# *AET (20W) Isolated DC/DC Converter Module*
# *Industry Standard Size, 2" ×1.6" ×0.48"*
# *9-36V/18-75V Inputs, 2.5V/3.3V/5V/±5V/12V/±12V/15V/±15V Outputs*

The AET (20W) Isolated DC/DC Converter is 4:1 wide input voltage family for low power applications. With efficiency up to 84% typical for 5V module, this product is allowed to work at operating temperature range from -40ºC to 71ºC and a wide input voltage range of 4:1. Single-output and dual-output models are available for a wide range of applications in telecommunication, transportation equipment, etc.. Housed in small package, 2" × 1.6" × 0.48", with industry standard pinout, AET family eases the PCB designs and mechanical designs of customers' end products.


**Industry Standard Size**
**2" × 1.6" × 0.48"**

## Special Features

- **Wide 4:1 input range**
- **High efficiency, 84%@5V**
- **-40°C to 90°C case surface operating temperature**
- **Input / Output isolation 1.5KVdc**
- **Low output ripple and noise**
- **Shielded metal case with size (2"x1.6"x0.48")**
- **Industrial standard pinout**
- **Lead-free soldering pins**
- **Fixed switching frequency (300KHz)**
- **Positive enable function**
- **Adjustable Output Voltage**
- **Built-in input filter meets EN55022 / FCC Class A without external components**

## Environmental Specifications

- **Operating temperature: -40°C to +71°C**
- **Storage temperature: -55°C to +105°C**
- **RoHS compliant**

## Electrical Parameters

### Input

| | |
|---|---|
| **Input range** | **9-36 VDC; 18-75 VDC** |
| **Input Surge** | **50V / 100ms; 100V / 100ms** |
| **Efficiency** | **84% @5V (Typical)** |

### Output

| | |
|---|---|
| **Regulation (Line, Load, Temp)** | **<1.5%** |
| **Ripple and noise** | **100mV p-p max** |
| **Output Voltage Adjust Range** | **± 10% of nominal output** |
| **Transient Response** | **5% max deviation with 50% load to full load 300uS (max) recovery** |
| **Short Circuit Protection** | **Indefinite** |
| **Over Voltage Protection** | **120-130% nominal output** |

## Safety

**Designed to meet EN60950 (up to SELV limit)**

AET (20W) SERIES

THIS SPECIFICATION COVERS THE REQUIREMENTS
FOR AN INDUSTRY STANDARD PACKAGE OF 2"x1.6"x0.48", 4:1 INPUT RANGE,
20W, SINGLE OUTPUT AND DUAL OUTPUT ISOLATED DC/DC CONVERTER

**PART NUMBERS**

| MODEL NAME / SIS CODE | Nominal Vin ($V_{I, nom}$) / Range of Vin | Vout / Iout |
|---|---|---|
| **AET06G18-L** | **24V / 9-36V** | **2.5V / 6A** |
| **AET06F18-L** | **24V / 9-36V** | **3.3V / 6A** |
| **AET04A18-L** | **24V / 9-36V** | **5V / 4A** |
| **AET02AA18-L** | **24V / 9-36V** | **±5V / ±2A** |
| **AET01B18-L** | **24V / 9-36V** | **12V / 1.67A** |
| **AET00BB18-L** | **24V / 9-36V** | **±12V / ±0.83A** |
| **AET01C18-L** | **24V / 9-36V** | **15V / 1.33A** |
| **AET00CC18-L** | **24V / 9-36V** | **±15V / ±0.67A** |
| **AET06G36-L** | **48V / 18-75V** | **2.5V / 6A** |
| **AET06F36-L** | **48V / 18-75V** | **3.3V / 6A** |
| **AET04A36-L** | **48V / 18-75V** | **5V / 4A** |
| **AET02AA36-L** | **48V / 18-75V** | **±5V / ±2A** |
| **AET01B36-L** | **48V / 18-75V** | **12V / 1.67A** |
| **AET00BB36-L** | **48V / 18-75V** | **±12V / ±0.83A** |
| **AET01C36-L** | **48V / 18-75V** | **15V / 1.33A** |
| **AET00CC36-L** | **48V / 18-75V** | **±15V / ±0.67A** |

## ELECTRICAL SPECIFICATIONS

**STANDARD TEST CONDITION** on a single unit, unless otherwise specified.

| | |
|---|---|
| $T_A$ : | 25°C (Ambient Air) |
| +Vin : | 24V ±2% (AETxxxx18-L) |
| | 48V ±2% (AETxxxx36-L) |
| –Vin : | Return pin for +Vin |
| Enable : | Open (Positive Enable) |
| +Vout : | Connect to load |
| –Vout : | Connect to load (return) |
| Trim (Vadj) : | Open |

## ABSOLUTE MAXIMUM RATINGS

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of the IPS. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

| Parameter | Device | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| a) Input Voltage: | | | | | | |
| Continuous: | AETxxxx18-L | $V_I$ | 0 | - | 36 | $V_{dc}$ |
| Transient (100ms) | AETxxxx18-L | $V_{I, trans}$ | 0 | - | 50 | $V_{dc}$ |
| Continuous: | AETxxxx36-L | $V_I$ | 0 | - | 75 | $V_{dc}$ |
| Transient (100ms) | AETxxxx36-L | $V_{I, trans}$ | 0 | - | 100 | $V_{dc}$ |
| b) Operating Temperature | | | | | | |
| Ambient | All | $T_A$ | -40 | - | 71 | ºC |
| Case Surface | | $T_C$ | -40 | - | 100 | ºC |
| c) Storage Temperature | All | $T_{STG}$ | -55 | - | 105 | ºC |
| d) Operating Humidity | All | - | - | - | 95 | % |
| e) I/O Isolation (Conditions : 0.5mA for 60 sec) | | | | | | |
| Input-Output | All | - | - | - | 1500 | $V_{dc}$ |
| f) Output Power | 2.5V | $P_{o, max}$ | - | - | 15 | W |
| | Others | $P_{o, max}$ | - | - | 20 | W |

## INPUT SPECIFICATIONS

| Parameter | Device | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| a) Operating Input Voltage | AETxxxx18-L | $V_I$ | 9 | 24 | 36 | $V_{dc}$ |
| | AETxxxx36-L | $V_I$ | 18 | 48 | 75 | $V_{dc}$ |
| b) Maximum Input Current | | | | | | |
| AETxxxx18-L | 2.5V | $I_{I, max}$ | - | - | 3 | A |
| ($V_I$ = 0 to $V_{I, max}$ ; Io = $I_{o, max}$) | 3.3V | $I_{I, max}$ | - | - | 3.5 | A |
| | 5V / ±5V | $I_{I, max}$ | - | - | 4 | A |
| | 12V / ±12V | $I_{I, max}$ | - | - | 4 | A |
| | 15V / ±15V | $I_{I, max}$ | - | - | 4 | A |
| AETxxxx36-L | 2.5V | $I_{I, max}$ | - | - | 1.5 | A |
| ($V_I$ = 0 to $V_{I, max}$ ; Io = $I_{o, max}$) | 3.3V | $I_{I, max}$ | - | - | 2 | A |
| | 5V / ±5V | $I_{I, max}$ | - | - | 2.5 | A |
| | 12V / ±12V | $I_{I, max}$ | - | - | 2.5 | A |
| | 15V / ±15V | $I_{I, max}$ | - | - | 2.5 | A |
| c) No Load Input Power ($V_I = V_{I, nom}$ ) | All | - | - | - | 0.5 | W |
| d) Recommended External Fuse Ratings | | | | | | |
| AETxxxx18-L | 2.5V | | - | 4 | - | A |
| | 3.3V | | - | 4 | - | A |
| | 5V / ±5V | | - | 5 | - | A |
| | 12V / ±12V | | - | 5 | - | A |
| | 15V / ±15V | | - | 5 | - | A |
| AETxxxx36-L | 2.5V | | - | 2 | - | A |
| | 3.3V | | - | 3 | - | A |
| | 5V / ±5V | | - | 3 | - | A |
| | 12V / ±12V | | - | 3 | - | A |
| | 15V / ±15V | | - | 3 | - | A |

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

## OUTPUT SPECIFICATIONS

| Parameter | Device | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| a) Output Voltage Setpoint | 2.5V | $V_{o, set}$ | 2.46 | 2.50 | 2.54 | $V_{dc}$ |
| ($V_I = V_{I, min}$ to $V_{I, max}$ ; Io = $I_{o, max}$ ; | 3.3V | $V_{o, set}$ | 3.25 | 3.30 | 3.35 | $V_{dc}$ |
| $T_A$ = 25 ºC) | 5V | $V_{o, set}$ | 4.92 | 5.00 | 5.08 | $V_{dc}$ |
| | 12V | $V_{o, set}$ | 11.82 | 12.00 | 12.18 | $V_{dc}$ |
| | 15V | $V_{o, set}$ | 14.77 | 15.00 | 15.23 | $V_{dc}$ |
| | ±5V | $V_{o, set}$ | ±4.92 | ±5.00 | ±5.08 | $V_{dc}$ |
| | ±12V | $V_{o, set}$ | ±11.82 | ±12.00 | ±12.18 | $V_{dc}$ |
| | ±15V | $V_{o, set}$ | ±14.77 | ±15.00 | ±15.23 | $V_{dc}$ |
| b) Output Regulation: | | | | | | |
| Line ($V_I = V_{I, max}$ to $V_{I, min}$ ; Io = $I_{o, max}$) | All | - | - | - | 0.5 | % |
| Load ($V_I = V_{I, nom}$ ; Io = $I_{o, min}$ to $I_{o, max}$) | All | - | - | - | 0.5 | % |
| Cross ($V_I = V_{I, nom}$; Io = $+I_{o, max}$,$-I_{o, min}$ or $+I_{o, min}$,$-I_{o, max}$ to $+I_{o, max}$,$-I_{o, max}$ ) | ±5V/±12V/±15V | - | - | - | 4 | % |
| Temperature ($T_C$ = -40ºC to +90ºC) | All | - | - | - | 1 | %Vo |
| c) Output Ripple and Noise (Across 1µF @50V, X7R ceramic capacitor & 10µF @25V tantalum capacitor) See Figure 1. Peak-to-Peak (5 Hz to 20 MHz) | All | - | - | - | 100 | mVp-p |
| d) Rated Output Current | | | | | | |
| Single Output | 2.5V | Io | 600 | - | 6000 | mA |
| | 3.3V | Io | 600 | - | 6000 | mA |
| | 5V | Io | 400 | - | 4000 | mA |
| | 12V | Io | 167 | - | 1667 | mA |
| | 15V | Io | 133 | - | 1333 | mA |
| Dual Output | ±5V | Io | ±200 | - | ±2000 | mA |
| | ±12V | Io | ±83 | - | ±833 | mA |
| | ±15V | Io | ±67 | - | ±667 | mA |
| e) Efficiency | 2.5V | - | - | 80 | - | % |
| ($V_I = V_{I, nom}$ ; $I_{o, max}$ ; $T_A$ = 25°C) | 3.3V | - | - | 83 | - | % |
| | 5V | - | - | 84 | - | % |
| | 12V | - | - | 85 | - | % |
| | 15V | - | - | 85 | - | % |
| | ±5V | - | - | 84 | - | % |
| | ±12V | - | - | 85 | - | % |
| | ±15V | - | - | 85 | - | % |
| f) Switching Frequency | All | - | 270 | 300 | 330 | KHz |

**OUTPUT SPECIFICATIONS (Cont.)**

| Parameter | Device | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| g) Dynamic Response : ($\Delta Io/\Delta t = 0.08A/\mu s$ ; $V_I = V_{I, nom}$ ; $T_A = 25°C$) | | | | | | |
| Load Change from Io = 50% to 100% of $I_{o, max}$ | 2.5V/3.3V/5V/±5V | - | - | - | 5 | %Vo |
| | 12V/±12V/15V/±15V | - | - | - | 2 | %Vo |
| Peak Deviation Settling Time (to $V_{o, nom}$) | All | - | - | - | 300 | µsec |
| h) Turn-On Time (Io = $I_{o, max}$ ; Vo within 1%) | All | - | - | 6 | 10 | msec |
| i) Output Voltage Overshoot (Io = $I_{o, max}$ ; $T_A = 25°C$) | All | - | - | 1 | 4 | %Vo |

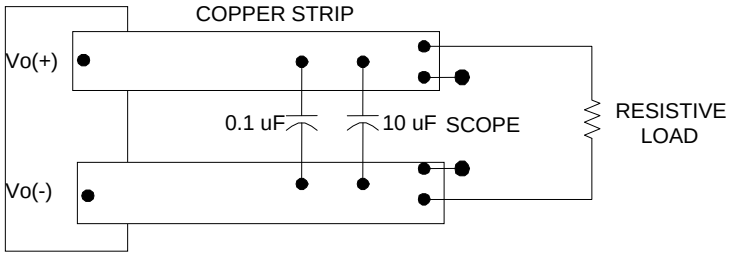
**FEATURE SPECIFICATIONS**

| Parameter | Device | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Enable Pin Voltage | | | | | | |
| Logic Low | All | OFF | -0.7 | - | 1.0 | V |
| Logic High | All | ON | 2.5 | - | $V_I$ | V |
| OPEN | All | ON | - | - | - | |
| Enable Pin Current | | | | | | |
| Logic Low | All | OFF | - | - | 1 | mA |
| Logic High (leakage current, @ $V_I$) | All | ON | - | - | 1 | uA |
| OPEN | All | ON | - | - | 0 | uA |
| Output Voltage Adjustment Range | All | - | 90 | - | 110 | %Vo |
| Output Overvoltage Clamp | 2.5V | Vo, clamp | 3.30 | - | 4.20 | V |
| | 3.3V | Vo, clamp | 3.90 | - | 4.50 | V |
| | 5V | Vo, clamp | 6.20 | - | 7.00 | V |
| | 12V | Vo, clamp | 15.00 | - | 17.00 | V |
| | 15V | Vo, clamp | 18.00 | - | 20.00 | V |
| | ±5V | Vo, clamp | ±6.20 | - | ±7.00 | V |
| | ±12V | Vo, clamp | ±15.00 | - | ±17.00 | V |
| | ±15V | Vo, clamp | ±18.00 | - | ±20.00 | V |

**FEATURE SPECIFICATIONS (Cont.)**

| | | | | | | |
|---|---|---|---|---|---|---|
| Undervoltage Lockout | | | | | | |
| Turn-on Point | AETxxxx18-L | - | - | 8.6 | 9 | V |
| | AETxxxx36-L | - | - | 16 | 18 | V |
| Turn-off Point | AETxxxx18-L | - | 6.5 | 8.4 | - | V |
| | AETxxxx36-L | - | 13 | 15 | - | V |
| Isolation Capacitance | All | - | - | 1000 | - | PF |
| Isolation Resistance | All | - | 10 | - | - | MΩ |
| Calculated MTBF ($Io = I_{o,max}$ ; $T_A = 25°C$) | All | - | 600K | 850K | - | Hours |
| Weight | All | - | - | - | 65 | g |

## TEST SETUP




Note: Use a 0.1µF @50V X7R ceramic capacitor and a 10µF @25V tantalum capacitor. Scope measurement should be made using a BNC socket. Position the load between 51 mm and 76 mm (2 in. and 3 in.) from module.

Figure 1 : Peak-to-Peak Output Noise Measurement Test Setup

## Basic Operation and Features

The AET converters were designed specifically to address applications where high power density is required.
These modules provide 1500Vdc isolation and operate from the input ranges of 9V-36V and 18V-75V with standard features such as Enable, Trim, OCP and OVP.

## Output Overcurrent Protection

To provide protection in an output overload or short circuit condition, the converter is equipped with current limiting circuitry and can endure the fault condition for an unlimited duration. At the point of current-limit inception, the converter goes into "Hiccup Mode", causing the output current to be limited both in peak and duration. The converter operates normally once the output current is brought back into its specified range.

## Output Overvoltage Protection

In a fault condition of output overvoltage, the converter latches which ensures that the output voltage does not exceed $V_{o,\,clamp,\,max}$ .

## Enable Function

Positive Logic Enable turns the converter on during a logic-high voltage or an open circuit on the enable pin, and off during a logic-low.

## Trim Function

Output Voltage adjustment is accomplished by connecting an external resistor between the Trim Pin and either the +Vout or –Vout Pins.

**To adjust Vo to a higher value**, please refer to Figure 2.
An external resistor, Radj_up, should be connected between the Trim Pin and the –Vout Pin. From equation (1), Radj_up resistor can be determined for the required output voltage.

### Equation (1)

For Vo=2.5V modules, $Vo = \frac{3800}{15200+Radj\_up} + 2.5$

For Vo=3.3V modules, $Vo = \frac{2393}{7250+Radj\_up} + 3.3$

For Vo=5V modules, $Vo = \frac{9550}{19100+Radj\_up} + 5$

For Vo=12V modules, $Vo = \frac{37200}{31000+Radj\_up} + 12$

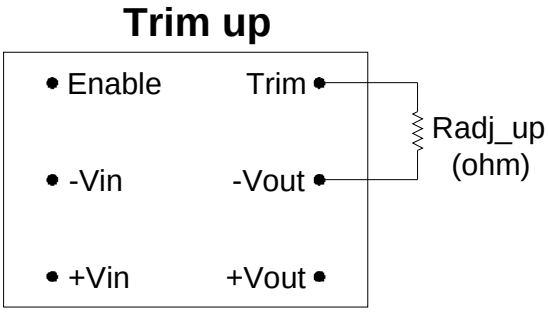



Figure 2. Circuit Configuration to Increase Output Voltage

For Vo=15V modules, $Vo = \frac{36450}{24300+Radj\_up} + 15$

For Vo=±5V modules, $Vo = \pm \left| \left( \frac{20654}{20654+Radj\_up} + 10 \right) \div 2 \right|$

For Vo=±12V modules, $Vo = \pm \left| \left( \frac{87600}{36500+Radj\_up} + 24 \right) \div 2 \right|$

For Vo=±15V modules, $Vo = \pm \left| \left( \frac{66300}{22100+Radj\_up} + 30 \right) \div 2 \right|$

Where: Radj_up is in Ω
Vo is not changed when Radj_up is not connected
110% Vo is obtained when Radj_up = 0 Ω (i.e. Trim Pin is shorted to –Vout Pin)

**To adjust Vo to a lower value**, please refer to Figure 3.
An external resistor, Radj_down, should be connected between the Trim Pin and the +Vout Pin. From equation (2), Radj_down resistor can be determined for the required output voltage.

**Equation (2)**

For Vo=2.5V modules, $Vo = \frac{35100+2.5\ Radj\_down}{15600+Radj\_down}$

For Vo=3.3V modules, $Vo = \frac{43956+3.3\ Radj\_down}{14800+Radj\_down}$

For Vo=5V modules, $Vo = \frac{86400+5\ Radj\_down}{19200+Radj\_down}$

For Vo=12V modules, $Vo = \frac{1468800+12\ Radj\_down}{136000+Radj\_down}$

For Vo=15V modules, $Vo = \frac{1957500+15\ Radj\_down}{145000+Radj\_down}$

For Vo=±5V modules, $Vo = \pm \left| \left( \frac{631980+10\ Radj\_down}{70220+Radj\_down} \right) \div 2 \right|$

For Vo=±12V modules, $Vo = \pm \left| \left( \frac{8152000+24\ Radj\_down}{377400+Radj\_down} \right) \div 2 \right|$

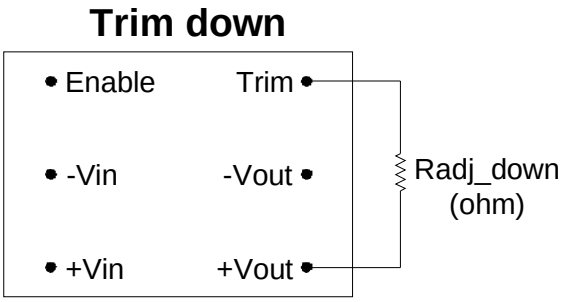
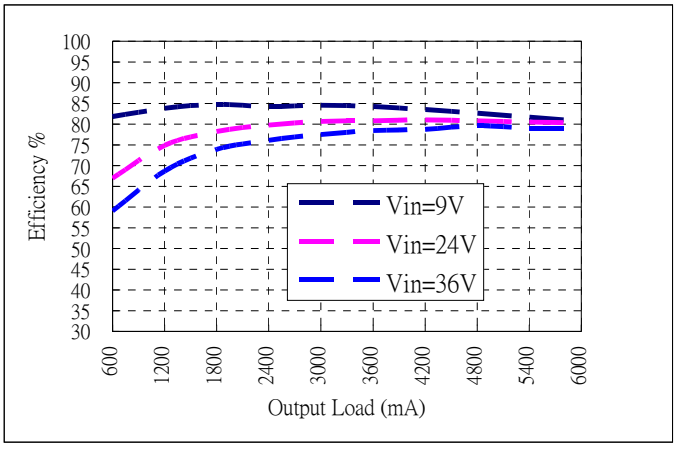



Figure 3. Circuit Configuration to Increase Output Voltage

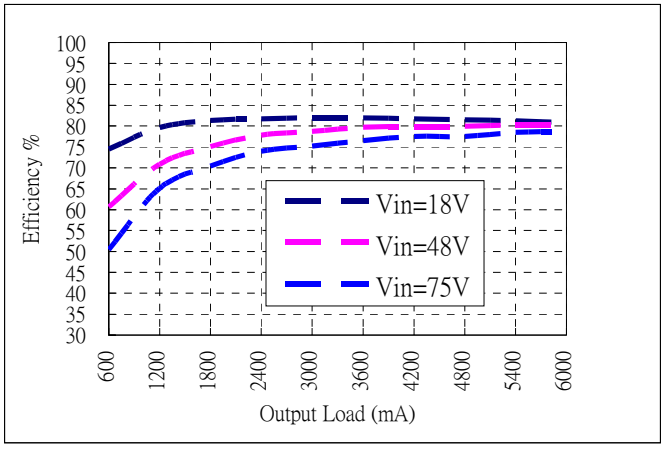
For Vo=±15V modules, $Vo = \pm \left| \left( \frac{7971000+30\ Radj\_down}{295220+Radj\_down} \right) \div 2 \right|$

Where: Radj_down is in Ω
Vo is not changed when Radj_down is not connected
90% Vo is obtained when Radj_down = 0 Ω (i.e. Trim Pin is shorted to +Vout Pin)

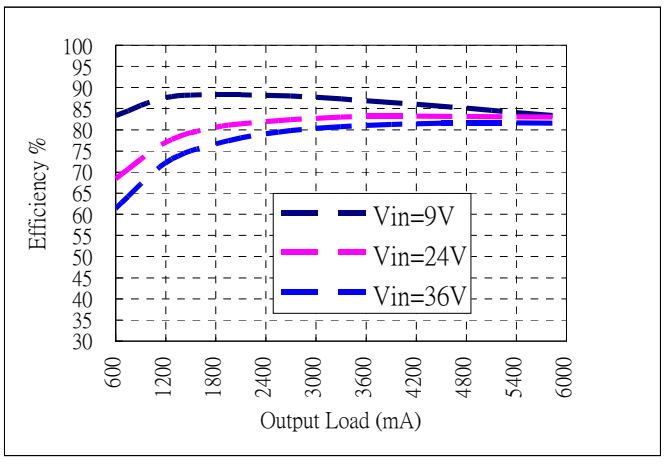
## Performance Curves – Efficiency Curve



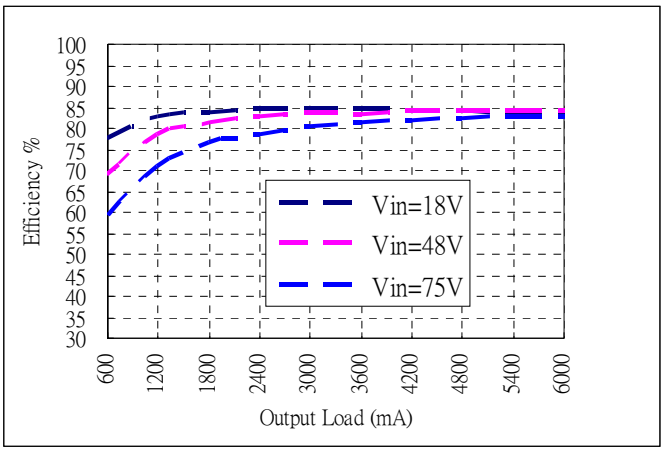

**Efficiency vs. Load @ +25℃ Ambient, AET06G18-L**



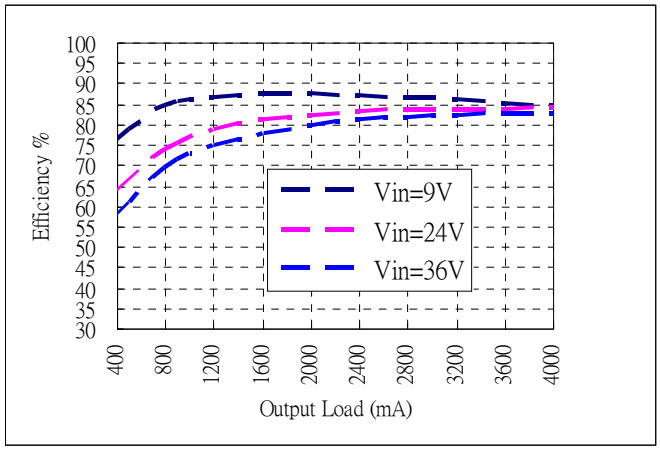

**Efficiency vs. Load @ +25℃ Ambient, AET06G36-L**



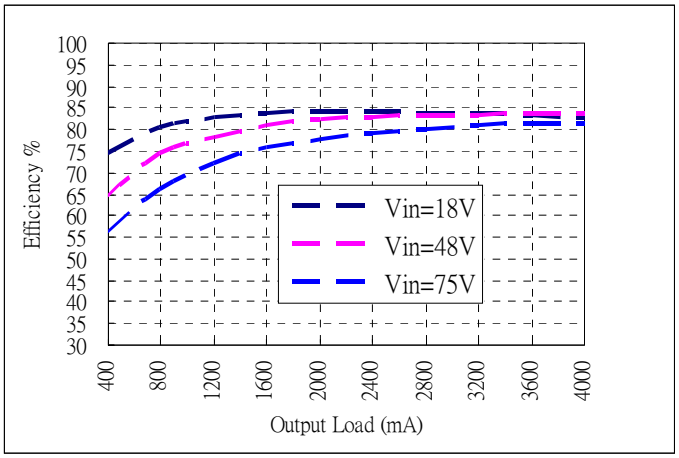

**Efficiency vs. Load @ +25℃ Ambient, AET06F18-L**



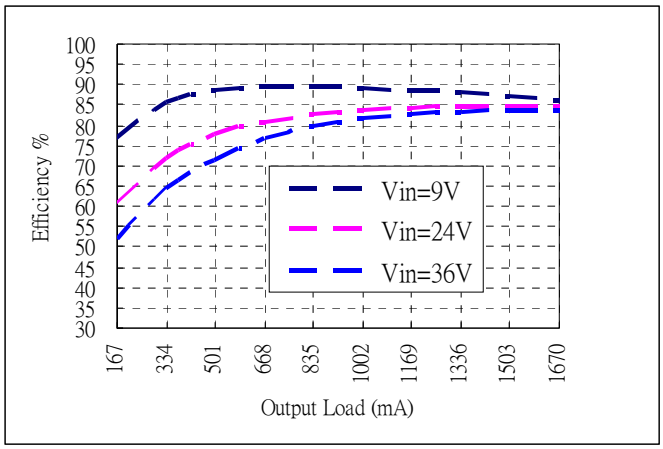

**Efficiency vs. Load @ +25℃ Ambient, AET06F36-L**



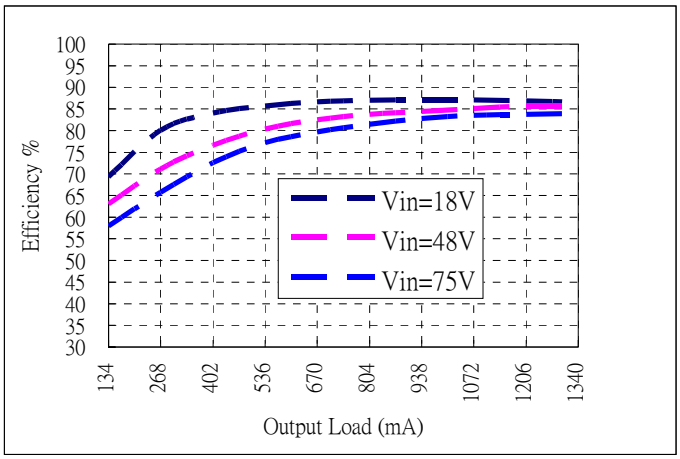

**Efficiency vs. Load @ +25℃ Ambient, AET04A18-L**



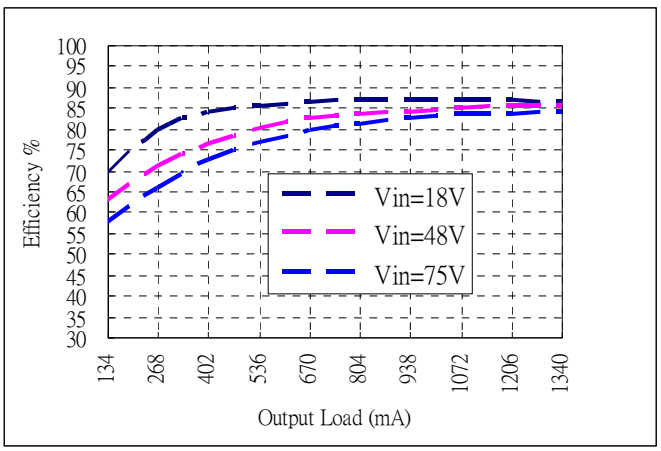

**Efficiency vs. Load @ +25℃ Ambient, AET04A36-L**



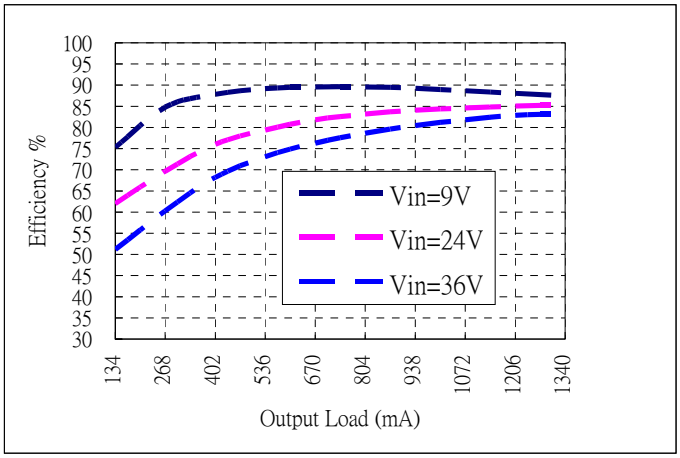

**Efficiency vs. Load @ +25℃ Ambient, AET01B18-L**



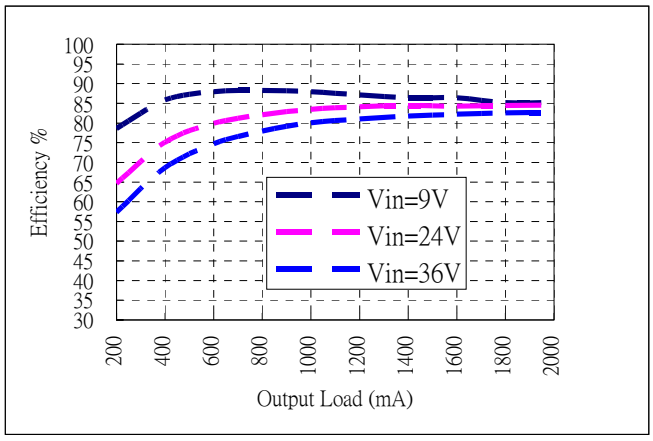

**Efficiency vs. Load @ +25℃ Ambient, AET01B36-L**



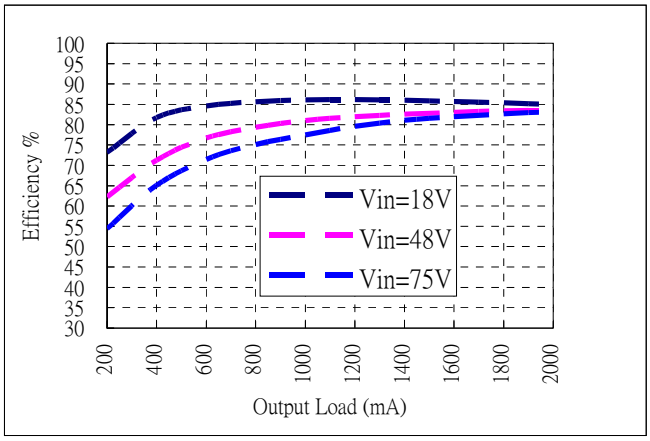

**Efficiency vs. Load @ +25℃ Ambient, AET01C18-L**



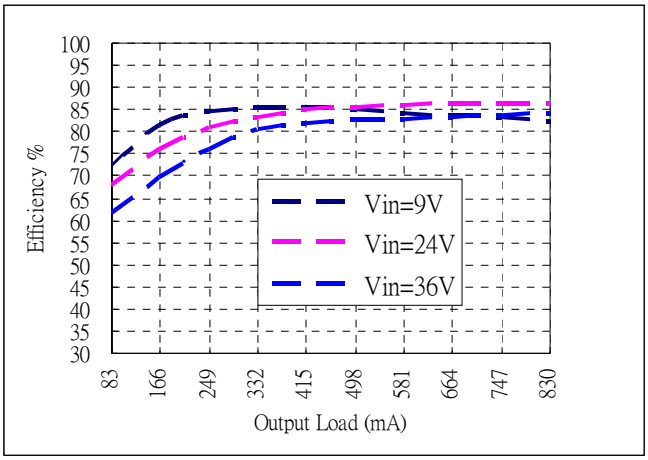

**Efficiency vs. Load @ +25℃ Ambient, AET01C36-L**



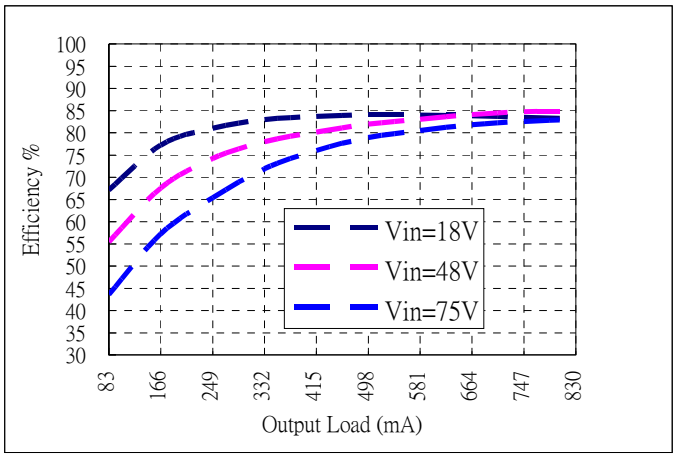

**Efficiency vs. Load @ +25℃ Ambient,AET02AA18-L**



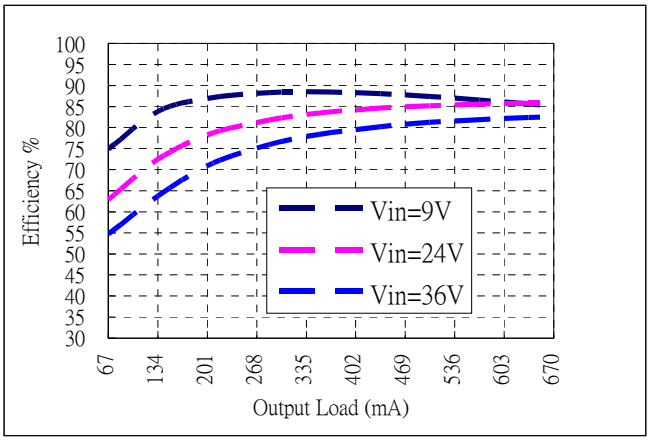

**Efficiency vs. Load @ +25℃ Ambient, AET02AA36-L**



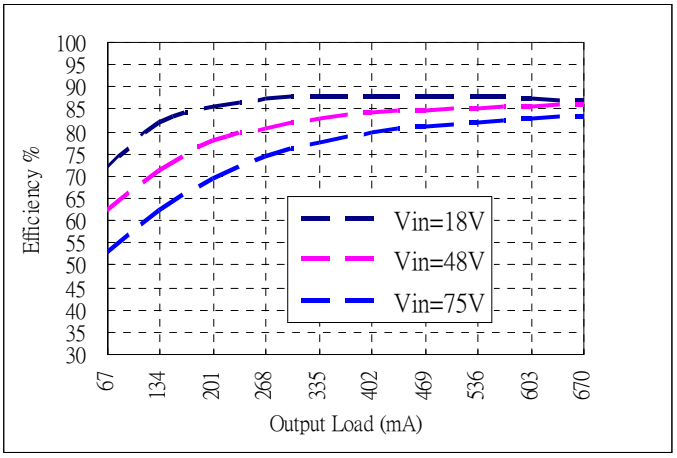

**Efficiency vs. Load @ +25℃ Ambient, AET00BB18-L**




**Efficiency vs. Load @ +25℃ Ambient, AET00BB36-L**

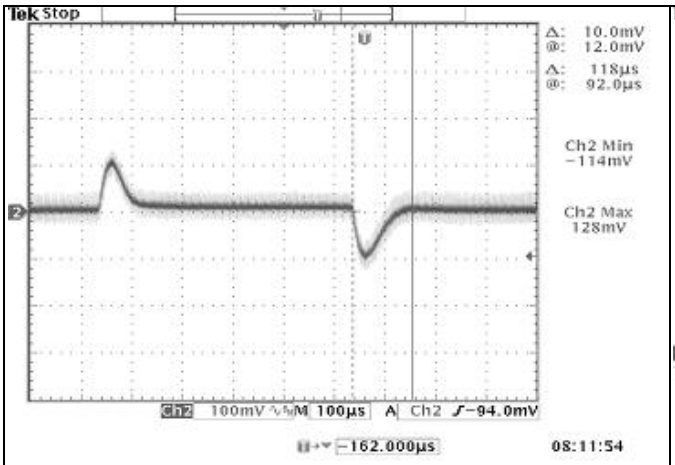



**Efficiency vs. Load @ +25℃ Ambient, AET00CC18-L**

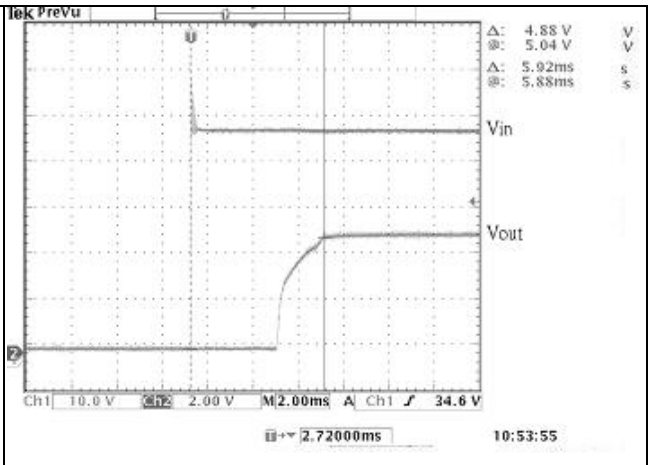



**Efficiency vs. Load @ +25℃ Ambient, AET00CC36-L**

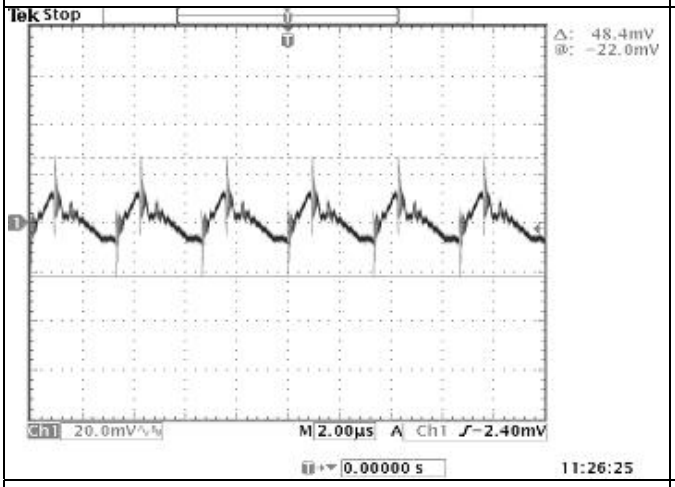
## Performance Curves



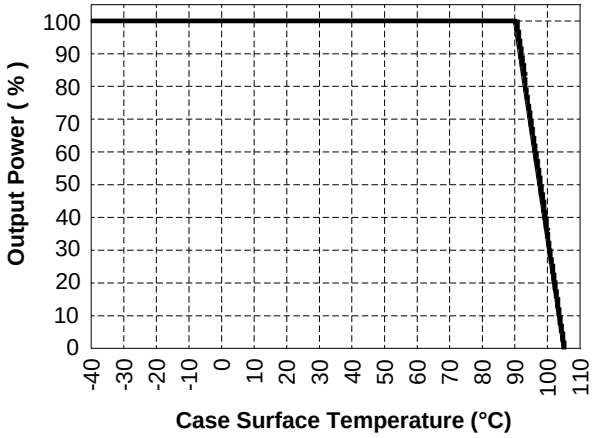

Transient Response – 50% to 100% load (AET04A18-L)




Start-Up Time (AET04A18-L)

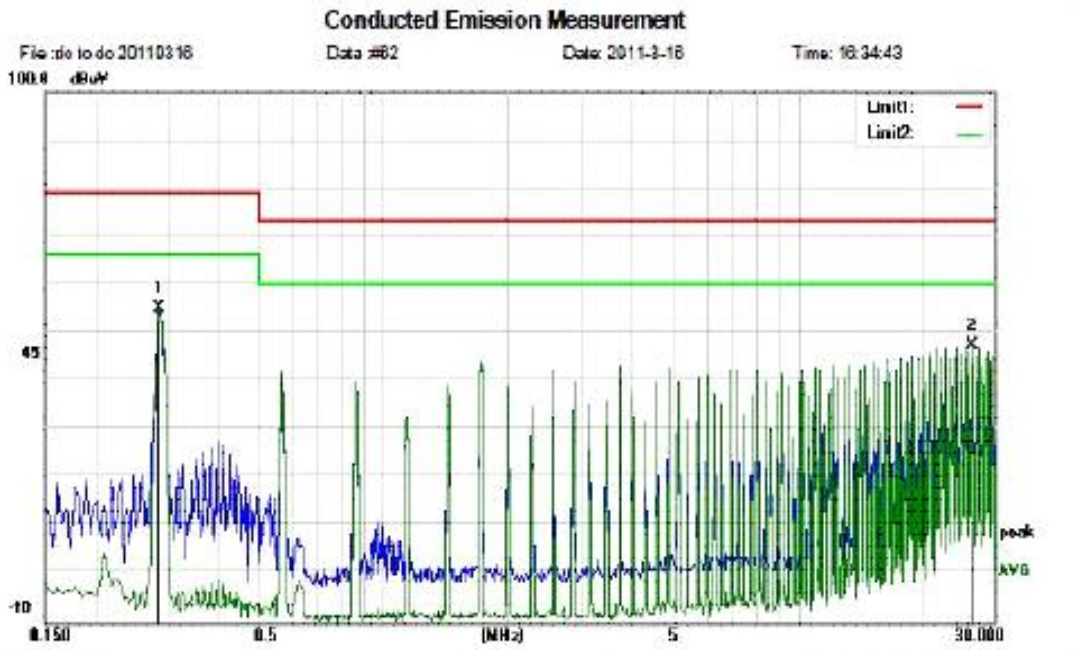



Ripple & Noise (AET04A18-L)




Power Derating

## Conducted EMI Performance

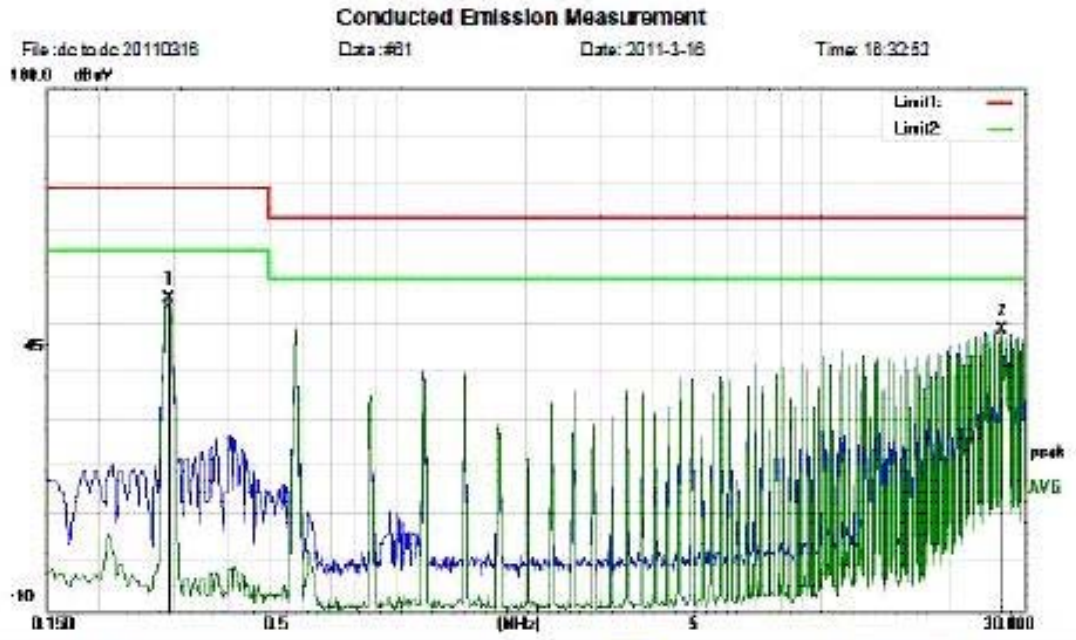



Site Chamber #1
Limit: (CE)EN55022 class A_QP
EUT: dc to dc converter
M/N: AET04A18-L
Mode: Full Load
Note:

Phase: L
Power: DC 24V

Temperature: 20
Humidity: 57 %
Test Result: Pass

| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dB | dBuV | dBuV | dB | Detector | Comment |
| 1 | * | 0.2860 | 54.88 | 0.12 | 55.00 | 79.00 | -24.00 | peak | |
| 2 | | 26.5140 | 46.00 | 1.28 | 47.28 | 73.00 | -25.72 | peak | |




Site: Chamber #1
Limit: (CE)EN55022 class A_QP
EUT: dc to dc converter
M/N: AET04A18-L
Mode: Full Load
Note:

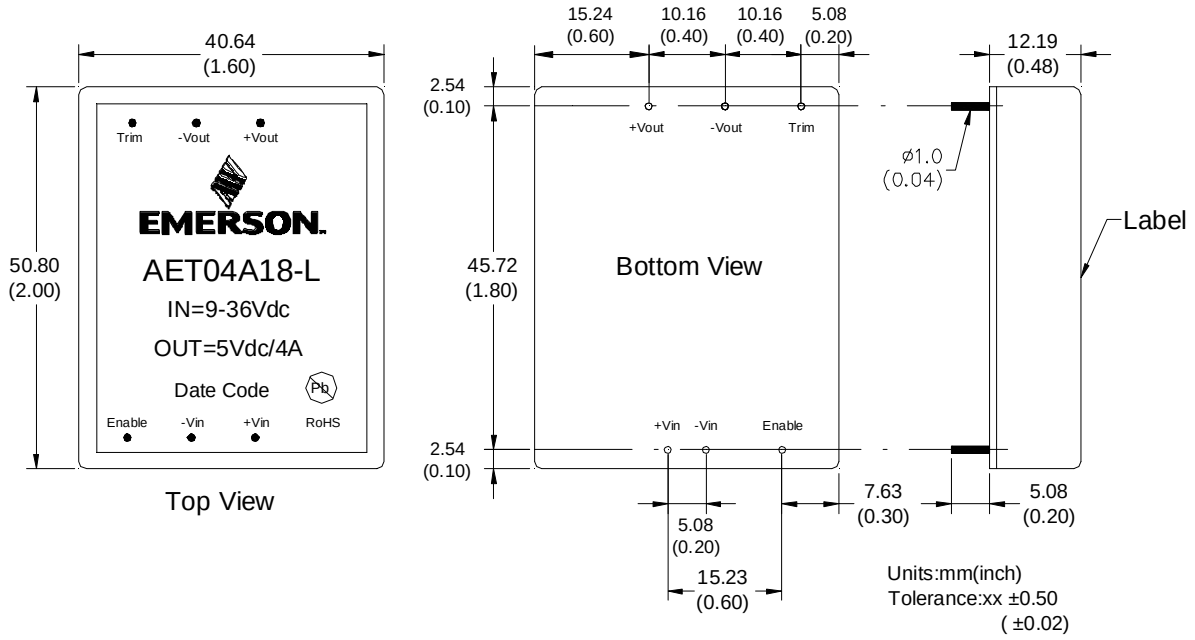
Phase: N
Power: DC 24V

Temperature: 20
Humidity: 57 %
Test Result: Pass

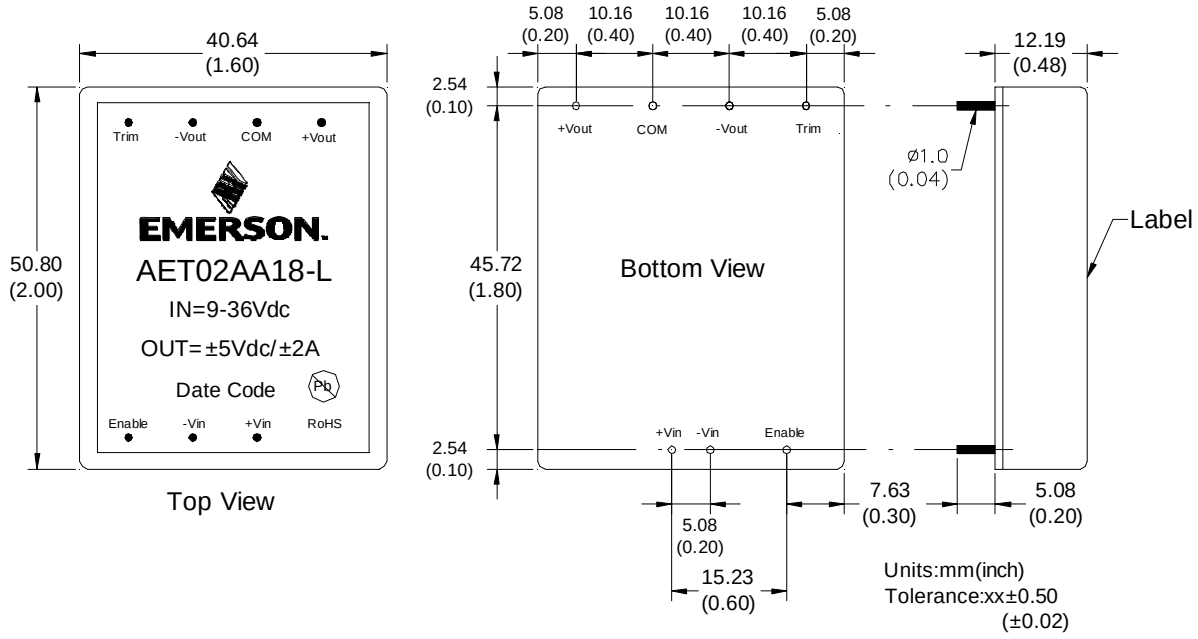
| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dB | dBuV | dBuV | dB | Detector | Comment |
| 1 | * | 0.2900 | 56.83 | 0.12 | 55.95 | 79.00 | -23.05 | peak | |
| 2 | | 26.5500 | 47.97 | 1.28 | 49.25 | 73.00 | -23.75 | peak | |

## Mechanical Dimensions and Module Pin Assignment

### Single Output



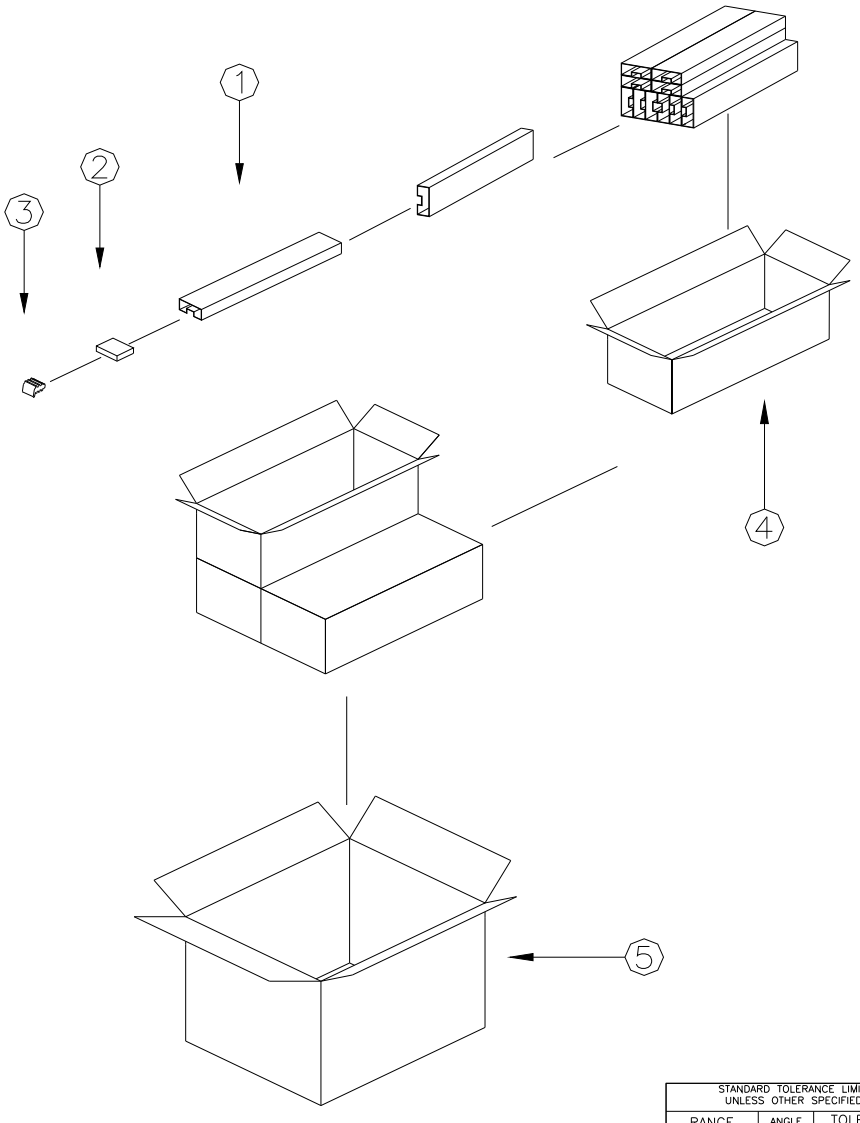

### Dual Output



## Package Information

| REV | REF | DESCRIPTION | AUTH | DATE |
|---|---|---|---|---|
| | | | | |

1. PACKING TUBE: 360*53.4*21.4mm ; ONE TUBE = 8 PCS
2. PRODUCTS: AET SERIES
3. STOPPER
4. INNER CARTON: 388*159*115mm
   ONE INNER CARTON = 10 TUBES = 80 PCS
5. OUTER CARTON: 405*334*263mm
   ONE OUTER CARTON = 4 INNER CARTONS = 320 PCS




| STANDARD TOLERANCE LIMITS UNLESS OTHER SPECIFIED. | | | THIRD ANGLE PROJECTION | |
|---|---|---|---|---|
| RANGE | ANGLE | TOLERANCE | | |
| >0~3 | ±1° | ±0.1 | | |
| >3~6 | ±2° | ±0.15 | UNIT:m/m | |
| >6~30 | ±3° | ±0.18 | SCALE | REV |
| >30~120 | ±5° | ±0.20 | 1 : 1 | A1 |

## Recommended Lead-Free Wave Soldering Temperature Profile