

# Technical Reference Note

## AET (20W) Family

### ***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 -40°C to 71°C 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

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

#### Output

<b>Regulation (Line, Load, Temp)</b>	<b>&lt;1.5%</b>
<b>Ripple and noise</b>	<b>100mV p-p max</b>
<b>Output Voltage Adjust Range</b>	<b>± 10% of nominal output</b>
<b>Transient Response</b>	<b>5% max deviation with 50% load to full load 300uS (max) recovery</b>
<b>Short Circuit Protection</b>	<b>Indefinite</b>
<b>Over Voltage Protection</b>	<b>120-140% nominal output</b>

#### Safety

**Designed to meet EN60950**



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### 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 ( $V_{I, \text{nom}}$ ) / 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	$\pm 5V / \pm 2A$
AET01B18-L	24V / 9-36V	12V / 1.67A
AET00BB18-L	24V / 9-36V	$\pm 12V / \pm 0.83A$
AET01C18-L	24V / 9-36V	15V / 1.33A
AET00CC18-L	24V / 9-36V	$\pm 15V / \pm 0.67A$
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	$\pm 5V / \pm 2A$
AET01B36-L	48V / 18-75V	12V / 1.67A
AET00BB36-L	48V / 18-75V	$\pm 12V / \pm 0.83A$
AET01C36-L	48V / 18-75V	15V / 1.33A
AET00CC36-L	48V / 18-75V	$\pm 15V / \pm 0.67A$

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### ELECTRICAL SPECIFICATIONS

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

$T_A$ :	25°C (Ambient Air)
+Vin :	24V $\pm$ 2% (AETxxxx18-L) 48V $\pm$ 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	°C
Case Surface		$T_C$	-40	-	100	°C
c) Storage Temperature	All	$T_{STG}$	-55	-	105	°C
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

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## INPUT SPECIFICATIONS

Parameter	Device	Symbol	Min	Typ	Max	Unit	
a) Operating Input Voltage	AETxxxx18-L	$V_1$	9	24	36	$V_{dc}$	
	AETxxxx36-L	$V_1$	18	48	75	$V_{dc}$	
b) Maximum Input Current AETxxxx18-L ( $V_1 = 0$ to $V_{1,max}$ ; $I_o = I_{o,max}$ )	2.5V	$I_{1,max}$	-	-	3	A	
	3.3V	$I_{1,max}$	-	-	3.5	A	
	5V / $\pm 5V$	$I_{1,max}$	-	-	4	A	
	12V / $\pm 12V$	$I_{1,max}$	-	-	4	A	
	15V / $\pm 15V$	$I_{1,max}$	-	-	4	A	
	AETxxxx36-L ( $V_1 = 0$ to $V_{1,max}$ ; $I_o = I_{o,max}$ )	2.5V	$I_{1,max}$	-	-	1.5	A
		3.3V	$I_{1,max}$	-	-	2	A
		5V / $\pm 5V$	$I_{1,max}$	-	-	2.5	A
		12V / $\pm 12V$	$I_{1,max}$	-	-	2.5	A
		15V / $\pm 15V$	$I_{1,max}$	-	-	2.5	A
	c) No Load Input Power ( $V_1 = V_{1,nom}$ )	All	-	-	-	0.5	W
	d) Recommended External Fuse Ratings AETxxxx18-L	2.5V		-	4	-	A
		3.3V		-	4	-	A
5V / $\pm 5V$			-	5	-	A	
12V / $\pm 12V$			-	5	-	A	
15V / $\pm 15V$			-	5	-	A	
AETxxxx36-L		2.5V		-	2	-	A
		3.3V		-	3	-	A
		5V / $\pm 5V$		-	3	-	A
		12V / $\pm 12V$		-	3	-	A
		15V / $\pm 15V$		-	3	-	A

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

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## OUTPUT SPECIFICATIONS

Parameter	Device	Symbol	Min	Typ	Max	Unit	
a) Output Voltage Setpoint ( $V_I = V_{I, \min}$ to $V_{I, \max}$ ; $I_o = I_{o, \max}$ ; $T_A = 25^\circ\text{C}$ )	2.5V	$V_{o, \text{set}}$	2.46	2.50	2.54	$V_{dc}$	
	3.3V	$V_{o, \text{set}}$	3.25	3.30	3.35	$V_{dc}$	
	5V	$V_{o, \text{set}}$	4.92	5.00	5.08	$V_{dc}$	
	12V	$V_{o, \text{set}}$	11.82	12.00	12.18	$V_{dc}$	
	15V	$V_{o, \text{set}}$	14.77	15.00	15.23	$V_{dc}$	
	$\pm 5\text{V}$	$V_{o, \text{set}}$	$\pm 4.92$	$\pm 5.00$	$\pm 5.08$	$V_{dc}$	
	$\pm 12\text{V}$	$V_{o, \text{set}}$	$\pm 11.82$	$\pm 12.00$	$\pm 12.18$	$V_{dc}$	
	$\pm 15\text{V}$	$V_{o, \text{set}}$	$\pm 14.77$	$\pm 15.00$	$\pm 15.23$	$V_{dc}$	
b) Output Regulation: Line ( $V_I = V_{I, \max}$ to $V_{I, \min}$ ; $I_o = I_{o, \max}$ )	All	-	-	-	0.5	%	
	Load ( $V_I = V_{I, \text{nom}}$ ; $I_o = I_{o, \min}$ to $I_{o, \max}$ )	All	-	-	0.5	%	
	Cross ( $V_I = V_{I, \text{nom}}$ ; $I_o = +I_{o, \max}, -I_{o, \min}$ or $+I_{o, \min}, -I_{o, \max}$ to $+I_{o, \max}, -I_{o, \max}$ )	$\pm 5\text{V}/\pm 12\text{V}/\pm 15\text{V}$	-	-	-	4	%
	Temperature ( $T_C = -40^\circ\text{C}$ to $+90^\circ\text{C}$ )	All	-	-	-	1	% $V_o$
c) Output Ripple and Noise (Across $1\mu\text{F}$ @50V, X7R ceramic capacitor & $10\mu\text{F}$ @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	$I_o$	600	-	6000	mA	
	3.3V	$I_o$	600	-	6000	mA	
	5V	$I_o$	400	-	4000	mA	
	12V	$I_o$	167	-	1667	mA	
	15V	$I_o$	133	-	1333	mA	
	Dual Output	$\pm 5\text{V}$	$I_o$	$\pm 200$	-	$\pm 2000$	mA
		$\pm 12\text{V}$	$I_o$	$\pm 83$	-	$\pm 833$	mA
$\pm 15\text{V}$		$I_o$	$\pm 67$	-	$\pm 667$	mA	
e) Efficiency ( $V_I = V_{I, \text{nom}}$ ; $I_o, \text{max}$ ; $T_A = 25^\circ\text{C}$ )	2.5V	-	-	80	-	%	
	3.3V	-	-	83	-	%	
	5V	-	-	84	-	%	
	12V	-	-	85	-	%	
	15V	-	-	85	-	%	
	$\pm 5\text{V}$	-	-	84	-	%	
	$\pm 12\text{V}$	-	-	85	-	%	
$\pm 15\text{V}$	-	-	85	-	%		
f) Switching Frequency	All	-	270	300	330	KHz	

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## OUTPUT SPECIFICATIONS (Cont.)

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

## FEATURE SPECIFICATIONS

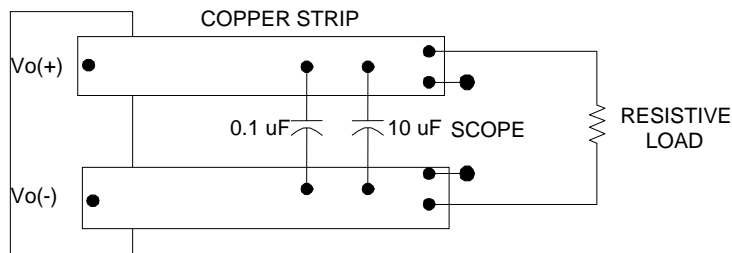
Parameter	Device	Symbol	Min	Typ	Max	Unit
Enable Pin Voltage						
Logic Low	All	OFF	-0.7	-	1.0	V
Logic High	All	ON	2.5	-	$V_I$	V
OPEN	All	ON	-	-	-	
Enable Pin Current						
Logic Low	All	OFF	-	-	1	mA
Logic High (leakage current, @ $V_I$ )	All	ON	-	-	1	$\mu A$
OPEN	All	ON	-	-	0	$\mu A$
Output Voltage Adjustment Range	All	-	90	-	110	%Vo
Output Overvoltage Clamp						
	2.5V	$V_{o, clamp}$	3.0	-	3.5	V
	3.3V	$V_{o, clamp}$	4.0	-	4.6	V
	5V	$V_{o, clamp}$	6.0	-	7.0	V
	12V	$V_{o, clamp}$	14.4	-	16.8	V
	15V	$V_{o, clamp}$	18.0	-	20.0	V
	$\pm 5V$	$V_{o, clamp}$	$\pm 6.0$	-	$\pm 7.0$	V
	$\pm 12V$	$V_{o, clamp}$	$\pm 14.4$	-	$\pm 16.8$	V
	$\pm 15V$	$V_{o, clamp}$	$\pm 18.0$	-	$\pm 20.0$	V

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## 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 ( $I_o = I_{o,max}$ ; $T_A = 25^\circ\text{C}$ )	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

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### 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 will operate back normally once the output current is brought back into its specified range.

### Output Overvoltage Protection

The output overvoltage system consists of a separate control loop, independent of the primary control loop. This control loop has a higher voltage set point than the primary loop. In a fault condition of output overvoltage, the converter latches and clamps the output to a lower voltage level to ensure that the output voltage does not exceed  $V_{o, clamp, max}$ . The converter will operate back normally once the fault is removed and the input voltage is cycled or the enable pin is toggled.

### 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  $V_o$  to a higher value**, please refer to Figure 2.

An external resistor,  $R_{adj\_up}$ , should be connected between the Trim Pin and the -Vout Pin. From equation (1),  $R_{adj\_up}$  resistor can be determined for the required output voltage.

#### Equation (1)

$$\text{For } V_o=2.5V \text{ modules, } V_o = \frac{3800}{15200+R_{adj\_up}} + 2.5$$

$$\text{For } V_o=3.3V \text{ modules, } V_o = \frac{2393}{7250+R_{adj\_up}} + 3.3$$

$$\text{For } V_o=5V \text{ modules, } V_o = \frac{9550}{19100+R_{adj\_up}} + 5$$

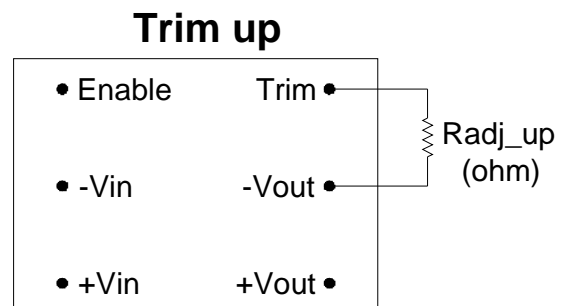


Figure 2. Circuit Configuration to Increase Output Voltage



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

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

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

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

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

Where: R<sub>adj\_up</sub> is in Ω

V<sub>o</sub> is not changed when R<sub>adj\_up</sub> is not connected

110% V<sub>o</sub> is obtained when R<sub>adj\_up</sub> = 0 Ω (i.e. Trim Pin is shorted to -V<sub>out</sub> Pin)

**To adjust V<sub>o</sub> to a lower value**, please refer to Figure 3.

An external resistor, R<sub>adj\_down</sub>, should be connected between the Trim Pin and the +V<sub>out</sub> Pin. From equation (2), R<sub>adj\_down</sub> resistor can be determined for the required output voltage.

### Equation (2)

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

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

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

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

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

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

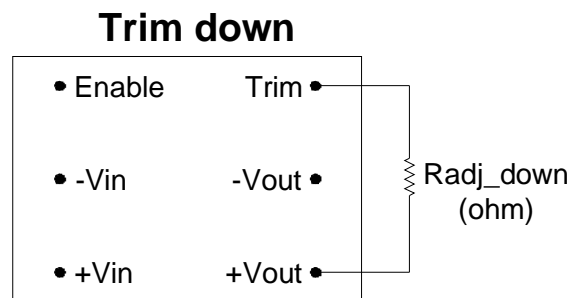


Figure 3. Circuit Configuration to Decrease Output Voltage

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

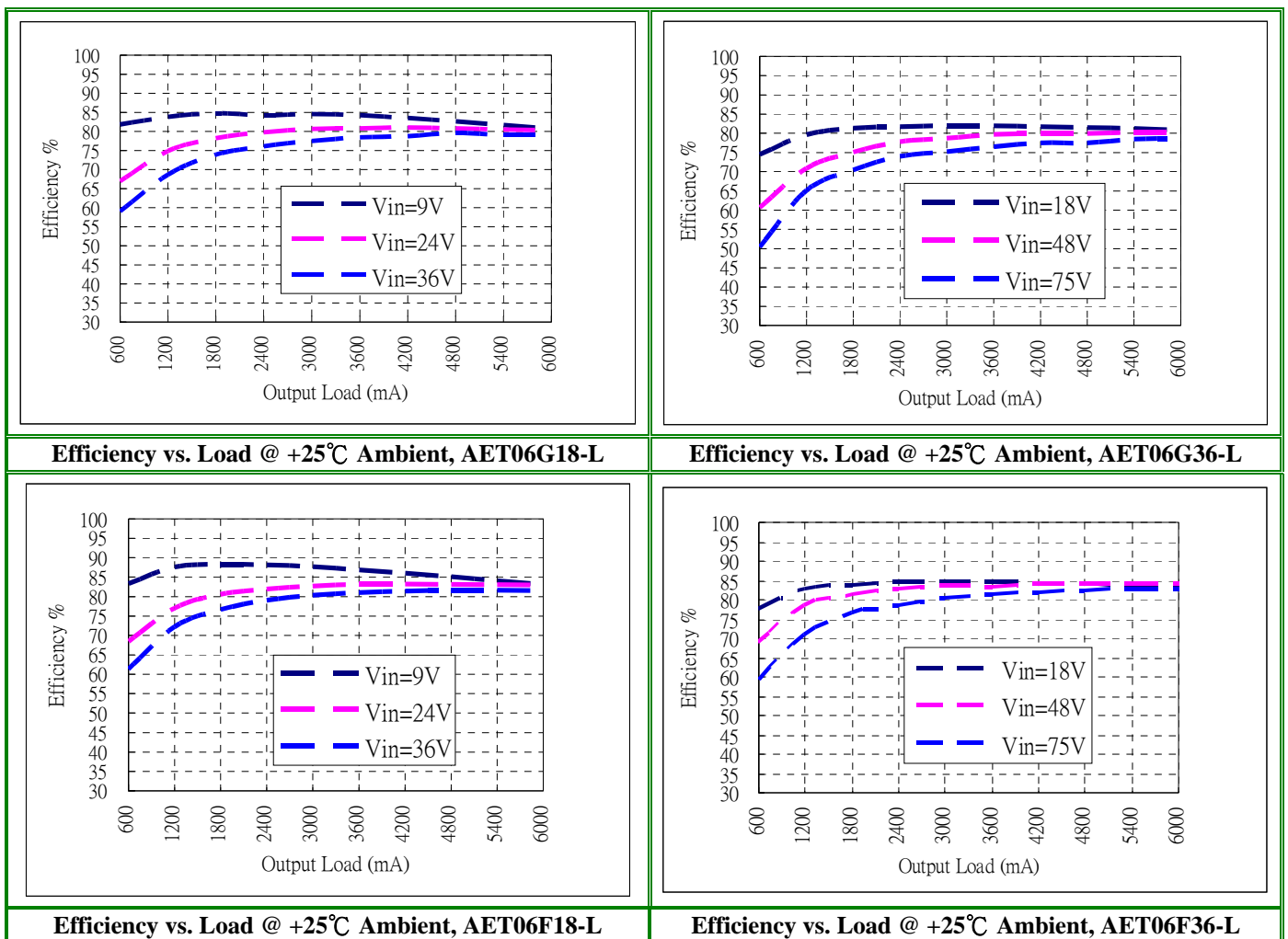
For  $V_o = \pm 15V$  modules,  $V_o = \pm \left| \left( \frac{7971000 + 30 \text{ Radj\_down}}{295220 + \text{Radj\_down}} \right) \div 2 \right|$

Where: Radj\_down is in  $\Omega$

$V_o$  is not changed when Radj\_down is not connected

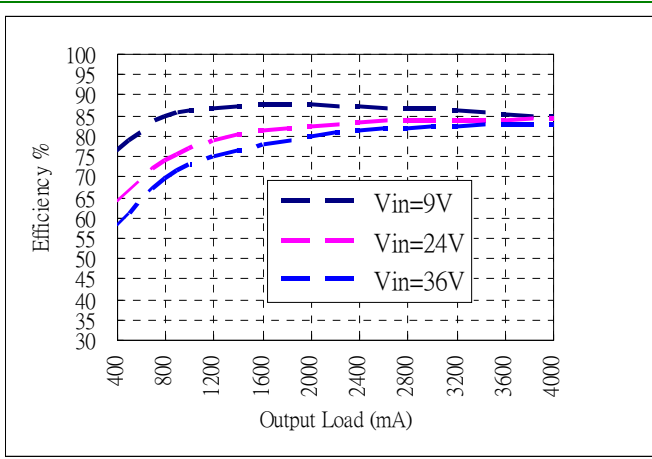
90%  $V_o$  is obtained when Radj\_down = 0  $\Omega$  (i.e. Trim Pin is shorted to +Vout Pin)

## Performance Curves – Efficiency Curve

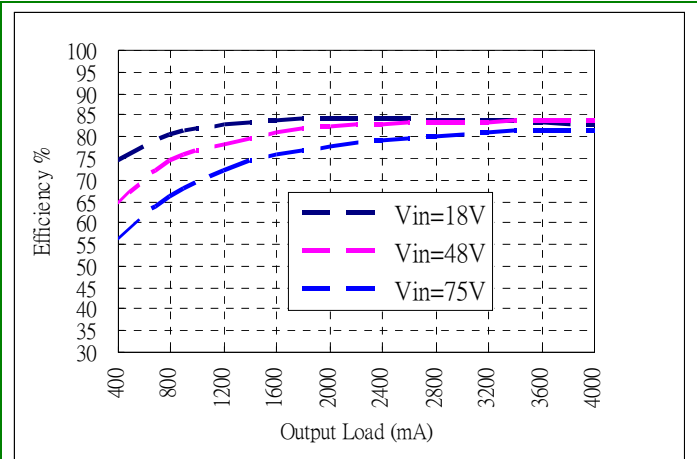


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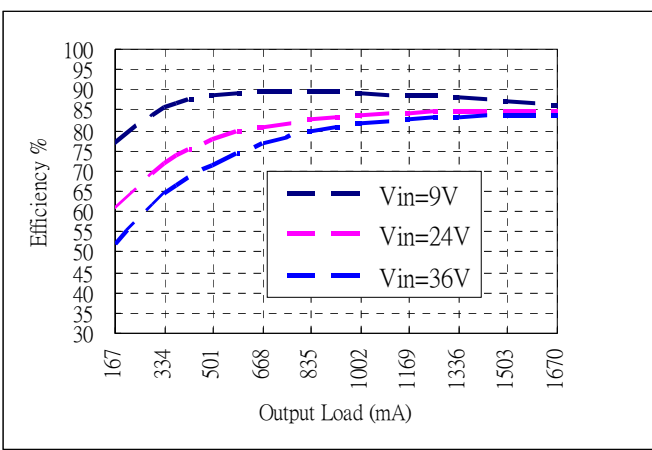
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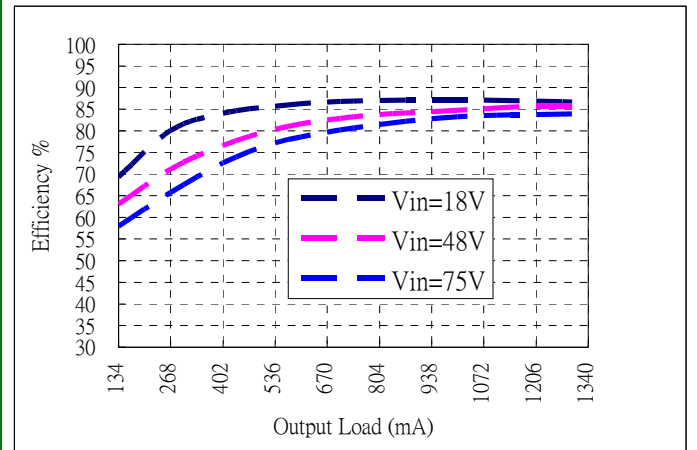
**Efficiency vs. Load @ +25°C Ambient, AET04A18-L**



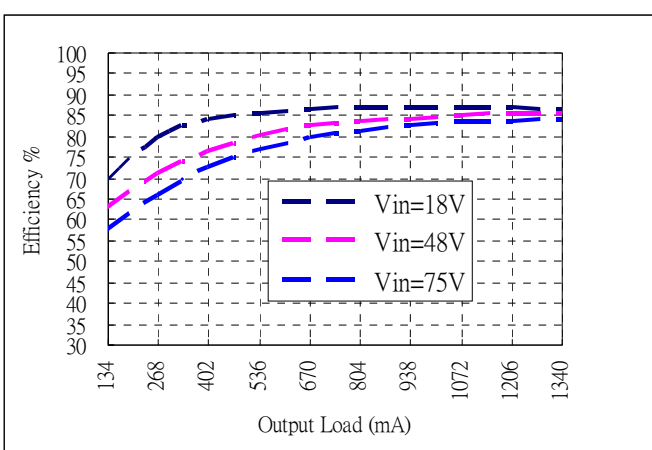
**Efficiency vs. Load @ +25°C Ambient, AET04A36-L**



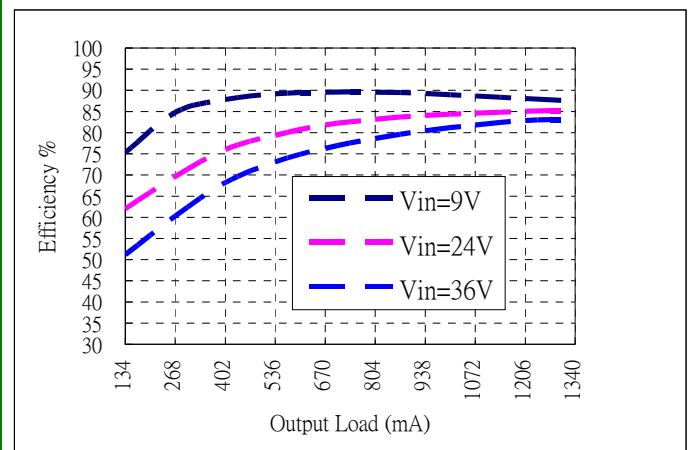
**Efficiency vs. Load @ +25°C Ambient, AET01B18-L**



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



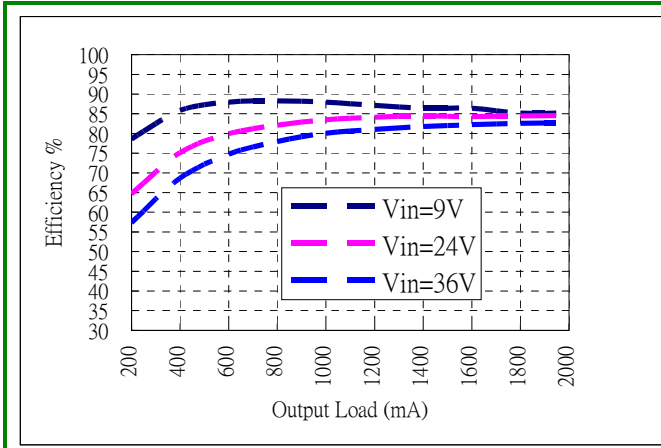
**Efficiency vs. Load @ +25°C Ambient, AET01C18-L**



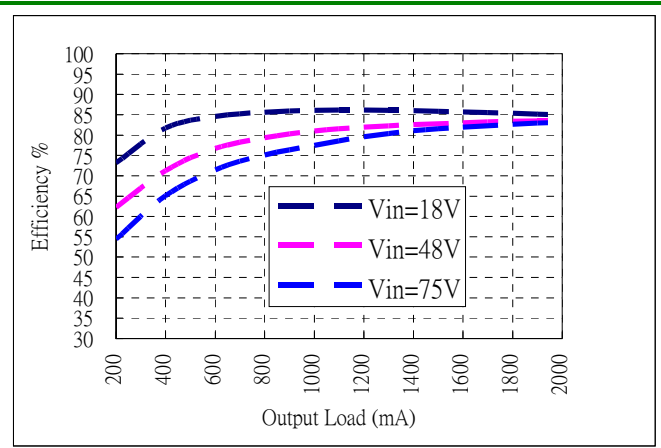
**Efficiency vs. Load @ +25°C Ambient, AET01C36-L**

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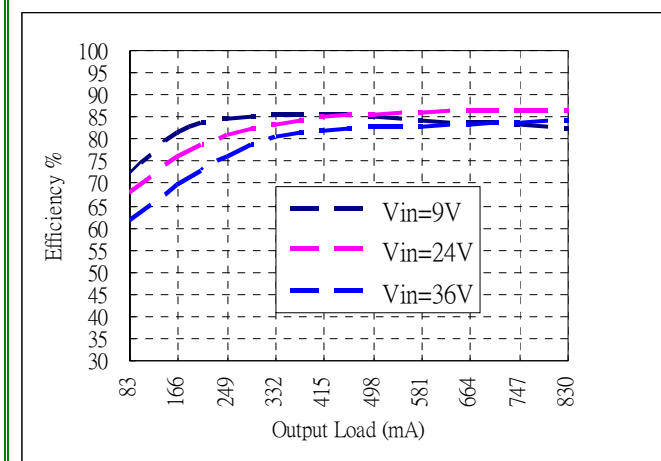
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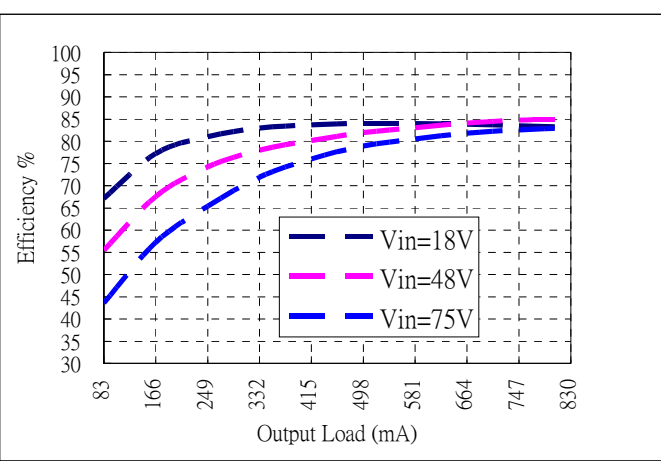
Efficiency vs. Load @ +25°C Ambient, AET02AA18-L



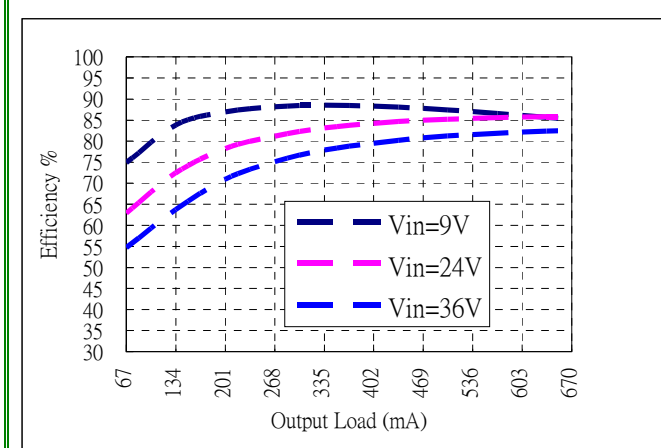
Efficiency vs. Load @ +25°C Ambient, AET02AA36-L



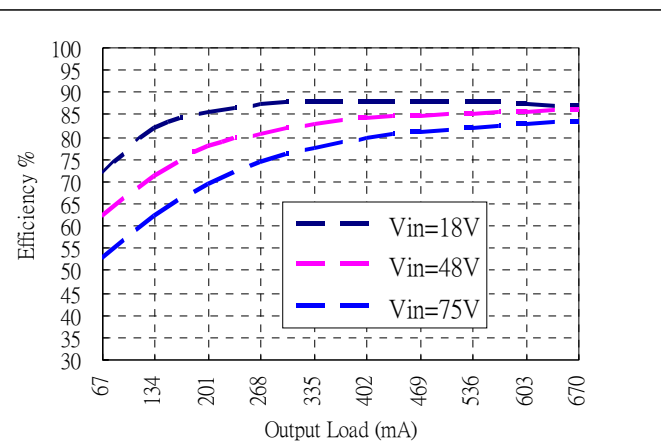
Efficiency vs. Load @ +25°C Ambient, AET00BB18-L



Efficiency vs. Load @ +25°C Ambient, AET00BB36-L



Efficiency vs. Load @ +25°C Ambient, AET00CC18-L

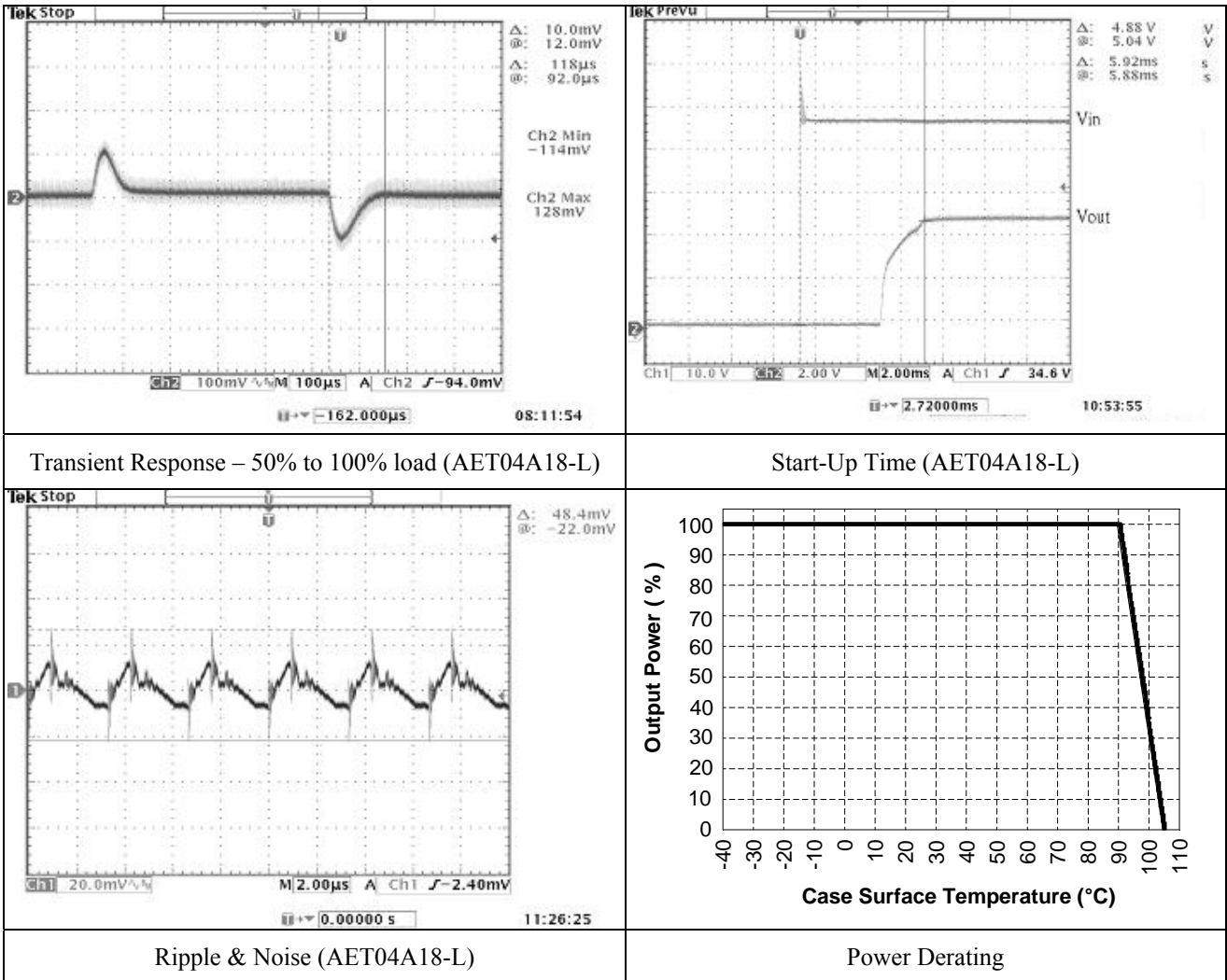


Efficiency vs. Load @ +25°C Ambient, AET00CC36-L

# Technical Reference Note AET (20W) Family



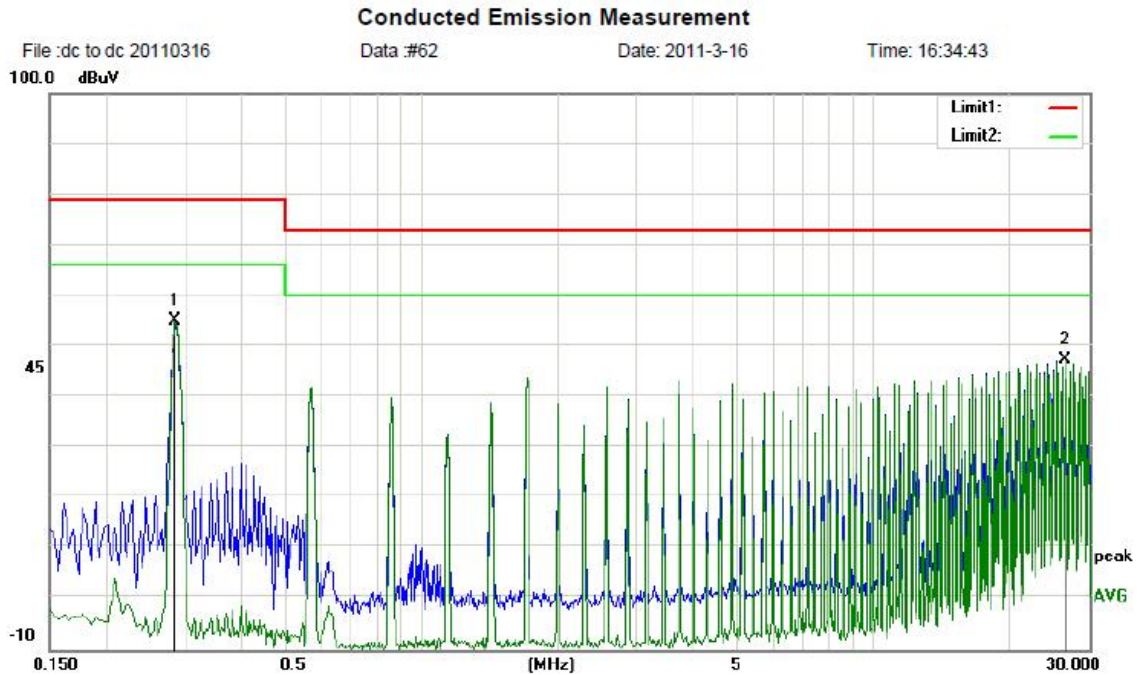
## Performance Curves



# Technical Reference Note AET (20W) Family



## Conducted EMI Performance



Site Chamber #1	Phase: <b>L</b>	Temperature: 20
Limit: (CE)EN55022 class A_QP	Power: DC 24V	Humidity: 57 %
EUT: dc to dc converter		Test Result: Pass
M/N: AET04A18-L		
Mode: Full Load		
Note:		

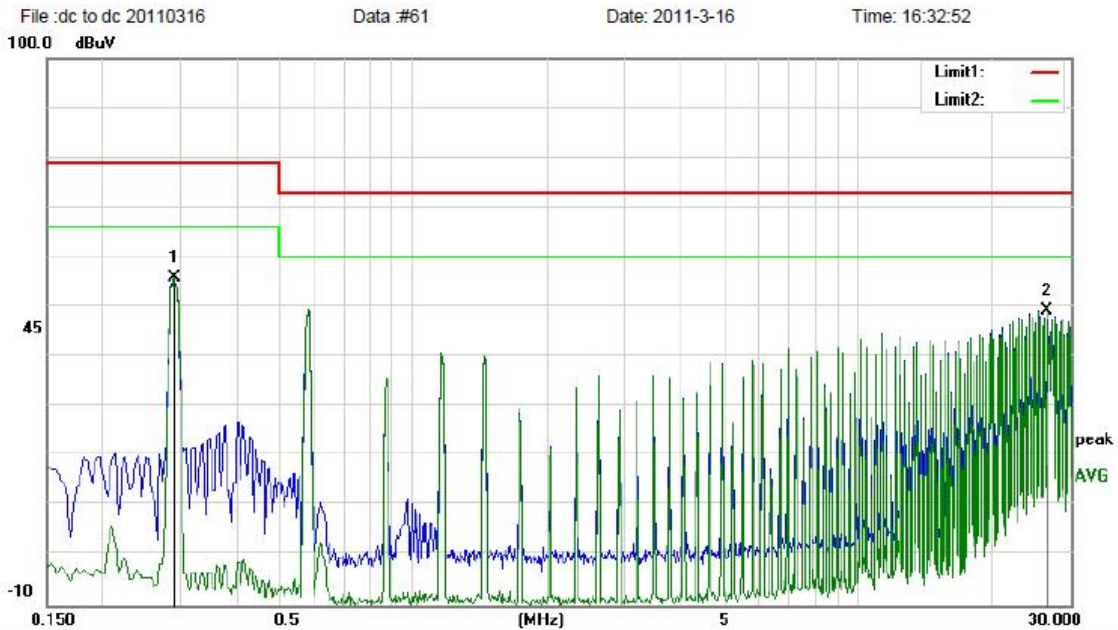
No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Over dB	Detector	Comment
1	*	0.2860	54.88	0.12	55.00	79.00	-24.00	peak	
2		26.5140	46.00	1.28	47.28	73.00	-25.72	peak	



# Technical Reference Note AET (20W) Family



### Conducted Emission Measurement



Site Chamber #1	Phase: <i>N</i>	Temperature: 20
Limit: (CE)EN55022 class A_QP	Power: DC 24V	Humidity: 57 %
EUT: dc to dc converter		Test Result: Pass
M/N: AET04A18-L		
Mode: Full Load		
Note:		

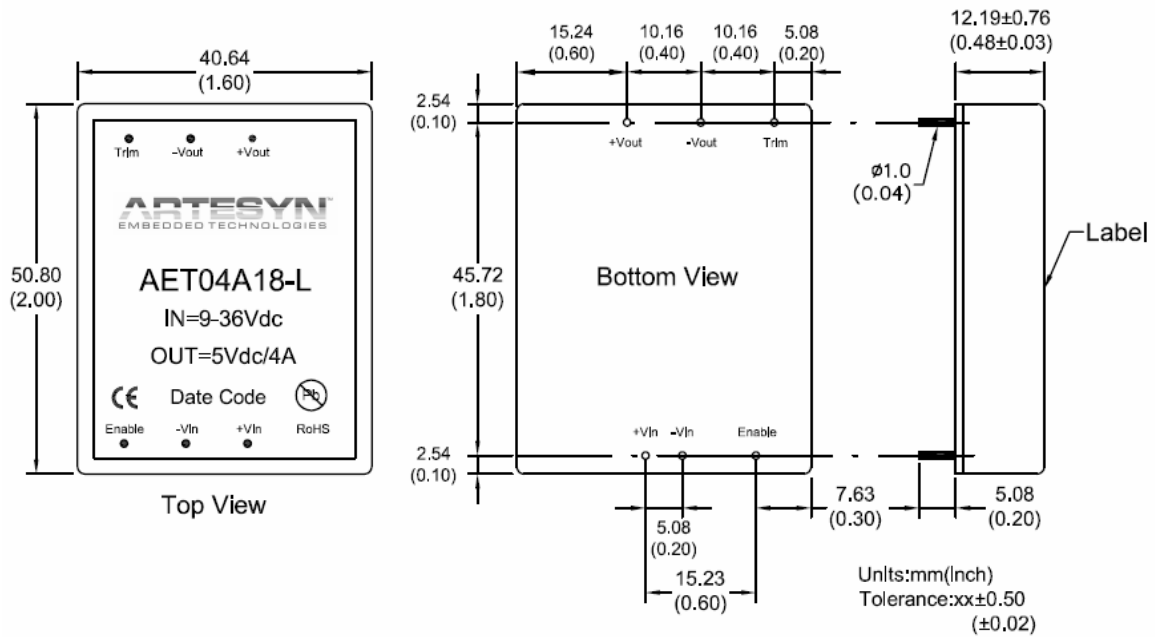
No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Over dB	Detector	Comment
1	*	0.2900	55.83	0.12	55.95	79.00	-23.05	peak	
2		26.5500	47.97	1.28	49.25	73.00	-23.75	peak	

# Technical Reference Note AET (20W) Family

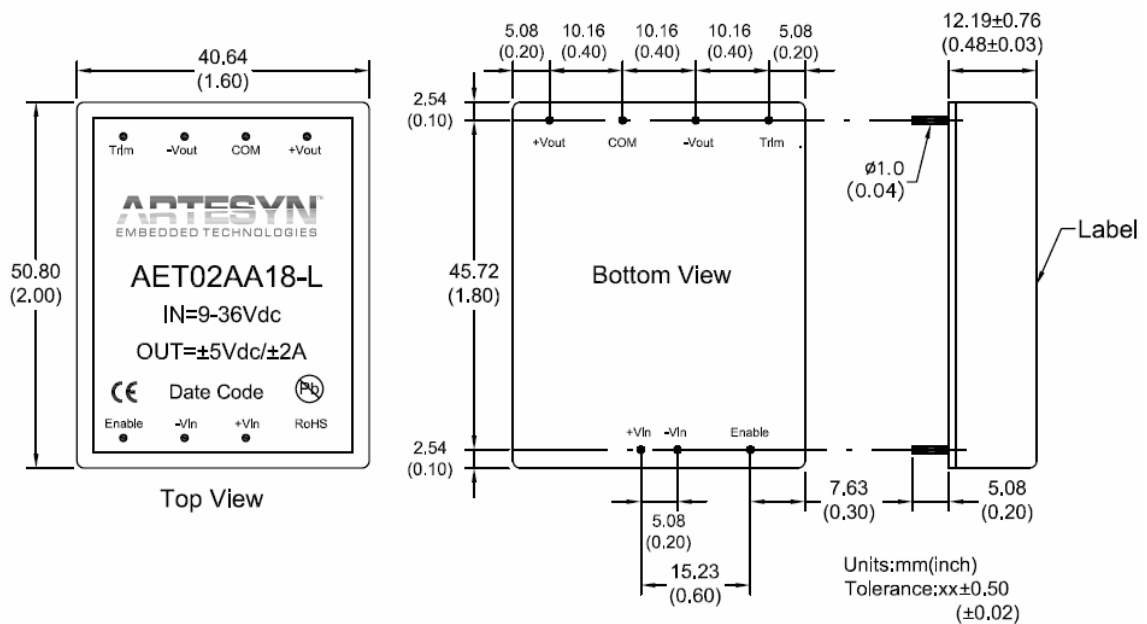


## Mechanical Dimensions and Module Pin Assignment

### Single Output



### Dual Output





# Technical Reference Note AET (20W) Family

## 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	REV
RANGE	ANGLE	TOLERANCE		
>0~3	±1'	±0.1	UNIT:m/m	A1
>3~6	±2'	±0.15		
>6~30	±3'	±0.18	SCALE 1 : 1	A1
>30~120	±5'	±0.20		

# Technical Reference Note AET (20W) Family



## Recommended Lead-Free Wave Soldering Temperature Profile

