



# P-DUKE POWER

## FED20 Series

DC-DC Converter  
Up to 20 Watts

### 3

YEARS  
WARRANTY

ROHS  
COMPLIANT

REACH  
COMPLIANT



Automation



Datacom



IPC



Industry



Measurement



Telecom



Automobile



Boat



Charger



Medical



PV



Railway

c US

CB CE

1600  
VDC  
Isolation  
Voltage

2 : 1  
Input  
Range

6  
sided  
Shielding

NO  
Min. Load  
Required

REMOTE  
ON  
OFF

OCP

OVP

SCP

### PART NUMBER STRUCTURE

| FED20       | - | 48                              | S               | 05                                                                 | - | M3                                                                                                                        | N                                                                    | HC                                                                  |
|-------------|---|---------------------------------|-----------------|--------------------------------------------------------------------|---|---------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|---------------------------------------------------------------------|
| Series Name |   | Input Voltage (VDC)             | Output Quantity | Output Voltage (VDC)                                               |   | Operating Temp. Options                                                                                                   | Remote On/Off Options                                                | Assembly Options                                                    |
|             |   | 12:9~18<br>24:18~36<br>48:36~75 | S:Single        | 1P5:1.5<br>1P8:1.8<br>2P5:2.5<br>3P3:3.3<br>05:5<br>12:12<br>15:15 |   | <input type="checkbox"/> :Standard<br>-40~+100°C<br>With derating<br><b>M3</b> :M3 Version<br>-55~+100°C<br>With derating | <input type="checkbox"/> :Positive logic<br><b>N</b> :Negative logic | <input type="checkbox"/> : None<br><b>HC</b> : Heat-sink with Clamp |
|             |   |                                 | D: Dual         | 12:±12<br>15:±15                                                   |   |                                                                                                                           |                                                                      |                                                                     |

## TECHNICAL SPECIFICATION All specifications are typical at nominal input, full load and 25°C unless otherwise noted

| Model Number | Input Range | Output Voltage | Output Current @Full Load | Input Current @ No Load | Efficiency | Maximum Capacitor Load |
|--------------|-------------|----------------|---------------------------|-------------------------|------------|------------------------|
|              | VDC         | VDC            | mA                        | mA                      | %          | μF                     |
| FED20-12S1P5 | 9 ~ 18      | 1.5            | 6000                      | 70                      | 78         | 65000                  |
| FED20-12S1P8 | 9 ~ 18      | 1.8            | 6000                      | 75                      | 79         | 65000                  |
| FED20-12S2P5 | 9 ~ 18      | 2.5            | 6000                      | 80                      | 83         | 33000                  |
| FED20-12S3P3 | 9 ~ 18      | 3.3            | 5000                      | 115                     | 85         | 13000                  |
| FED20-12S05  | 9 ~ 18      | 5              | 4000                      | 75                      | 87         | 6800                   |
| FED20-12S12  | 9 ~ 18      | 12             | 1670                      | 90                      | 86         | 2200                   |
| FED20-12S15  | 9 ~ 18      | 15             | 1330                      | 35                      | 86         | 755                    |
| FED20-12D12  | 9 ~ 18      | ±12            | ±833                      | 45                      | 86         | ±680                   |
| FED20-12D15  | 9 ~ 18      | ±15            | ±667                      | 50                      | 86         | ±450                   |
| FED20-24S1P5 | 18 ~ 36     | 1.5            | 6000                      | 35                      | 80         | 65000                  |
| FED20-24S1P8 | 18 ~ 36     | 1.8            | 6000                      | 45                      | 81         | 65000                  |
| FED20-24S2P5 | 18 ~ 36     | 2.5            | 6000                      | 40                      | 84         | 33000                  |
| FED20-24S3P3 | 18 ~ 36     | 3.3            | 5000                      | 30                      | 86         | 13000                  |
| FED20-24S05  | 18 ~ 36     | 5              | 4000                      | 35                      | 89         | 6800                   |
| FED20-24S12  | 18 ~ 36     | 12             | 1670                      | 55                      | 87         | 2200                   |
| FED20-24S15  | 18 ~ 36     | 15             | 1330                      | 40                      | 87         | 755                    |
| FED20-24D12  | 18 ~ 36     | ±12            | ±833                      | 30                      | 87         | ±680                   |
| FED20-24D15  | 18 ~ 36     | ±15            | ±667                      | 30                      | 88         | ±450                   |
| FED20-48S1P5 | 36 ~ 75     | 1.5            | 6000                      | 15                      | 80         | 65000                  |
| FED20-48S1P8 | 36 ~ 75     | 1.8            | 6000                      | 20                      | 82         | 65000                  |
| FED20-48S2P5 | 36 ~ 75     | 2.5            | 6000                      | 30                      | 84         | 33000                  |
| FED20-48S3P3 | 36 ~ 75     | 3.3            | 5000                      | 15                      | 87         | 13000                  |
| FED20-48S05  | 36 ~ 75     | 5              | 4000                      | 20                      | 89         | 6800                   |
| FED20-48S12  | 36 ~ 75     | 12             | 1670                      | 35                      | 88         | 2200                   |
| FED20-48S15  | 36 ~ 75     | 15             | 1330                      | 50                      | 87         | 755                    |
| FED20-48D12  | 36 ~ 75     | ±12            | ±833                      | 20                      | 88         | ±680                   |
| FED20-48D15  | 36 ~ 75     | ±15            | ±667                      | 20                      | 88         | ±450                   |

## INPUT SPECIFICATIONS

| Parameter                     | Conditions                                                                                                                                                                        | Min.          | Typ.           | Max.                                                                                         | Unit     |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------------|----------------------------------------------------------------------------------------------|----------|
| Operating input voltage range | 12Vin(nom)<br>24Vin(nom)<br>48Vin(nom)                                                                                                                                            | 9<br>18<br>36 | 12<br>24<br>48 | 18<br>36<br>75                                                                               | VDC      |
| Start up time                 | Constant resistive load<br>Power up<br>Remote ON/OFF                                                                                                                              |               | 10<br>10       |                                                                                              | ms       |
| Input surge voltage           | 100 ms, max.<br>12Vin(nom)<br>24Vin(nom)<br>48Vin(nom)                                                                                                                            |               |                | 36<br>50<br>100                                                                              | VDC      |
| Input filter                  |                                                                                                                                                                                   |               |                | L-C type                                                                                     |          |
| Remote ON/OFF                 | Referred to -Vin pin<br>Positive logic DC-DC ON<br>(Standard) DC-DC OFF<br>Negative logic DC-DC ON<br>(Option) DC-DC OFF<br>Input current of Ctrl pin<br>Remote off input current | -0.5          | 2.5            | Open or 3 ~ 12VDC<br>Short or 0 ~ 1.2VDC<br>Short or 0 ~ 1.2VDC<br>Open or 3 ~ 12VDC<br>+0.5 | mA<br>mA |

**OUTPUT SPECIFICATIONS**

| Parameter                        | Conditions                                           |         |                                 | Min.                            | Typ.            | Max.  | Unit  |
|----------------------------------|------------------------------------------------------|---------|---------------------------------|---------------------------------|-----------------|-------|-------|
| Voltage accuracy                 | Low Line to High Line at Full Load                   |         |                                 | -1.0                            |                 | +1.0  | %     |
| Line regulation                  | No Load to Full Load                                 |         |                                 | -0.2                            |                 | +0.2  | %     |
| Load regulation                  | Asymmetrical load 25%/100% FL                        |         |                                 | -0.5                            |                 | +0.5  | %     |
| Cross regulation                 | Single                                               | Dual    |                                 | -5.0                            |                 | +5.0  | %     |
| Voltage adjustability            | Single output                                        |         |                                 | -10                             |                 | +10   | %     |
| Ripple and noise                 | Measured by 20MHz bandwidth<br>With a 0.1μF/50V MLCC | Single  | Others<br>5Vout, 12Vout, 15Vout |                                 | 60<br>75<br>100 |       | mVp-p |
|                                  |                                                      | Dual    | All                             |                                 |                 |       |       |
| Temperature coefficient          | 25% load step change                                 |         |                                 | -0.02                           |                 | +0.02 | %/°C  |
| Transient response recovery time | Zener diode clamp                                    |         |                                 |                                 | 250             |       | μs    |
| Over voltage protection          |                                                      | 1.5Vout |                                 |                                 | 3.9             |       | VDC   |
|                                  |                                                      | 1.8Vout |                                 |                                 | 3.9             |       |       |
|                                  |                                                      | 2.5Vout |                                 |                                 | 3.9             |       |       |
|                                  |                                                      | 3.3Vout |                                 |                                 | 3.9             |       |       |
|                                  |                                                      | 5Vout   |                                 |                                 | 6.2             |       |       |
|                                  |                                                      | 12Vout  |                                 |                                 | 15              |       |       |
|                                  |                                                      | 15Vout  |                                 |                                 | 18              |       |       |
| Over load protection             | % of Iout rated                                      |         |                                 |                                 |                 | 150   | %     |
| Short circuit protection         |                                                      |         |                                 | Continuous, automatics recovery |                 |       |       |

**GENERAL SPECIFICATIONS**

| Parameter             | Conditions               |                                          | Min.         | Typ. | Max.                         | Unit |
|-----------------------|--------------------------|------------------------------------------|--------------|------|------------------------------|------|
| Isolation voltage     | 1 minute                 | Input to Output<br>Input(Output) to Case | 1600<br>1600 |      |                              | VDC  |
| Isolation resistance  | 500VDC                   |                                          | 1            |      |                              | GΩ   |
| Isolation capacitance |                          |                                          |              |      | 1000                         | pF   |
| Switching frequency   |                          |                                          | 450          | 500  | 550                          | kHz  |
| Safety approvals      | IEC/ EN/ UL 62368-1      |                                          |              |      | UL:E193009<br>CB: UL(Demko)  |      |
| Case material         |                          |                                          |              |      | Nickel-coated copper         |      |
| Base material         |                          |                                          |              |      | Non-conductive black plastic |      |
| Potting material      |                          |                                          |              |      | Epoxy (UL94 V-0)             |      |
| Weight                |                          |                                          |              |      | 27g (0.95oz)                 |      |
| MTBF                  | MIL-HDBK-217F, Full load |                                          |              |      | 1.583 x 10 <sup>6</sup> hrs  |      |

**ENVIRONMENTAL SPECIFICATIONS**

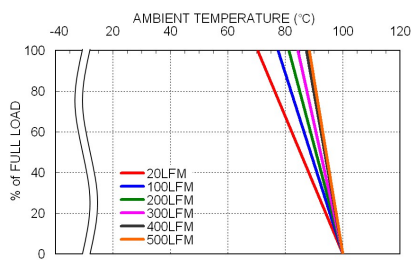
| Parameter                     | Conditions        |               | Min. | Typ. | Max.         | Unit |
|-------------------------------|-------------------|---------------|------|------|--------------|------|
| Operating ambient temperature | Standard<br>M3    | With derating | -40  |      | +100         | °C   |
|                               |                   | With derating | -55  |      | +100         |      |
| Maximum case temperature      |                   |               |      |      | 100          | °C   |
| Storage temperature range     |                   |               | -55  |      | +125         | °C   |
| Thermal impedance             | Without heat-sink |               |      | 12   |              | °C/W |
|                               | With heat-sink    |               |      | 10   |              |      |
| Thermal shock                 |                   |               |      |      | MIL-STD-810F |      |
| Vibration                     |                   |               |      |      | MIL-STD-810F |      |
| Relative humidity             |                   |               |      |      | 5% to 95% RH |      |

## EMC SPECIFICATIONS

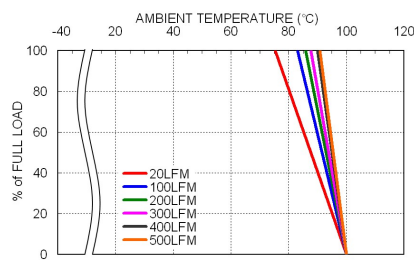
| Parameter                      | Conditions  |                                                                                                         | Level            |
|--------------------------------|-------------|---------------------------------------------------------------------------------------------------------|------------------|
| EMI                            | EN55032     | With external components                                                                                | Class A, Class B |
| EMS                            | EN55024     |                                                                                                         |                  |
| ESD                            | EN61000-4-2 | Air $\pm 8\text{kV}$ and Contact $\pm 6\text{kV}$                                                       | Perf. Criteria B |
| Radiated immunity              | EN61000-4-3 | 10 V/m                                                                                                  | Perf. Criteria A |
| Fast transient                 | EN61000-4-4 | $\pm 2\text{kV}$                                                                                        | Perf. Criteria A |
| Surge                          | EN61000-4-5 | With an external input filter capacitor<br>(Nippon chemi-con KY series, 220 $\mu\text{F}/100\text{V}$ ) | Perf. Criteria B |
|                                |             | $\pm 1\text{kV}$                                                                                        |                  |
| Conducted immunity             | EN61000-4-6 | 10 Vr.m.s                                                                                               | Perf. Criteria A |
| Power frequency magnetic field | EN61000-4-8 | 100A/m continuous; 1000A/m 1 second                                                                     | Perf. Criteria A |

**CAUTION:** This power module is not internally fused. An input line fuse must always be used.

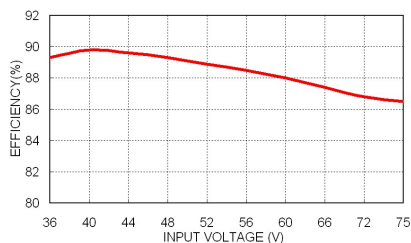
## CHARACTERISTIC CURVE



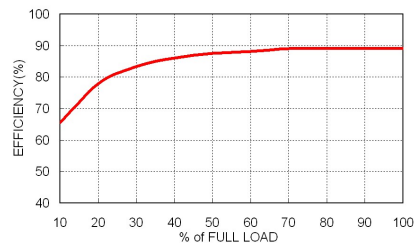
FED20-48S05 Derating Curve



FED20-48S05 Derating Curve With Heat-sink



FED20-48S05 Efficiency vs. Input Voltage



FED20-48S05 Efficiency vs. Output Load

## FUSE CONSIDERATION

This power module is not internally fused. An input line fuse must always be used.

This encapsulated power module can be used in a wide variety of applications, ranging from simple stand-alone operation to an integrated part of sophisticated power architecture.

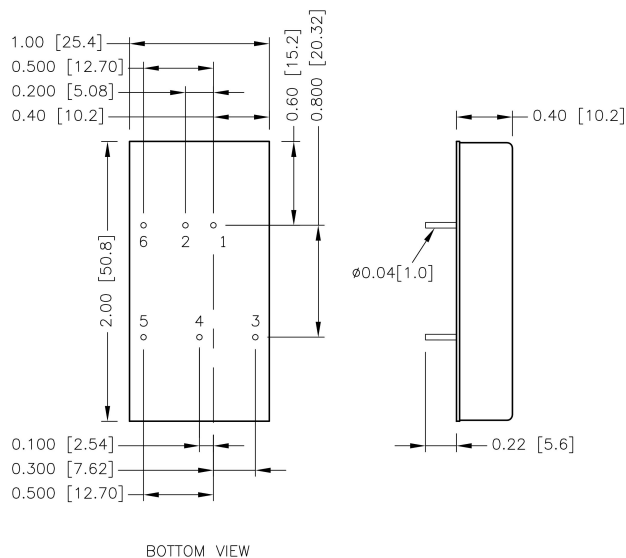
To maximum flexibility, internal fusing is not included; however, to achieve maximum safety and system protection, always use an input line fuse.

The input line fuse suggest as below :

| Model                   | Fuse Rating (A) | Fuse Type |
|-------------------------|-----------------|-----------|
| FED20-12S□□、FED20-12D□□ | 4               | Slow-Blow |
| FED20-24S□□、FED20-24D□□ | 2               | Slow-Blow |
| FED20-48S□□、FED20-48D□□ | 1.25            | Slow-Blow |

The table based on the information provided in this data sheet on inrush energy and maximum DC input current at low Vin.

## MECHANICAL DRAWING



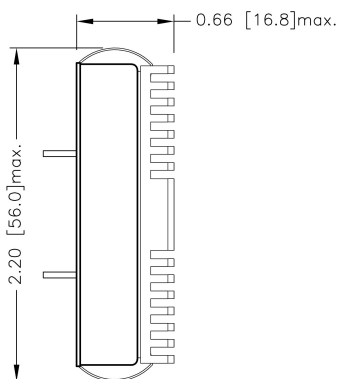
### PIN CONNECTION

| PIN | SINGLE | DUAL   |
|-----|--------|--------|
| 1   | +Vin   | +Vin   |
| 2   | -Vin   | -Vin   |
| 3   | +Vout  | +Vout  |
| 4   | Trim   | Common |
| 5   | -Vout  | -Vout  |
| 6   | Ctrl   | Ctrl   |

1. All dimensions in inch [mm]
2. Tolerance :x.xx±0.02 [x.x±0.5]  
x.xxx±0.01 [x.xx±0.25]
3. Pin pitch tolerance ±0.01 [0.25]
4. Pin dimension tolerance ±0.004[0.10]

## HEAT-SINK OPTIONS

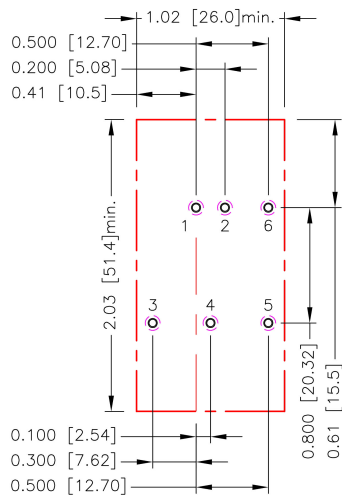
-HC (Heat-sink with clamps)



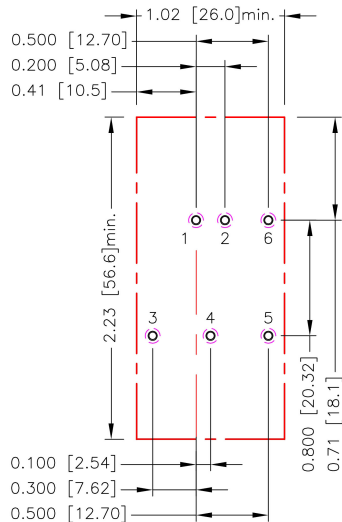
\* All dimensions in inch [mm]

## RECOMMENDED PAD LAYOUT

### Standard



### -HC



All dimensions in inch[mm]  
 Pad size(lead free recommended)  
 Through hole 1.2.3.4.5.6:  $\varnothing 0.051[1.30]$   
 Top view pad 1.2.3.4.5.6:  $\varnothing 0.064[1.63]$   
 Bottom view pad 1.2.3.4.5.6:  $\varnothing 0.102[2.60]$

## THERMAL CONSIDERATIONS

The power module operates in a variety of thermal environments.

However, sufficient cooling should be provided to help ensure reliable operation of the unit.

Heat is removed by conduction, convection, and radiation to the surrounding Environment.

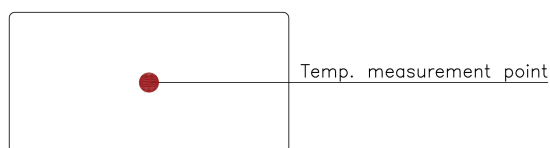
Proper cooling can be verified by measuring the point as the figure below.

The temperature at this location should not exceed "Maximum case temperature".

When Operating, adequate cooling must be provided to maintain the test point temperature at or below "Maximum case temperature".

You can limit this Temperature to a lower value for extremely high reliability.

- Thermal test condition with vertical direction by natural convection (20LFM).



TOP VIEW

## OUTPUT VOLTAGE ADJUSTMENT

Output voltage set point adjustment allows the user to increase or decrease the output voltage set point of the module.

This is accomplished by connecting an external resistor between the Trim pin and either the +Output or -Output pins.

With an external resistor between the Trim and -Vout, the output voltage set point increases.

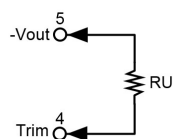
With an external resistor between the Trim and +Vout, the output voltage set point decreases.

The external Trim resistor needs to be at least 1/16W of rated power.

### EXTERNAL OUTPUT TRIMMING

Output can be externally trimmed by using the method shown below.

Trim-up



#### □□S1P5

| $\Delta V$ (%)   | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    |
|------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Vout (V)         | 1.515 | 1.530 | 1.545 | 1.560 | 1.575 | 1.590 | 1.605 | 1.620 | 1.635 | 1.650 |
| RU (k $\Omega$ ) | 4.578 | 2.065 | 1.227 | 0.808 | 0.557 | 0.389 | 0.270 | 0.180 | 0.110 | 0.054 |

#### □□S1P8

| $\Delta V$ (%)   | 1      | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    |
|------------------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Vout (V)         | 1.818  | 1.836 | 1.854 | 1.872 | 1.89  | 1.908 | 1.926 | 1.944 | 1.962 | 1.98  |
| RU (k $\Omega$ ) | 11.639 | 5.205 | 3.060 | 1.988 | 1.344 | 0.915 | 0.609 | 0.379 | 0.200 | 0.057 |

#### □□S2P5

| $\Delta V$ (%)   | 1      | 2      | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    |
|------------------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|
| Vout (V)         | 2.525  | 2.550  | 2.575 | 2.600 | 2.625 | 2.650 | 2.675 | 2.700 | 2.725 | 2.75  |
| RU (k $\Omega$ ) | 37.076 | 16.675 | 9.874 | 6.474 | 4.434 | 3.074 | 2.102 | 1.374 | 0.807 | 0.354 |

#### □□S3P3

| $\Delta V$ (%)   | 1      | 2      | 3      | 4      | 5     | 6     | 7     | 8     | 9     | 10    |
|------------------|--------|--------|--------|--------|-------|-------|-------|-------|-------|-------|
| Vout (V)         | 3.333  | 3.366  | 3.399  | 3.432  | 3.465 | 3.498 | 3.531 | 3.564 | 3.597 | 3.630 |
| RU (k $\Omega$ ) | 57.930 | 26.165 | 15.577 | 10.283 | 7.106 | 4.988 | 3.476 | 2.341 | 1.459 | 0.753 |

#### □□S05

| $\Delta V$ (%)   | 1      | 2      | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    |
|------------------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|
| Vout (V)         | 5.050  | 5.100  | 5.150 | 5.200 | 5.250 | 5.300 | 5.350 | 5.400 | 5.450 | 5.500 |
| RU (k $\Omega$ ) | 36.570 | 16.580 | 9.917 | 6.585 | 4.586 | 3.253 | 2.302 | 1.588 | 1.032 | 0.588 |

#### □□S12

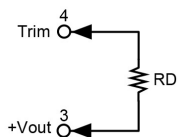
| $\Delta V$ (%)   | 1       | 2       | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     |
|------------------|---------|---------|--------|--------|--------|--------|--------|--------|--------|--------|
| Vout (V)         | 12.120  | 12.240  | 12.360 | 12.480 | 12.600 | 12.720 | 12.840 | 12.960 | 13.080 | 13.200 |
| RU (k $\Omega$ ) | 367.910 | 165.950 | 98.636 | 64.977 | 44.782 | 31.318 | 21.701 | 14.488 | 8.879  | 4.391  |

#### □□S15

| $\Delta V$ (%)   | 1       | 2       | 3       | 4      | 5      | 6      | 7      | 8      | 9      | 10     |
|------------------|---------|---------|---------|--------|--------|--------|--------|--------|--------|--------|
| Vout (V)         | 15.150  | 15.300  | 15.450  | 15.600 | 15.750 | 15.900 | 16.050 | 16.200 | 16.350 | 16.500 |
| RU (k $\Omega$ ) | 404.180 | 180.590 | 106.060 | 68.796 | 46.437 | 31.531 | 20.883 | 12.898 | 6.687  | 1.718  |

## OUTPUT VOLTAGE ADJUSTMENT(CONTINUED)

Trim-down



### □□S1P5

| $\Delta V$ (%)   | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    |
|------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Vout (V)         | 1.485 | 1.470 | 1.455 | 1.440 | 1.425 | 1.410 | 1.395 | 1.380 | 1.365 | 1.350 |
| RD (k $\Omega$ ) | 5.704 | 2.571 | 1.527 | 1.005 | 0.692 | 0.483 | 0.334 | 0.222 | 0.135 | 0.065 |

### □□S1P8

| $\Delta V$ (%)   | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    |
|------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Vout (V)         | 1.782 | 1.764 | 1.746 | 1.728 | 1.710 | 1.692 | 1.674 | 1.656 | 1.638 | 1.620 |
| RD (k $\Omega$ ) | 14.66 | 6.57  | 3.874 | 2.525 | 1.716 | 1.177 | 0.792 | 0.503 | 0.278 | 0.098 |

### □□S2P5

| $\Delta V$ (%)   | 1      | 2      | 3      | 4     | 5     | 6     | 7     | 8     | 9     | 10    |
|------------------|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|
| Vout (V)         | 2.475  | 2.450  | 2.425  | 2.400 | 2.375 | 2.350 | 2.325 | 2.300 | 2.275 | 2.250 |
| RD (k $\Omega$ ) | 49.641 | 22.481 | 13.428 | 8.902 | 6.186 | 4.375 | 3.082 | 2.112 | 1.358 | 0.754 |

### □□S3P3

| $\Delta V$ (%)   | 1      | 2      | 3      | 4      | 5     | 6     | 7     | 8     | 9     | 10    |
|------------------|--------|--------|--------|--------|-------|-------|-------|-------|-------|-------|
| Vout (V)         | 3.267  | 3.234  | 3.201  | 3.168  | 3.135 | 3.102 | 3.069 | 3.036 | 3.003 | 2.970 |
| RD (k $\Omega$ ) | 69.470 | 31.235 | 18.490 | 12.117 | 8.294 | 5.745 | 3.924 | 2.559 | 1.497 | 0.647 |

### □□S05

| $\Delta V$ (%)   | 1      | 2      | 3      | 4     | 5     | 6     | 7     | 8     | 9     | 10    |
|------------------|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|
| Vout (V)         | 4.950  | 4.900  | 4.850  | 4.800 | 4.750 | 4.700 | 4.650 | 4.600 | 4.550 | 4.500 |
| RD (k $\Omega$ ) | 45.533 | 20.612 | 12.306 | 8.152 | 5.660 | 3.999 | 2.812 | 1.922 | 1.230 | 0.676 |

### □□S12

| $\Delta V$ (%)   | 1       | 2       | 3       | 4      | 5      | 6      | 7      | 8      | 9      | 10     |
|------------------|---------|---------|---------|--------|--------|--------|--------|--------|--------|--------|
| Vout (V)         | 11.880  | 11.760  | 11.640  | 11.520 | 11.400 | 11.280 | 11.160 | 11.040 | 10.920 | 10.800 |
| RD (k $\Omega$ ) | 460.990 | 207.950 | 123.600 | 81.423 | 56.118 | 39.249 | 27.199 | 18.162 | 11.132 | 5.509  |

### □□S15

| $\Delta V$ (%)   | 1       | 2       | 3       | 4      | 5      | 6      | 7      | 8      | 9      | 10     |
|------------------|---------|---------|---------|--------|--------|--------|--------|--------|--------|--------|
| Vout (V)         | 14.850  | 14.700  | 14.550  | 14.400 | 14.250 | 14.100 | 13.950 | 13.800 | 13.650 | 13.500 |
| RD (k $\Omega$ ) | 499.820 | 223.410 | 131.270 | 85.204 | 57.563 | 39.136 | 25.974 | 16.102 | 8.424  | 2.282  |