

## Highly Efficient 75W Quarter-brick DC/DC Converter

for Railway Applications



Railway



Industrial

### **QBE75W** Series DC/DC Converters

- 75W Output Power
- Standard 1/4 Brick Package
- 4:1 Input Range: 9–36, 18–75, and 40–160 Vdc
- Output Voltage: 3.3, 5, 12, 15, 24, 28, 48, and 54Vdc
- 3000Vac Reinforced Insulation for 110Vin
- 3000Vdc Basic Insulation for 24 and 48Vin
- 5000m Operating Altitude
- EN 50155, IEC/UL/EN 62368-1 Safety Approval (\*pending)
- 3 Years Product Warranty

【お問い合わせ先】

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# P-DUKE POWER

## QBE75W Series

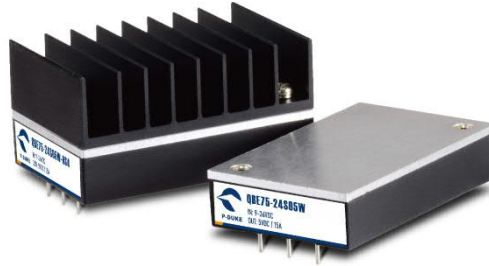
Quarter-Brick DC-DC Converter  
Up to 75 Watts

# 3

YEARS  
WARRANTY

ROHS  
COMPLIANT

REACH  
COMPLIANT



Railway



Automation



Datacom



IPC



Industry



Measurement



Telecom



Automobile



Boat



Charger



Medical



PV

3000  
VAC  
Reinforced  
Insulation

3000  
VDC  
Basic  
Insulation

4 : 1  
Wide  
Input  
Range

NO  
Min. Load  
Required

LOW  
Standby  
Power

Operating  
Altitude  
5000  
meter

REMOTE  
ON  
OFF

OCP

OTP

OVP

SCP

UVP

### PART NUMBER STRUCTURE

| QBE75       | - | 48                                   | S                  | 05                                                                    | W              | - | P                                                                                    | HS                                                                                                                                                                                                            |
|-------------|---|--------------------------------------|--------------------|-----------------------------------------------------------------------|----------------|---|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Series Name |   | Input<br>Voltage<br>(VDC)            | Output<br>Quantity | Output<br>Voltage<br>(VDC)                                            | Input<br>Range |   | Ctrl and Pin<br>Options                                                              | Assembly<br>Options                                                                                                                                                                                           |
|             |   | 24: 9~36<br>48: 18~75<br>110: 40~160 | S:Single           | 3P3:3.3<br>05:5<br>12:12<br>15:15<br>24:24<br>28:28<br>48:48<br>54:54 | 4:1            |   | <input type="checkbox"/> :Negative logic<br><input type="checkbox"/> :Positive logic | <input type="checkbox"/> : None<br><b>Heat-sink type</b><br>HS:7G-0029B-F;H=0.24"<br>HS2:7G-0031B-F;H=0.24"<br>HS4:7GA0124P01-F;H=0.65"<br>HS5:7GA0125P01-F;H=1"<br><b>Through hole type</b><br>TH:No thread* |

\* The module can't equip Heat-sink with TH option.

## 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            | A                         | mA                     | %          | μF                     |
| QBE75-24S3P3W  | 9 ~ 36      | 3.3            | 20                        | 35                     | 89         | 64000                  |
| QBE75-24S05W   | 9 ~ 36      | 5              | 15                        | 40                     | 90         | 30600                  |
| QBE75-24S12W   | 9 ~ 36      | 12             | 6.3                       | 40                     | 91         | 5250                   |
| QBE75-24S15W   | 9 ~ 36      | 15             | 5                         | 40                     | 92         | 3400                   |
| QBE75-24S24W   | 9 ~ 36      | 24             | 3.2                       | 40                     | 91         | 1330                   |
| QBE75-24S28W   | 9 ~ 36      | 28             | 2.7                       | 40                     | 91         | 1000                   |
| QBE75-24S48W   | 9 ~ 36      | 48             | 1.6                       | 40                     | 90         | 330                    |
| QBE75-24S54W   | 9 ~ 36      | 54             | 1.39                      | 45                     | 90         | 250                    |
| QBE75-48S3P3W  | 18 ~ 75     | 3.3            | 20                        | 15                     | 89         | 64000                  |
| QBE75-48S05W   | 18 ~ 75     | 5              | 15                        | 15                     | 90         | 30600                  |
| QBE75-48S12W   | 18 ~ 75     | 12             | 6.3                       | 15                     | 91         | 5250                   |
| QBE75-48S15W   | 18 ~ 75     | 15             | 5                         | 15                     | 91         | 3400                   |
| QBE75-48S24W   | 18 ~ 75     | 24             | 3.2                       | 15                     | 91         | 1330                   |
| QBE75-48S28W   | 18 ~ 75     | 28             | 2.7                       | 15                     | 91         | 1000                   |
| QBE75-48S48W   | 18 ~ 75     | 48             | 1.6                       | 25                     | 90         | 330                    |
| QBE75-48S54W   | 18 ~ 75     | 54             | 1.39                      | 25                     | 90         | 250                    |
| QBE75-110S3P3W | 40 ~ 160    | 3.3            | 20                        | 8                      | 89         | 64000                  |
| QBE75-110S05W  | 40 ~ 160    | 5              | 15                        | 8                      | 90         | 30600                  |
| QBE75-110S12W  | 40 ~ 160    | 12             | 6.3                       | 8                      | 91         | 5250                   |
| QBE75-110S15W  | 40 ~ 160    | 15             | 5                         | 8                      | 91         | 3400                   |
| QBE75-110S24W  | 40 ~ 160    | 24             | 3.2                       | 10                     | 91         | 1330                   |
| QBE75-110S28W  | 40 ~ 160    | 28             | 2.7                       | 10                     | 91         | 1000                   |
| QBE75-110S48W  | 40 ~ 160    | 48             | 1.6                       | 12                     | 90         | 330                    |
| QBE75-110S54W  | 40 ~ 160    | 54             | 1.39                      | 12                     | 90         | 250                    |

| INPUT SPECIFICATIONS          |                         |                           |               |                     |      |           |
|-------------------------------|-------------------------|---------------------------|---------------|---------------------|------|-----------|
| Parameter                     | Conditions              |                           |               | Min.                | Typ. | Max. Unit |
| Operating input voltage range | 24Vin(nom)              |                           |               | 9                   | 24   | 36        |
|                               | 48Vin(nom)              |                           |               | 18                  | 48   | 75        |
|                               | 110Vin(nom)             |                           |               | 40                  | 110  | 160       |
| Start up voltage              | 24Vin(nom)              |                           |               |                     |      | 9         |
|                               | 48Vin(nom)              |                           |               |                     |      | 18        |
|                               | 110Vin(nom)             |                           |               |                     |      | 40        |
| Shutdown voltage              | 24Vin(nom)              |                           |               | 7.5                 | 8.0  | 8.8       |
|                               | 48Vin(nom)              |                           |               | 15.5                | 16.0 | 17.5      |
|                               | 110Vin(nom)             |                           |               | 33.0                | 34.5 | 36.0      |
| Start up time                 | Constant resistive load | Power up                  | Remote ON/OFF |                     | 75   | 100 ms    |
| Input surge voltage           | 1 second, max.          | 24Vin(nom)                |               |                     |      | 50        |
|                               |                         | 48Vin(nom)                |               |                     |      | 100       |
|                               |                         | 110Vin(nom)               |               |                     |      | 185       |
| Input filter <sup>(1)</sup>   |                         |                           |               | Pi type             |      |           |
| Remote ON/OFF                 | Referred to -Vin pin    | Negative logic            | DC-DC ON      | Short or 0 ~ 1.2VDC |      |           |
|                               |                         | (Standard)                | DC-DC OFF     | Open or 3 ~ 12 VDC  |      |           |
|                               |                         | Positive logic            | DC-DC ON      | Open or 3 ~ 12 VDC  |      |           |
|                               |                         | (Option)                  | DC-DC OFF     | Short or 0 ~ 1.2VDC |      |           |
|                               |                         | Input current of Ctrl pin |               | -0.5                | +1   | mA        |
|                               |                         | Remote off input current  |               |                     | 3    | mA        |

**OUTPUT SPECIFICATIONS**

| Parameter                        | Conditions                                                                                                                | Min.                           | Typ. | Max.  | Unit    |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------|--------------------------------|------|-------|---------|
| Voltage accuracy                 |                                                                                                                           | -1.0                           |      | +1.0  | %       |
| Line regulation                  | Low Line to High Line at Full Load                                                                                        | -0.1                           |      | +0.1  | %       |
| Load regulation                  | No Load to Full Load                                                                                                      | -0.2                           |      | +0.2  | %       |
|                                  | 3.3 & 5Vout<br>Others                                                                                                     | -0.1                           |      | +0.1  |         |
| Voltage adjustability            | Maximum output deviation is inclusive of remote sense                                                                     | -20                            |      | +10   | %       |
| Remote sense                     | % of Vout(nom)<br>If remote sense is not being used, sense pins should connect to the output pins with the same polarity. |                                |      | 10    | %       |
| Ripple and noise                 | Measured by 20MHz bandwidth                                                                                               |                                | 80   |       | mVp-p   |
|                                  | With a 1 $\mu$ F/25V X7R MLCC and a 47 $\mu$ F/20V SP-CAP                                                                 |                                | 100  |       |         |
|                                  | With a 22 $\mu$ F/25V X7R MLCC                                                                                            |                                | 120  |       |         |
|                                  | With a 4.7 $\mu$ F/50V X7R MLCC                                                                                           |                                | 220  |       |         |
|                                  | With a 4.7 $\mu$ F/100V X7R MLCC                                                                                          |                                | 300  |       |         |
| Temperature coefficient          |                                                                                                                           | -0.02                          |      | +0.02 | %/°C    |
| Transient response recovery time | 25% load step change                                                                                                      |                                | 250  |       | $\mu$ s |
| Over voltage protection          | % of Vout(nom); Hiccup mode                                                                                               | 115                            | 125  | 130   | %       |
| Over load protection             | % of Iout rated; Hiccup mode                                                                                              | 125                            | 150  | 170   | %       |
| Short circuit protection         |                                                                                                                           | Continuous, automatic recovery |      |       |         |

**GENERAL SPECIFICATIONS**

| Parameter                    | Conditions                          | Min.                                  | Typ.                                            | Max.         | Unit       |
|------------------------------|-------------------------------------|---------------------------------------|-------------------------------------------------|--------------|------------|
| Isolation voltage            | 1 minute<br>(Reinforced insulation) | 110Vin(nom)                           | Input to Output<br>Input (Output) to Base-Plate | 3000<br>1500 | VAC        |
|                              | 1 minute<br>(Basic insulation)      | Others                                | Input to Output<br>Input (Output) to Base-Plate | 3000<br>1600 | VDC        |
| Isolation resistance         | 500VDC                              | 1                                     |                                                 |              | G $\Omega$ |
| Isolation capacitance        |                                     |                                       |                                                 | 1500         | pF         |
| Switching frequency          |                                     | 140                                   | 190                                             | 250          | kHz        |
| Safety approvals (Pending)   |                                     | IEC/ EN/ UL 62368-1                   |                                                 |              |            |
| Standard approvals (Pending) |                                     | EN50155<br>EN45545-2                  |                                                 |              |            |
| Case material                |                                     | Aluminum base-plate with plastic case |                                                 |              |            |
| Potting material             |                                     | Silicone (UL94 V-0)                   |                                                 |              |            |
| Weight                       |                                     | 67g (2.36oz)                          |                                                 |              |            |
| MTBF                         | MIL-HDBK-217F, Full load            | 6.824 x 10 <sup>5</sup> hrs           |                                                 |              |            |

**ENVIRONMENTAL SPECIFICATIONS**

| Parameter                        | Conditions                        | Min.                  | Typ. | Max. | Unit |
|----------------------------------|-----------------------------------|-----------------------|------|------|------|
| Operating base-plate temperature |                                   | -40                   |      | +105 | °C   |
| Maximum case temperature         |                                   |                       |      | 105  | °C   |
| Over temperature protection      |                                   |                       | 110  |      | °C   |
| Storage temperature range        |                                   | -55                   |      | +125 | °C   |
| Operating altitude               |                                   |                       |      | 5000 | m    |
| Thermal impedance                | Module without assembly option    |                       | 9    |      | °C/W |
|                                  | Only mount on the iron base-plate |                       | 2.8  |      |      |
|                                  | Heat-sink type with 0.24" Height  |                       | 7.1  |      |      |
|                                  | Heat-sink type with 0.65" Height  |                       | 4.2  |      |      |
|                                  | Heat-sink type with 1" Height     |                       | 3.4  |      |      |
| Thermal shock                    |                                   | MIL-STD-810F          |      |      |      |
| Shock                            |                                   | EN61373, MIL-STD-810F |      |      |      |
| Vibration                        |                                   | EN61373, MIL-STD-810F |      |      |      |
| Relative humidity                |                                   | 5% to 95% RH          |      |      |      |

## EMC SPECIFICATIONS

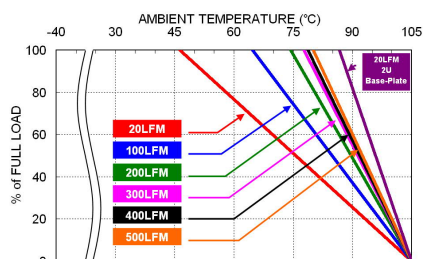
| Parameter                      | Conditions                                                    | Level                                                                                                                                                                                                                     |
|--------------------------------|---------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| EMI                            | EN55032, EN50121-3-2 With external components                 | Class A, Class B                                                                                                                                                                                                          |
| EMS                            | EN55035, EN50121-3-2                                          |                                                                                                                                                                                                                           |
| ESD                            | EN61000-4-2 Air $\pm 8\text{kV}$ and Contact $\pm 6\text{kV}$ | Perf. Criteria A                                                                                                                                                                                                          |
| Radiated immunity              | EN61000-4-3 20 V/m                                            | Perf. Criteria A                                                                                                                                                                                                          |
| Fast transient                 | EN61000-4-4 $\pm 2\text{kV}$                                  | Perf. Criteria A                                                                                                                                                                                                          |
|                                | QBE75-24S□□W<br>QBE75-48S□□W<br>QBE75-110S□□W                 | With 2 pcs of aluminum electrolytic capacitor (Nippon Chemi-con KY series, 330 $\mu\text{F}/100\text{V}$ )<br>With 2 pcs of aluminum electrolytic capacitor (Nippon Chemi-con KXJ series, 150 $\mu\text{F}/200\text{V}$ ) |
| Surge                          | EN61000-4-5 $\pm 2\text{kV}$                                  | Perf. Criteria A                                                                                                                                                                                                          |
|                                | QBE75-24S□□W<br>QBE75-48S□□W<br>QBE75-110S□□W                 | With 2 pcs of aluminum electrolytic capacitor (Nippon Chemi-con KY series, 330 $\mu\text{F}/100\text{V}$ )<br>With 2 pcs of aluminum electrolytic capacitor (Nippon Chemi-con KXJ series, 150 $\mu\text{F}/200\text{V}$ ) |
| 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                                                                                                                                                                                                          |

### Note:

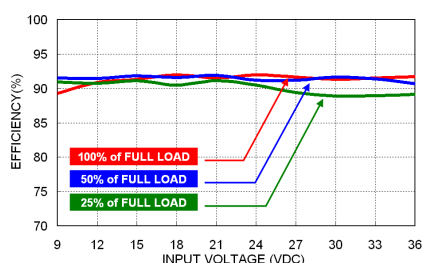
- Input source impedance: The power module will operate as specifications without external components, assuming that the source voltage has a very low impedance and reasonable input voltage regulation. Highly inductive source impedances can affect the stability of the power module. Since real-world voltage source has finite impedance, performance can be improved by adding external filter capacitor. The QBE75-24S□□W and QBE75-48S□□W recommended external filter capacitor Nippon Chemi-con KY series, 330 $\mu\text{F}/100\text{V}$ . The QBE75-110S□□W recommended external filter capacitor Nippon Chemi-con KXJ series, 150 $\mu\text{F}/200\text{V}$ .
- BASE-PLATE GROUNDING: When connect two screw bolts to shield plane, the EMI could be reduced.

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

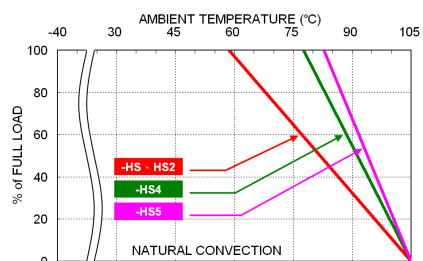
## CHARACTERISTIC CURVE



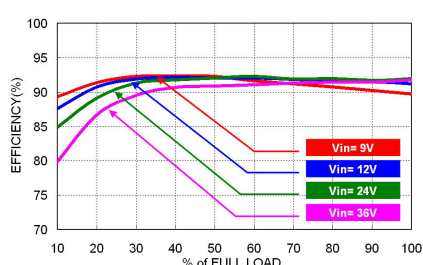
QBE75-24S15W Derating Curve



QBE75-24S15W Efficiency vs. Input Voltage



QBE75-24S15W Derating Curve with Heat-sink  
(See Thermal Considerations)



QBE75-24S15W 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.

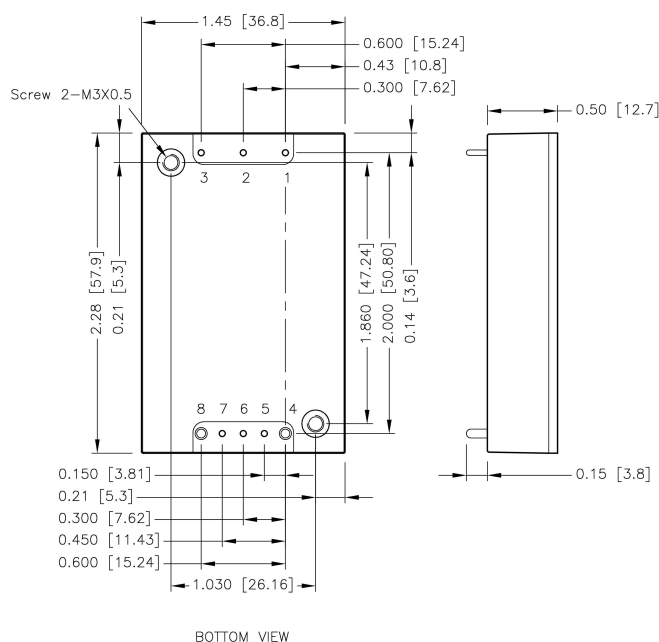
To maximum flexibility, internal fusing is not included; however, to achieve maximum safety and system protection, always use an input line fuse.

The input line fuse suggest as below :

| Model         | Fuse Rating (A) | Fuse Type   |
|---------------|-----------------|-------------|
| QBE75-24S□□W  | 15              | Fast-Acting |
| QBE75-48S□□W  | 8               | Fast-Acting |
| QBE75-110S□□W | 3.15            | 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

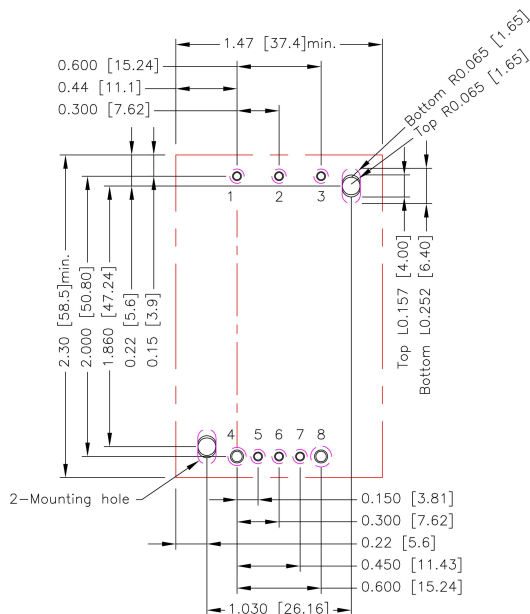


### PIN CONNECTION

| PIN | DEFINE  | DIAMETER  |
|-----|---------|-----------|
| 1   | - Vin   | 0.04 Inch |
| 2   | Ctrl    | 0.04 Inch |
| 3   | + Vin   | 0.04 Inch |
| 4   | - Vout  | 0.06 Inch |
| 5   | - Sense | 0.04 Inch |
| 6   | Trim    | 0.04 Inch |
| 7   | + Sense | 0.04 Inch |
| 8   | + Vout  | 0.06 Inch |

1. All dimensions in inch [mm]
2. Tolerance :x.xx±0.02 [x.x±0.5]  
x.xxx±0.010 [x.xx±0.25]
3. Pin dimension tolerance ±0.004[0.10]
4. The screw locked torque:MAX 3.5kgf-cm [0.34N-m]

## RECOMMENDED PAD LAYOUT



All dimensions in inch[mm]

Pad size(lead free recommended)

Through hole 1.2.3.5.6.7:  $\varnothing 0.051[1.30]$

Through hole 4.8:  $\varnothing 0.075[1.90]$

Through hole of mounting:  $\varnothing 0.126[3.20]$

Top view pad 1.2.3.5.6.7:  $\varnothing 0.064[1.63]$

Top view pad 4.8: Ø0.094[2.38]

Top view pad of mounting: Groove R0.065[1.65]L0.157[4.00]

Bottom view pad 1.2.3.5.6.7:  $\varnothing 0.102[2.60]$

Bottom view pad 8:  $\varnothing 0.150[3.80]$

Bottom view pad 4:  $\varnothing 0.130[3.30]$

Bottom view pad of mounting:Groove R0.065[1.65]L0.252[6.40]

## 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.

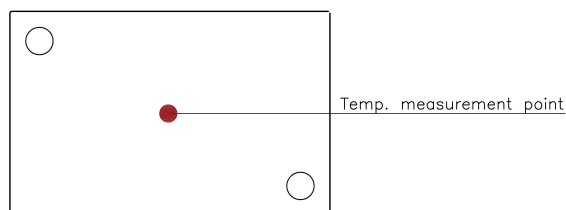
Proper cooling can be verified by measuring the point as the figure below.

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.

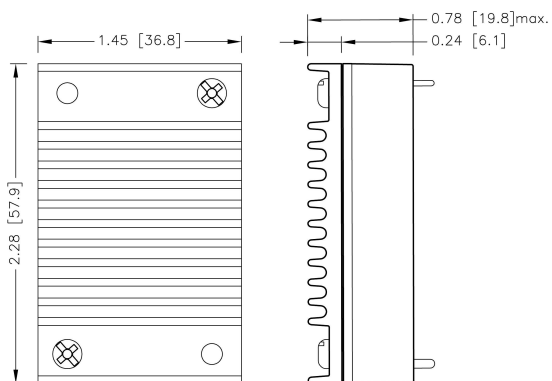
- Thermal test condition with vertical direction by natural convection (20LFM).
- The iron base-plate dimension is 19" X 3.5" X 0.063" (The height is EIA standard 2U).
- The heat-sink is optional and P/N: 7G-0029B-F, 7G-0031B-F, 7GA0124P01-F, 7GA0125P01-F.



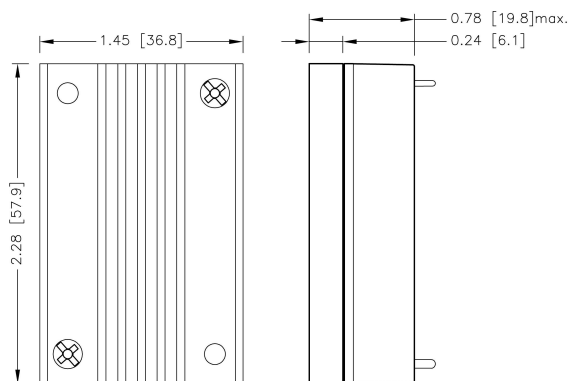
BASE PLATE

## HEAT-SINK TYPE OPTIONS

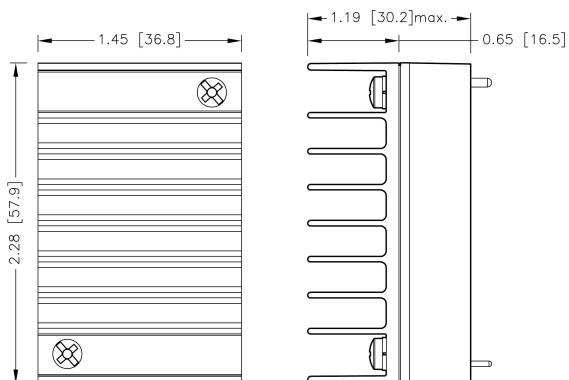
QBE75-□□S□□W -HS  
7G-0029B-F



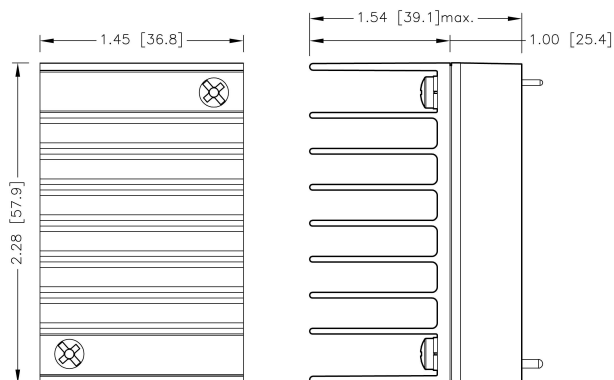
QBE75-□□S□□W -HS2  
7G-0031B-F



QBE75-□□S□□W -HS4  
7GA0124P01-F



QBE75-□□S□□W -HS5  
7GA0125P01-F



1. All dimensions in inch [mm]
2. Tolerance :x.xx±0.02 [x.x±0.5]

## OUTPUT VOLTAGE ADJUSTMENT

Output voltage is adjustable for 10% trim up or -20% trim down of nominal output voltage by connecting an external resistor between the Trim pin and either the +Sense or -Sense pins.

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

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

Maximum output deviation is +10% inclusive of remote sense.

The external Trim resistor needs to be at least 1/8W of rated power.

### Trim Up Equation

$$R_U = \left[ \frac{G \times 2.5}{(V_{0,up} - V_{0,nom})} - H \right] k\Omega$$

### Trim Down Equation

$$R_D = \left[ \frac{(V_{0,down} - 2.5) \times G}{(V_{0,nom} - V_{0,down})} - H \right] k\Omega$$

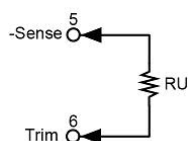
### Trim Constants

| Module        | G   | H   |
|---------------|-----|-----|
| QBE75-□□S3P3W | 5.1 | 1   |
| QBE75-□□S05W  | 5.1 | 2   |
| QBE75-□□S12W  | 10  | 5.1 |
| QBE75-□□S15W  | 10  | 5.1 |
| QBE75-□□S24W  | 56  | 13  |
| QBE75-□□S28W  | 56  | 13  |
| QBE75-□□S48W  | 66  | 27  |
| QBE75-□□S54W  | 66  | 27  |

### EXTERNAL OUTPUT TRIMMING

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

#### Trim-up



#### □□S3P3W

| △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 |
| R <sub>U</sub> (kΩ) | 385.36 | 192.18 | 127.79 | 95.59 | 76.27 | 63.39 | 54.19 | 47.30 | 41.93 | 37.64 |

#### □□S05W

| △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 |
| R <sub>U</sub> (kΩ) | 253.00 | 125.50 | 83.00 | 61.75 | 49.00 | 40.50 | 34.43 | 29.88 | 26.33 | 23.50 |

#### □□S12W

| △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 |
| R <sub>U</sub> (kΩ) | 203.23 | 99.07  | 64.34  | 46.98  | 36.57  | 29.62  | 24.66  | 20.94  | 18.05  | 15.73  |

#### □□S15W

| △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 |
| R <sub>U</sub> (kΩ) | 161.57 | 78.23  | 50.46  | 36.57  | 28.23  | 22.68  | 18.71  | 15.73  | 13.42  | 11.57  |

#### □□S24W

| △V (%)              | 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 |
| R <sub>U</sub> (kΩ) | 570.33 | 278.67 | 181.44 | 132.83 | 103.67 | 84.22  | 70.33  | 59.92  | 51.81  | 45.33  |

#### □□S28W

| △V (%)              | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     |
|---------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Vout (V)            | 28.280 | 28.560 | 28.840 | 29.120 | 29.400 | 29.680 | 29.960 | 30.240 | 30.520 | 30.800 |
| R <sub>U</sub> (kΩ) | 487.00 | 237.00 | 153.67 | 112.00 | 87.00  | 70.33  | 58.43  | 49.50  | 42.56  | 37.00  |

#### □□S48W

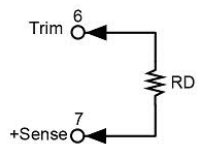
| △V (%)              | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     |
|---------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Vout (V)            | 48.480 | 48.960 | 49.440 | 49.920 | 50.400 | 50.880 | 51.360 | 51.840 | 52.320 | 52.800 |
| R <sub>U</sub> (kΩ) | 316.75 | 144.88 | 87.58  | 58.94  | 41.75  | 30.29  | 22.11  | 15.97  | 11.19  | 7.38   |

#### □□S54W

| △V (%)              | 1       | 2       | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     |
|---------------------|---------|---------|--------|--------|--------|--------|--------|--------|--------|--------|
| Vout (V)            | 54.540  | 55.080  | 55.620 | 56.160 | 56.700 | 57.240 | 57.780 | 58.320 | 58.860 | 59.400 |
| R <sub>U</sub> (kΩ) | 278.156 | 125.378 | 74.452 | 48.989 | 33.711 | 23.526 | 16.65  | 11.19  | 6.95   | 3.56   |

## 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 $\Omega$ ) | 117.54 | 55.72 | 35.11 | 24.81 | 18.63 | 14.51 | 11.56 | 9.35  | 7.64  | 6.26  |
| $\Delta V$ (%)   | 11     | 12    | 13    | 14    | 15    | 16    | 17    | 18    | 19    | 20    |
| Vout (V)         | 2.937  | 2.904 | 2.871 | 2.838 | 2.805 | 2.772 | 2.739 | 2.706 | 2.673 | 2.640 |
| RD (k $\Omega$ ) | 5.14   | 4.20  | 3.41  | 2.73  | 2.14  | 1.63  | 1.17  | 0.77  | 0.41  | 0.08  |

### □□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 $\Omega$ ) | 247.90 | 120.40 | 77.90 | 56.65 | 43.90 | 35.40 | 29.33 | 24.78 | 21.23 | 18.40 |
| $\Delta V$ (%)   | 11     | 12     | 13    | 14    | 15    | 16    | 17    | 18    | 19    | 20    |
| Vout (V)         | 4.450  | 4.400  | 4.350 | 4.300 | 4.250 | 4.200 | 4.150 | 4.100 | 4.050 | 4.000 |
| RD (k $\Omega$ ) | 16.08  | 14.15  | 12.52 | 11.11 | 9.90  | 8.84  | 7.90  | 7.07  | 6.32  | 5.65  |

### □□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 $\Omega$ ) | 776.57 | 380.73 | 248.79 | 182.82 | 143.23 | 116.84 | 98.00  | 83.86  | 72.86  | 64.07  |
| $\Delta V$ (%)   | 11     | 12     | 13     | 14     | 15     | 16     | 17     | 18     | 19     | 20     |
| Vout (V)         | 10.680 | 10.560 | 10.440 | 10.320 | 10.200 | 10.080 | 9.960  | 9.840  | 9.720  | 9.600  |
| RD (k $\Omega$ ) | 56.87  | 50.87  | 45.80  | 41.45  | 37.68  | 34.38  | 31.47  | 28.88  | 26.57  | 24.48  |

### □□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 $\Omega$ ) | 818.23 | 401.57 | 262.68 | 193.23 | 151.57 | 123.79 | 103.95 | 89.07  | 77.47  | 68.23  |
| $\Delta V$ (%)   | 11     | 12     | 13     | 14     | 15     | 16     | 17     | 18     | 19     | 20     |
| Vout (V)         | 13.350 | 13.200 | 13.050 | 12.900 | 12.750 | 12.600 | 12.450 | 12.300 | 12.150 | 12.000 |
| RD (k $\Omega$ ) | 60.66  | 54.34  | 49.00  | 44.42  | 40.46  | 36.98  | 33.92  | 31.20  | 28.76  | 26.57  |

### □□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 $\Omega$ ) | 4947.67 | 2439.33 | 1603.22 | 1185.17 | 934.33 | 767.11 | 647.67 | 558.08 | 488.41 | 432.67 |
| $\Delta V$ (%)   | 11      | 12      | 13      | 14      | 15     | 16     | 17     | 18     | 19     | 20     |
| Vout (V)         | 21.360  | 21.12   | 20.88   | 20.64   | 20.40  | 20.16  | 19.92  | 19.68  | 19.44  | 19.20  |
| RD (k $\Omega$ ) | 378.06  | 349.06  | 316.90  | 289.33  | 265.44 | 244.54 | 226.10 | 209.70 | 195.04 | 181.83 |

### □□S28W

| $\Delta V$ (%)   | 1       | 2       | 3       | 4       | 5      | 6      | 7      | 8      | 9      | 10     |
|------------------|---------|---------|---------|---------|--------|--------|--------|--------|--------|--------|
| Vout (V)         | 27.720  | 27.440  | 27.160  | 26.880  | 26.600 | 26.320 | 26.040 | 25.760 | 25.480 | 25.200 |
| RD (k $\Omega$ ) | 5031.00 | 2481.00 | 1631.00 | 1206.00 | 951.00 | 781.00 | 659.57 | 568.50 | 497.67 | 441.00 |
| $\Delta V$ (%)   | 11      | 12      | 13      | 14      | 15     | 16     | 17     | 18     | 19     | 20     |
| Vout (V)         | 24.920  | 24.640  | 24.360  | 24.080  | 23.800 | 23.520 | 23.240 | 22.960 | 22.680 | 22.400 |
| RD (k $\Omega$ ) | 394.64  | 356.00  | 323.31  | 295.29  | 271.00 | 249.75 | 231.00 | 214.33 | 199.42 | 186.00 |

## OUTPUT VOLTAGE ADJUSTMENT(CONTINUED)

Trim-down

### □□S48W

| $\Delta V$ (%)   | 1       | 2       | 3       | 4       | 5       | 6      | 7      | 8      | 9      | 10     |
|------------------|---------|---------|---------|---------|---------|--------|--------|--------|--------|--------|
| Vout (V)         | 47.520  | 47.04   | 46.56   | 46.08   | 45.60   | 45.12  | 44.64  | 44.16  | 43.68  | 43.20  |
| RD (k $\Omega$ ) | 6163.25 | 3035.13 | 1992.42 | 1471.06 | 1158.25 | 949.71 | 800.75 | 689.03 | 602.14 | 532.63 |
| $\Delta V$ (%)   | 11      | 12      | 13      | 14      | 15      | 16     | 17     | 18     | 19     | 20     |
| Vout (V)         | 42.720  | 42.240  | 41.760  | 41.280  | 40.800  | 40.320 | 39.840 | 39.360 | 38.880 | 38.400 |
| RD (k $\Omega$ ) | 475.75  | 428.35  | 388.25  | 353.88  | 324.08  | 298.2  | 275.01 | 254.54 | 236.28 | 219.81 |

### □□S54W

| $\Delta V$ (%)   | 1       | 2       | 3       | 4       | 5       | 6      | 7      | 8      | 9      | 10     |
|------------------|---------|---------|---------|---------|---------|--------|--------|--------|--------|--------|
| Vout (V)         | 53.460  | 52.920  | 52.380  | 51.840  | 51.300  | 50.760 | 50.220 | 49.680 | 49.140 | 48.600 |
| RD (k $\Omega$ ) | 6201.44 | 3054.22 | 2005.15 | 1480.61 | 1165.89 | 956.07 | 806.21 | 693.81 | 606.38 | 536.44 |
| $\Delta V$ (%)   | 11      | 12      | 13      | 14      | 15      | 16     | 17     | 18     | 19     | 20     |
| Vout (V)         | 48.060  | 47.520  | 46.980  | 46.440  | 45.900  | 45.360 | 44.820 | 44.280 | 43.740 | 43.200 |
| RD (k $\Omega$ ) | 479.22  | 431.54  | 391.19  | 356.60  | 326.63  | 300.40 | 277.26 | 256.69 | 238.29 | 221.72 |