

100V/2A, High Efficiency Step-Down Converter in ESOP8 Package

Description

ETA1815 is a high-efficiency nonsynchronous DC-to-DC step-down switching regulator with up to 100V operation input voltage and up to 110V standoff voltage. It is capable of delivering up to 2A output current. ETA1815 adopts an adaptive COT control scheme that enables very fast transient response and provides a very smooth transition when the output varies from light load to heavy load. During light load, ETA1815 goes into a PFM mode that saves switching loss achieving high efficiency. The adaptive COT control also maintains a constant switching frequency across line and load.

ETA1815 is available in ESOP8 package.

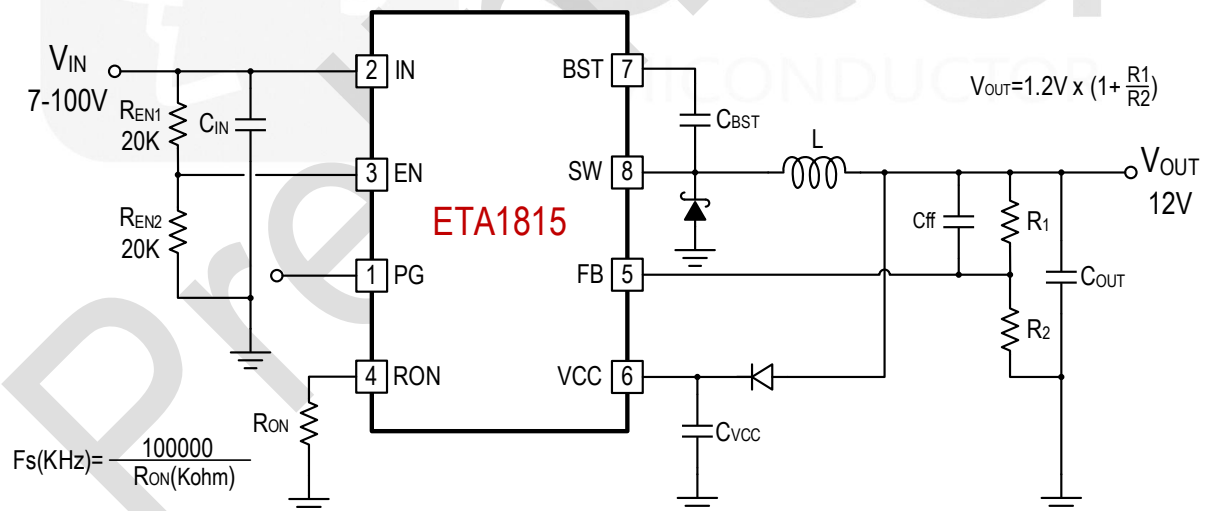
Features

- ♦ Wide Input Range: 7V-100V
- ♦ Wide Output Range: 1.2V-24V
- ♦ 110V Standoff Input Voltage
- ♦ Up to 2A Output Current
- ♦ 3.2A Peak Current Limit
- ♦ Adaptive COT Control
- ♦ Ultra-fast Load Transient Response
- ♦ High Efficiency PFM Mode at Light Load
- ♦ Adjustable Switching Frequency
- ♦ Thermal Shutdown and UVLO
- ♦ Available in ESOP8 Package
- ♦ Pb Free, RoHS and REACH Compliant
- ♦ Halogen Free and "Green" Device

Applications

- ♦ Non-Isolated Telecommunication Buck Regulator
- ♦ Secondary High Voltage Post Regulator
- ♦ Automotive Systems

Typical Application

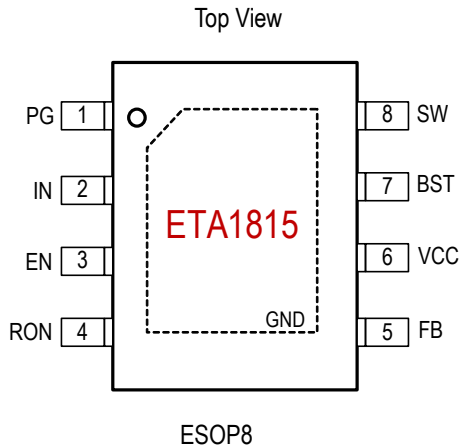


Ordering Information

PART No.	PACKAGE	TOP MARK ⁽¹⁾	Pcs/Reel
ETA1815E8A	ESOP8	ETA1815 YWWLL	4000
ETA1815: Product Code			
YWW: Date Code			
LL: Lot Trace Code			

(1) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

Pin Configuration



Absolute Maximum Ratings

(Note: Exceeding these limits may damage the device. Exposure to absolute maximum rating conditions for long periods may affect device reliability.)

IN Voltage	110V
EN, RON, SW Voltage	$V_{IN} + 0.3V$
BST Voltage	$SW + 6V$
FB Voltage	6V
VCC, PG Voltage	30V
SW to ground current	Internally limited
Junction Temperature	150°C
Storage Temperature Range	-55°C to 150°C
Thermal Resistance θ_{JC} θ_{JA}	
ESOP8	10.....30
Lead Temperature (Soldering, 10sec)	260°C

Recommended Operating Conditions

(Note: The device is not guaranteed to function outside its operating conditions.)

Ambient Temperature Range	-40°C to 105°C
Junction Temperature Range	-40°C to 125°C

Pin Description

PIN #	NAME	DESCRIPTION
1	PG	Power good pin. This pin is high impedance if the output voltage is within regulation, otherwise it is pulled low.
2	IN	Input power pin. Bypass to GND with a minimum 1uF capacitor.
3	EN	Enable pin. Pull high to enable, pull low to disable. It has an accurate threshold for setting UVLO externally.
4	RON	On Time programming pin. Connect a resistor from this pin to GND to set the on time or frequency. The switching frequency equals to: $F_{SW}(KHz) = 100000/R_{ON}(Kohm)$
5	FB	Feedback Input. Connect an external resistor divider from the output to FB and GND to set V_{OUT}
6	VCC	Power supply pin for internal circuit. Bypass with a 100nF capacitor.
7	BST	Bootstrap pin . Connect a 100nF capacitor from this pin to SW
8	SW	Inductor Connection for output . Connect an inductor between SW and the regulator output.
Exposed Pad	GND	Ground pin

Electrical Characteristics

($V_{IN} = 48V$, $V_{OUT} = 5V$, unless otherwise specified. Typical values are at $T_A = 25^\circ C$.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Input Voltage Range		7		100	V
Input UVLO			6.5	7	V
Input Supply Current	$V_{FB}=1.3V$, no switching		130		μA
Input Shutdown Current			2		μA
VCC Internal Voltage			4.2		V
FB Voltage	$T_A=25^\circ C$		1.2		V
	$T_A=-40^\circ C$ to $105^\circ C$		1.2		V
FB Input Current			0	1	μA
Switching Frequency Range	$F_{SW}(KHz)=100000/R_{ON}(Kohm)$	200		1000	KHz
Minimum ON time			140		ns
Minimum Off time			320		ns
Short Circuit Hiccup Time	On Time		2		mS
	Off Time		13		mS
FB Hiccup Threshold			0.12		V
High Side Switch On Resistance			500		m Ω
High Side Current Limit			3.2		A
SW Leakage Current	$V_{SW} = 0V$, $V_{EN} = 0V$			1	μA
Power Good Low Threshold	Falling, Hysteresis = 5%		90		% V_{REF}
Power Good High Threshold	Rising, Hysteresis = 5%		120		% V_{REF}
EN Rising Threshold	Rising, Hysteresis = 140mV		1.2		V
EN Input Current	$V_{EN} = 2V$			1	μA
Thermal Shutdown	Rising, Hysteresis = $15^\circ C$		150		$^\circ C$

Functional Description

ETA1815 is a high efficiency DC-to-DC step-down switching regulator with operation input voltage up to 100V and standoff voltage up to 110V. It is capable of delivering up to 2A output current and adopts an adaptive COT control scheme.

Constant On-Time Control

ETA1815 employs constant on-time (COT) control providing fast transient with pseudo fixed switching frequency. At the beginning of each switching cycle, since the feedback voltage (V_{FB}) is lower than the internal reference voltage (V_{REF}), the high-side MOSFET is turned on during one on-time and the inductor current rises to charge up the output voltage. The on-time is determined by the input voltage and output voltage. After the on-time, the high-side MOSFET turns off. The inductor current drops and the output capacitors are discharged. When the output voltage decreases and the V_{FB} decreased below the V_{REF} or SS, the high-side MOSFET turns on again after another dead time duration. This repeats on cycle-by-cycle.

Enable

EN is a digital control pin that turns the ETA1815 on and off. Driving EN High to turn on the regulator, Low to turn it off. Connecting the EN pin through a pull up resistor or shorting EN to IN will automatically turn on the chip whenever plug in IN.

Over Current Protection

The inductor current is monitored during high-side FET turn on. ETA1815 implements over current protection with cycle-by-cycle limiting high-side MOSFET peak current during unexpected overload or output hard short.

ETA1815 also provide a HS current limit off timer for making the IC safer when trigger over current condition. Once trigger HS over current, the present on-time period is immediately terminated to avoid the inductor current run away. The length of off time is controlled by FB voltage and VIN voltage and could be calculated by the following equation.

$$T_{off} = 1.5 \times \left(\frac{V_{IN}}{20 \times V_{FB} + 4.35} \right) \mu s$$

Over-Temperature Protection

Thermal protection disables the output when the junction temperature rises to approximately 150°C, allowing the device to cool down. When the junction temperature cools to approximately 135°C, the output circuitry is again enabled. Depending on power dissipation, thermal resistance, and ambient temperature, the thermal protection circuit may cycle on and off. This cycling limits regulator dissipation, protecting the device from damage as a result of overheating.

Application Information

External Output Voltage Setting

In external Output Voltage Setting Version selected, the ETA18152 regulator is programmed by using an external resistor divider. The output voltage is calculated by using the below equation.

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_1}{R_2} \right)$$

Where: V_{REF} = 1.2V typically (the internal reference voltage)

Resistors R2 has to be between 1KOhm to 20KOhm and thus R1 is calculated by the following equation.

$$R_1 = \left(\frac{V_{OUT}}{V_{REF}} - 1 \right) \times R_2$$

Inductor Selection

The selection of inductors is a trade-off among cost, size, efficiency, and transient response requirements. Typically, three key inductor parameters are specified for device operation: inductance value (L), inductor saturation current (I_{SAT}), and DC resistance (DCR). The switching frequency, input voltage, output voltage, and selected inductor peak to peak ripple current determines the inductor value as follow:

$$L = \frac{V_{OUT}}{F_{SW} \times \Delta I_L} \times \left(1 - \frac{V_{OUT}}{V_{IN}} \right)$$

A good rule for determining the inductance value is to design the peak to peak ripple current in the inductor about 30% of the maximum output current. The peak inductor current can be calculated by:

$$I_{L_PEAK} = I_{OUT} + \frac{\Delta I_L}{2} = I_{OUT} + \frac{V_{OUT}}{2F_{SW} \times L} \times \left(1 - \frac{V_{OUT}}{V_{IN}} \right)$$

Input Capacitor Selection

The input capacitor is required to supply AC current to the step-down converter and maintain the DC input voltage. It is recommended to place ceramic capacitors as close to the VIN as possible to achieve optimal performance. The RMS current in the capacitor can be estimated with the equation:

$$I_{CIN} = I_{OUT} \times \sqrt{\frac{V_{OUT}}{V_{IN}} \times \left(1 - \frac{V_{OUT}}{V_{IN}} \right)}$$

From the above, it can be seen that the input ripple current reaches its maximum at $V_{IN} = 2V_{OUT}$ where $I_{CIN} = I_{OUT}/2$. Therefore, select an input capacitor with RMS current rating greater than half of the maximum load current.

If there is an input voltage ripple requirement in the system, choose an input capacitor that meets the specification. The input capacitor can be calculated by the following equation:

$$C_{IN} = \frac{I_{OUT}}{F_{SW} \times \Delta V_{IN}} \times \frac{V_{OUT}}{V_{IN}} \times \left(1 - \frac{V_{OUT}}{V_{IN}} \right)$$

Output Capacitor Selection

The output capacitor is required to maintain the DC output voltage. The output voltage ripple can be estimated with the equation:

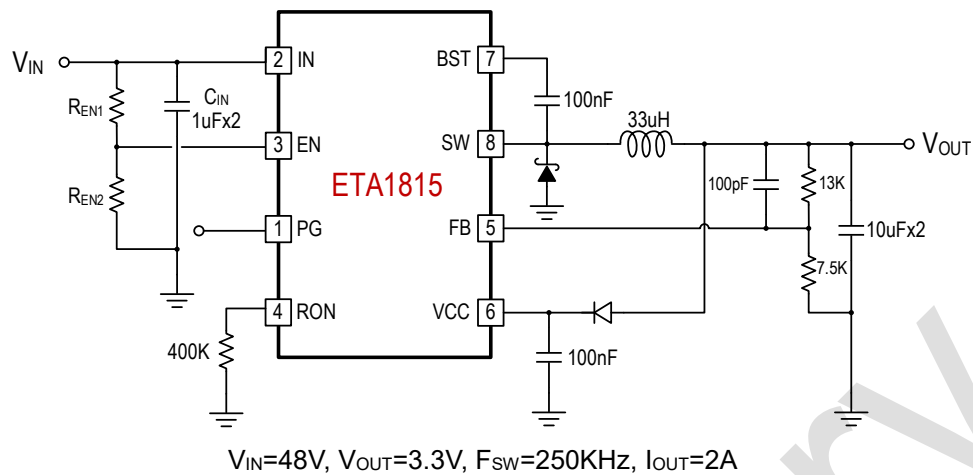
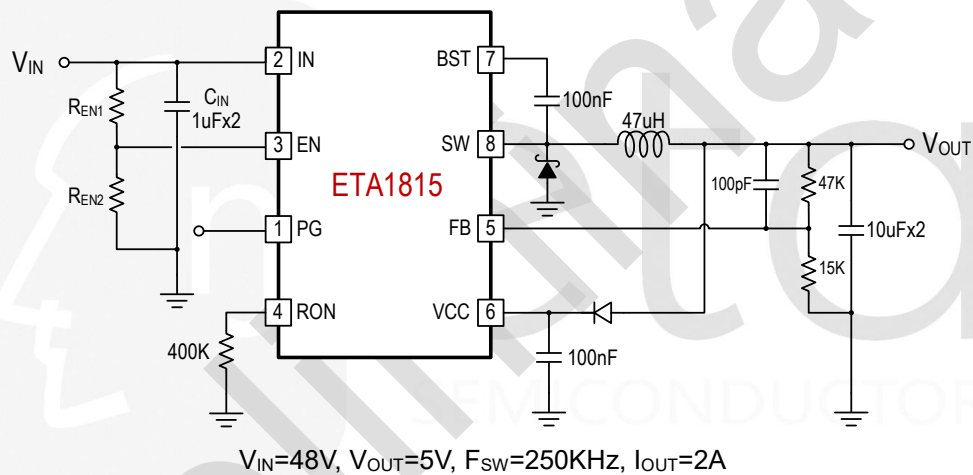
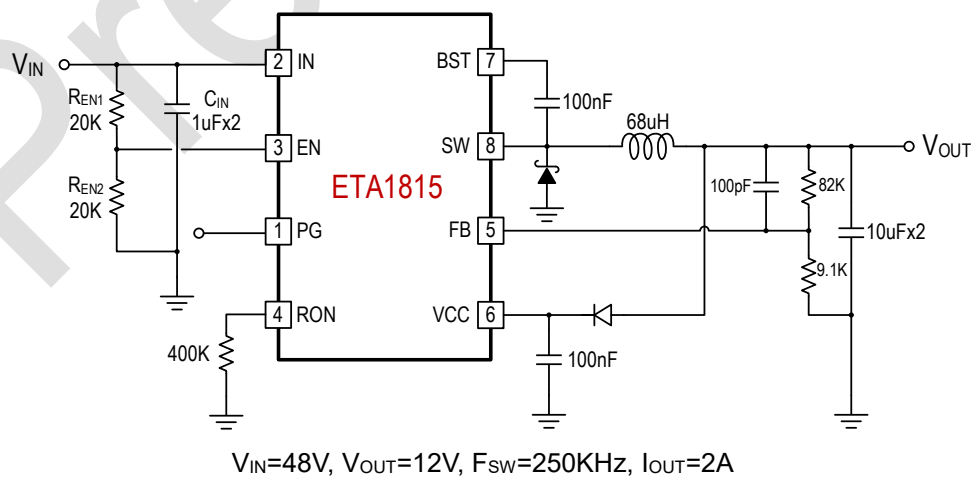
$$\Delta V_{OUT} = \frac{V_{OUT}}{F_{SW} \times L} \times \left(1 - \frac{V_{OUT}}{V_{IN}} \right) \times \left(R_{ESR} + \frac{1}{8 \times F_{SW} \times C_{OUT}} \right)$$

To achieve better load transient response, larger output capacitors can be used. However, the maximum output capacitor limit should also be considered. If the output capacitance value is too high, the output voltage cannot reach the set value during soft start. The maximum output capacitor value C_{OUT_MAX} can be limited approximately with the equation:

$$C_{OUT_MAX} = (I_{LIM_AVG} - I_{OUT}) \times \frac{T_{SS}}{V_{OUT}}$$

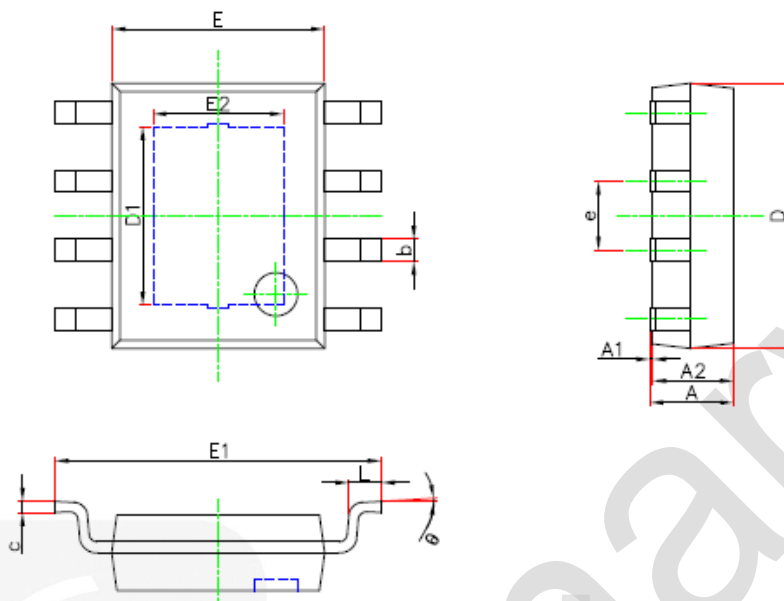
Where I_{LIM_AVG} is the average start-up current during the soft-start period, and T_{SS} is the soft-start time.

Typical Application Circuit



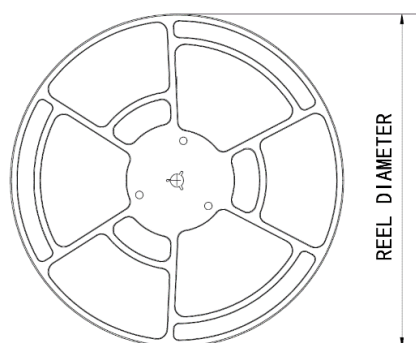
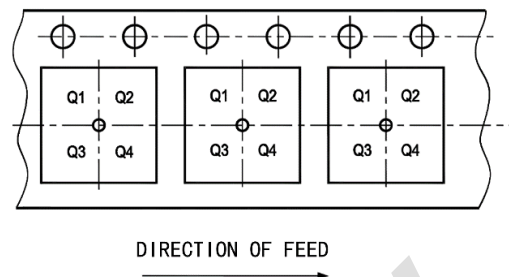
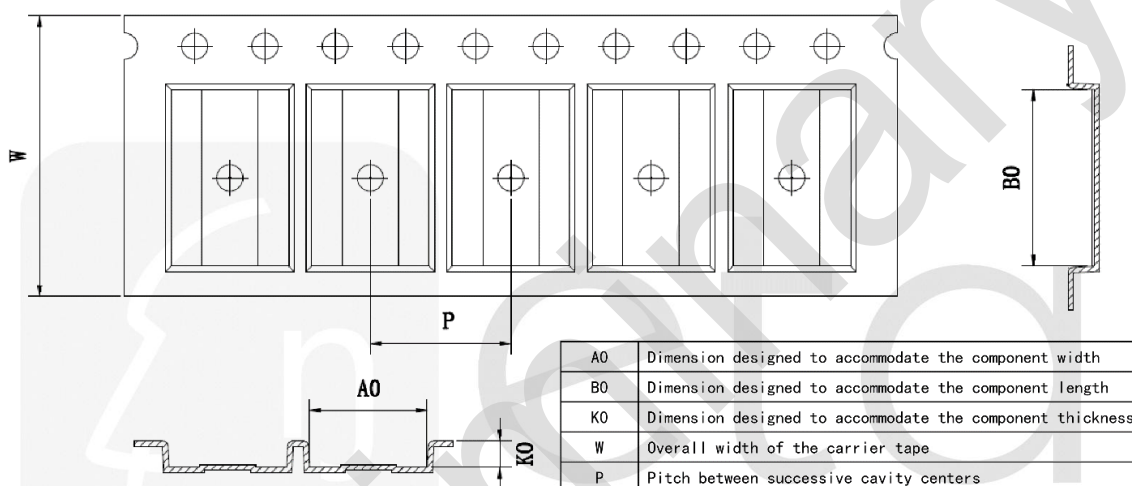
Package Outline

Package: ESOP8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.300	1.700	0.051	0.067
A1	0.000	0.100	0.000	0.004
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
D1	3.202	3.402	0.126	0.134
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
E2	2.313	2.513	0.091	0.099
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

Tape and Reel Information



Device	Package Type	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P (mm)	W (mm)	Pin1 Quadrant
ETA1815E8A	ESOP8	8	4000	330	12.7	6.6	5.4	2.05	8	12	Q1