

## TRANSIENT VOLTAGE SUPPRESSOR

# VRD

VRD is a transient voltage suppressor used for protecting electric circuits from surge voltage and thus preventing breakdown.

VRD has superior surge suppression characteristics, such as extremely fast response time, very low clamping voltage, and high surge capacity. Unlike metal oxide varistors, VRD does not have characteristics to change with surge variations within the rated capacity. This feature comprises another superior characteristics of the VRD as a transient voltage suppressors.



### Part number

|                       |   |
|-----------------------|---|
| <b>Z2 033 U - 52Z</b> | 52Z : Axial tapping winding type                    |
|                       | 52R : Axial tapping relay type                      |
|                       | FT : Radial form tapping type                       |
|                       | Nil : individually packed in a bag                  |
|                       | U : Uni-Polar                                       |
|                       | Nil : Bi-Polar                                      |
|                       | Break down voltage                                  |
|                       | Type  |
|                       | Z2 : Rated electricity 1.0W                         |
|                       | Z6 : Rated electricity 2.0W                         |
|                       | ZD : Rated electricity 0.5W (reverse blocking type) |

### Electrical characteristics

Figure 1 shows the electrical characteristics. Bipolar type has almost symmetrical breakdown Voltage ( $V_B$ ) The reverse breakdown voltage of the ZD type is 200 Volts or more at  $10\mu A$  DC.



Fig 1

### Taping

One of standard taping is as shown in Figure.



Fig 2

Unit:(mm)

### Taping qty

| Part series | Taping method  | Qty(pcs)     |       |
|-------------|----------------|--------------|-------|
| Z2,Z2U      | Axial tapping  | reel type    | 5,000 |
|             |                | winding type | 2,000 |
|             | Radial tapping | winding type | 2,000 |
|             |                |              |       |
| Z6,Z6U      | Axial tapping  | reel type    | 2,500 |
|             |                | winding type | 1,000 |

### Surge capability

Allowable surge capability ( $P_{PPM}$ ) is determined by the following equation:

$$P_{PPM} = I_{PPM} \times V_C$$

$I_{PPM}$ : Rated peak impulse current

$V_C$ : clamping voltage

The allowable surge capability (Rated peak impulse power dissipation  $P_{PPM}$ ) of VRD is shown in following Figure 3 and the surge capability derating characteristics are shown in Figure 6.

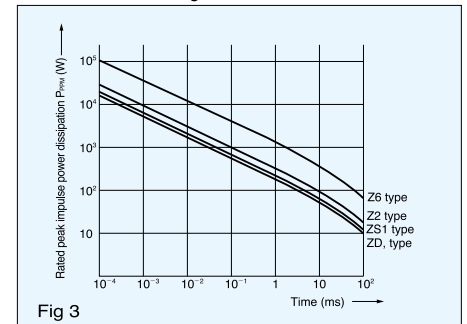


Fig 3

### Surge waveform

There are many types of surge waveform depending on the source of the surge. For the VRD surge suppression characteristics test, the EXP waveform shown below is used. The EXP waveform is shown as  $t_a/t_b$  depending on the time width, however 10/1000 waveform is used as the standard test waveform.

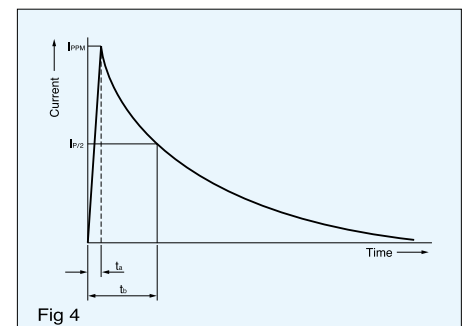


Fig 4

### Surge suppression characteristics

When EXP waveform is applied, the surge suppression waveform shown in the figure 5 can be observed.



### Power derating



### Z2 type VRD has bipolar or unipolar electrical characteristics.

Maximum ratings

Rated peak impulse power dissipation  
:500 W (10/1000 $\mu$ s)  
6.00 kW (8/20 $\mu$ s)

Rated average power dissipation:1W  
Operating and storage temperature  
: -40°C to 125°C

Symbol mark



| Part No.      |                | Stand-off voltage<br>$V_s$<br>V | Stand-by current<br>$I_b$<br>$\mu$ A | Breakdown voltage<br>$V_{(BR)}$<br>V | Pulsed d.c. test current<br>$I_T$<br>mA | Clamping Voltage & Rated peak impulse current |                |              |                | Temperature coefficient (TYP) | Capacitance (TYP) pF |
|---------------|----------------|---------------------------------|--------------------------------------|--------------------------------------|---|---|----------------|--------------|----------------|-------------------------------|----------------------|
| Bi-polar type | Uni-polar type |                                 |                                      |                                      |   | 10/1000 $\mu$ s                               |                | 8/20 $\mu$ s |                |                               |                      |
|               |                |                                 |                                      |                                      |   | $V_C$<br>V                                    | $I_{PPM}$<br>A | $V_C$<br>V   | $I_{PPM}$<br>A |                               |                      |
| -             | Z2008U         | 6.63                            | 500                                  | 7.38-9.02                            | 10                                      | 12.5  | 40.0           | 16.3         | 372            | 0.063                         | 2400                 |
| -             | Z2010U         | 8.10                            | 20                                   | 9.00-11.0                            |   | 15.0  | 33.4           | 19.5         | 311            | 0.071                         | 1900                 |
| Z2012         | -              | 9.72                            |                                      | 10.8-13.2                            |   | 17.3  | 28.9           | 22.7         | 267            | 0.066                         | 790                  |
| -             | Z2012U         |                                 |                                      | 10.8-13.2                            |   |   |                |              |                | 0.074                         | 1580                 |
| Z2015         | -              | 12.1                            |                                      | 13.5-16.5                            |   | 22.0  | 22.7           | 28.4         | 213            | 0.075                         | 640                  |
| -             | Z2015U         |                                 |                                      | 13.5-16.5                            |   |   |                |              |                | 0.079                         | 1280                 |
| Z2018         | -              | 14.5                            |                                      | 16.2-19.8                            |   | 26.5  | 18.8           | 34.0         | 178            | 0.079                         | 520                  |
| -             | Z2018U         |                                 |                                      | 16.2-19.8                            |   |   |                |              |                | 0.083                         | 1040                 |
| Z2022         | -              | 17.8                            |                                      | 19.8-24.2                            |   | 31.9  | 15.7           | 41.2         | 147            | 0.082                         | 420                  |
| -             | Z2022U         |                                 |                                      | 19.8-24.2                            |   |   |                |              |                | 0.086                         | 840                  |
| Z2027         | -              | 21.8                            |                                      | 24.3-29.7                            |   | 39.1  | 12.8           | 50.5         | 120            | 0.085                         | 340                  |
| -             | Z2027U         |                                 |                                      | 24.3-29.7                            |   |   |                |              |                | 0.089                         | 680                  |
| Z2033         | -              | 26.8                            |                                      | 29.7-36.3                            |   | 47.7  | 10.5           | 61.7         | 98.2           | 0.087                         | 280                  |
| -             | Z2033U         |                                 |                                      | 29.7-36.3                            |   |   |                |              |                | 0.092                         | 560                  |
| Z2039         | -              | 31.6                            |                                      | 35.1-42.9                            |   | 56.4  | 8.86           | 73.0         | 83.0           | 0.090                         | 240                  |
| -             | Z2039U         |                                 |                                      | 35.1-42.9                            |   |   |                |              |                | 0.095                         | 480                  |
| Z2047         | -              | 38.1                            | 5                                    | 42.3-51.7                            | 1                                       | 67.8  | 7.37           | 88.0         | 68.9           | 0.092                         | 200                  |
| -             | Z2047U         |                                 |                                      | 42.3-51.7                            |   |   |                |              |                | 0.097                         | 400                  |
| Z2056         | -              | 45.4                            |                                      | 50.4-61.6                            |   | 80.5  | 6.21           | 105.0        | 57.7           | 0.094                         | 160                  |
| -             | Z2056U         |                                 |                                      | 50.4-61.6                            |   |   |                |              |                | 0.099                         | 320                  |
| Z2068         | -              | 55.1                            |                                      | 61.2-74.8                            |   | 98.0  | 5.10           | 127.0        | 47.7           | 0.096                         | 130                  |
| -             | Z2068U         |                                 |                                      | 61.2-74.8                            |   |   |                |              |                | 0.100                         | 260                  |
| Z2082         | -              | 66.4                            |                                      | 73.8-90.2                            |   | 118.0   | 4.24           | 153.0        | 39.6           | 0.099                         | 110                  |
| -             | Z2082U         |                                 |                                      | 73.8-90.2                            |   |   |                |              |                | 0.102                         | 220                  |
| Z2100         | -              | 81.0                            |                                      | 90.0-110                             |   | 144.0   | 3.47           | 187.0        | 32.4           | 0.101                         | 90                   |
| -             | Z2100U         |                                 |                                      | 90.0-110                             |   |   |                |              |                | 0.104                         | 180                  |
| Z2120         | -              | 97.2                            |                                      | 108-132                              |   | 173.0   | 2.89           | 222.0        | 27.3           | 0.103                         | 75                   |
| -             | Z2120U         |                                 |                                      | 108-132                              |   |   |                |              |                | 0.106                         | 150                  |
| Z2150         | -              | 121.0                           |                                      | 135-165                              |   | 215.0   | 2.32           | 277.0        | 21.9           | 0.105                         | 60                   |
| -             | Z2150U         |                                 |                                      | 135-165                              |   |   |                |              |                | 0.107                         | 120                  |
| Z2180         | -              | 146.0                           |                                      | 162-198                              |   | 258.0   | 1.94           | 333.0        | 18.2           | 0.106                         | 49                   |
| -             | Z2180U         |                                 |                                      | 162-198                              |   |   |                |              |                | 0.108                         | 98                   |

NOTE: Nonsuffix:bi-polar, suffix"U" : uni-polar.

| Part No.      |                | Stand-off voltage<br>V <sub>s</sub><br>V | Stand-by current<br>I <sub>b</sub><br>μA | Breakdown voltage<br>V <sub>(BR)</sub><br>V | Pulsed d.c. test current<br>I <sub>T</sub><br>mA | Clamping Voltage & Rated peak impulse current |                       |                     |                       | Max. temp. coef.<br>%/°C | Capacitance (TYP)<br>pF |
|---------------|----------------|--|--|---|--|---|-----------------------|---------------------|-----------------------|--------------------------|-------------------------|
| Bi-polar type | Uni-polar type |  |  |   |  | 10/1000μs                                     |                       | 8/20μs              |                       |                          |                         |
|               |                |  |  |   |  | V <sub>C</sub><br>V                           | I <sub>PPM</sub><br>A | V <sub>C</sub><br>V | I <sub>PPM</sub><br>A |                          |                         |
| Z6012         | -              | 9.72                                     | 10                                       | 10.8-13.2                                   | 1  | 17.3  | 86.7                  | 22.7                | 802                   | 0.066                    | 4400                    |
| -             | Z6012U         |  |  | 10.8-13.2                                   |  |   |                       |                     |                       | 0.074                    | 8800                    |
| Z6015         | -              | 12.1                                     | 10                                       | 13.5-16.5                                   | 1  | 22.0  | 68.2                  | 28.4                | 641                   | 0.075                    | 3300                    |
| -             | Z6015U         |  |  | 13.5-16.5                                   |  |   |                       |                     |                       | 0.079                    | 6600                    |
| Z6018         | -              | 14.5                                     | 10                                       | 16.2-19.8                                   | 1  | 26.5  | 56.6                  | 34.0                | 535                   | 0.079                    | 2700                    |
| -             | Z6018U         |  |  | 16.2-19.8                                   |  |   |                       |                     |                       | 0.083                    | 5400                    |
| Z6022         | -              | 17.8                                     | 10                                       | 19.8-24.2                                   | 1  | 31.9  | 47.0                  | 41.2                | 442                   | 0.082                    | 2400                    |
| -             | Z6022U         |  |  | 19.8-24.2                                   |  |   |                       |                     |                       | 0.086                    | 4400                    |
| Z6027         | -              | 21.8                                     | 10                                       | 24.3-29.7                                   | 1  | 39.1  | 38.4                  | 50.5                | 360                   | 0.085                    | 1700                    |
| -             | Z6027U         |  |  | 24.3-29.7                                   |  |   |                       |                     |                       | 0.089                    | 3300                    |
| Z6033         | -              | 26.8                                     | 5  | 29.7-36.3                                   | 1  | 47.7  | 31.4                  | 61.7                | 295                   | 0.087                    | 1400                    |
| -             | Z6033U         |  |  | 29.7-36.3                                   |  |   |                       |                     |                       | 0.092                    | 2800                    |
| Z6039         | -              | 31.6                                     | 5  | 35.1-42.9                                   | 1  | 56.4  | 26.6                  | 73.0                | 249                   | 0.090                    | 1200                    |
| -             | Z6039U         |  |  | 35.1-42.9                                   |  |   |                       |                     |                       | 0.095                    | 2400                    |
| Z6047         | -              | 38.1                                     | 5  | 42.3-51.7                                   | 1  | 67.8  | 22.1                  | 88.0                | 207                   | 0.092                    | 1000                    |
| -             | Z6047U         |  |  | 42.3-51.7                                   |  |   |                       |                     |                       | 0.097                    | 2000                    |
| Z6056         | -              | 45.4                                     | 5  | 50.4-61.6                                   | 1  | 80.5  | 18.6                  | 105.0               | 173                   | 0.094                    | 850                     |
| -             | Z6056U         |  |  | 50.4-61.6                                   |  |   |                       |                     |                       | 0.099                    | 1700                    |
| Z6068         | -              | 55.1                                     | 5  | 61.2-74.8                                   | 1  | 98.0  | 15.3                  | 127.0               | 143                   | 0.096                    | 720                     |
| -             | Z6068U         |  |  | 61.2-74.8                                   |  |   |                       |                     |                       | 0.100                    | 1440                    |
| Z6082         | -              | 66.4                                     | 5  | 73.8-90.2                                   | 1  | 118.0   | 12.7                  | 153.0               | 119                   | 0.099                    | 610                     |
| -             | Z6082U         |  |  | 73.8-90.2                                   |  |   |                       |                     |                       | 0.102                    | 1220                    |
| Z6100         | -              | 81.0                                     | 5  | 90.0-110                                    | 1  | 144.0   | 10.4                  | 187.0               | 97.3                  | 0.101                    | 520                     |
| -             | Z6100U         |  |  | 90.0-110                                    |  |   |                       |                     |                       | 0.104                    | 1040                    |
| Z6120         | -              | 97.2                                     | 5  | 108-132                                     | 1  | 173.0   | 8.67                  | 222.0               | 82.0                  | 0.103                    | 440                     |
| -             | Z6120U         |  |  | 108-132                                     |  |   |                       |                     |                       | 0.106                    | 880                     |
| -             | Z6150U         | 121.0                                    | 5  | 135-165                                     | 1  | 215.0   | 6.98                  | 277.0               | 65.7                  | 0.107                    | 720                     |

NOTE : Nonsuffix : Bi-polar, suffix "U" : Uni-polar.

### Z6 type VRD has bipolar or unipolar electrical characteristics.

Maximum ratings  
 Rated peak impulse power dissipation : 1.5kW(10/1000μs)  
 18.0kW(8/20μs)  
 Rated average power dissipation: 2W  
 Operating and storage temperature : -40°C to 125°C

Symbol mark



| VRD part No. | Stand-off voltage<br>V <sub>s</sub><br>V | Stand-by current<br>I <sub>b</sub><br>μA | Breakdown voltage<br>V <sub>(BR)</sub><br>V | Pulsed d.c. test current<br>I <sub>T</sub><br>mA | Clamping Voltage & Rated peak impulse current |                       |                     |                       | Max. temp. coef.<br>%/°C | Capacitance (TYP)<br>pF |
|--------------|--|--|---|--|---|-----------------------|---------------------|-----------------------|--------------------------|-------------------------|
|              |  |  |   |  | 10/1000μs                                     |                       | 8/20μs              |                       |                          |                         |
|              |  |  |   |  | V <sub>C</sub><br>V                           | I <sub>PPM</sub><br>A | V <sub>C</sub><br>V | I <sub>PPM</sub><br>A |                          |                         |
| ZD015        | 11.4                                     | 10                                       | 12.8-17.2                                   | 1  | 24.0  | 10.4                  | 31.0                | 96.7                  | 0.075                    | 31.5                    |
| ZD018        | 13.7                                     |  | 15.3-20.7                                   |  | 28.0  | 8.93                  | 36.0                | 83.3                  | 0.079                    | 31.0                    |
| ZD022        | 16.8                                     | 5  | 18.7-25.3                                   | 1  | 33.2  | 7.53                  | 43.0                | 69.7                  | 0.082                    | 29.0                    |
| ZD027        | 20.6                                     |  | 23.0-31.0                                   |  | 40.0  | 6.25                  | 52.0                | 57.7                  | 0.085                    | 28.2                    |
| ZD033        | 25.2                                     | 5  | 28.1-37.9                                   | 1  | 48.6  | 5.14                  | 63.0                | 47.6                  | 0.087                    | 27.2                    |
| ZD039        | 29.8                                     |  | 33.2-44.8                                   |  | 57.4  | 4.35                  | 74.0                | 40.5                  | 0.090                    | 26.3                    |
| ZD047        | 35.9                                     | 5  | 40.0-54.0                                   | 1  | 68.5  | 3.65                  | 89.0                | 33.7                  | 0.092                    | 25.0                    |
| ZD056        | 42.8                                     |  | 47.6-64.4                                   |  | 81.0  | 3.08                  | 106.0               | 28.6                  | 0.094                    | 24.1                    |
| ZD068        | 52.0                                     | 5  | 57.8-78.2                                   | 1  | 98.0  | 2.55                  | 127.0               | 23.8                  | 0.096                    | 22.0                    |

### Low capacitance type

Maximum ratings  
 Reverse voltage: 200 VDC  
 Rated peak impulse power dissipation : 250 W(10/1000μs)  
 3.00 kW(8/20μs)  
 Rated average power dissipation: 500 mW  
 Operating and storage temperature : -40°C to 125°C

Symbol mark



# SMD VRD

## Part number



## Dimensions



## Marking



|                                      | Rating                |
|--------------------------------------|-----------------------|
| Rated average power dissipation      | 1.0W                  |
| Rated peak impulse power dissipation | 300W(10/1000 $\mu$ s) |
|                                      | 1200W(1.2/50 $\mu$ s) |
|                                      | 2000W(8/20 $\mu$ s)   |
| Storage temp. range                  | -40°C~150°C           |

## Taping



| A              | B              | W                  | F                  | E              | P <sub>1</sub> |
|----------------|----------------|--------------------|--------------------|----------------|----------------|
| 3.0<br>±0.1    | 5.2<br>±0.1    | 12.0<br>±0.3       | 5.5<br>±0.05       | 1.75<br>±0.1   | 4.0<br>±0.1    |
| P <sub>2</sub> | P <sub>0</sub> | phi D <sub>0</sub> | phi D <sub>1</sub> | T <sub>1</sub> | T <sub>2</sub> |
| 2.0<br>±0.1    | 4.0<br>±0.1    | 1.5<br>+0.1<br>-0  | 1.5<br>+0.2<br>-0  | 0.3<br>±0.05   | (2.6)          |

Unit (mm)

## Specifications

### ZS type

| Part No. | Breakdown voltage | Stand-off voltage | Stand-by current | Maximum clamping voltage & Maximum peak pulse current |      |              |      | Temperature coefficient (TYP) | Capacitance (TYP) |           |
|----------|-------------------|-------------------|------------------|---|------|--------------|------|-------------------------------|-------------------|-----------|
|          |                   |                   |                  | V <sub>Cmax</sub> /I <sub>PPM</sub>                   |      |              |      |                               |                   | 25°C~50°C |
|          |                   |                   |                  | 10/1000 $\mu$ s                                       |      | 8/20 $\mu$ s |      |                               |                   |           |
|          |                   |                   |                  | V   | A    | V            | A    |                               |                   |           |
| ZS1012   | 12(10.8~13.2)     | 9.72              | 10               | 17.3  | 17.3 | 22.4         | 89.3 | 0.066                         | 551               |           |
| ZS1015   | 15(13.5~16.5)     | 12.1              | 5                | 22.0  | 13.6 | 28.5         | 70.2 | 0.075                         | 465               |           |
| ZS1018   | 18(16.2~19.8)     | 14.5              |                  | 26.5  | 11.3 | 34.4         | 58.1 | 0.079                         | 376               |           |
| ZS1022   | 22(19.8~24.2)     | 17.8              |                  | 31.9  | 9.40 | 41.4         | 48.3 | 0.082                         | 299               |           |
| ZS1027   | 27(24.3~29.7)     | 21.8              |                  | 39.1  | 7.67 | 50.7         | 39.4 | 0.085                         | 248               |           |
| ZS1033   | 33(29.7~36.3)     | 26.8              |                  | 47.7  | 6.29 | 61.8         | 32.4 | 0.087                         | 198               |           |
| ZS1039   | 39(35.1~42.9)     | 31.6              |                  | 56.4  | 5.32 | 73.1         | 27.4 | 0.090                         | 164               |           |
| ZS1047   | 47(42.3~51.7)     | 38.1              |                  | 67.8  | 4.42 | 88.0         | 22.7 | 0.092                         | 137               |           |

### ZS-U type

| Part No. | Breakdown voltage | Stand-off voltage | Stand-by current | Maximum clamping voltage & Maximum peak pulse current |      |              |      | Temperature coefficient (TYP) | Capacitance (TYP) |           |
|----------|-------------------|-------------------|------------------|---|------|--------------|------|-------------------------------|-------------------|-----------|
|          |                   |                   |                  | V <sub>Cmax</sub> /I <sub>PPM</sub>                   |      |              |      |                               |                   | 25°C~50°C |
|          |                   |                   |                  | 10/1000 $\mu$ s                                       |      | 8/20 $\mu$ s |      |                               |                   |           |
|          |                   |                   |                  | V   | A    | V            | A    |                               |                   |           |
| ZS1012U  | 12(10.8~13.2)     | 9.72              | 10               | 17.3  | 17.3 | 22.4         | 89.3 | 0.066                         | 1,102             |           |
| ZS1015U  | 15(13.5~16.5)     | 12.1              | 5                | 22.0  | 13.6 | 28.5         | 70.2 | 0.075                         | 929               |           |
| ZS1018U  | 18(16.2~19.8)     | 14.5              |                  | 26.5  | 11.3 | 34.4         | 58.1 | 0.079                         | 751               |           |
| ZS1022U  | 22(19.8~24.2)     | 17.8              |                  | 31.9  | 9.40 | 41.4         | 48.3 | 0.082                         | 598               |           |
| ZS1027U  | 27(24.3~29.7)     | 21.8              |                  | 39.1  | 7.67 | 50.7         | 39.4 | 0.085                         | 497               |           |
| ZS1033U  | 33(29.7~36.3)     | 26.8              |                  | 47.7  | 6.29 | 61.8         | 32.4 | 0.087                         | 395               |           |
| ZS1039U  | 39(35.1~42.9)     | 31.6              |                  | 56.4  | 5.32 | 73.1         | 27.4 | 0.090                         | 328               |           |
| ZS1047U  | 47(42.3~51.7)     | 38.1              |                  | 67.8  | 4.42 | 88.0         | 22.7 | 0.092                         | 274               |           |

### ZS-D type

| Part No. | Breakdown voltage | Stand-off voltage | Stand-by current | Maximum clamping voltage & Maximum peak pulse current |      |              |      | Temperature coefficient (TYP) | Capacitance (TYP) |           |
|----------|-------------------|-------------------|------------------|---|------|--------------|------|-------------------------------|-------------------|-----------|
|          |                   |                   |                  | V <sub>Cmax</sub> /I <sub>PPM</sub>                   |      |              |      |                               |                   | 25°C~50°C |
|          |                   |                   |                  | 10/1000 $\mu$ s                                       |      | 8/20 $\mu$ s |      |                               |                   |           |
|          |                   |                   |                  | V   | A    | V            | A    |                               |                   |           |
| ZS1012D  | 12(10.8~13.2)     | 9.72              | 10               | 17.3  | 17.3 | 22.4         | 89.3 | 0.066                         | 30.2              |           |
| ZS1015D  | 15(13.5~16.5)     | 12.1              | 5                | 22.0  | 13.6 | 28.5         | 70.2 | 0.075                         | 29.1              |           |
| ZS1018D  | 18(16.2~19.8)     | 14.5              |                  | 26.5  | 11.3 | 34.4         | 58.1 | 0.079                         | 28.2              |           |
| ZS1022D  | 22(19.8~24.2)     | 17.8              |                  | 31.9  | 9.40 | 41.4         | 48.3 | 0.082                         | 27.3              |           |
| ZS1027D  | 27(24.3~29.7)     | 21.8              |                  | 39.1  | 7.67 | 50.7         | 39.4 | 0.085                         | 26.4              |           |
| ZS1033D  | 33(29.7~36.3)     | 26.8              |                  | 47.7  | 6.29 | 61.8         | 32.4 | 0.087                         | 25.5              |           |
| ZS1039D  | 39(35.1~42.9)     | 31.6              |                  | 56.4  | 5.32 | 73.1         | 27.4 | 0.090                         | 24.8              |           |
| ZS1047D  | 47(42.3~51.7)     | 38.1              |                  | 67.8  | 4.42 | 88.0         | 22.7 | 0.092                         | 24.0              |           |