

# Features

## Switching Regulator

- Efficiency up to 95%, no need for heatsinks
- High reflow temperature SMD package
- Adjustable output voltage buck converter
- Wide input range (4.74V - 32V)
- Short circuit protection, thermal shutdown
- Remote on/off control
- Very low shutdown current
- Positive to negative converter

**RECOM**  
DC/DC Converter

## R-78AA-0.5

**0.5 Amp  
SMD  
Single Output**



EN60950-1 certified  
IEC60950-1 certified

## Description

The R-78AAx-0.5SMD series are adjustable output non-isolated buck converters that meet the requirements for RoHS 10/10 as well as the reflow soldering temperatures associated with vapor phase soldering, making these high efficiency switching regulators ideally suited to modern pick-and-place mass production. The efficiency of up to 97% means that very little energy is wasted as heat. The additional features of remote on/off control, continuous short circuit protection and adjustable output voltages will find many uses in the battery-powered, industrial, medical and automotive markets.

## Selection Guide

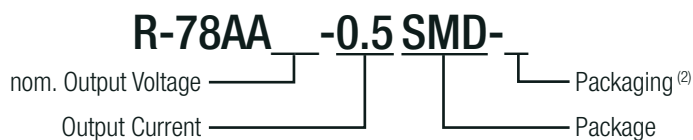
| Part Number      | Input Voltage Range [VDC] <sup>(1)</sup> | Output Voltage [VDC] | Vout Adjust Range [VDC] | Output Current [A] | Efficiency @ min Vin [%] | Efficiency @ max. Vin [%] |
|------------------|------------------------------------------|----------------------|-------------------------|--------------------|--------------------------|---------------------------|
| R-78AA1.5-0.5SMD | 4.75 - 30                                | 1.5                  | fixed                   | 0.5                | 73                       | 63                        |
| R-78AA1.8-0.5SMD | 4.75 - 32                                | 1.8                  | 1.5 - 3.0               | 0.5                | 82                       | 71                        |
| R-78AA2.5-0.5SMD | 4.75 - 32                                | 2.5                  | 1.5 - 3.0               | 0.5                | 87                       | 77                        |
| R-78AA3.3-0.5SMD | 4.75 - 32                                | 3.3                  | 3.0 - 5.5               | 0.5                | 91                       | 81                        |
| R-78AA5.0-0.5SMD | 6.5 - 32                                 | 5.0                  | 3.0 - 8.0               | 0.5                | 94                       | 86                        |
| R-78AA6.5-0.5SMD | 8.0 - 32                                 | 6.5                  | 3.3 - 11.0              | 0.5                | 95                       | 88                        |
| R-78AA9.0-0.5SMD | 11 - 32                                  | 9.0                  | 4.5 - 12.6              | 0.5                | 96                       | 92                        |
| R-78AA12-0.5SMD  | 15 - 32                                  | 12                   | 4.5 - 12.6              | 0.5                | 97                       | 94                        |
| R-78AA15-0.5SMD  | 18 - 32                                  | 15                   | fixed                   | 0.5                | 97                       | 95                        |

### Notes:

Note1: Input voltage ranges valid for nominal output voltages

Vin must be higher than Vout including adjust range and dropout voltage

## Model Numbering



### Notes:

Note2: add suffix -R for tape & reel packaging

### Ordering Examples:

R-78AA5.0-0.5SMD-R = 5.0VDC Output Voltage, 0.5A, SMD, tape and reel packaging

R-78AA2.5-0.5SMD = 2.5VDC Output Voltage, 0.5A, SMD, tube

**Specifications** (measured @ Ta= 25°C, 10% minimum load, unless otherwise stated)

### BASIC CHARACTERISTICS

| Parameter                      | Condition                                               |                                   | Min.                                                    | Typ.               | Max.               |
|--------------------------------|---------------------------------------------------------|-----------------------------------|---------------------------------------------------------|--------------------|--------------------|
| Absolute Maximum Input Voltage |                                                         |                                   |                                                         |                    | 34VDC              |
| Quiescent Current              | Vin= min. to max.                                       |                                   |                                                         | 5mA                | 7mA                |
| Internal Power Dissipation     |                                                         |                                   |                                                         |                    | 0.4W               |
| Output Voltage Adjustability   |                                                         |                                   | see calculation                                         |                    |                    |
| Minimum Load <sup>(3)</sup>    |                                                         |                                   | 0%                                                      |                    |                    |
| Start-up time                  | ON/OFF CTRL                                             |                                   |                                                         | 50ms               |                    |
| ON/OFF CTRL                    | DC-DC ON<br>DC-DC OFF                                   |                                   | Open or 2.8VDC < Vr < 5VDC<br>GND or 0VDC < Vr < 0.8VDC |                    |                    |
| Input Current of CTRL Pin      | DC-DC OFF                                               |                                   |                                                         | 1.8µA              |                    |
| Standby Current                |                                                         |                                   |                                                         | 20µA               | 30µA               |
| CTRL Threshold Voltage         |                                                         |                                   | 2.4VDC                                                  | 2.6VDC             | 2.8VDC             |
| CTRL Voltage Hysteresis        |                                                         |                                   |                                                         | 250mV              |                    |
| Internal Operating Frequency   |                                                         |                                   | 280kHz                                                  | 330kHz             | 380kHz             |
| Output Ripple and Noise        | 20MHz BW                                                | 1.5VDC tp 6.5VDC<br>9VDC to 15VDC |                                                         | 20mVp-p<br>30mVp-p | 30mVp-p<br>40mVp-p |
| Maximum Capacitive Load        | with normal start-up time, no external components       |                                   |                                                         |                    | 470µF              |
|                                | with <1 second start-up time + diode protection circuit |                                   |                                                         |                    | 6800µF             |

**Notes:**

Note3: Operation under no load will not harm the converter, but specifications may not be met.  
A minimum load of 6mA is recommended

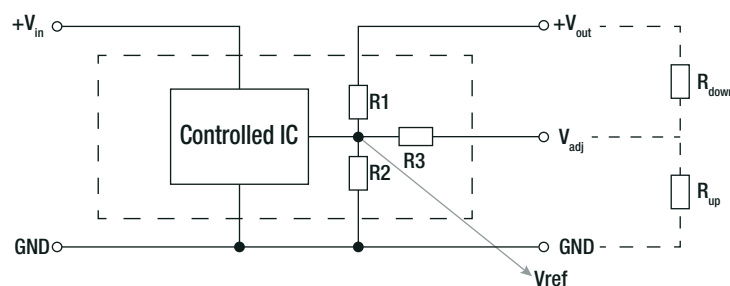
### Output Voltage Adjustability

#### Adjustment Resistor Values

| V0   | R1     | R2   | R3     | Vref(V) |
|------|--------|------|--------|---------|
| 1.8V | 10kΩ   | 21kΩ | 5.6kΩ  | 1.23    |
| 2.5V | 22kΩ   | 21kΩ | 5.6kΩ  | 1.23    |
| 3.3V | 16.9kΩ | 10kΩ | 5.6kΩ  | 1.23    |
| 5.0V | 30.9kΩ | 10kΩ | 10kΩ   | 1.23    |
| 6.5V | 43kΩ   | 10kΩ | 10kΩ   | 1.23    |
| 9V   | 63.4kΩ | 10kΩ | 22.1kΩ | 1.23    |
| 12V  | 88.7kΩ | 10kΩ | 22.1kΩ | 1.23    |

$$R_{down} = \frac{R2(R1 + R3) \times (V_{ref} - V_o) + V_{ref} \times R1R3}{R2V_o - V_{ref}(R1 + R2)}$$

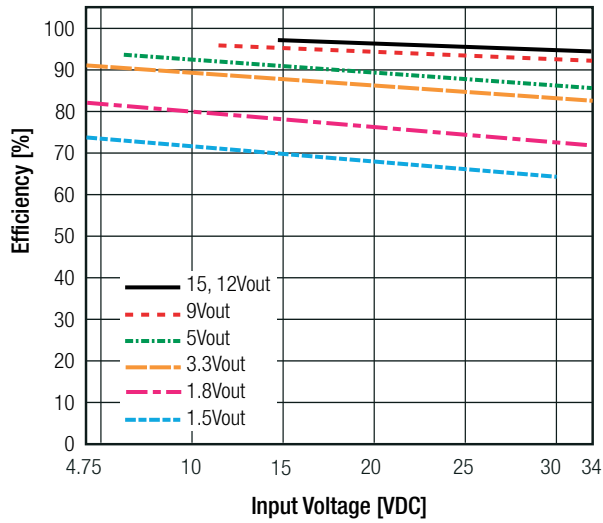
$$R_{up} = \frac{R2R3(V_{ref} - V_o) + V_{ref}R1(R2 + R3)}{R2(V_o - V_{ref}) - V_{ref}R1}$$



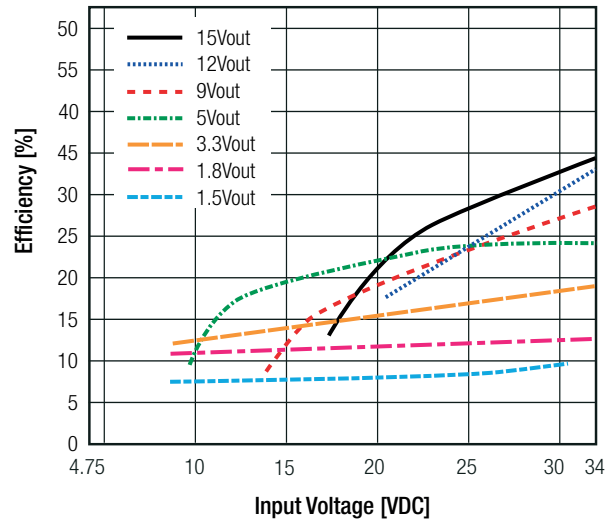
continued on next page

**Specifications** (measured @  $T_a = 25^\circ\text{C}$ , 10% minimum load, unless otherwise stated)

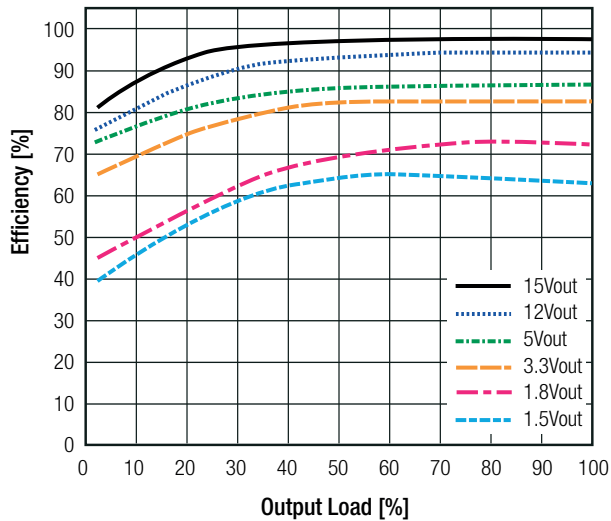
Efficiency vs.  $V_{in}$  (full load)



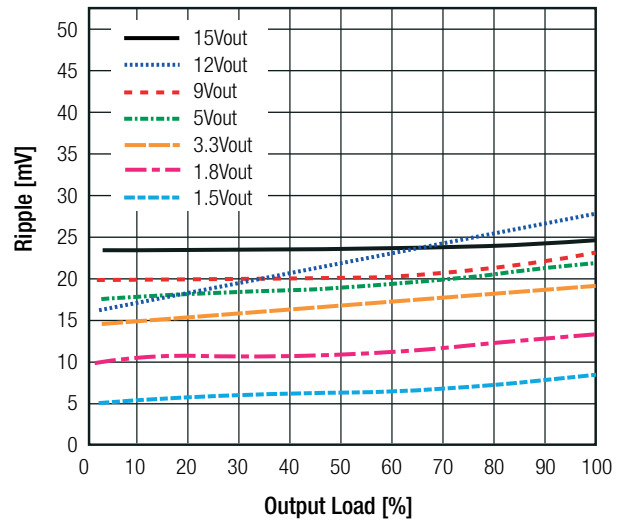
Ripple vs.  $V_{in}$  (full load)



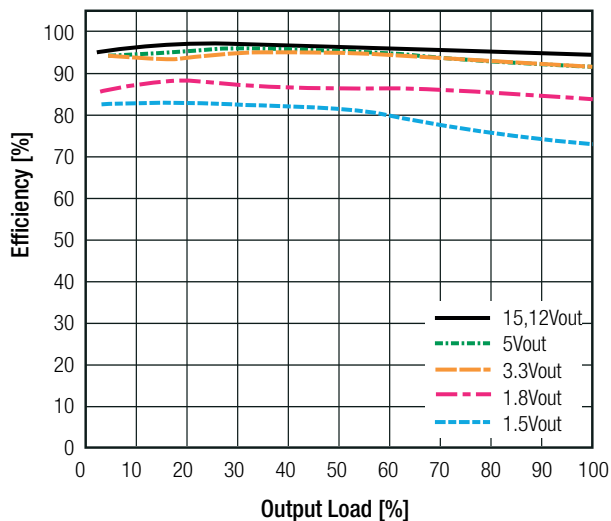
Efficiency vs. Load (max.  $V_{in}$ )



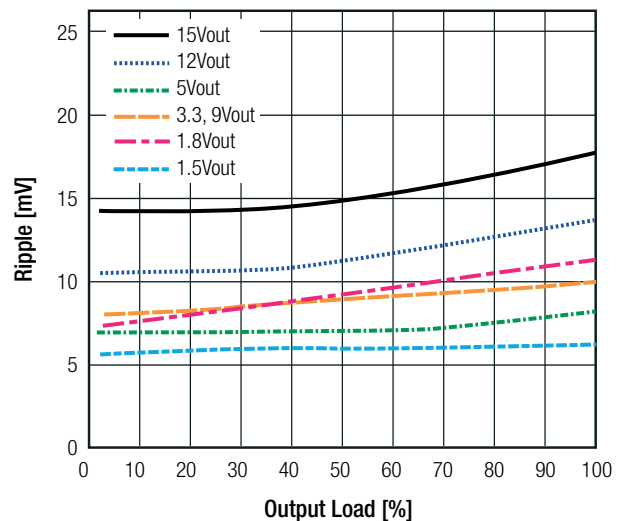
Ripple vs. Load (max.  $V_{in}$ )



Efficiency vs. Load (min.  $V_{in}$ )



Ripple vs. Load (min.  $V_{in}$ )



**Specifications** (measured @ Ta= 25°C, 10% minimum load, unless otherwise stated)

### REGULATIONS

| Parameter          | Condition                             |                   | Value                    |
|--------------------|---------------------------------------|-------------------|--------------------------|
| Output Accuracy    | full load                             |                   | ±2.0% typ. / ±3.0% max.  |
| Line Regulation    | low line to high line<br>at full load | 1.5 VDC tp 6.5VDC | ±0.2% typ. / ±0.4% max.  |
|                    |                                       | 9VDC to 15VDC     | ±0.1% typ. / ±0.2% max.  |
| Load Regulation    | 10% to 100% load                      | 1.5 VDC tp 6.5VDC | ±0.7% typ. / ±1.0% max.  |
|                    |                                       | 9VDC to 15VDC     | ±0.25% typ. / ±0.4% max. |
| Transient Response | with a 100µF output<br>capacitor      | 100% <-> 50% load | ±85mV typ. / ±100mV max. |
|                    |                                       | 100% <-> 10% load | ±100mV typ.              |

### PROTECTIONS

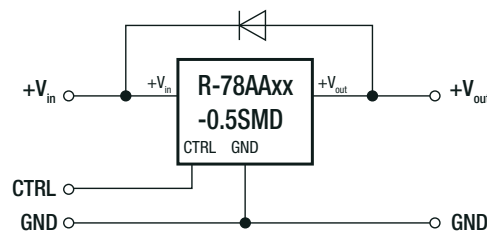
| Parameter                      | Condition       | Value                          |
|--------------------------------|-----------------|--------------------------------|
| Short Circuit Protection (SCP) |                 | continuous, automatic recovery |
| Short Circuit Input Current    | nom. Vin= 24VDC | 60mA typ. / 100mA max.         |

#### Optional Diode Protection Circuit

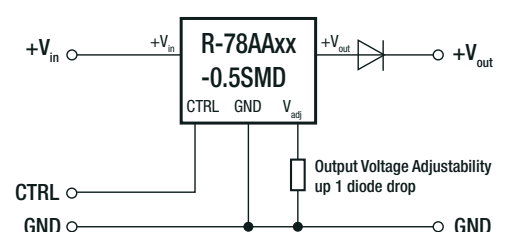
Add a blocking diode to Vout if current can flow backwards into the output, as this can damage the converter when it is powered down.

The diode can either be fitted across the device if the source is low impedance or fitted in series with the output (recommended).

#### Optional Protection 1:



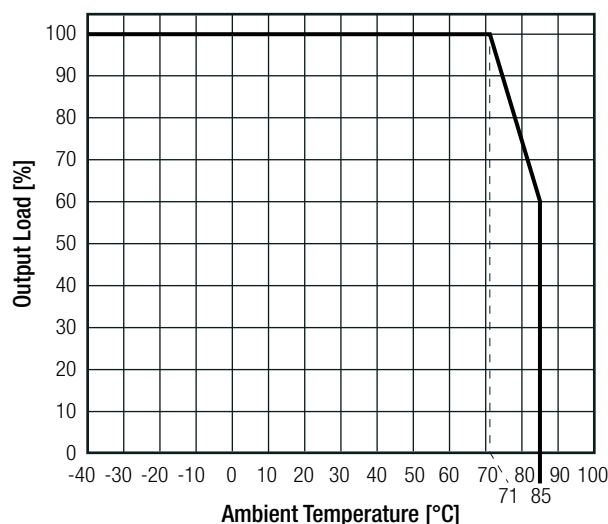
#### Optional Protection 2:



### ENVIRONMENTAL

| Parameter                   | Condition                        |       | Value                                 |
|-----------------------------|----------------------------------|-------|---------------------------------------|
| Operating Temperature Range | with derating (see graph)        |       | -40°C to +85°C                        |
| Maximum Case Temperature    |                                  |       | +100°C                                |
| Temperature Coefficient     |                                  |       | ±0.015%/°C                            |
| Thermal Impedance           | 0.1m/s, horizontal               |       | 70°C/W                                |
| Operating Altitude          |                                  |       | 2000m                                 |
| Operating Humidity          | non-condensing                   |       | 5% - 95% RH max.                      |
| Pollution Degree            |                                  |       | PD2                                   |
| MTBF                        | according to MIL-HDBK-217F, G.B. | +25°C | 21098 - 29253 x 10 <sup>3</sup> hours |
|                             |                                  | +71°C | 4214 - 7365 x 10 <sup>3</sup> hours   |

#### Derating Graph



**Specifications** (measured @ Ta= 25°C, 10% minimum load, unless otherwise stated)

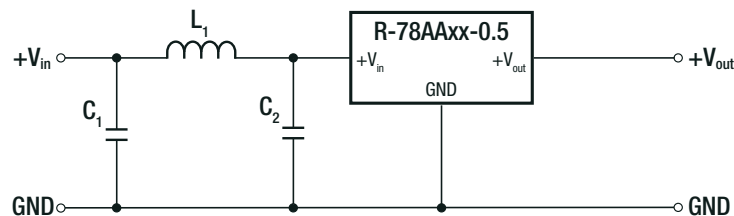
### SAFETY AND CERTIFICATIONS

| Certificate Type (Safety)                                         | Report / File Number | Standard                                                               |
|-------------------------------------------------------------------|----------------------|------------------------------------------------------------------------|
| Information Technology Equipment, General Requirements for Safety | 1603123              | IEC60950-1:2005, 2nd Edition + AM 2:2013<br>EN60950-1:2006 + AM 2:2013 |
| EAC                                                               | RU-AT.49.09571       | TP TC 004/2011                                                         |
| RoHS 2+                                                           |                      | RoHS 2011/65/EU + AM2015/863                                           |

### EMC Compliance

| Condition                                                                     | Standard / Criterion   |
|-------------------------------------------------------------------------------|------------------------|
| Electromagnetic compatibility of multimedia equipment - Emission requirements | EN55032, Class A and B |
| ESD Electrostatic discharge immunity test                                     | Air ±8kV; Contact ±4kV |
| Radiated, radio-frequency, electromagnetic field immunity test                | 3V/m                   |

### EMC Filter Suggestion according to EN55032



#### Component List Class A

| MODEL            | C1                | L1                     |
|------------------|-------------------|------------------------|
| R-78AA5.0-0.5SMD | 10µF<br>100V MLCC | 3.9µH choke<br>RLS-397 |
| R-78AA12-0.5SMD  |                   |                        |
| R-78AA15-0.5SMD  |                   |                        |

#### Component List Class B

| MODEL            | C1                | C2                | L1                     |
|------------------|-------------------|-------------------|------------------------|
| R-78AA5.0-0.5SMD | 10µF<br>100V MLCC | 10µF<br>100V MLCC | 5.6µH choke<br>RLS-567 |
| R-78AA12-0.5SMD  |                   |                   |                        |
| R-78AA15-0.5SMD  |                   |                   |                        |

#### Notes:

Note4: Filter suggestions are valid for indicated part numbers only. For other part numbers, please contact RECOM tech support for advice

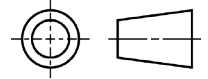
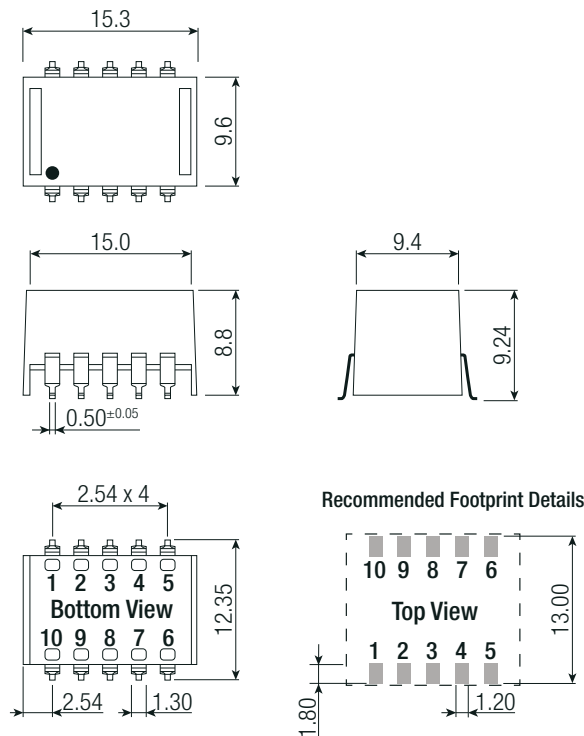
### DIMENSION AND PHYSICAL CHARACTERISTICS

| Parameter         | Type        | Value                                                       |
|-------------------|-------------|-------------------------------------------------------------|
| Material          | case<br>PCB | non-conductive black plastic, (UL94 V-2)<br>FR4, (UL94 V-1) |
| Dimension (LxWxH) |             | 15.3 x 9.6 x 8.8mm                                          |
| Weight            |             | 2.7g typ.                                                   |

continued on next page

**Specifications** (measured @  $T_a = 25^\circ\text{C}$ , 10% minimum load, unless otherwise stated)

Dimension Drawing (mm)



Pinning information

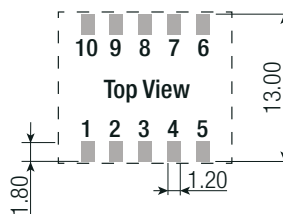
| Pin #   | Single |
|---------|--------|
| 1,2     | +Vin   |
| 3,7,8,9 | GND    |
| 4,5     | +Vout  |
| 6       | Vadj   |
| 10      | CTRL   |

Tolerance:

xx.x = 0.5mm

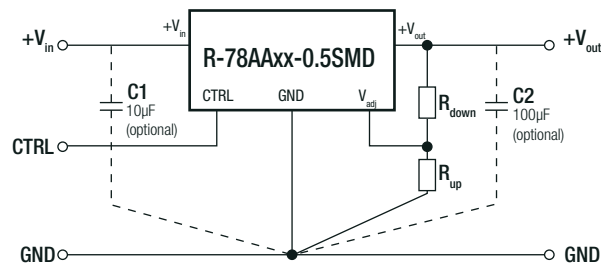
xx.xx = ±0.25mm

Recommended Footprint Details



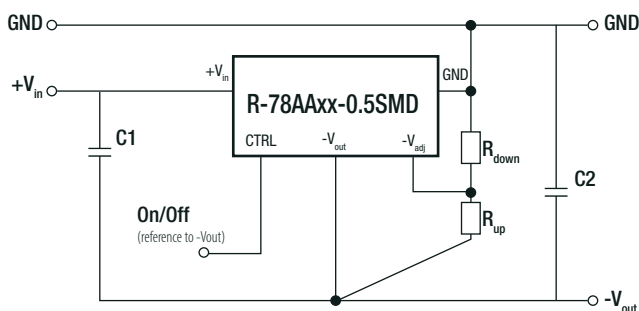
## INSTALLATION AND APPLICATION

### Standard Application Circuit



To protect the converter from high inrush currents, use soft start Vin and C1 = 10µF  
Output capacitor C2 recommended if load is very dynamic

### Positive to Negative Converter

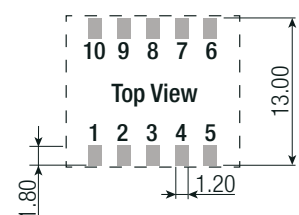


C1 and C2 are required and should be fitted close to the converter pins.

Maximum capacitiv load including C2 is 220µF

Pin Connections

| Pin #   | Negative | Positive |
|---------|----------|----------|
| 1,2     | +Vin     | +Vin     |
| 3,7,8,9 | -Vout    | GND      |
| 4,5     | GND      | +Vout    |
| 6       | -Vadj    | +Vadj    |
| 10      | CTRL     | CTRL     |



continued on next page

### Specifications (measured @ Ta= 25°C, 10% minimum load, unless otherwise stated)

#### Selection Guide - Negative Output

| Part Number      | Input Voltage Range [VDC] | Output Voltage [VDC] | Output Current [A] | Efficiency    |                | External Capacitor |                   |
|------------------|---------------------------|----------------------|--------------------|---------------|----------------|--------------------|-------------------|
|                  |                           |                      |                    | @ min Vin [%] | @ max. Vin [%] | C1                 | C2 <sup>(5)</sup> |
| R-78AA1.5-0.5SMD | 4.75 - 28                 | -1.5                 | -0.4               | 68            | 67             | 10µF/35V           | 22µF/6.3V         |
| R-78AA1.8-0.5SMD | 4.75 - 28                 | -1.8                 | -0.4               | 71            | 70             | 10µF/50V           | 22µF/6.3V         |
| R-78AA2.5-0.5SMD | 4.75 - 28                 | -2.5                 | -0.4               | 75            | 76             | 10µF/50V           | 22µF/6.3V         |
| R-78AA3.3-0.5SMD | 4.75 - 28                 | -3.3                 | -0.4               | 77            | 80             | 10µF/50V           | 22µF/6.3V         |
| R-78AA5.0-0.5SMD | 4.75 - 28                 | -5.0                 | -0.4               | 79            | 84             | 10µF/50V           | 22µF/10V          |
| R-78AA6.5-0.5SMD | 5.0 - 26                  | -6.5                 | -0.3               | 81            | 86             | 10µF/50V           | 10µF/10V          |
| R-78AA9.0-0.5SMD | 8.0 - 18                  | -9.0                 | -0.2               | 87            | 89             | 10µF/50V           | 10µF/16V          |
| R-78AA12-0.5SMD  | 8.0 - 18                  | -12                  | -0.2               | 87            | 90             | 10µF/50V           | 10µF/25V          |
| R-78AA15-0.5SMD  | 8.0 - 18                  | -15                  | -0.2               | 87            | 91             | 10µF/50V           | 10µF/25V          |

#### Notes:

Note5: Maximum Capacitive Load including C2 is 220µF

#### PACKAGING INFORMATION

| Parameter                   | Type                   | Value                  |
|-----------------------------|------------------------|------------------------|
| Packaging Dimension (LxWxH) | tube                   | 530.0 x 17.0 x 13.0mm  |
|                             | tape and reel (carton) | 355.0 x 342.0 x 36.0mm |
| Packaging Quantity          | tube                   | 33pcs                  |
|                             | tape and reel          | 250pcs                 |
| Tape Width                  |                        | 24mm                   |
| Storage Temperature Range   |                        | -55°C to +125°C        |
| Storage Humidity            |                        | 95% RH max.            |

The product information and specifications may be subject to changes even without prior written notice. The product has been designed for various applications; its suitability lies in the responsibility of each customer. The products are not authorized for use in safety-critical applications without RECOM's explicit written consent. A safety-critical application is an application where a failure may reasonably be expected to endanger or cause loss of life, inflict bodily harm or damage property. The applicant shall indemnify and hold harmless RECOM, its affiliated companies and its representatives against any damage claims in connection with the unauthorized use of RECOM products in such safety-critical applications.