

## 20V N-Channel Enhancement Mode MOSFET

### Description

The AP60N02D uses advanced trench technology to provide excellent  $R_{DS(ON)}$ , low gate charge and operation with gate voltages as low as 2.5V. This device is suitable for use as a Battery protection or in other Switching application.

### General Features

$V_{DS}=20V$   $I_D=60A$

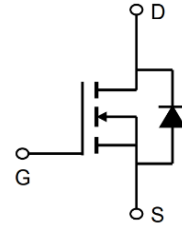
$R_{DS(ON)} < 5.5m\Omega$  @  $V_{GS}=4.5V$  (Type: 4.1m $\Omega$ )

### Application

Battery protection

Load switch

Uninterruptible power supply



### Package Marking and Ordering Information

| Product ID | Pack      | Marking           | Qty(PCS) |
|------------|-----------|-------------------|----------|
| AP60N02D   | TO-252-3L | AP60N02D XXX YYYY | 2500     |

### Absolute Maximum Ratings (TC=25°C unless otherwise noted)

| Symbol     | Parameter   | Max.        | Units |
|------------|---|-------------|-------|
| VDSS       | Drain-Source Voltage                                | 20          | V     |
| VGSS       | Gate-Source Voltage                                 | ±12         | V     |
| ID@TA=25°C | Continuous Drain Current, VGS @ 4.5V                | 60          | A     |
| ID@TA=70°C | Continuous Drain Current, VGS @ 4.5V                | 42          | A     |
| IDM        | Pulsed Drain Current <small>note1</small>           | 210         | A     |
| EAS        | Single Pulsed Avalanche Energy <small>note2</small> | 56.2        | mJ    |
| PD@TA=25°C | Power Dissipation                                   | 57          | W     |
| RθJC       | Thermal Resistance, Junction to Case                | 2.63        | °C/W  |
| TJ, TSTG   | Operating and Storage Temperature Range             | -55 to +175 | °C    |



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### Electrical Characteristics ( $T_c=25^\circ\text{C}$ , unless otherwise noted)

| Symbol   | Parameter  | Test Condition                                     | Min. | Typ. | Max.      | Units      |
|----------|--|--|------|------|-----------|------------|
| V(BR)DSS | Drain-Source Breakdown Voltage                           | VGS=0V, ID=250 $\mu$ A                             | 20   | 24   | -         | V          |
| IDSS     | Zero Gate Voltage Drain Current                          | VDS=20V, VGS=0V,                                   | -    | -    | 1.0       | $\mu$ A    |
| IGSS     | Gate to Body Leakage Current                             | VDS=0V, VGS= $\pm$ 12V                             | -    | -    | $\pm$ 100 | nA         |
| VGS(th)  | Gate Threshold Voltage                                   | VDS=VGS, ID=250 $\mu$ A                            | 0.5  | 0.7  | 1.2       | V          |
| RDS(on)  | Static Drain-Source on-Resistance note3                  | VGS=4.5V, ID=30A                                   | -    | 4.1  | 5.5       | m $\Omega$ |
|          |  | VGS=2.5V, ID=20A                                   | -    | 7.4  | 9.0       |            |
| Ciss     | Input Capacitance  | VDS=10V, VGS=0V,<br>f = 1.0MHz                     | -    | 2500 | -         | pF         |
| Coss     | Output Capacitance                                       |  | -    | 407  | -         | pF         |
| Crss     | Reverse Transfer Capacitance                             |  | -    | 386  | -         | pF         |
| Qg       | Total Gate Charge  | VDS=10V, ID=30A,<br>VGS=4.5V                       | -    | 32   | -         | nC         |
| Qgs      | Gate-Source Charge                                       |  | -    | 3    | -         | nC         |
| Qgd      | Gate-Drain("Miller") Charge                              |  | -    | 11   | -         | nC         |
| td(on)   | Turn-on Delay Time                                       | VDS=10V,<br>ID=30A, RGEN=3 $\Omega$ ,<br>VGS =4.5V | -    | 17   | -         | ns         |
| tr       | Turn-on Rise Time  |  | -    | 49   | -         | ns         |
| td(off)  | Turn-off Delay Time                                      |  | -    | 74   | -         | ns         |
| tf       | Turn-off Fall Time                                       |  | -    | 26   | -         | ns         |
| IS       | Maximum Continuous Drain to Source Diode Forward Current |  | -    | -    | 75        | A          |
| ISM      | Maximum Pulsed Drain to Source Diode Forward Current     |  | -    | -    | 300       | A          |
| VSD      | Drain to Source Diode Forward Voltage                    | VGS = 0V, IS=30A                                   | -    | -    | 1.2       | V          |

#### Notes:

- 1、Repetitive Rating: Pulse Width Limited by Maximum Junction Temperature
- 2、The test condition is, VDD=10V, VG=4.5V, L=0.5mH, RG=25 $\Omega$ , IAS=15A
- 3、The data tested by pulsed Pulse Test: Pulse Width $\leq$ 300 $\mu$ s, Duty Cycle $\leq$ 0.5%
- 4、The power dissipation is limited by 150 $^\circ\text{C}$  junction temperature

### Typical Characteristics

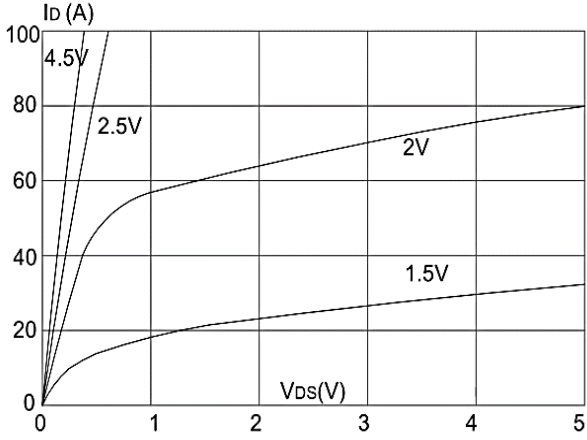


Figure 1: Output Characteristics

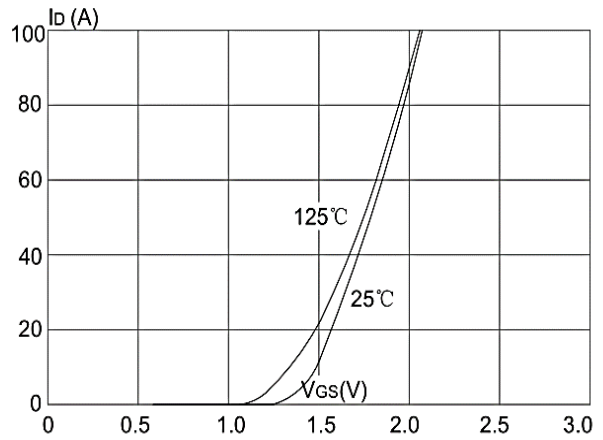


Figure 2: Typical Transfer Characteristics

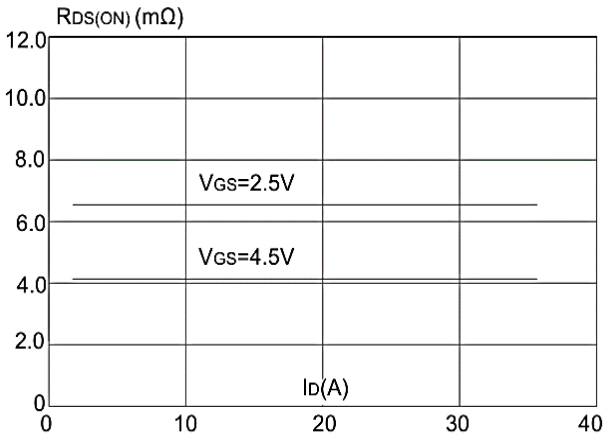


Figure 3: On-resistance vs. Drain Current

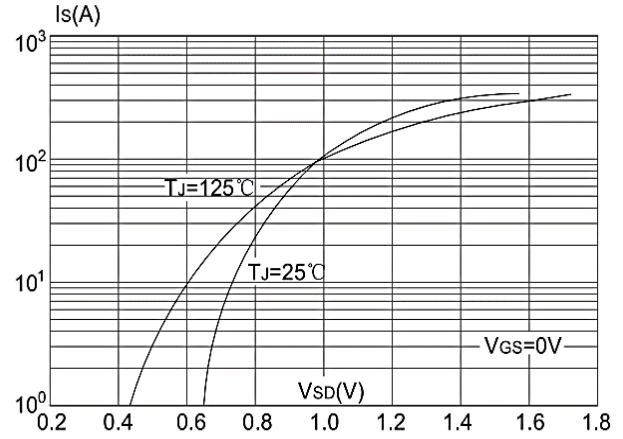


Figure 4: Body Diode Characteristics

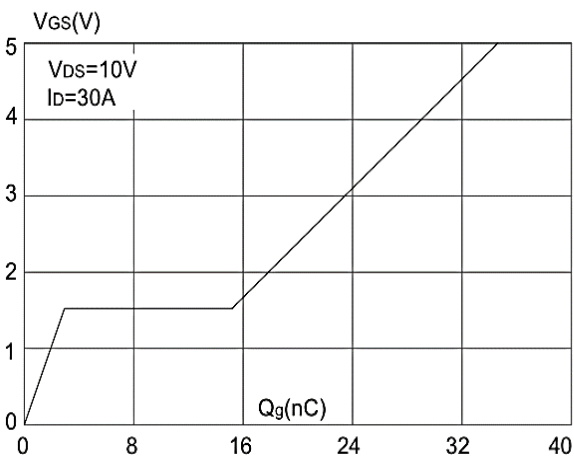


Figure 5: Gate Charge Characteristics

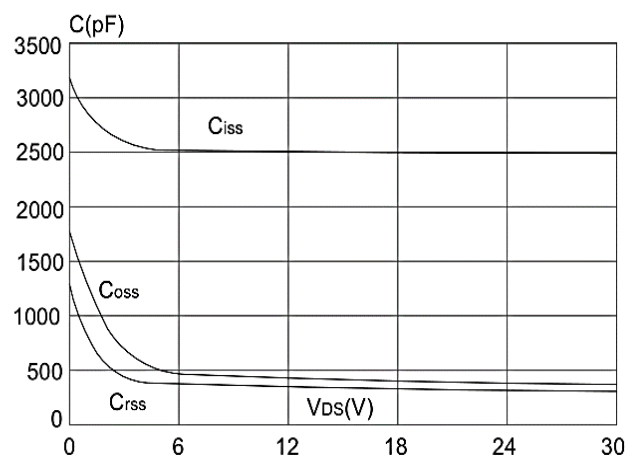
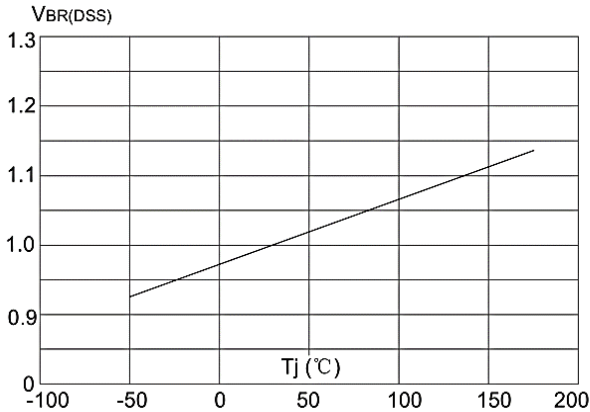
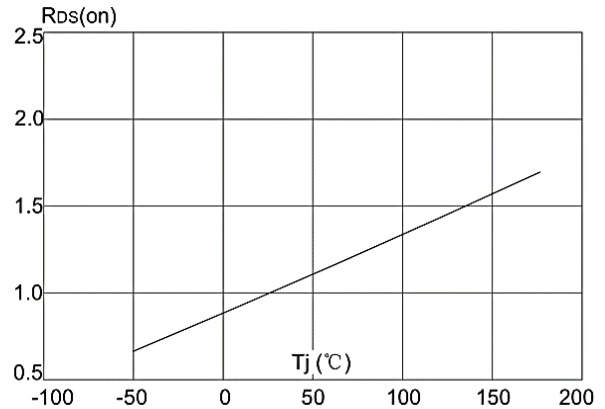


Figure 6: Capacitance Characteristics

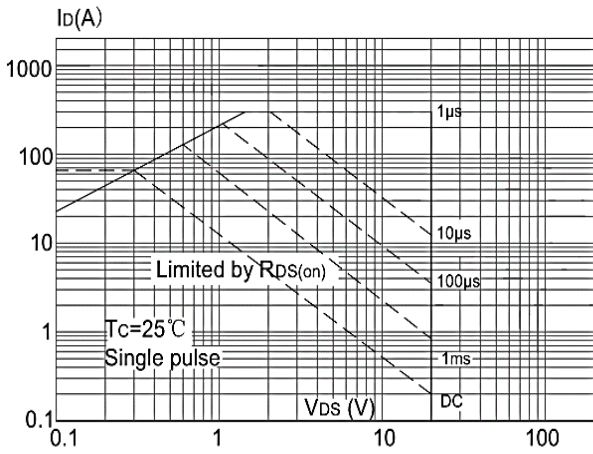
**20V N-Channel Enhancement Mode MOSFET**



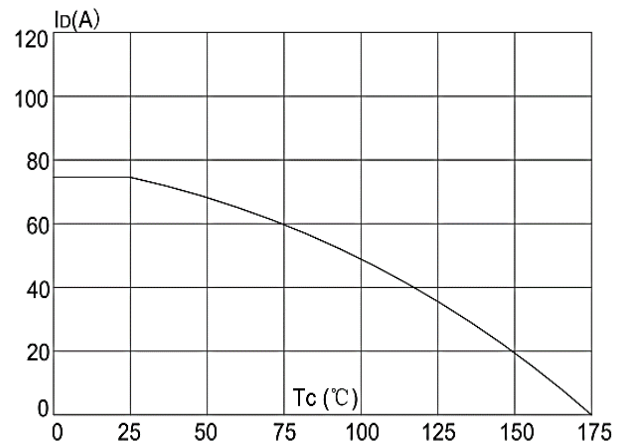
**Figure 7: Normalized Breakdown Voltage vs. Junction Temperature**



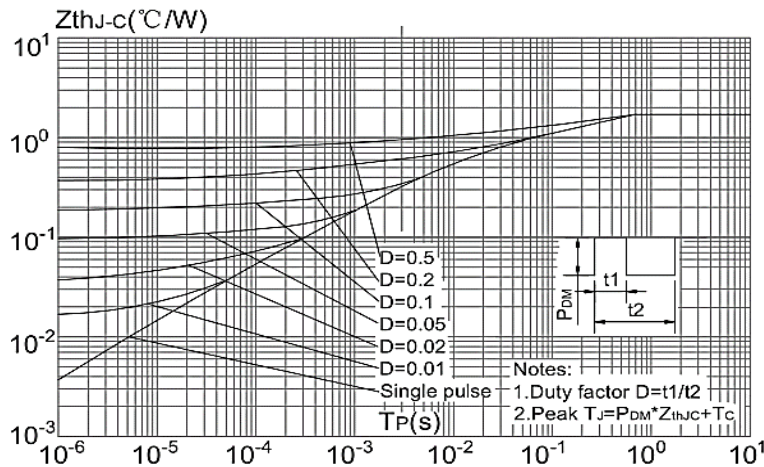
**Figure 8: Normalized on Resistance vs. Junction Temperature**



**Figure 9: Maximum Safe Operating Area Current Temperature**

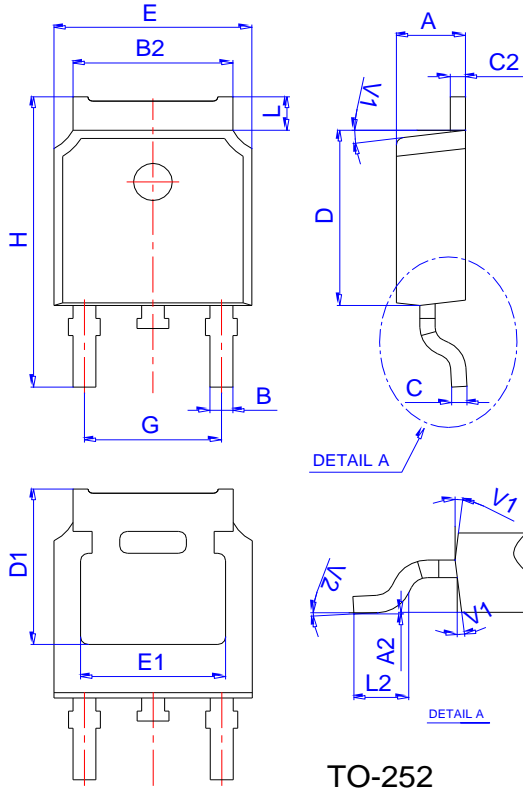


**Figure 10: Maximum Continuous Drain vs. Case**



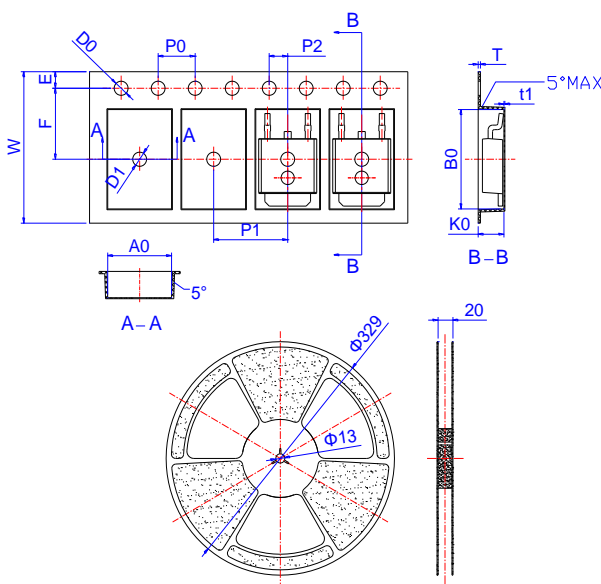
**Figure.11: Maximum Effective Transient Thermal Impedance, Junction-to-Case**

### Package Mechanical Data:TO-252-3L



| Ref. | Dimensions  |      |       |          |      |       |
|------|-------------|------|-------|----------|------|-------|
|      | Millimeters |      |       | Inches   |      |       |
|      | Min.        | Typ. | Max.  | Min.     | Typ. | Max.  |
| A    | 2.10        |      | 2.50  | 0.083    |      | 0.098 |
| A2   | 0           |      | 0.10  | 0        |      | 0.004 |
| B    | 0.66        |      | 0.86  | 0.026    |      | 0.034 |
| B2   | 5.18        |      | 5.48  | 0.202    |      | 0.216 |
| C    | 0.40        |      | 0.60  | 0.016    |      | 0.024 |
| C2   | 0.44        |      | 0.58  | 0.017    |      | 0.023 |
| D    | 5.90        |      | 6.30  | 0.232    |      | 0.248 |
| D1   | 5.30REF     |      |       | 0.209REF |      |       |
| E    | 6.40        |      | 6.80  | 0.252    |      | 0.268 |
| E1   | 4.63        |      |       | 0.182    |      |       |
| G    | 4.47        |      | 4.67  | 0.176    |      | 0.184 |
| H    | 9.50        |      | 10.70 | 0.374    |      | 0.421 |
| L    | 1.09        |      | 1.21  | 0.043    |      | 0.048 |
| L2   | 1.35        |      | 1.65  | 0.053    |      | 0.065 |
| V1   |             | 7°   |       |          | 7°   |       |
| V2   | 0°          |      | 6°    | 0°       |      | 6°    |

### Reel Specification-TO-252



| Ref. | Dimensions  |       |       |        |       |       |
|------|-------------|-------|-------|--------|-------|-------|
|      | Millimeters |       |       | Inches |       |       |
|      | Min.        | Typ.  | Max.  | Min.   | Typ.  | Max.  |
| W    | 15.90       | 16.00 | 16.10 | 0.626  | 0.630 | 0.634 |
| E    | 1.65        | 1.75  | 1.85  | 0.065  | 0.069 | 0.073 |
| F    | 7.40        | 7.50  | 7.60  | 0.291  | 0.295 | 0.299 |
| D0   | 1.40        | 1.50  | 1.60  | 0.055  | 0.059 | 0.063 |
| D1   | 1.40        | 1.50  | 1.60  | 0.055  | 0.059 | 0.063 |
| P0   | 3.90        | 4.00  | 4.10  | 0.154  | 0.157 | 0.161 |
| P1   | 7.90        | 8.00  | 8.10  | 0.311  | 0.315 | 0.319 |
| P2   | 1.90        | 2.00  | 2.10  | 0.075  | 0.079 | 0.083 |
| A0   | 6.85        | 6.90  | 7.00  | 0.270  | 0.271 | 0.276 |
| B0   | 10.45       | 10.50 | 10.60 | 0.411  | 0.413 | 0.417 |
| K0   | 2.68        | 2.78  | 2.88  | 0.105  | 0.109 | 0.113 |
| T    | 0.24        |       | 0.27  | 0.009  |       | 0.011 |
| t1   | 0.10        |       |       | 0.004  |       |       |
| 10P0 | 39.80       | 40.00 | 40.20 | 1.567  | 1.575 | 1.583 |

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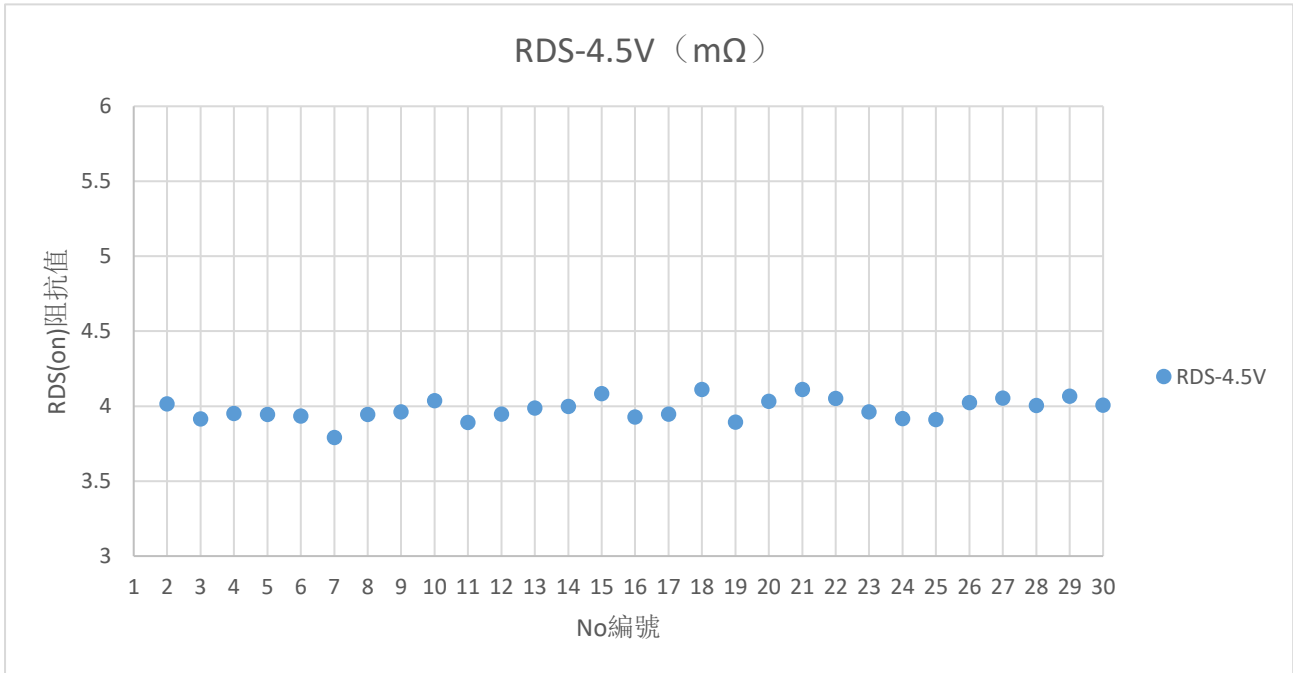
**20V N-Channel Enhancement Mode MOSFET**

| <b>Edition</b> | <b>Date</b> | <b>Change</b>                  |
|----------------|-------------|--------------------------------|
| Rve3.8         | 2018/8/31   | Initial release                |
| Rve3.9         | 2019/11/31  | Reduce RDS(on)                 |
| Rve4.0         | 2020/5/02   | Change of specification format |

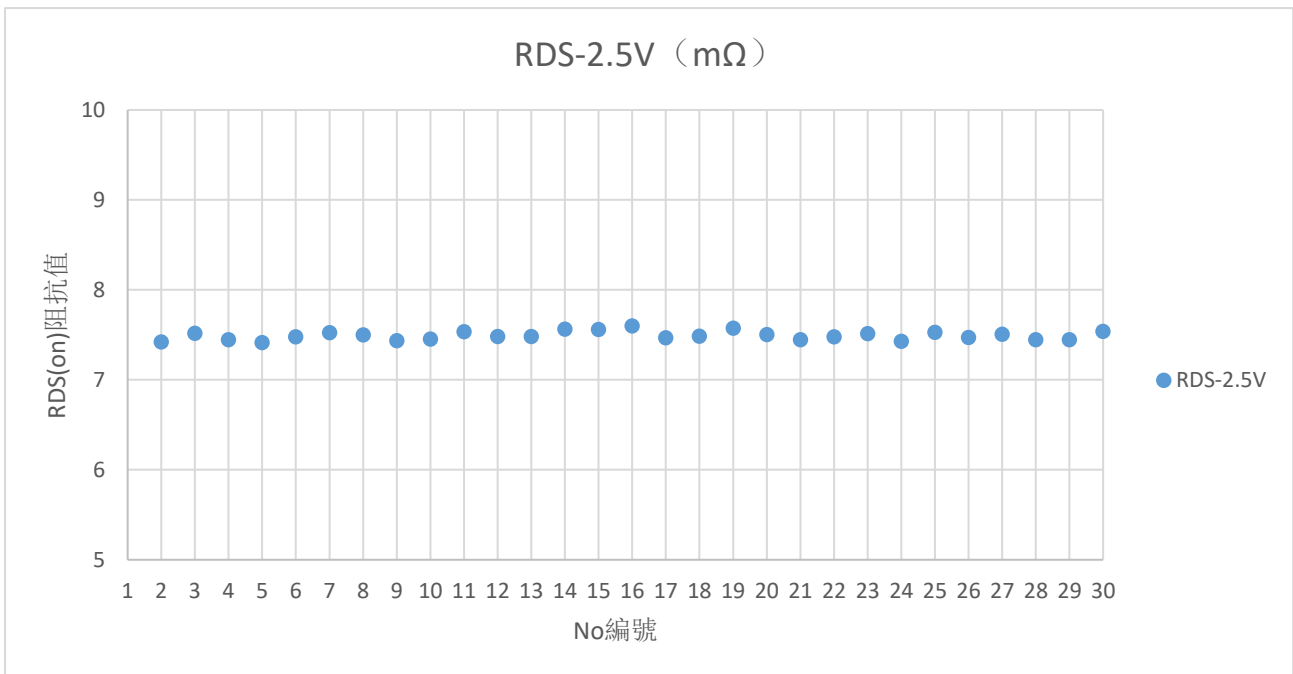
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### Test Report For 30PCS (30pcs 典型測試報告)



Test: VGS=4.5V ID=30A



Test: VGS=2.5V ID=20A



