



P-DUKE POWER

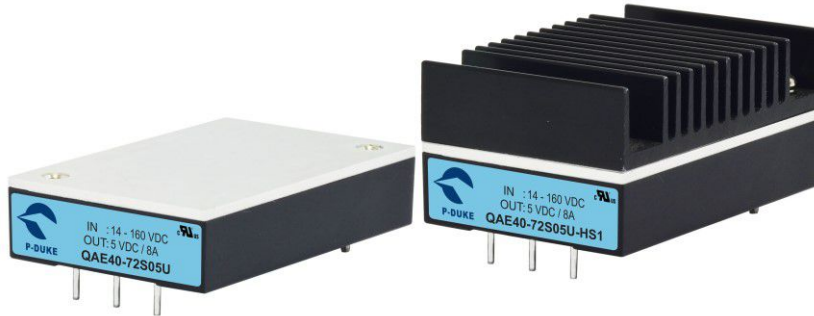
QAE40U Series

QUARTER-BRICK DC-DC Converter
Up to 40 Watts

3
YEARS
WARRANTY

ROHS
COMPLIANT

REACH
COMPLIANT



Railway



Automation



Datacom



IPC



Industry



Measurement



Telecom



Automobile



Boat



Charger



Medical



PV

UL US CB CE UK CA

3000
VAC
Reinforced
Insulation

2250
VDC
Basic
Insulation

12:1
Ultra-Wide
Input
Range

HOLD
UP

NO
Min. Load
Required

LOW
Standby
Power

REMOTE
ON
OFF

OCP

OTP

OVP

SCP

UVP

PART NUMBER STRUCTURE

| QAE40 | - | 72 | S | 05 | U | - | K | P | HS |
|-------------|---|------------------------|-----------------|--|-------------|---|---|--|--|
| Series Name | | Input Voltage (VDC) | Output Quantity | Output Voltage (VDC) | Input Range | | Bus & UVP adj. Options | Remote Control Options | Assembly Options |
| | | 36: 9~75 72: 14~160 | S: Single | 05:5 12:12 15:15 24:24 28:28 48:48 53:53 | 8:1 12:1 | | □: None K: With Bus & UVP adj. V: With UVP adj. | □: Negative logic P: Positive logic | □: None Heat-sink type HS:7G-0029B-F;H=0.24" HS1:7G-0030B-F;H=0.5" HS2:7G-0031B-F;H=0.24" HS3:7G-0032B-F;H=0.5" HS4:7GA0124P01-F;H=0.65" HS5:7GA0125P01-F;H=1" Through hole type 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 |
| QAE40-36S05U | 9 ~ 75 | 5 | 8 | 20 | 89 | 16000 |
| QAE40-36S12U | 9 ~ 75 | 12 | 3.33 | 30 | 91 | 2800 |
| QAE40-36S15U | 9 ~ 75 | 15 | 2.67 | 30 | 91 | 1800 |
| QAE40-36S24U | 9 ~ 75 | 24 | 1.67 | 20 | 90 | 720 |
| QAE40-36S28U | 9 ~ 75 | 28 | 1.43 | 20 | 91 | 520 |
| QAE40-36S48U | 9 ~ 75 | 48 | 0.83 | 20 | 91 | 180 |
| QAE40-36S53U | 9 ~ 75 | 53 | 0.75 | 20 | 91 | 150 |
| QAE40-72S05U | 14 ~ 160 | 5 | 8 | 15 | 89 | 16000 |
| QAE40-72S12U | 14 ~ 160 | 12 | 3.33 | 20 | 91 | 2800 |
| QAE40-72S15U | 14 ~ 160 | 15 | 2.67 | 20 | 91 | 1800 |
| QAE40-72S24U | 14 ~ 160 | 24 | 1.67 | 15 | 90 | 720 |
| QAE40-72S28U | 14 ~ 160 | 28 | 1.43 | 15 | 91 | 520 |
| QAE40-72S48U | 14 ~ 160 | 48 | 0.83 | 15 | 90 | 180 |
| QAE40-72S53U | 14 ~ 160 | 53 | 0.75 | 15 | 91 | 150 |

| INPUT SPECIFICATIONS | | | | | | |
|-------------------------------|--------------------------|---------------------------|---------------------|---------------------|-----------|-------------------|
| Parameter | Conditions | | Min. | Typ. | Max. | Unit |
| Operating input voltage range | 36Vin(nom) 72Vin(nom) | | 9 14 | 36 72 | 75 160 | VDC |
| Start up voltage | 36Vin(nom) 72Vin(nom) | | | | | 9 14 VDC |
| Shutdown voltage | 36Vin(nom) 72Vin(nom) | | 7.3 10 | 7.7 11 | 8.1 12 | VDC |
| Start up time | Constant resistive load | Power up | | | | 75 100 ms |
| | | Remote ON/OFF | | | | 75 100 ms |
| Input Transient voltage | 100 mS, max. | 36Vin(nom) 72Vin(nom) | 8.1 12 | VDC | | |
| Input surge voltage | 1 second, max. | 36Vin(nom) 72Vin(nom) | | | | 100 185 VDC |
| Input filter ⁽¹⁾ | Pi type | | | | | |
| Remote ON/OFF | Referred to -Vin pin | Negative logic (Standard) | DC-DC ON | Short or 0 ~ 1.2VDC | | |
| | | DC-DC OFF | Open or 3 ~ 12VDC | | | |
| | | Positive logic (Option) | DC-DC ON | Open or 3 ~ 12VDC | | |
| | | 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 | -0.1 | | +0.1 | % |
| Voltage adjustability | Maximum output deviation is inclusive of remote sense | -20 | | +10 | % |
| Remote sense | % of Vout(nom). If remote sense is not being used, SENSE pins should be connected to corresponding polarity OUTPUT pins. | | | 10 | % |
| Ripple and noise | Measured by 20MHz bandwidth With a 1 μ F/25V X7R MLCC and a 22 μ F/25V POS-CAP 5Vout With a 22 μ F/25V X7R MLCC 12Vout, 15Vout With a 4.7 μ F/50V X7R MLCC 24Vout, 28Vout With a 2.2 μ F/100V X7R MLCC 48Vout, 53Vout | | 75 100 200 300 | | mVp-p |
| Temperature coefficient | | -0.02 | | +0.02 | %/°C |
| Transient response recovery time | 25% load step change | | 250 | | μ s |
| Over voltage protection | % of Vout(nom); Hiccup mode | 120 | | 135 | % |
| Over load protection | % of Iout rated; Hiccup mode | 120 | | 140 | % |
| Short circuit protection | | Continuous, automatic recovery | | | |

GENERAL SPECIFICATIONS

| Parameter | Conditions | Min. | Typ. | Max. | Unit |
|-----------------------|--------------------------|---------------------------------------|------------------------------|----------------------------|------------|
| Isolation voltage | 1 minute | 72Vin(nom) | Input to Output | 3000 | VAC |
| | (Reinforced insulation) | | Input (Output) to Base-Plate | 1500 | |
| | 1 minute | 36Vin(nom) | Input to Output | 2250 | VDC |
| | (Basic insulation) | | Input (Output) to Base-Plate | 1600 | |
| Isolation resistance | 500VDC | | | 1 | G Ω |
| Isolation capacitance | | | | 1000 | pF |
| Switching frequency | | 160 | 180 | 200 | kHz |
| Safety approvals | IEC/ EN/ UL 62368-1 | | | UL:E193009 CB:UL(Demko) | |
| Standard approvals | EN50155 EN45545-2 | | | | |
| Case material | | Aluminum base-plate with plastic case | | | |
| Potting material | | Silicone (UL94 V-0) | | | |
| Weight | | 64g (2.26oz) | | | |
| MTBF | MIL-HDBK-217F, Full load | 8.297 x 10 ⁵ hrs | | | |

ENVIRONMENTAL SPECIFICATIONS

| Parameter | Conditions | Min. | Typ. | Max. | Unit |
|----------------------------------|---|------|--|------|-----------------------|
| Operating base-plate temperature | With derating | -40 | | +105 | °C |
| Maximum case temperature | | | | 105 | °C |
| Over temperature protection | | | 110 | | °C |
| Storage temperature range | | -55 | | +125 | °C |
| Thermal impedance | Module without assembly option Only mount on the iron base-plate Heat-sink type with 0.24" Height Heat-sink type with 0.5" Height Heat-sink type with 0.65" Height Heat-sink type with 1" Height | | 8.3 2.5 7.4 6.2 5.1 4.1 | | °C/W |
| Thermal shock | | | | | MIL-STD-810F |
| Shock | | | | | EN61373, MIL-STD-810F |
| Vibration | | | | | EN61373, MIL-STD-810F |
| Relative humidity | | | | | 5% to 95% RH |

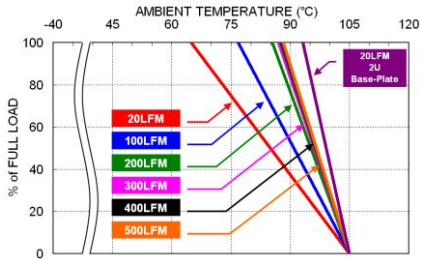
| EMC SPECIFICATIONS | | |
|--------------------------------|----------------------|---|
| Parameter | Conditions | Level |
| EMI | EN55032, EN50121-3-2 | With external components |
| EMS | EN55035, EN50121-3-2 | |
| ESD | EN61000-4-2 | Air $\pm 8kV$ and Contact $\pm 6kV$ |
| Radiated immunity | EN61000-4-3 | 20 V/m |
| Fast transient | EN61000-4-4 | $\pm 2kV$ |
| | QAE40-36S□□U | With 2 pcs of aluminum electrolytic capacitor (Nippon Chemi-con KY series, 220 μ F/100V) |
| | QAE40-72S□□U | With 2 pcs of aluminum electrolytic capacitor (Nippon Chemi-con KXJ series, 150 μ F/200V) |
| Surge | EN61000-4-5 | EN55035: $\pm 1kV$ and EN50121-3-2: $\pm 2kV$ |
| | QAE40-36S□□U | With 2 pcs of aluminum electrolytic capacitor (Nippon Chemi-con KY series, 220 μ F/100V) |
| | QAE40-72S□□U | With 2 pcs of aluminum electrolytic capacitor (Nippon Chemi-con KXJ series, 150 μ F/200V) |
| Conducted immunity | EN61000-4-6 | 10 Vr.m.s |
| Power frequency magnetic field | EN61000-4-8 | 100A/m continuous; 1000A/m 1 second |

Note:

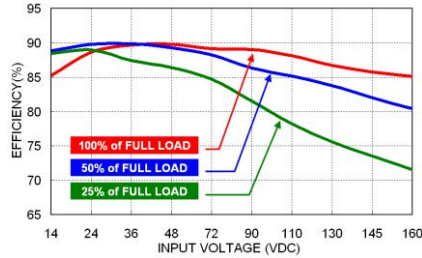
- Input source impedance: The power module will operate as specifications without external components, assuming that the source voltage has a very low impedance and reasonable input voltage regulation. Highly inductive source impedances can affect the stability of the power module. Since real-world voltage source has finite impedance, performance can be improved by adding external filter capacitor.
The QAE40-36S□□U recommended Nippon Chemi-con KY series, 220 μ F/100V.
The QAE40-72S□□U recommended Nippon Chemi-con KXJ series, 150 μ F/200V.
- 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.

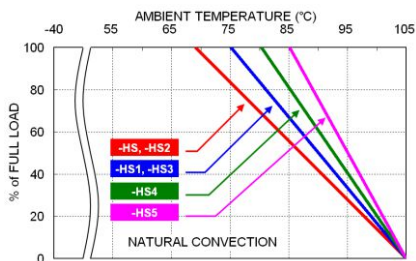
CHARACTERISTIC CURVE



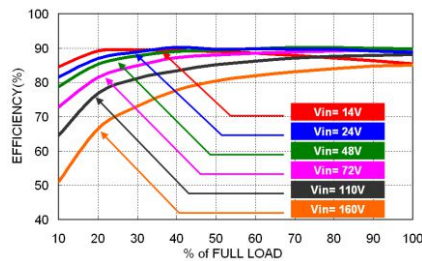
QAE40-72S05U Derating Curve
(See Thermal Considerations)



QAE40-72S05U Efficiency vs. Input Voltage



QAE40-72S05U Derating Curve with Heat-sink
(See Thermal Considerations)



QAE40-72S05U 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.

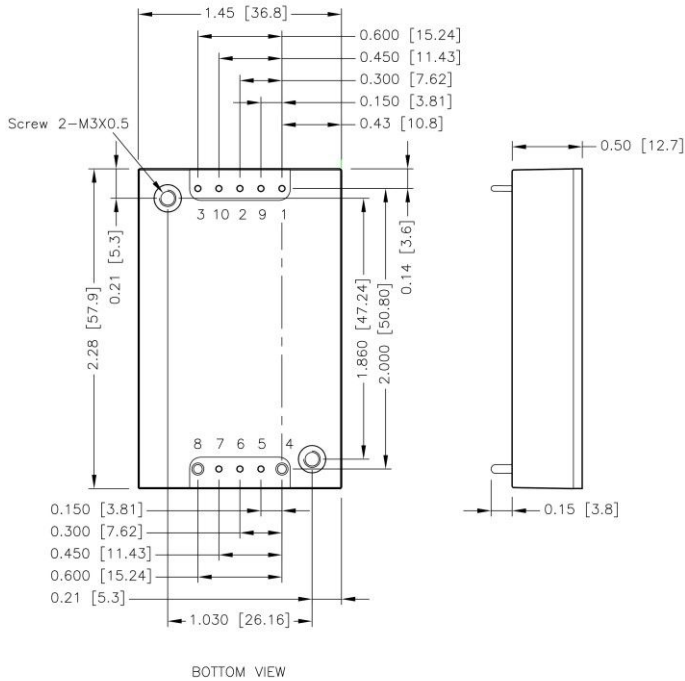
To maximum flexibility, internal fusing is not included; however, to achieve maximum safety and system protection, always use an input line fuse.

The input line fuse suggest as below :

| Model | Fuse Rating (A) | Fuse Type |
|--------------|-----------------|-------------|
| QAE40-36S□□U | 8 | Fast-Acting |
| QAE40-72S□□U | 5 | 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

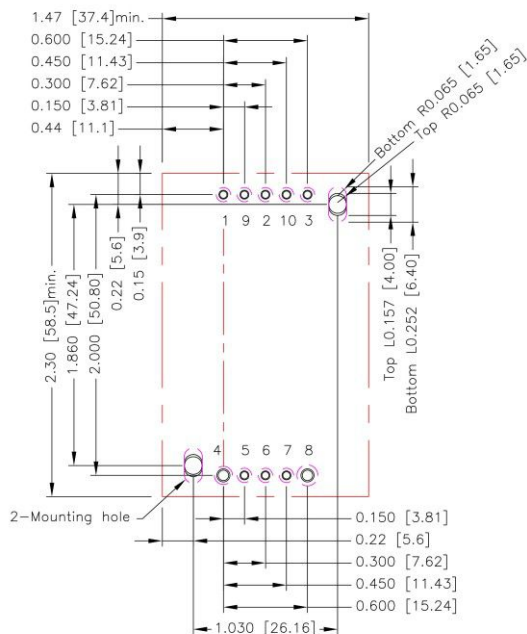


PIN CONNECTION

| 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 |
| 9 | Bus | 0.04 Inch |
| 10 | UVLO | 0.04 Inch |

- All dimensions in inch [mm]
- Tolerance :x.xx±0.02 [x.x±0.5]
x.xxx±0.010 [x.xx±0.25]
- Pin dimension tolerance ±0.004[0.10]
- 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 1.2.3.5.6.7.9.10:∅0.051[1.30]
- Through hole 4.8:∅0.075[1.90]
- Through hole of mounting:∅0.126[3.20]
- Top view pad 1.2.3.5.6.7.9.10:∅0.064[1.63]
- Top view pad 4.8:∅0.094[2.38]
- Top view pad of mounting:Groove R0.065[1.65]L0.157[4.00]
- Bottom view pad 1.2.3.5.6.7.9.10:∅0.102[2.60]
- Bottom view pad 8:∅0.150[3.80]
- Bottom view pad 4:∅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.

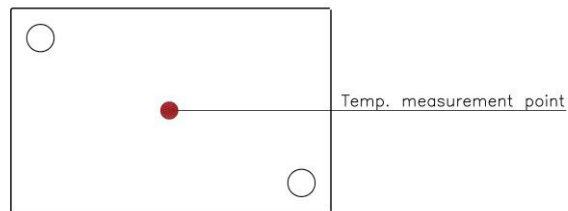
Proper cooling can be verified by measuring the point as the figure below.

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.

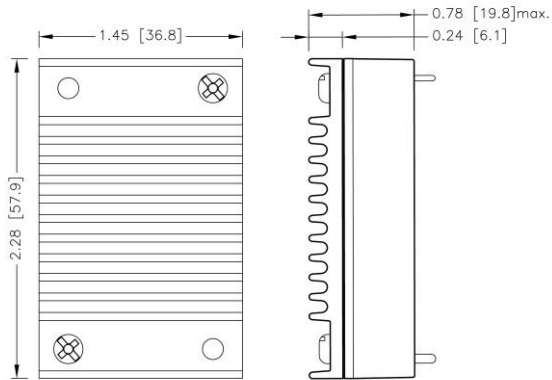
- Thermal test condition with vertical direction by natural convection (20LFM).
- The iron base-plate dimension is 19" X 3.5" X 0.063" (The height is EIA standard 2U).
- The heat-sink is optional and P/N: 7G-0029B-F, 7G-0030B-F, 7G-0031B-F, 7G-0032B-F, 7GA0124P01-F, 7GA0125P01-F.



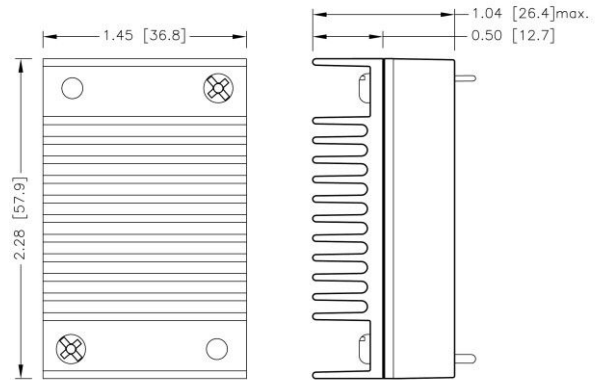
BASE PLATE

HEAT-SINK TYPE OPTIONS

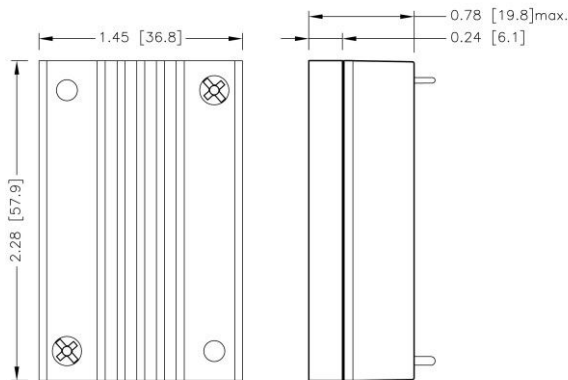
QAE40-□□S□□U -HS
7G-0029B-F



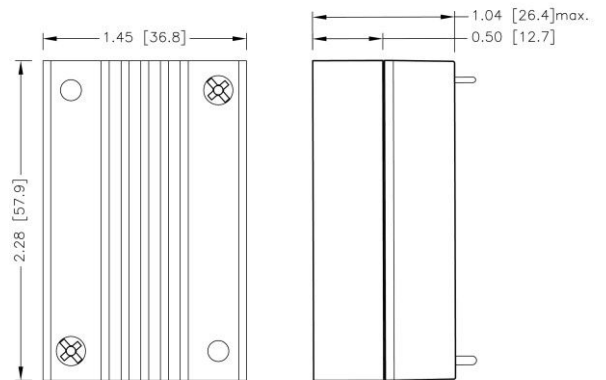
QAE40-□□S□□U -HS1
7G-0030B-F



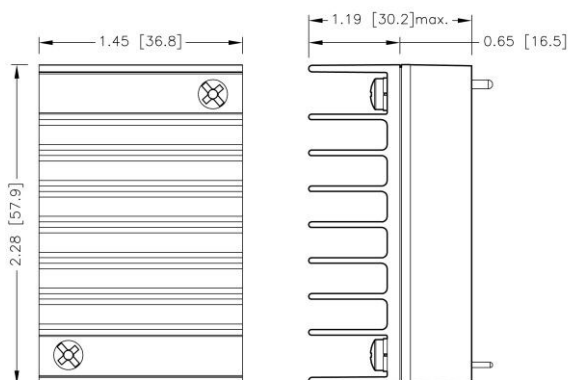
QAE40-□□S□□U -HS2
7G-0031B-F



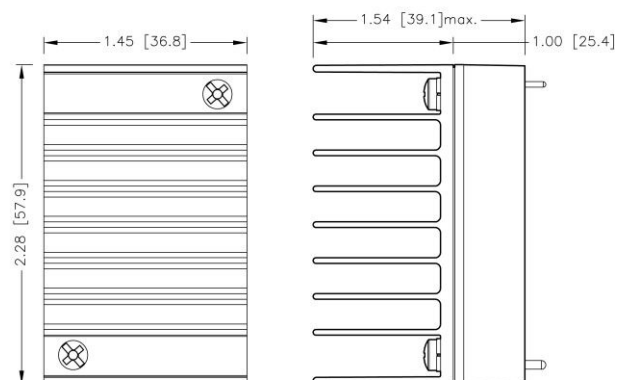
QAE40-□□S□□U -HS3
7G-0032B-F



QAE40-□□S□□U -HS4
7GA0124P01-F

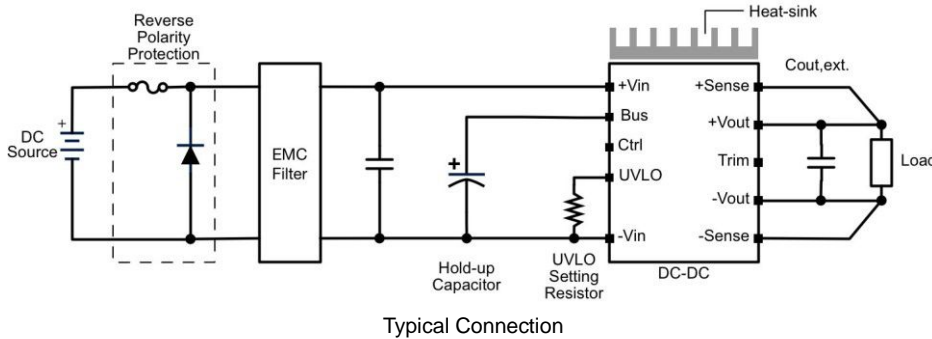


QAE40-□□S□□U -HS5
7GA0125P01-F



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

TYPICAL APPLICATION

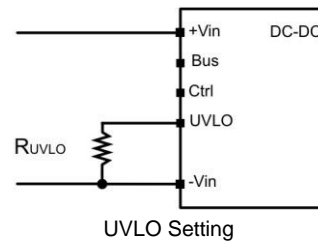


■ **UVLO**

This series product has ultra wide input range. It could cover many kind of nominal input voltage in one module. In order to preventing incorrect operating under different input system, it offers UVLO adjustment by connecting a resistor to set UVLO threshold.

■ **UVLO Constants**

| Model | A | B | C |
|--------------|--------|-------|------|
| QAE40-36S□□U | 48000 | 8273 | 0.96 |
| QAE40-72S□□U | 120000 | 12500 | 2.4 |



■ **UVLO Equation**

Start-up Voltage

$$V_{\text{start-up}} = 1.25 \times \left[\frac{A \times (R_{\text{UVLO}} + B)}{R_{\text{UVLO}} \times B} + 1 \right]$$

Shutdown Voltage

$$V_{\text{shutdown}} = V_{\text{start-up}} - C$$

■ **UVLO values for various nominal input voltage and R_{UVLO} table**

QAE40-36S□□U

| Nominal Vin | 12V | 24V | 36V | 48V |
|-----------------------|--------|----------|---------|---------|
| Start-up voltage | 8.46 V | 13.36 V | 20.56 V | 27.76 V |
| Shutdown voltage | 7.5 V | 12.4 V | 19.6 V | 26.8 V |
| UVLO Setting resistor | Open | 12.35 KΩ | 4.98 KΩ | 3.12 KΩ |

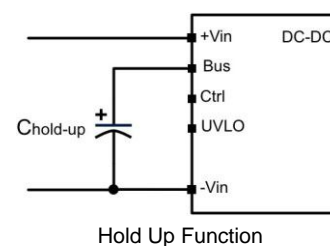
QAE40-72S□□U

| Nominal Vin | 24 V | 36 V | 48 V | 72 V | 96 V | 110 V |
|-----------------------|----------|----------|---------|---------|---------|---------|
| Start-up voltage | 14.8 V | 22 V | 29.2 V | 43.6 V | 58 V | 66.4 V |
| Shutdown voltage | 12.4 V | 19.6 V | 26.8 V | 41.2 V | 55.6 V | 64 V |
| UVLO Setting resistor | 96.77 KΩ | 17.14 KΩ | 9.40 KΩ | 4.94 KΩ | 3.35 KΩ | 2.82 KΩ |

■ **Hold Up Time**

Generally, connecting a large number of hold up capacitors on input are necessary to get a long duration of hold up time for S2, C2 described in EN50155. The Bus pin features excellent function can simply connect capacitors to Bus pin with less quantity of capacitors. It helps reduce layout area and smooth the inrush current.

For further information, please contact P-DUKE.



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 decreases.

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

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

$$R_U = \left(\frac{5.11V_{OUT}(100 + \Delta\%)}{1.225\Delta\%} - \frac{511 + 10.22\Delta\%}{\Delta\%} \right) k\Omega$$

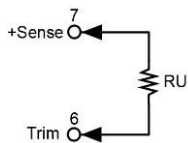
Trim Down Equation

$$R_D = \left(\frac{511}{\Delta\%} - 10.22 \right) k\Omega$$

EXTERNAL OUTPUT TRIMMING

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

Trim-up



□□S05U

| ΔV (%) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------------|---------|---------|---------|---------|--------|--------|---------|---------|---------|---------|
| Vout (V) | 5.05 | 5.10 | 5.15 | 5.20 | 5.25 | 5.30 | 5.35 | 5.40 | 5.45 | 5.50 |
| RU (k Ω) | 1585.35 | 797.994 | 535.542 | 404.316 | 325.58 | 273.09 | 235.596 | 207.476 | 185.605 | 168.109 |

□□S12U

| ΔV (%) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------------|---------|---------|---------|---------|--------|---------|---------|---------|--------|---------|
| Vout (V) | 12.12 | 12.24 | 12.36 | 12.48 | 12.60 | 12.72 | 12.84 | 12.96 | 13.08 | 13.20 |
| RU (k Ω) | 4534.55 | 2287.19 | 1538.08 | 1163.52 | 938.78 | 788.956 | 681.939 | 601.676 | 539.25 | 489.309 |

□□S15U

| ΔV (%) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Vout (V) | 15.15 | 15.30 | 15.45 | 15.60 | 15.75 | 15.90 | 16.05 | 16.20 | 16.35 | 16.50 |
| RU (k Ω) | 5798.49 | 2925.42 | 1967.73 | 1488.89 | 1201.58 | 1010.04 | 873.229 | 770.619 | 690.812 | 626.966 |

□□S24U

| ΔV (%) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------------|---------|---------|--------|-------|---------|--------|--------|---------|--------|---------|
| Vout (V) | 24.24 | 24.48 | 24.72 | 24.96 | 25.20 | 25.44 | 25.68 | 25.92 | 26.16 | 26.40 |
| RU (k Ω) | 9590.32 | 4840.11 | 3256.7 | 2465 | 1989.98 | 1673.3 | 1447.1 | 1277.45 | 1145.5 | 1039.94 |

□□S28U

| ΔV (%) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------------|----------|---------|---------|---------|---------|---------|----------|----------|---------|---------|
| Vout (V) | 28.28 | 28.56 | 28.84 | 29.12 | 29.40 | 29.68 | 29.96 | 30.24 | 30.52 | 30.80 |
| RU (k Ω) | 11275.58 | 5691.08 | 3829.58 | 2898.83 | 2340.38 | 1968.08 | 1702.151 | 1502.705 | 1347.58 | 1223.48 |

□□S48U

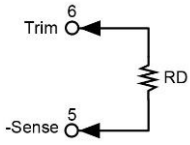
| ΔV (%) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Vout (V) | 48.48 | 48.96 | 49.44 | 49.92 | 50.40 | 50.88 | 51.36 | 51.84 | 52.32 | 52.80 |
| RU (k Ω) | 19701.9 | 9945.94 | 6693.96 | 5067.97 | 4092.38 | 3441.99 | 2977.42 | 2628.99 | 2357.99 | 2141.19 |

□□S53U

| ΔV (%) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------------|-----------|-----------|----------|----------|---------|----------|----------|----------|----------|----------|
| Vout (V) | 53.53 | 54.06 | 54.59 | 55.12 | 55.65 | 56.18 | 56.71 | 57.24 | 57.77 | 58.30 |
| RU (k Ω) | 21808.437 | 11009.651 | 7410.056 | 5610.259 | 4530.38 | 3810.461 | 3296.233 | 2910.562 | 2610.596 | 2370.623 |

OUTPUT VOLTAGE ADJUSTMENT(CONTINUED)

Trim-down



□□S□□U

| | | | | | | | | | | |
|------------------|--------|--------|---------|--------|--------|--------|--------|--------|--------|-------|
| ΔV (%) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| RD (k Ω) | 500.78 | 245.28 | 160.113 | 117.53 | 91.98 | 74.947 | 62.78 | 53.655 | 46.558 | 40.88 |
| ΔV (%) | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| RD (k Ω) | 36.235 | 32.363 | 29.088 | 26.28 | 23.847 | 21.718 | 19.839 | 18.169 | 16.675 | 15.33 |