



# P-DUKE POWER

## LCD10W Series

DC-DC Converter  
Up to 10 Watts

**3**  
YEARS  
WARRANTY

ROHS  
COMPLIANT

REACH  
COMPLIANT



Automation



Datacom



IPC



Industry



Measurement



Telecom



Automobile



Boat



Charger



Medical



PV



Railway



**1600**  
VDC  
Isolation  
Voltage

**4 : 1**  
Wide  
Input  
Range

**6**  
sided  
Shielding

Internal  
EN55032  
Class  
Filter **B**

**LOW**  
Standby  
Power

**NO**  
Min. Load  
Required

**REMOTE**  
**ON**  
**OFF**

**OCP**

**OVP**

**SCP**

**UVP**

### PART NUMBER STRUCTURE

| LCD10 -     | 48                  | S               | 05   | W           | - | A   | HC  |
|-------------|---------------------|-----------------|--|-------------|---|---|---|
| Series Name | Input Voltage (VDC) | Output Quantity | Output Voltage (VDC)                       | Input Range |   | Remote ON/OFF & Trim Options  | Assembly Options  |
|             | 24:9~36<br>48:18~75 | S:Single        | 3P3:3.3<br>05:5<br>12:12<br>15:15<br>24:24 | 4:1         |   | <input type="checkbox"/> :Negative logic<br><b>A</b> :Positive logic<br><b>B</b> :Without Ctrl pin<br><b>C</b> :Negative logic without Trim pin<br><b>D</b> :Without Ctrl & Trim pin<br><b>E</b> :Positive logic without Trim pin | <input type="checkbox"/> : None<br><b>HC</b> : Heat-sink with Clamp |
|             |                     | D:Dual          | 05:±5<br>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                     |
| LCD10-24S3P3W | 9 ~ 36      | 3.3            | 3000                      | 6                      | 85         | 3500                   |
| LCD10-24S05W  | 9 ~ 36      | 5              | 2000                      | 6                      | 87         | 2500                   |
| LCD10-24S12W  | 9 ~ 36      | 12             | 830                       | 6                      | 90         | 430                    |
| LCD10-24S15W  | 9 ~ 36      | 15             | 670                       | 6                      | 91         | 350                    |
| LCD10-24S24W  | 9 ~ 36      | 24             | 416                       | 6                      | 90         | 125                    |
| LCD10-24D05W  | 9 ~ 36      | ±5             | ±1000                     | 6                      | 87         | ±1440                  |
| LCD10-24D12W  | 9 ~ 36      | ±12            | ±416                      | 6                      | 89         | ±250                   |
| LCD10-24D15W  | 9 ~ 36      | ±15            | ±333                      | 6                      | 89         | ±180                   |
| LCD10-48S3P3W | 18 ~ 75     | 3.3            | 3000                      | 4                      | 85         | 3500                   |
| LCD10-48S05W  | 18 ~ 75     | 5              | 2000                      | 4                      | 87         | 2500                   |
| LCD10-48S12W  | 18 ~ 75     | 12             | 830                       | 4                      | 90         | 430                    |
| LCD10-48S15W  | 18 ~ 75     | 15             | 670                       | 4                      | 90         | 350                    |
| LCD10-48S24W  | 18 ~ 75     | 24             | 416                       | 4                      | 90         | 125                    |
| LCD10-48D05W  | 18 ~ 75     | ±5             | ±1000                     | 4                      | 87         | ±1440                  |
| LCD10-48D12W  | 18 ~ 75     | ±12            | ±416                      | 4                      | 89         | ±250                   |
| LCD10-48D15W  | 18 ~ 75     | ±15            | ±333                      | 4                      | 89         | ±180                   |

| INPUT SPECIFICATIONS          |                         |                                    |      |      |                     |      |
|-------------------------------|-------------------------|------------------------------------|------|------|---------------------|------|
| Parameter                     | Conditions              |                                    | Min. | Typ. | Max.                | Unit |
| Operating input voltage range | 24Vin(nom)              |                                    | 9    | 24   | 36                  | VDC  |
|                               | 48Vin(nom)              |                                    | 18   | 48   | 75                  |      |
| Start up voltage              | 24Vin(nom)              |                                    |      |      | 9                   | VDC  |
|                               | 48Vin(nom)              |                                    |      |      | 18                  |      |
| Shutdown voltage              | 24Vin(nom)              |                                    | 7.5  | 8    | 8.8                 | VDC  |
|                               | 48Vin(nom)              |                                    | 15.5 | 16   | 17.5                |      |
| Start up time                 | Constant resistive load | Power up                           |      |      | 30                  | ms   |
|                               |                         | Remote ON/OFF                      |      |      | 30                  |      |
| Input surge voltage           | 1 second, max.          | 24Vin(nom)                         |      |      | 50                  | VDC  |
|                               |                         | 48Vin(nom)                         |      |      | 100                 |      |
| Remote ON/OFF                 | Referred to -Vin pin    | Positive logic DC-DC ON (Option)   |      |      | Open or 3 ~ 15VDC   | mA   |
|                               |                         | Negative logic DC-DC ON (Standard) |      |      | Short or 0 ~ 1.2VDC |      |
|                               |                         | DC-DC OFF                          |      |      | Short or 0 ~ 1.2VDC |      |
|                               |                         | DC-DC OFF                          |      |      | Open or 3 ~ 15VDC   |      |
|                               |                         | Input current of Ctrl pin          | -0.5 |      | 1.0                 | mA   |
|                               |                         | Remote off input current           |      | 2.5  |                     | mA   |

**OUTPUT SPECIFICATIONS**

| Parameter                        | Conditions   |                                  | Min.                            | Typ.     | Max.  | Unit  |
|----------------------------------|--|----------------------------------|---------------------------------|----------|-------|-------|
| Output power                     | Output voltage trimmed up 10%                                |                                  |                                 |          | 11    | W     |
|                                  | Output voltage trimmed up 20%                                |                                  |                                 |          | 12    |       |
| Voltage accuracy                 |  |                                  | -1.0                            |          | +1.0  | %     |
| Line regulation                  | Low Line to High Line at Full Load                           | Single                           | -0.2                            |          | +0.2  | %     |
|                                  |  | Dual                             | -0.5                            |          | +0.5  |       |
| Load regulation                  | No Load to Full Load   | Single                           | -0.2                            |          | +0.2  | %     |
|                                  |  | Dual                             | -1.0                            |          | +1.0  |       |
|                                  | 10% Load to 90%Load  | Single                           | -0.1                            |          | +0.1  |       |
|                                  |  | Dual                             | -0.8                            |          | +0.8  |       |
| Cross regulation                 | Asymmetrical load 25%/100% FL                                | Dual                             | -5.0                            |          | +5.0  | %     |
| Voltage adjustability            | Single output  | 3.3Vout, 12Vout                  | -10                             |          | +10   | %     |
|                                  |  | Others                           | -10                             |          | +20   |       |
| Ripple and noise                 | Measured by 20MHz bandwidth<br>With a 10µF/25V X7R 1206 MLCC | 3.3Vout, 5Vout<br>12Vout, 15Vout |                                 | 40<br>60 |       | mVp-p |
|                                  | With a 1µF/50V X7R 1206 MLCC                                 | 24Vout                           |                                 | 60       |       |       |
| Temperature coefficient          |  |                                  | -0.02                           |          | +0.02 | %/°C  |
| Transient response recovery time | 25% load step change   |                                  |                                 | 250      |       | µs    |
| Over voltage protection          |  | 3.3Vout                          | 3.7                             |          | 5.4   | VDC   |
|                                  |  | 5Vout                            | 6.3                             |          | 7.4   |       |
|                                  |  | 12Vout                           | 13.5                            |          | 19.6  |       |
|                                  |  | 15Vout                           | 18.3                            |          | 22.0  |       |
|                                  |  | 24Vout                           | 29.1                            |          | 32.5  |       |
| Over load protection             | % of lout rated; Hiccup mode                                 |                                  |                                 | 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                        |      |      | VDC  |
|                       |                          |  | 1000                        |      |      |      |
| Isolation resistance  | 500VDC                   |  | 1                           |      |      | GΩ   |
| Isolation capacitance |                          |  | 1500                        |      |      | pF   |
| Switching frequency   |                          |  | 297                         | 330  | 363  | kHz  |
| Safety approvals      | IEC /EN /UL 62368-1      |  | UL:E193009<br>CB:UL(Demko)  |      |      |      |
| Case material         |                          |  | Copper                      |      |      |      |
| Base material         |                          |  | FR4 PCB                     |      |      |      |
| Potting material      |                          |  | Epoxy (UL94 V-0)            |      |      |      |
| Weight                |                          |  | 16.5g (0.58oz)              |      |      |      |
| MTBF                  | MIL-HDBK-217F, Full load |  | 3.376 x 10 <sup>6</sup> hrs |      |      |      |

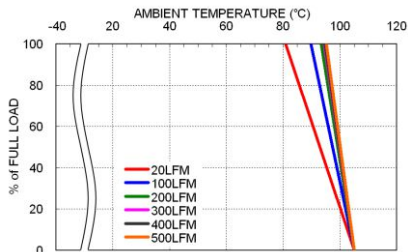
**ENVIRONMENTAL SPECIFICATIONS**

| Parameter                     | Conditions                          |  | Min.           | Typ. | Max.        | Unit |
|-------------------------------|-------------------------------------|--|----------------|------|-------------|------|
| Operating ambient temperature | Without derating<br>With derating   |  | -40<br>+81     |      | +81<br>+105 | °C   |
| Maximum case temperature      |                                     |  | 105            |      |             | °C   |
| Storage temperature range     |                                     |  | -55            |      | +125        | °C   |
| Thermal impedance             | Without heat-sink<br>With heat-sink |  | 16.18<br>15.13 |      |             | °C/W |
| Thermal shock                 |                                     |  | MIL-STD-810F   |      |             |      |
| Vibration                     |                                     |  | MIL-STD-810F   |      |             |      |
| Relative humidity             |                                     |  | 5% to 95% RH   |      |             |      |

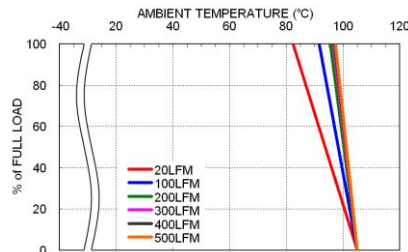
| EMC SPECIFICATIONS             |             |  |                  |
|--------------------------------|-------------|--|------------------|
| Parameter                      | Conditions  |  | Level            |
| EMI                            | EN55032     | Without external components  | Class A          |
|                                |             | With external components   | Class B          |
| EMS                            | EN55035     |  |                  |
| ESD                            | EN61000-4-2 | Air $\pm$ 8kV and Contact $\pm$ 6kV  | Perf. Criteria A |
| Radiated immunity              | EN61000-4-3 | 10 V/m   | Perf. Criteria A |
| Fast transient                 | EN61000-4-4 | $\pm$ 2kV  | Perf. Criteria A |
|                                |             | With an external input filter capacitor (Nippon chemi-con KY series, 220 $\mu$ F/100V) |                  |
| Surge                          | EN61000-4-5 | $\pm$ 1kV  | Perf. Criteria A |
|                                |             | With an external input filter capacitor (Nippon chemi-con KY series, 220 $\mu$ F/100V) |                  |
| Conducted immunity             | EN61000-4-6 | 3 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.

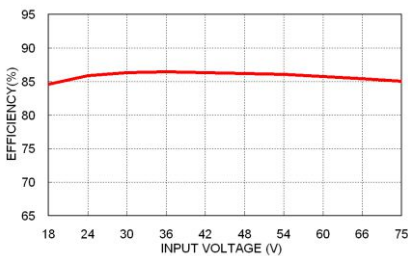
## CHARACTERISTIC CURVE



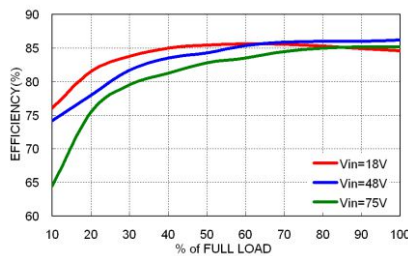
LCD10-48S05W Derating Curve



LCD10-48S05W Derating Curve With Heat-sink



LCD10-48S05W Efficiency vs. Input Voltage



LCD10-48S05W 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.

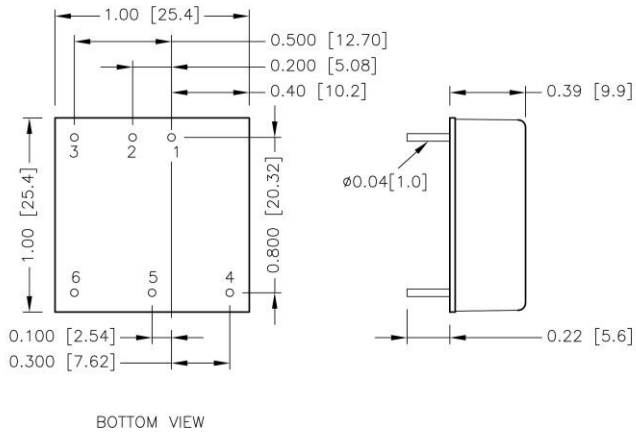
To maximum flexibility, internal fusing is not included; however, to achieve maximum safety and system protection, always use an input line fuse.

The input line fuse suggest as below :

| Model                     | Fuse Rating (A) | Fuse Type |
|---------------------------|-----------------|-----------|
| LCD10-24S□□W、LCD10-24D□□W | 2               | Slow-Blow |
| LCD10-48S□□W、LCD10-48D□□W | 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



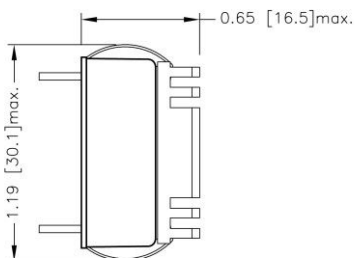
### PIN CONNECTION

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

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

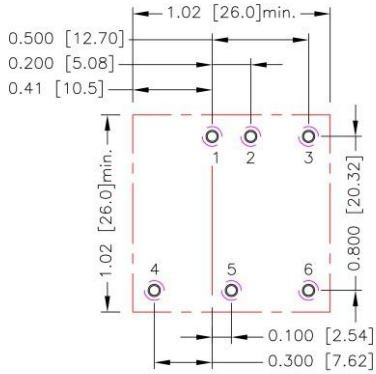
-HC (Heat-sink with clamps)



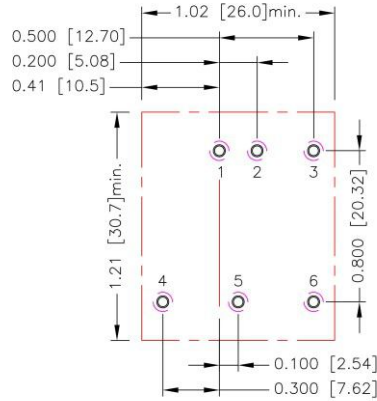
\* All dimensions in inch [mm]

## RECOMMENDED PAD LAYOUT

### Standard



### -HC



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

## 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.

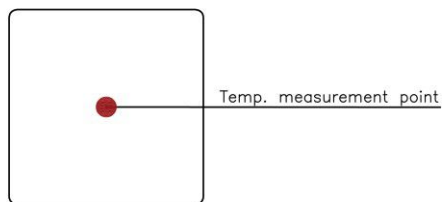
Proper cooling can be verified by measuring the point as the figure below.

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 -Output pin, the output voltage set point increases. With an external resistor between the Trim and +Output pin, the output voltage set point decreases. The external Trim resistor needs to be at least 1/16W of rated power.

### Trim Up Equation

$$R_U = \left[ \frac{G \times L}{(V_{o,up} - L - K)} - H \right] \Omega$$

### Trim Down Equation

$$R_D = \left[ \frac{(V_{o,down} - L) \times G}{(V_o - V_{o,down})} - H \right] \Omega$$

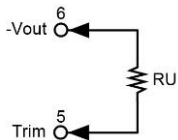
### Trim constants

| Module        | G     | H     | K    | L   |
|---------------|-------|-------|------|-----|
| LCD10-□□S3P3W | 5110  | 2050  | 0.8  | 2.5 |
| LCD10-□□S05W  | 5110  | 2050  | 2.5  | 2.5 |
| LCD10-□□S12W  | 10000 | 5110  | 9.5  | 2.5 |
| LCD10-□□S15W  | 10000 | 5110  | 12.5 | 2.5 |
| LCD10-□□S24W  | 56000 | 13000 | 21.5 | 2.5 |

### EXTERNAL OUTPUT TRIMMING

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

Trim-up



#### □□S3P3W

| ΔV (%)   | 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 (kΩ)  | 385.071 | 191.511 | 126.990 | 94.730 | 75.374 | 62.470 | 53.253 | 46.340 | 40.963 | 36.662 |

#### □□S05W

| ΔV (%)   | 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 (kΩ)  | 253.450 | 125.700 | 83.117 | 61.825 | 49.050 | 40.533 | 34.450 | 29.888 | 26.339 | 23.500 |

| ΔV (%)   | 11     | 12     | 13     | 14     | 15     | 16     | 17     | 18     | 19     | 20     |
|----------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Vout (V) | 5.550  | 5.600  | 5.650  | 5.700  | 5.750  | 5.800  | 5.850  | 5.900  | 5.950  | 6.000  |
| RU (kΩ)  | 21.177 | 19.242 | 17.604 | 16.200 | 14.983 | 13.919 | 12.979 | 12.144 | 11.397 | 10.725 |

#### □□S12W

| ΔV (%)   | 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 (kΩ)  | 203.223 | 99.057 | 64.334 | 46.973 | 36.557 | 29.612 | 24.652 | 20.932 | 18.038 | 15.723 |

#### □□S15W

| ΔV (%)   | 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 (kΩ)  | 161.557 | 78.223 | 50.446 | 36.557 | 28.223 | 22.668 | 18.700 | 15.723 | 13.409 | 11.557 |

| ΔV (%)   | 11     | 12     | 13     | 14     | 15     | 16     | 17     | 18     | 19     | 20     |
|----------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Vout (V) | 16.650 | 16.800 | 16.950 | 17.100 | 17.250 | 17.400 | 17.550 | 17.700 | 17.850 | 18.000 |
| RU (kΩ)  | 10.042 | 8.779  | 7.711  | 6.795  | 6.001  | 5.307  | 4.694  | 4.149  | 3.662  | 3.223  |

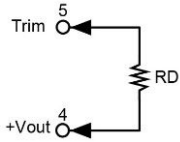
#### □□S24W

| ΔV (%)   | 1       | 2       | 3       | 4       | 5       | 6      | 7      | 8      | 9      | 10     |
|----------|---------|---------|---------|---------|---------|--------|--------|--------|--------|--------|
| Vout (V) | 24.240  | 24.480  | 24.720  | 24.960  | 25.200  | 25.440 | 25.680 | 25.920 | 26.160 | 26.400 |
| RU (kΩ)  | 570.333 | 278.667 | 181.444 | 132.833 | 103.667 | 84.222 | 70.333 | 59.917 | 51.815 | 45.333 |

| ΔV (%)   | 11     | 12     | 13     | 14     | 15     | 16     | 17     | 18     | 19     | 20     |
|----------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Vout (V) | 26.640 | 26.880 | 27.120 | 27.360 | 27.600 | 27.840 | 28.080 | 28.320 | 28.560 | 28.800 |
| RU (kΩ)  | 40.030 | 35.611 | 31.872 | 28.667 | 25.889 | 23.458 | 21.314 | 19.407 | 17.702 | 16.167 |

## OUTPUT VOLTAGE ADJUSTMENT(CONTINUED)

Trim-down



### □□S3P3W

| $\Delta V$ (%)   | 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 $\Omega$ ) | 116.719 | 54.779 | 34.133 | 23.810 | 17.616 | 13.486 | 10.537 | 8.325 | 6.604 | 5.228 |

### □□S05W

| $\Delta V$ (%)   | 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 $\Omega$ ) | 248.340 | 120.590 | 78.007 | 56.715 | 43.940 | 35.423 | 29.340 | 24.778 | 21.229 | 18.390 |

### □□S12W

| $\Delta V$ (%)   | 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 $\Omega$ ) | 776.557 | 380.723 | 248.779 | 182.807 | 143.223 | 116.834 | 97.985 | 83.848 | 72.853 | 64.057 |

### □□S15W

| $\Delta V$ (%)   | 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 $\Omega$ ) | 818.223 | 401.557 | 262.668 | 193.223 | 151.557 | 123.779 | 103.938 | 89.057 | 77.483 | 68.223 |

### □□S24W

| $\Delta V$ (%)   | 1        | 2        | 3        | 4        | 5       | 6       | 7       | 8       | 9       | 10      |
|------------------|----------|----------|----------|----------|---------|---------|---------|---------|---------|---------|
| Vout (V)         | 23.760   | 23.520   | 23.280   | 23.040   | 22.800  | 22.560  | 22.320  | 22.080  | 21.840  | 21.600  |
| RD (k $\Omega$ ) | 4947.667 | 2439.333 | 1603.222 | 1185.167 | 934.333 | 767.111 | 647.667 | 558.083 | 488.407 | 432.667 |