

# APM2314AC-TL-VB Datasheet

## N-Channel 20 V (D-S) MOSFET

### PRODUCT SUMMARY

| $V_{DS}$ (V) | $R_{DS(on)}$ ( $\Omega$ ) | $I_D$ (A) <sup>e</sup> | $Q_g$ (Typ.) |
|--------------|---------------------------|------------------------|--------------|
| 20           | 0.022 at $V_{GS} = 4.5$ V | 6 <sup>a</sup>         | 8.8 nC       |
|              | 0.028 at $V_{GS} = 2.5$ V | 6 <sup>a</sup>         |              |
|              | 0.039 at $V_{GS} = 1.8$ V | 5.6                    |              |

### FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- Trench Power MOSFET
- 100 %  $R_g$  Tested
- Compliant to RoHS Directive 2002/95/EC



**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

### APPLICATIONS

- DC/DC Converters
- Load Switch for Portable Applications



### ABSOLUTE MAXIMUM RATINGS $T_A = 25$ °C, unless otherwise noted

| Parameter                                        | Symbol         | Limit                | Unit |
|--------------------------------------------------|----------------|----------------------|------|
| Drain-Source Voltage                             | $V_{DS}$       | 20                   | V    |
| Gate-Source Voltage                              | $V_{GS}$       | $\pm 12$             |      |
| Continuous Drain Current ( $T_J = 150$ °C)       | $I_D$          | 6 <sup>a</sup>       | A    |
|                                                  |                | 5.1                  |      |
|                                                  |                | 5 <sup>b, c</sup>    |      |
|                                                  |                | 4 <sup>b, c</sup>    |      |
| Pulsed Drain Current                             | $I_{DM}$       | 20                   |      |
| Continuous Source-Drain Diode Current            | $I_S$          | 1.75                 |      |
|                                                  |                | 1.04 <sup>b, c</sup> |      |
| Maximum Power Dissipation                        | $P_D$          | 2.1                  | W    |
|                                                  |                | 1.3                  |      |
|                                                  |                | 1.25 <sup>b, c</sup> |      |
|                                                  |                | 0.8 <sup>b, c</sup>  |      |
| Operating Junction and Storage Temperature Range | $T_J, T_{stg}$ | - 55 to 150          | °C   |
| Soldering Recommendations (Peak Temperature)     |                | 260                  |      |

### THERMAL RESISTANCE RATINGS

| Parameter                                   | Symbol     | Typical | Maximum | Unit |
|---------------------------------------------|------------|---------|---------|------|
| Maximum Junction-to-Ambient <sup>b, d</sup> | $R_{thJA}$ | 80      | 100     | °C/W |
| Maximum Junction-to-Foot (Drain)            | $R_{thJF}$ | 40      | 60      |      |

Notes:

- Package limited
- Surface Mounted on 1" x 1" FR4 board.
- $t = 5$  s.
- Maximum under steady state conditions is 125 °C/W.
- Based on  $T_C = 25$  °C.

| SPECIFICATIONS T <sub>J</sub> = 25 °C, unless otherwise noted |                                      |                                                                                                                        |      |       |       |       |
|---------------------------------------------------------------|--------------------------------------|------------------------------------------------------------------------------------------------------------------------|------|-------|-------|-------|
| Parameter                                                     | Symbol                               | Test Conditions                                                                                                        | Min. | Typ.  | Max.  | Unit  |
| Static                                                        |                                      |                                                                                                                        |      |       |       |       |
| Drain-Source Breakdown Voltage                                | V <sub>DS</sub>                      | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                                         | 20   |       |       | V     |
| V <sub>DS</sub> Temperature Coefficient                       | ΔV <sub>DS</sub> /T <sub>J</sub>     | I <sub>D</sub> = 250 μA                                                                                                |      | 25    |       | mV/°C |
| V <sub>GS(th)</sub> Temperature Coefficient                   | ΔV <sub>GS(th)</sub> /T <sub>J</sub> |                                                                                                                        |      | - 2.6 |       |       |
| Gate-Source Threshold Voltage                                 | V <sub>GS(th)</sub>                  | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                                            | 0.45 |       | 1.0   | V     |
| Gate-Source Leakage                                           | I <sub>GSS</sub>                     | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 8 V                                                                         |      |       | ± 100 | nA    |
| Zero Gate Voltage Drain Current                               | I <sub>DSS</sub>                     | V <sub>DS</sub> = 20 V, V <sub>GS</sub> = 0 V                                                                          |      |       | 1     | μA    |
|                                                               |                                      | V <sub>DS</sub> = 20 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 70 °C                                                  |      |       | 10    |       |
| On-State Drain Current <sup>a</sup>                           | I <sub>D(on)</sub>                   | V <sub>DS</sub> ≤ 5 V, V <sub>GS</sub> = 4.5 V                                                                         | 20   |       |       | A     |
| Drain-Source On-State Resistance <sup>a</sup>                 | R <sub>DS(on)</sub>                  | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 5.0 A                                                                        |      | 0.022 |       | Ω     |
|                                                               |                                      | V <sub>GS</sub> = 2.5 V, I <sub>D</sub> = 4.7 A                                                                        |      | 0.028 |       |       |
|                                                               |                                      | V <sub>GS</sub> = 1.8 V, I <sub>D</sub> = 4.3 A                                                                        |      | 0.039 |       |       |
| Forward Transconductance <sup>a</sup>                         | g <sub>fs</sub>                      | V <sub>DS</sub> = 10 V, I <sub>D</sub> = 5.0 A                                                                         |      | 24    |       | S     |
| Dynamic <sup>b</sup>                                          |                                      |                                                                                                                        |      |       |       |       |
| Input Capacitance                                             | C <sub>iss</sub>                     | V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 0 V, f = 1 MHz                                                               |      | 865   |       | pF    |
| Output Capacitance                                            | C <sub>oss</sub>                     |                                                                                                                        |      | 105   |       |       |
| Reverse Transfer Capacitance                                  | C <sub>rss</sub>                     |                                                                                                                        |      | 55    |       |       |
| Total Gate Charge                                             | Q <sub>g</sub>                       | V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 5 V, I <sub>D</sub> = 5.0 A                                                  |      | 12    | 18    | nC    |
|                                                               |                                      | V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 5.0 A                                                |      | 8.8   | 14    |       |
| Gate-Source Charge                                            | Q <sub>gs</sub>                      |                                                                                                                        |      | 1.1   |       |       |
| Gate-Drain Charge                                             | Q <sub>gd</sub>                      |                                                                                                                        |      | 0.7   |       |       |
| Gate Resistance                                               | R <sub>g</sub>                       | f = 1 MHz                                                                                                              | 0.5  | 2.4   | 4.8   | Ω     |
| Turn-On Delay Time                                            | t <sub>d(on)</sub>                   | V <sub>DD</sub> = 10 V, R <sub>L</sub> = 2.2 Ω<br>I <sub>D</sub> ≅ 4 A, V <sub>GEN</sub> = 4.5 V, R <sub>g</sub> = 1 Ω |      | 8     | 16    | ns    |
| Rise Time                                                     | t <sub>r</sub>                       |                                                                                                                        |      | 17    | 26    |       |
| Turn-Off Delay Time                                           | t <sub>d(off)</sub>                  |                                                                                                                        |      | 31    | 47    |       |
| Fall Time                                                     | t <sub>f</sub>                       |                                                                                                                        |      | 8     | 16    |       |
| Turn-On Delay Time                                            | t <sub>d(on)</sub>                   | V <sub>DD</sub> = 10 V, R <sub>L</sub> = 2.2 Ω<br>I <sub>D</sub> ≅ 4 A, V <sub>GEN</sub> = 5 V, R <sub>g</sub> = 1 Ω   |      | 5     | 10    |       |
| Rise Time                                                     | t <sub>r</sub>                       |                                                                                                                        |      | 13    | 20    |       |
| Turn-Off Delay Time                                           | t <sub>d(off)</sub>                  |                                                                                                                        |      | 21    | 32    |       |
| Fall Time                                                     | t <sub>f</sub>                       |                                                                                                                        |      | 6     | 12    |       |
| Drain-Source Body Diode Characteristics                       |                                      |                                                                                                                        |      |       |       |       |
| Continuous Source-Drain Diode Current                         | I <sub>S</sub>                       | T <sub>C</sub> = 25 °C                                                                                                 |      |       | 1.75  | A     |
| Pulse Diode Forward Current                                   | I <sub>SM</sub>                      |                                                                                                                        |      |       | 20    |       |
| Body Diode Voltage                                            | V <sub>SD</sub>                      | I <sub>S</sub> = 4 A, V <sub>GS</sub> = 0 V                                                                            |      | 0.75  | 1.2   | V     |
| Body Diode Reverse Recovery Time                              | t <sub>rr</sub>                      | I <sub>F</sub> = 4 A, dI/dt = 100 A/μs, T <sub>J</sub> = 25 °C                                                         |      | 12    | 20    | ns    |
| Body Diode Reverse Recovery Charge                            | Q <sub>rr</sub>                      |                                                                                                                        |      | 5     | 10    | nC    |
| Reverse Recovery Fall Time                                    | t <sub>a</sub>                       |                                                                                                                        |      | 7     |       | ns    |
| Reverse Recovery Rise Time                                    | t <sub>b</sub>                       |                                                                                                                        |      | 5     |       |       |

Notes:

a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ 

b. Guaranteed by design, not subject to production testing.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



**Output Characteristics**



**Transfer Characteristics**



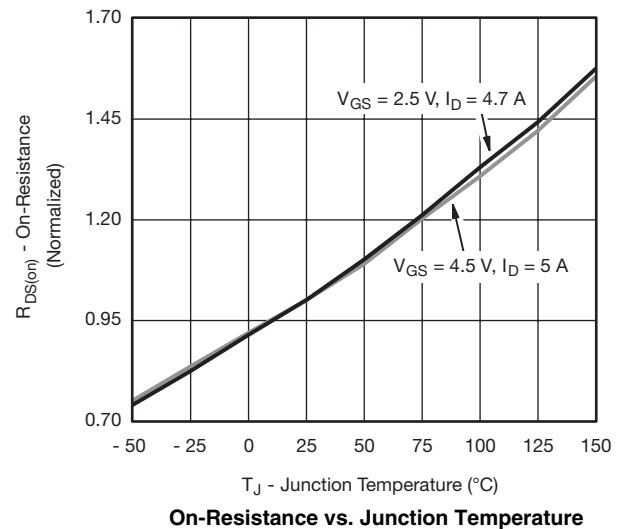
**On-Resistance vs. Drain Current and Gate Voltage**



**Capacitance**



**Gate Charge**



**On-Resistance vs. Junction Temperature**

A semi-logarithmic plot showing the source current  $I_S$  (in Amperes) on the y-axis versus the source-to-drain voltage  $V_{SD}$  (in Volts) on the x-axis. The y-axis is logarithmic, ranging from 0.1 to 100 A. The x-axis is linear, ranging from 0.0 to 1.2 V. Two curves are shown: one for  $T_J = 150\text{ }^{\circ}\text{C}$  and one for  $T_J = 25\text{ }^{\circ}\text{C}$ . Both curves show an exponential relationship between current and voltage, with the current increasing rapidly as voltage increases. The  $150\text{ }^{\circ}\text{C}$  curve is shifted to the left of the  $25\text{ }^{\circ}\text{C}$  curve, indicating higher current for the same voltage at higher temperature.

| $V_{SD}$ (V) | $I_S$ (A) at $T_J = 150\text{ }^{\circ}\text{C}$ | $I_S$ (A) at $T_J = 25\text{ }^{\circ}\text{C}$ |
|--------------|--------------------------------------------------|-------------------------------------------------|
| 0.35         | 0.1                                              | -                                               |
| 0.55         | 1.0                                              | 0.1                                             |
| 0.75         | 10.0                                             | 1.0                                             |
| 1.05         | 20.0                                             | 20.0                                            |

Graph showing On-Resistance ( $R_{DS(on)}$ ) versus Gate-to-Source Voltage ( $V_{GS}$ ) for the 2N7000 MOSFET at  $I_D = 5\text{ A}$ . The curves are plotted for two temperatures:  $T_J = 125\text{ }^{\circ}\text{C}$  (upper curve) and  $T_J = 25\text{ }^{\circ}\text{C}$  (lower curve). The on-resistance decreases sharply as  $V_{GS}$  increases from 1V to 2V, then levels off. The on-resistance is higher at  $125\text{ }^{\circ}\text{C}$  than at  $25\text{ }^{\circ}\text{C}$ .

| $V_{GS}$ (V) | $R_{DS(on)}$ ( $\Omega$ ) at $T_J = 125\text{ }^{\circ}\text{C}$ | $R_{DS(on)}$ ( $\Omega$ ) at $T_J = 25\text{ }^{\circ}\text{C}$ |
|--------------|------------------------------------------------------------------|-----------------------------------------------------------------|
| 1.2          | > 0.06                                                           | > 0.06                                                          |
| 1.5          | 0.055                                                            | 0.045                                                           |
| 2.0          | 0.048                                                            | 0.032                                                           |
| 3.0          | 0.042                                                            | 0.028                                                           |
| 4.0          | 0.039                                                            | 0.027                                                           |
| 6.0          | 0.037                                                            | 0.026                                                           |
| 8.0          | 0.036                                                            | 0.026                                                           |

Graph of  $V_{GS(th)}$  (V) versus  $T_J$  - Temperature ( $^{\circ}C$ ) for  $I_D = 250 \mu A$ .

| $T_J$ - Temperature ( $^{\circ}C$ ) | $V_{GS(th)}$ (V) |
|-------------------------------------|------------------|
| -50                                 | 0.78             |
| -25                                 | 0.72             |
| 0                                   | 0.66             |
| 25                                  | 0.60             |
| 50                                  | 0.54             |
| 75                                  | 0.48             |
| 100                                 | 0.42             |
| 125                                 | 0.36             |
| 150                                 | 0.30             |

The graph plots Power (W) on the y-axis against Time (s) on the x-axis. The y-axis ranges from 0 to 32 W with major grid lines every 8 W. The x-axis is logarithmic, ranging from 0.001 to 100 s with major grid lines at 0.001, 0.01, 0.1, 1, 10, and 100. A solid black curve starts at (0.001, 32) and decays towards zero. Vertical dashed lines are present at 0.001, 0.01, 0.1, 1, 10, and 100 s. Horizontal dashed lines are present at 8 W, 16 W, 24 W, and 32 W.

| Time (s) | Power (W) |
|----------|-----------|
| 0.001    | 32        |
| 0.01     | 16        |
| 0.1      | 8         |
| 1        | 4         |
| 10       | 2         |
| 100      | 1         |

Figure 10 is a Power Dissipation Capability graph. The y-axis represents Drain Current ( $I_D$ ) in Amperes (A) on a logarithmic scale from 0.01 to 100. The x-axis represents Drain-to-Source Voltage ( $V_{DS}$ ) in Volts (V) on a logarithmic scale from 0.1 to 100. The graph shows the relationship between  $I_D$  and  $V_{DS}$  for different pulse widths at  $T_A = 25^\circ\text{C}$  for a Single Pulse. The solid line represents the power limit, labeled "Limited by  $R_{DS(on)}^*$ ". The dashed line represents the thermal limit, labeled "BVDSS Limited". The graph also includes curves for pulse widths of 100  $\mu\text{s}$ , 1 ms, 10 ms, 100 ms, 1 s, 10 s, and DC.

### Safe Operating Area, Junction-to-Ambient

**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



**Current Derating\***



**Power Derating, Junction-to-Foot**



**Power Derating, Junction-to-Ambient**

\* The power dissipation  $P_D$  is based on  $T_{J(max.)} = 150$  °C, using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package limit.

**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



**SOT-23 (TO-236): 3-LEAD**

| Dim            | MILLIMETERS |      | INCHES     |       |
|----------------|-------------|------|------------|-------|
|                | Min         | Max  | Min        | Max   |
| A              | 0.89        | 1.12 | 0.035      | 0.044 |
| A <sub>1</sub> | 0.01        | 0.10 | 0.0004     | 0.004 |
| A <sub>2</sub> | 0.88        | 1.02 | 0.0346     | 0.040 |
| b              | 0.35        | 0.50 | 0.014      | 0.020 |
| c              | 0.085       | 0.18 | 0.003      | 0.007 |
| D              | 2.80        | 3.04 | 0.110      | 0.120 |
| E              | 2.10        | 2.64 | 0.083      | 0.104 |
| E <sub>1</sub> | 1.20        | 1.40 | 0.047      | 0.055 |
| e              | 0.95 BSC    |      | 0.0374 Ref |       |
| e <sub>1</sub> | 1.90 BSC    |      | 0.0748 Ref |       |
| L              | 0.40        | 0.60 | 0.016      | 0.024 |
| L <sub>1</sub> | 0.64 Ref    |      | 0.025 Ref  |       |
| S              | 0.50 Ref    |      | 0.020 Ref  |       |
| q              | 3°          | 8°   | 3°         | 8°    |

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DWG: 5479

# RECOMMENDED MINIMUM PADS FOR SOT-23



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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