

**60V N-Channel Power MOSFET**

• **General Description**

It combines trench MOSFET technology with a low resistance package to provide extremely low  $R_{DS(ON)}$ . It is suitable for automotive application.

• **Features**

- AEC-Q101 Qualified
- Low  $R_{DS(ON)}$  to minimize conductive loss
- Low Gate Charge for fast switching
- Low Thermal resistance

• **Application**

- BLDC Motor driver
- DC-DC
- Load switch

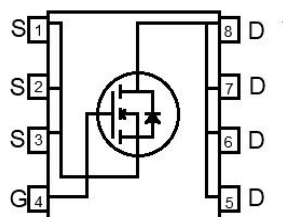
• **Ordering Information:**

|                           |            |
|---------------------------|------------|
| Part NO.                  | ZMA098N06M |
| Marking                   | 098N06     |
| Packing Information       | REEL TAPE  |
| Basic ordering unit (pcs) | 5000       |

• **Absolute Maximum Ratings** ( $T_C=25^{\circ}\text{C}$ )

| Parameter                        | Symbol    | Conditions                                                          | Value       | Unit               |
|----------------------------------|-----------|---------------------------------------------------------------------|-------------|--------------------|
| Drain-Source Voltage             | $V_{DS}$  |                                                                     | 60          | V                  |
| Gate-Source Voltage <sup>①</sup> | $V_{GS}$  |                                                                     | $\pm 20$    | V                  |
| Continuous Drain Current         | $I_D$     | $T_C=25^{\circ}\text{C}$                                            | 40          | A                  |
|                                  | $I_D$     | $T_C=75^{\circ}\text{C}$                                            | 37          | A                  |
|                                  | $I_D$     | $T_C=100^{\circ}\text{C}$                                           | 32          | A                  |
| Pulsed Drain Current             | $I_{DM}$  | Pulsed; $t_p \leq 10 \mu\text{s}$ ; $T_{mb} = 25^{\circ}\text{C}$ ; | 160         | A                  |
| Total Power Dissipation          | $P_D$     | $T_C=25^{\circ}\text{C}$                                            | 56          | W                  |
| Total Power Dissipation          | $P_D$     | $T_A=25^{\circ}\text{C}$                                            | 2.5         | W                  |
| Operating Junction Temperature   | $T_J$     |                                                                     | -55 to +175 | $^{\circ}\text{C}$ |
| Storage Temperature              | $T_{STG}$ |                                                                     | -55 to +175 | $^{\circ}\text{C}$ |
| Single Pulse Avalanche Energy    | $E_{AS}$  | $L=0.1\text{mH}$ , $V_{GS}=10\text{V}$ , $R_g=25\Omega$ ,           | 48          | mJ                 |
|                                  |           | $L=0.5\text{mH}$ , $V_{GS}=10\text{V}$ , $R_g=25\Omega$ ,           | 101         | mJ                 |
| ESD Level (HBM)                  | CLASS 2   |                                                                     |             |                    |

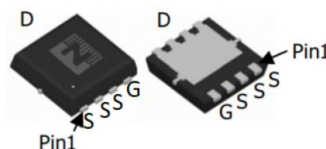
• **Product Summary**



$$V_{DS} = 60\text{V}$$

$$R_{DS(ON)} = 10\text{m}\Omega$$

$$I_D = 40\text{A}$$



DFN3\*3



**•Thermal resistance**

| Parameter                                         | Symbol     | Min. | Typ. | Max. | Unit |
|---------------------------------------------------|------------|------|------|------|------|
| Thermal resistance, junction - case               | $R_{thJC}$ |      | -    | 2.7  | °C/W |
| Thermal resistance, junction-ambient <sup>②</sup> | $R_{thJA}$ |      | -    | 60   | °C/W |
| Soldering temperature (total time<10s)            | Tsold      |      | -    | 260  | °C   |

**•Electronic Characteristics**

| Parameter                         | Symbol       | Condition                     | Min. | Typ. | Max. | Unit       |
|-----------------------------------|--------------|-------------------------------|------|------|------|------------|
| Drain-Source Breakdown Voltage    | $BV_{DSS}$   | $V_{GS}=0V, I_D=250\mu A$     | 60   |      |      | V          |
| Gate Threshold Voltage            | $V_{GS(TH)}$ | $V_{GS}=V_{DS}, I_D=250\mu A$ | 1.4  | 1.7  | 2.5  | V          |
| Drain-Source Leakage Current      | $I_{DSS}$    | $V_{GS}=0V, V_{DS}=60V$       |      |      | 1.0  | $\mu A$    |
| Gate- Source Leakage Current      | $I_{GSS}$    | $V_{GS}=\pm 20V, V_{DS}=0V$   |      |      | 100  | nA         |
| Static Drain-source On Resistance | $R_{DS(ON)}$ | $V_{GS}=10V, I_D=24A$         |      | 10   | 13   | m $\Omega$ |
|                                   |              | $V_{GS}=4.5V, I_D=12A$        |      | 12   | 15   | m $\Omega$ |
| Forward Transconductance          | $g_{FS}$     | $V_{DS}=5V, I_{SD}=10A$       |      | 14   |      | S          |
| Diode Forward Voltage             | $V_{FSD}$    | $V_{GS}=0V, I_{SD}=24A$       |      |      | 1.3  | V          |

**•Dynamic characteristics**

| Parameter                    | Symbol       | Condition                                        | Min. | Typ. | Max. | Unit     |
|------------------------------|--------------|--------------------------------------------------|------|------|------|----------|
| Input capacitance            | $C_{iss}$    | $f=1MHz, V_{DS}=25V$                             | -    | 2750 | -    | pF       |
| Output capacitance           | $C_{oss}$    |                                                  | -    | 185  | -    |          |
| Reverse transfer capacitance | $C_{rss}$    |                                                  | -    | 135  | -    |          |
| Gate Resistance              | $R_g$        | $f=1MHz$                                         | -    | 1.9  |      | $\Omega$ |
| Total gate charge            | $Q_g$        | $V_{DD}=15V, I_D=20A, V_{GS}=10V$                | -    | 30   | -    | nC       |
|                              | $Q_g(4.5V)$  |                                                  | -    | 17   | -    |          |
| Gate - Source charge         | $Q_{gs}$     |                                                  | -    | 8.4  | -    |          |
| Gate - Drain charge          | $Q_{gd}$     |                                                  | -    | 5.8  | -    |          |
| Turn-ON Delay time           | $t_{D(on)}$  | $V_{GS}=10V, V_{DS}=15V, R_G=3.3\Omega, I_D=20A$ | -    | 17   | -    | ns       |
| Turn-ON Rise time            | $t_r$        |                                                  | -    | 40   | -    | ns       |
| Turn-Off Delay time          | $t_{D(off)}$ |                                                  | -    | 22   | -    | ns       |
| Turn-Off Fall time           | $t_f$        |                                                  | -    | 12   | -    | ns       |
| Reverse Recovery Time        | $t_{RR}$     | $V_{DD}=20V, dI_S/dt=100A/\mu s, I_S=20A$        | -    | 50   | -    | ns       |
| Reverse Recovery Charge      | $Q_{RR}$     |                                                  | -    | 46   | -    | nC       |

Fig.1 Gate-Charge Characteristics

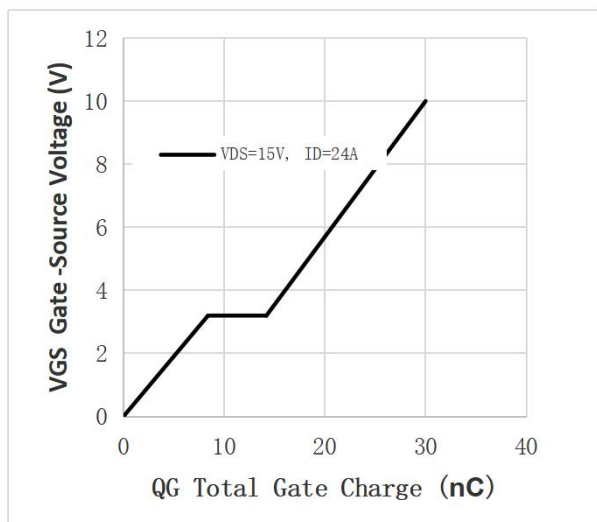


Fig.2 Capacitance Characteristics

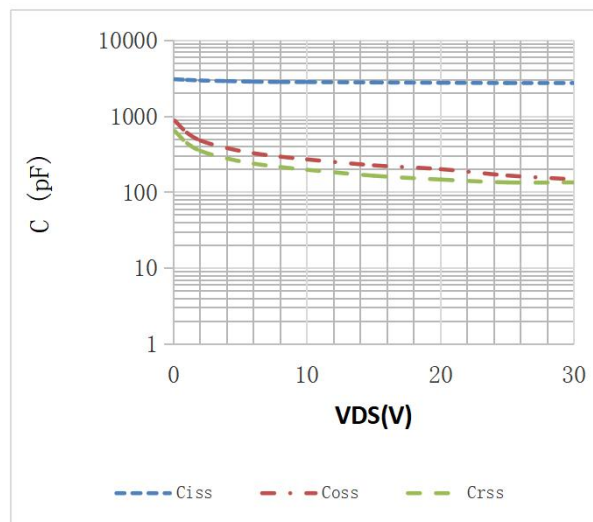


Fig.3 Power Dissipation

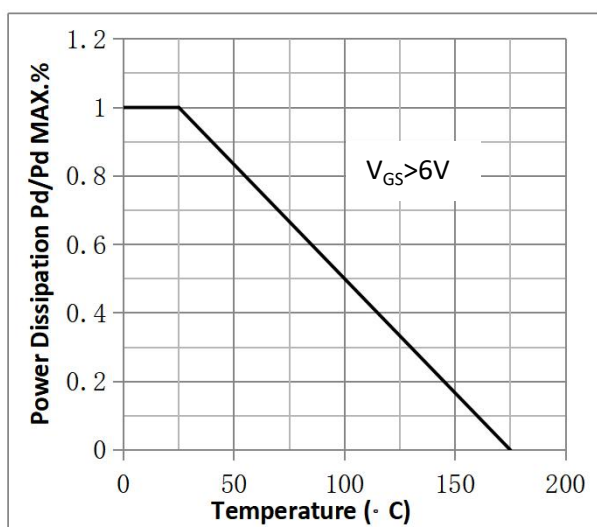


Fig.4 Typical output Characteristics

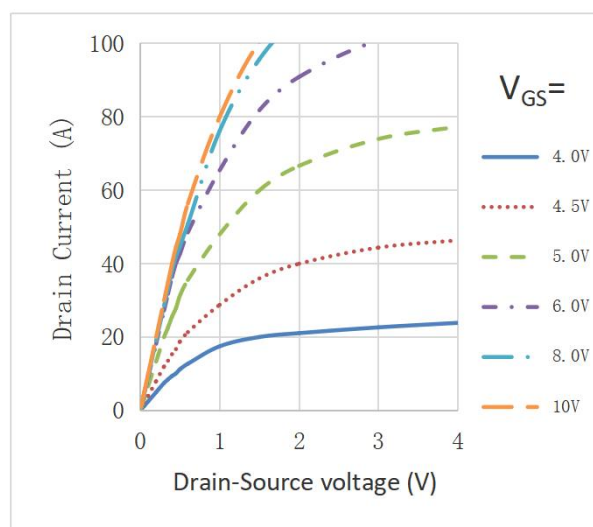


Fig.5 Threshold Voltage V.S Junction Temperature

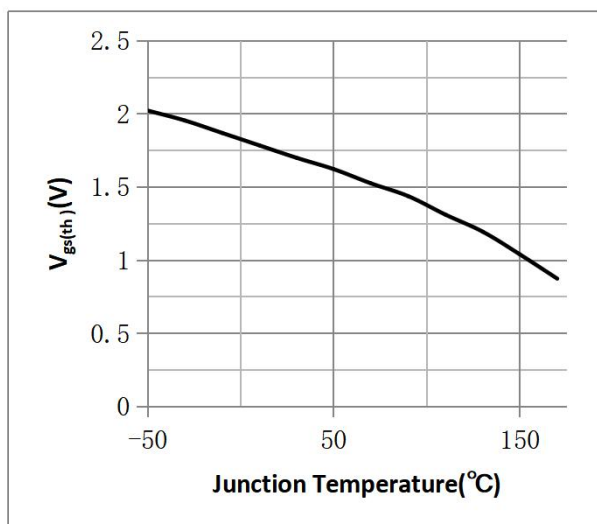


Fig.6 Resistance V.S Drain Current

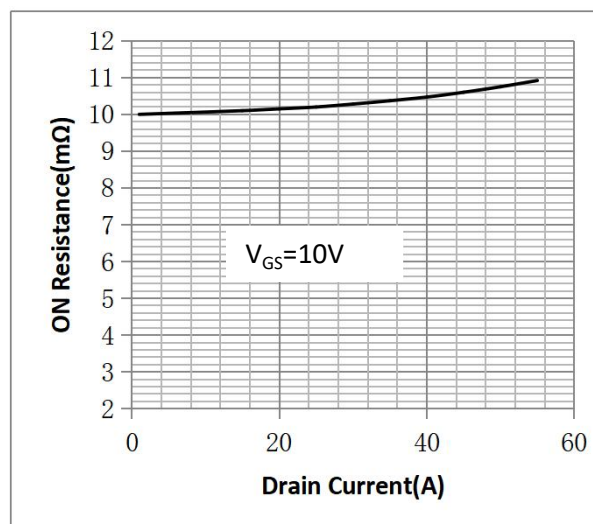


Fig.7 On-Resistance VS Gate Source Voltage

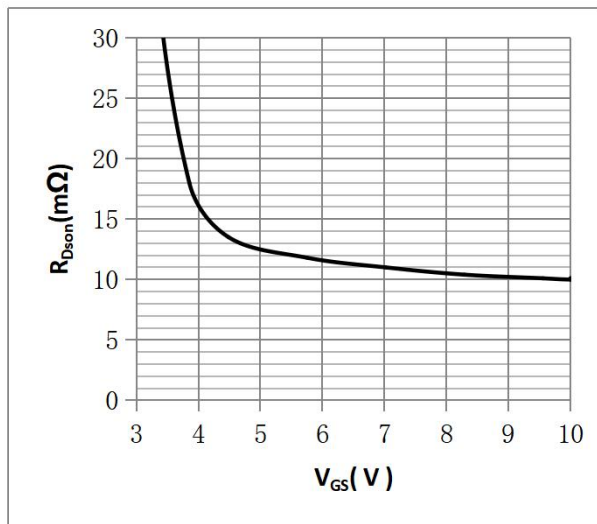


Fig.8 On-Resistance V.S Junction Temperature

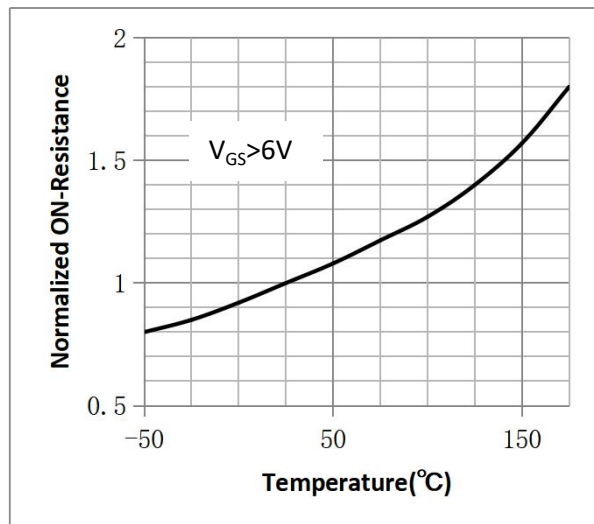


Figure 9. Diode Forward Voltage vs. Current

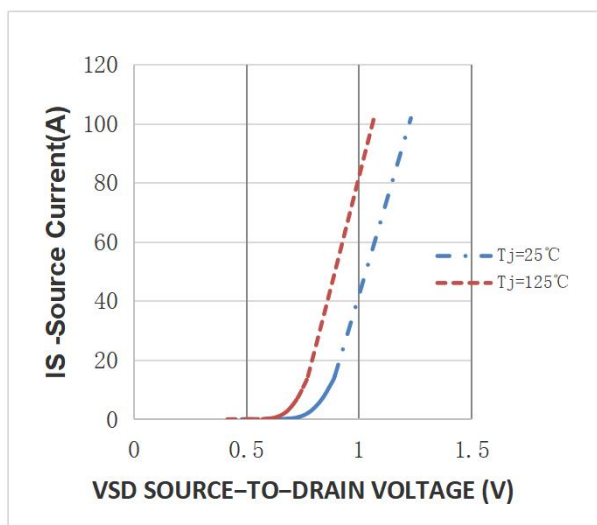


Figure 10. Transfer Characteristics

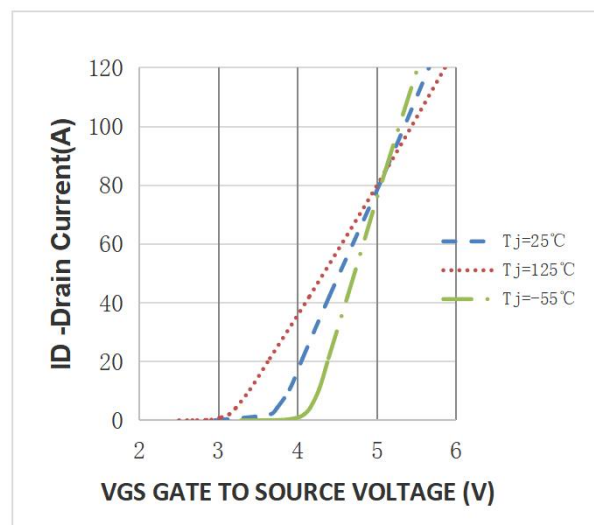


Fig.11 Safe Operating Area

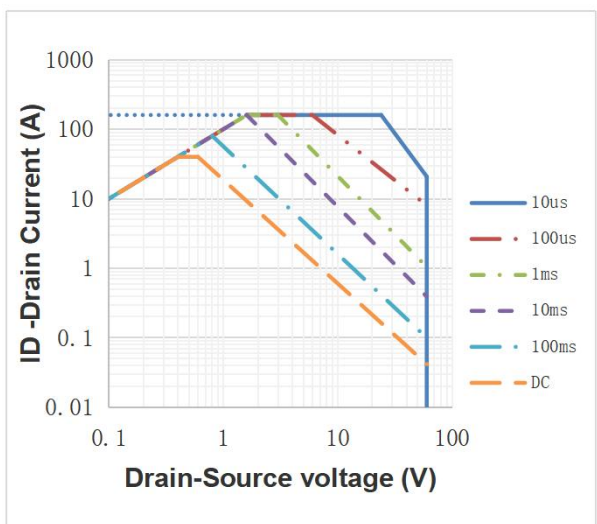
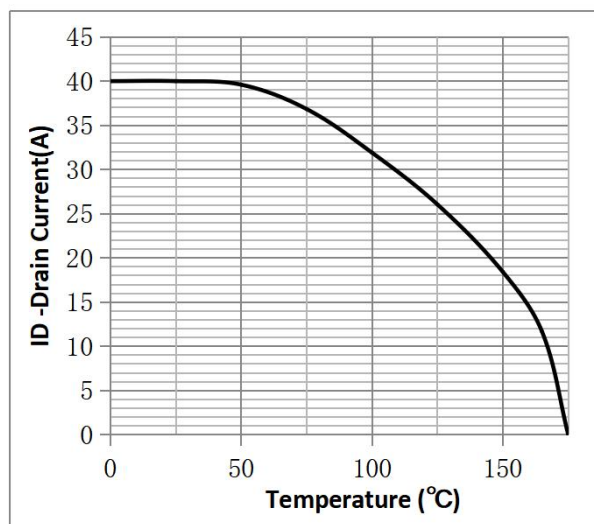
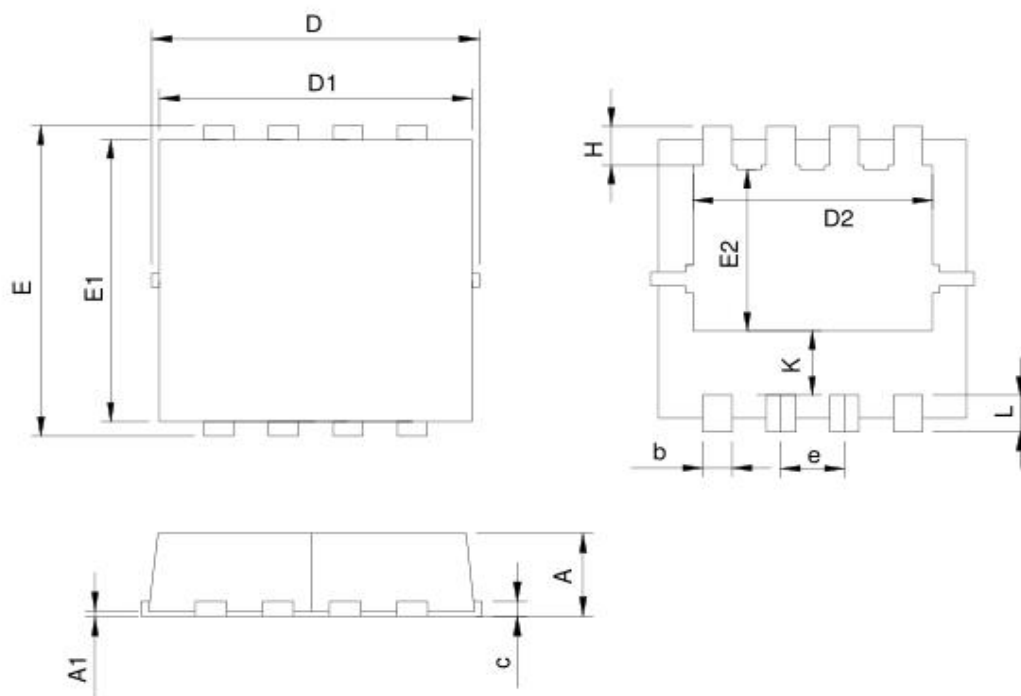


Fig.12 ID vs. Case Temperature<sup>③</sup>

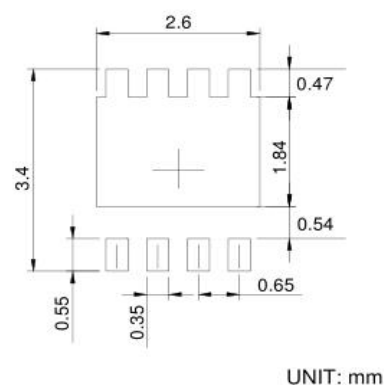


•DFN3\*3 Package Outline



| SYMBOL | DFN3.3x3.3-8 |      |           |       |
|--------|--------------|------|-----------|-------|
|        | MILLIMETERS  |      | INCHES    |       |
|        | MIN.         | MAX. | MIN.      | MAX.  |
| A      | 0.70         | 1.00 | 0.028     | 0.039 |
| A1     | 0.00         | 0.05 | 0.000     | 0.002 |
| b      | 0.25         | 0.35 | 0.010     | 0.014 |
| c      | 0.14         | 0.20 | 0.006     | 0.008 |
| D      | 3.10         | 3.50 | 0.122     | 0.138 |
| D1     | 3.05         | 3.25 | 0.120     | 0.128 |
| D2     | 2.35         | 2.55 | 0.093     | 0.100 |
| E      | 3.10         | 3.50 | 0.122     | 0.138 |
| E1     | 2.90         | 3.10 | 0.114     | 0.122 |
| E2     | 1.64         | 1.84 | 0.065     | 0.072 |
| e      | 0.65 BSC     |      | 0.026 BSC |       |
| H      | 0.32         | 0.52 | 0.013     | 0.020 |
| K      | 0.59         | 0.79 | 0.023     | 0.031 |
| L      | 0.25         | 0.55 | 0.010     | 0.022 |

**RECOMMENDED LAND PATTERN**



**Note:**

- ① Pulse :  $V_{GS}=+20V/-20V$ , Duty cycle=50%,  $T_j=175^{\circ}C$ ,  $t=1000$  hours; For DC , the following test conditions can be passed:  $V_{GS}=+20V/-10V$ ,  $T_j=175^{\circ}C$ ,  $t=1000$  hours;
- ② Device mounted on FR-4 substrate PC board, 2oz copper, with thermal bias to bottom layer 1inch square copper plate;
- ③ Practically the current will be limited by PCB, thermal design and operating temperature.  $V_{GS}=10V$ .

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## Revision History

| Version | Date       | Change                                                                                               |
|---------|------------|------------------------------------------------------------------------------------------------------|
| A       | 2020.3.10  | NEW                                                                                                  |
| B       | 2022.10.30 | 1.Add dynamic characteristics<br>2.Fig1~12 modify 3.Modify ID curve<br>4.Add Dynamic characteristics |
|         |            |                                                                                                      |
|         |            |                                                                                                      |
|         |            |                                                                                                      |
|         |            |                                                                                                      |
|         |            |                                                                                                      |
|         |            |                                                                                                      |