20        | 1.40 | 0.047     | 0.055 |
| e      | 0.95 BSC    |      | 0.037 BSC |       |
| e1     | 1.90 BSC    |      | 0.075 BSC |       |
| L      | 0.30        | 0.55 | 0.012     | 0.022 |
| L1     | 0.25 BSC    |      | 0.010 BSC |       |
| θ      | 0°          | 8°   | 0°        | 8°    |
| θ1     | 7° TYP      |      | 7° TYP    |       |

**Embossed Carrier Tape & Reel Specification — SOT23-3**



| Symbol | Millimeters |      | Inches |       |
|--------|-------------|------|--------|-------|
|        | Min         | Max  | Min    | Max   |
| E      | 1.65        | 1.85 | 0.065  | 0.073 |
| F      | 3.40        | 3.60 | 0.134  | 0.142 |
| P2     | 1.90        | 2.10 | 0.075  | 0.083 |
| D      | 1.40        | 1.60 | 0.055  | 0.063 |
| P0     | 3.90        | 4.10 | 0.154  | 0.161 |
| W      | 7.70        | 8.30 | 0.303  | 0.327 |
| P      | 3.90        | 4.10 | 0.154  | 0.161 |
| A0     | 3.05        | 3.25 | 0.120  | 0.128 |
| B0     | 2.67        | 2.87 | 0.105  | 0.113 |
| K0     | 1.12        | 1.32 | 0.044  | 0.052 |
| t      | 0.22        | 0.24 | 0.009  | 0.009 |

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