

18V, 2A, High Efficiency Synchronous Step-Down Converter in SOT23-6

DESCRIPTION

ETA8120 is a wide input range, high-efficiency and high frequency DC-to-DC step-down switching regulator, capable of delivering up to 2A of output current. It 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, ETA8120 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.

ETA8120 is available in SOT23-6 package.

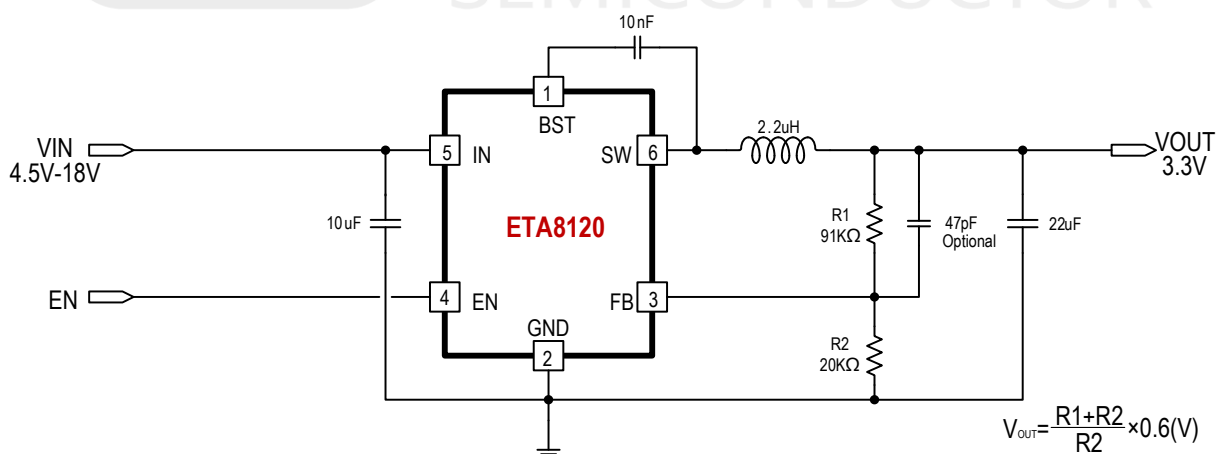
FEATURES

- ◆ Wide Input Range: 4.5V-18V
- ◆ Adaptive COT Control
- ◆ Ultra-fast load transient response
- ◆ High Efficiency PFM mode at light load
- ◆ High Efficiency Synchronous operation
- ◆ No load Iq 177uA
- ◆ Low Rdson Internal power FETs
- ◆ Capable of Delivering 2A
- ◆ No External Compensation Needed
- ◆ Thermal Shutdown and UVLO
- ◆ Available in SOT23-6 Package
- ◆ Pb Free, RoHS and REACH Compliant
- ◆ Halogen Free and "Green" Device

APPLICATIONS

- ◆ LCD TV
- ◆ Set Top Box
- ◆ xDSL Modem

TYPICAL APPLICATION

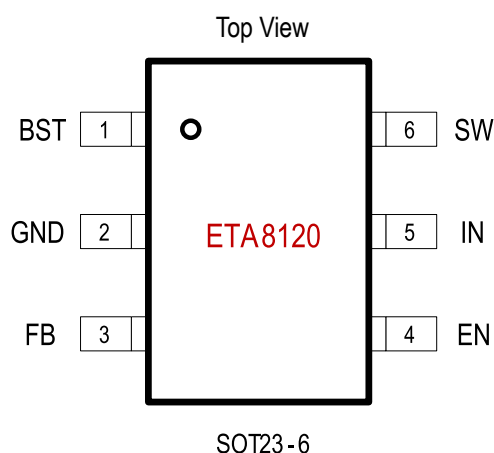


ORDERING INFORMATION

PART No.	PACKAGE	TOP MARK ⁽¹⁾	Pcs/Reel
ETA8120S2G	SOT23-6	CMYW	3000
		CM: Product Code	
		YW: Date 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, EN Voltage		-0.3V to 20V
SW Voltage		-0.3V (-5V for <10nS) to 20V (24V for <10nS)
BST Voltage		-0.3V to SW+6V
FB Voltage		-0.3V to 6V
Junction Temperature		150°C
Storage Temperature Range		-55°C to 150°C
Thermal Resistance	θ_{JA} θ_{JC}	
SOT23-6	180	90
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 85°C
Junction Temperature Range		-40°C to 125°C

ELECTRICAL CHARACTERISTICS

($V_{IN} = 12V$, $V_{OUT} = 3.3V$, unless otherwise specified. Typical values are at $T_A = 25^\circ C$.)

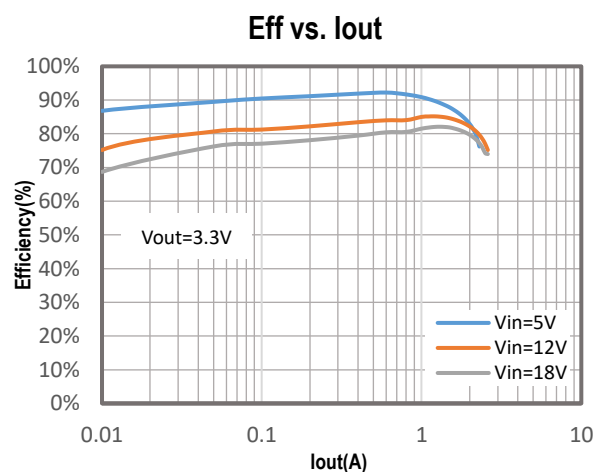
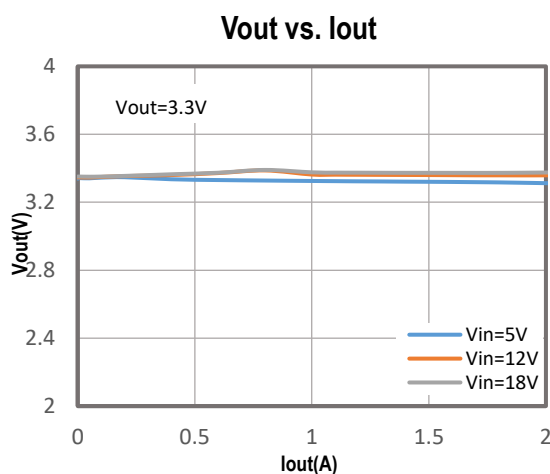
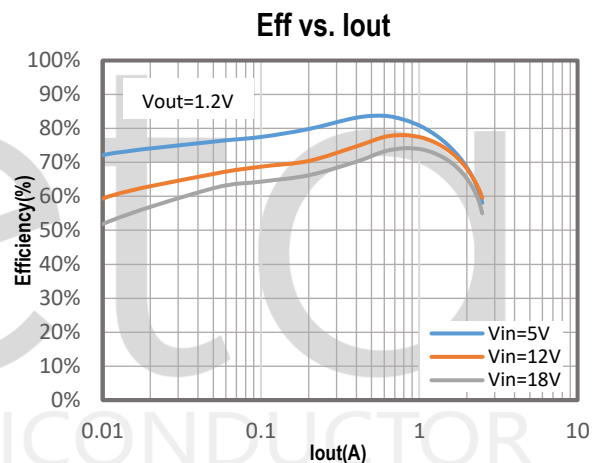
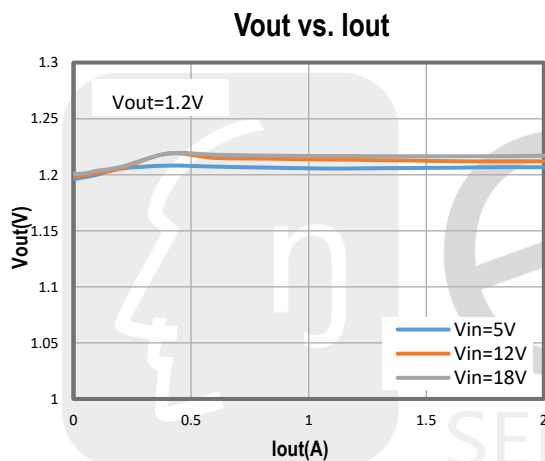
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Input Voltage Range		4.5		18	V
Input UVLO	Rising, Hysteresis = 200mV		3.5		V
Input Supply Current	No Switching		210		μA
Input Shutdown Current			7	14	μA
FB Voltage		0.588	0.6	0.612	V
FB Input Current			0	0.05	μA
Output Voltage Range		0.6		5.5	V
Switching Frequency			600		KHz
Maximum Duty Cycle			90		%
Short Circuit Hiccup Time	On Time		2		mS
Short Circuit Hiccup Time	Off Time		6		mS
FB Hiccup Threshold			0.2		V
High Side Switch On Resistance			160		m Ω
Low Side Switch On Resistance			95		m Ω
High Side Current Limit			4.2		A
SW Leakage Current	IN=SW=12V			10	μA
EN Rising Threshold	Rising	1	1.2	1.4	V
EN Falling Threshold	Falling	0.79	1	1.16	V
EN Input Current	$V_{EN}=2V$		1		μA
Thermal Shutdown	Rising, Hysteresis =45°C		170		°C

PIN DESCRIPTION

PIN #	NAME	DESCRIPTION
1	BST	Bootstrap pin. Connect a 10nF capacitor from this pin to SW
2	GND	Ground
3	FB	Feedback Input. Connect an external resistor divider from the output to FB and GND to set V_{OUT}
4	EN	Enable pin for the IC. Drive this pin high to enable the part, low or floating to disable.
5	IN	Supply Voltage. Bypass with a 10 μ F ceramic capacitor to GND
6	SW	Inductor Connection. Connect an inductor Between SW and the regulator output.

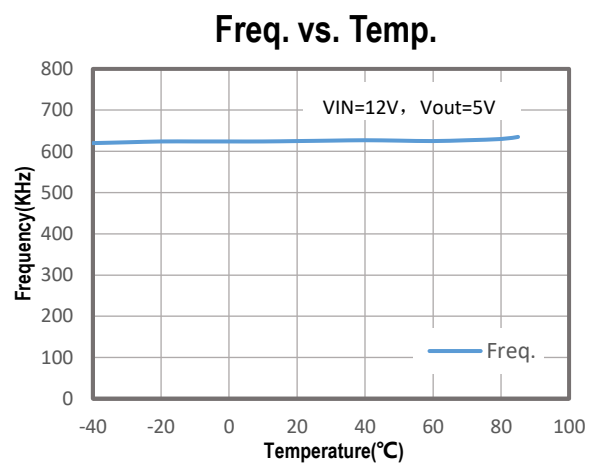
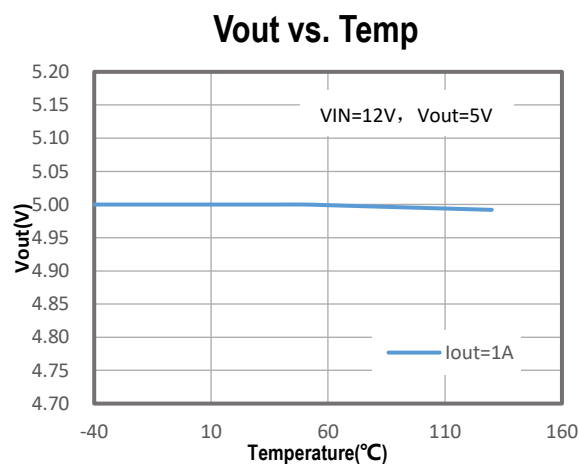
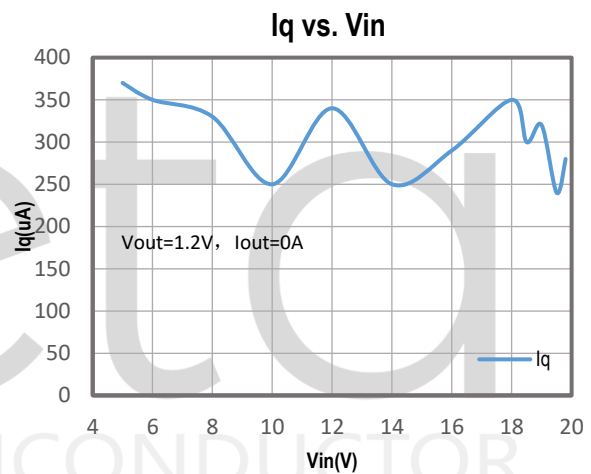
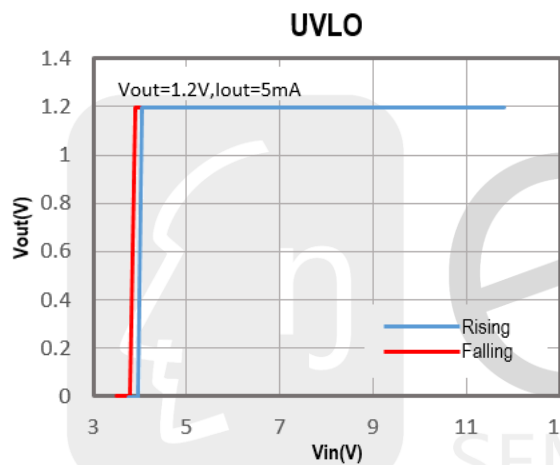
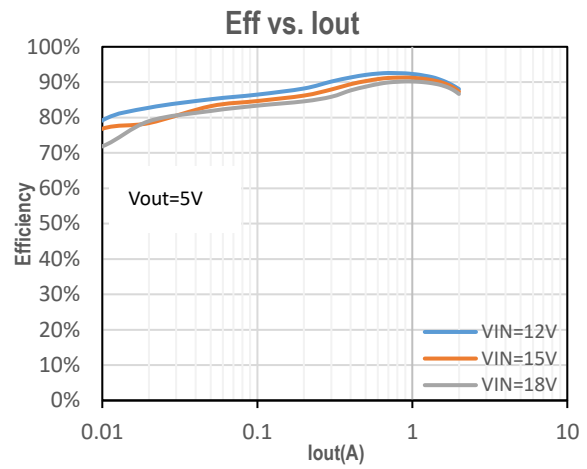
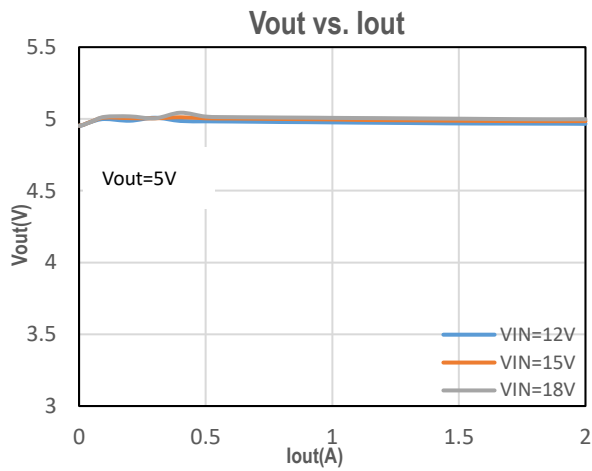
TYPICAL CHARACTERISTICS

(Typical values are with $C_{ff}=47pF$, at $T_A = 25^\circ C$ unless otherwise specified.)



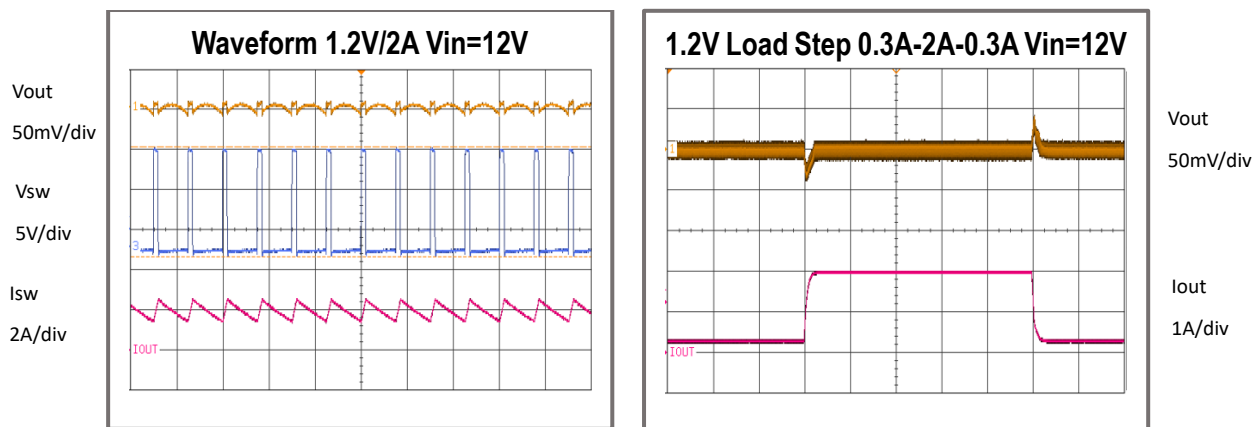
TYPICAL CHARACTERISTICS (cont'd)

(Typical values are with $C_{ff}=47\text{pF}$, at $T_A = 25^\circ\text{C}$ unless otherwise specified.)

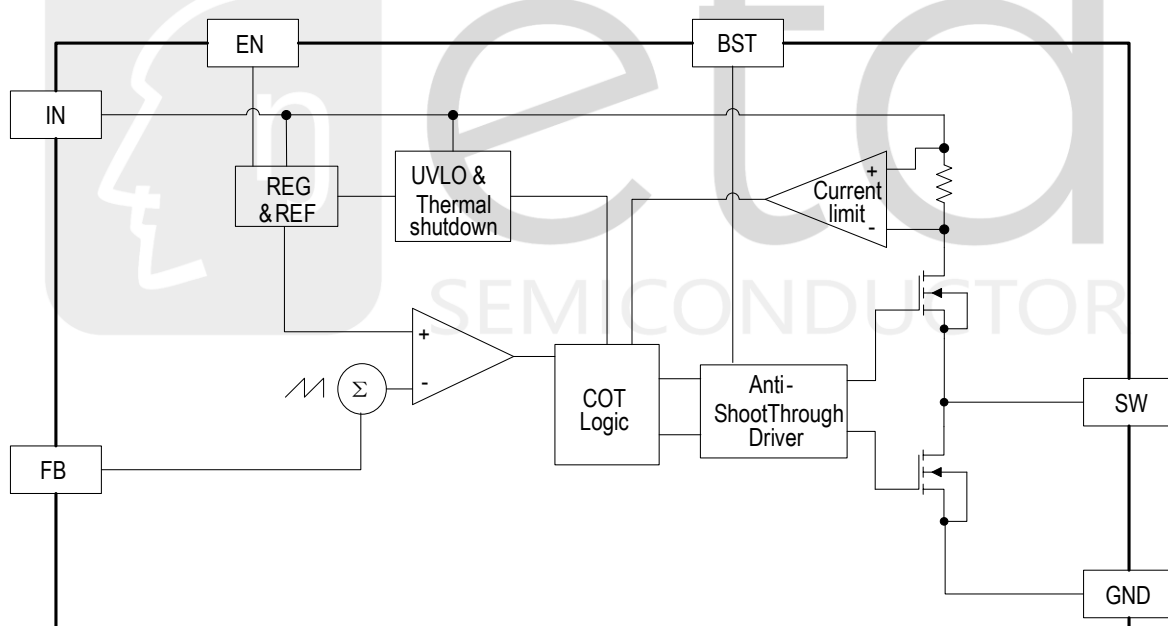


TYPICAL CHARACTERISTICS (cont'd)

(Typical values are with $C_{ff}=47\text{pF}$, at $T_A = 25^\circ\text{C}$ unless otherwise specified.)



FUNCTIONAL BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

The ETA8120 is a synchronous buck regulator ICs that integrates the adaptive COT control, top and bottom switches on the same die to minimize the switching transition loss and conduction loss.

ETA8120 is a wide input range, high-efficiency and high frequency DC-to-DC step-down switching regulator, capable of delivering up to 2A of output current. It 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. It compares the sum of the FB voltage and a ripple voltage that mimics the voltage due to the output ESR and capacitance. The constant-on-time timer varies with line to achieve relative constant switching frequency across line.

Light Load Operation

Traditionally, a fixed constant frequency PWM DC-DC regulator always switches even when the output load is small. When energy is shuffling back and forth through the power MOSFET, power is lost due to the finite $R_{ds(on)}$ of the MOSFET and parasitic capacitances. At light load, this loss is prominent and efficiency is therefore very low. ETA8120 goes into a power save mode during light load, thereby extending the range of high efficiency operation.

Enable

EN is a digital control pin that turns the ETA8120 on and off. Drive EN High to turn on the regulator, drive it Low to turn it off. An internal $1M\Omega$ resistor from EN pin to GND allows EN to float to shut down the chip. Connecting the EN pin through a pull up resistor or shorted EN to IN will automatically turn on the chip whenever plug in IN.

Over Current Protection and Hiccup

ETA8120 has a cycle-by-cycle over current limit for when the inductor current peak value is over the set current limit threshold. When the output voltage drop until FB falls below UV threshold (0.2V), the ETA8120 will enter hiccup mode. It will turn off the chip immediately for 6mS. After that, it will try to re-starts as normal for 2mS. After 2mS, if FB is still below UV threshold, then the chip enters hiccup mode again. If FB is higher than UV threshold, it will enter the normal mode.

Over-Temperature Protection

Thermal protection disables the output when the junction temperature rises to approximately 170°C , allowing the device to cool down. When the junction temperature cools to approximately 125°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 ETA8120 regulator is programmed using an external resistor divider. The output voltage is calculated using below equation.

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

Where: $V_{REF} = 0.6\text{V}$ typically (the internal reference voltage)

Resistors R2 has to be between 1kOhm to 70KOhm and thus R1 is calculated by following equation.

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

Components Selection

Table 1. Suggested Component Selections for the Application

V _{OUT} (V)	R ₁ (KΩ)	R ₂ (KΩ)	C _{ff} (pF)	L(μH)	C _{OUT} (μF)
0.8	6.8	20	47	2.2	1*22
0.9	10	20	47	2.2	1*22
1	12	18	47	2.2	1*22
1.2	20	20	47	2.2	1*22
1.35	20	16	47	2.2	1*22
1.5	18	12	47	2.2	1*22
1.8	36	18	47	2.2	1*22
2.5	47	15	47	2.2	1*22
3.3	91	20	47	2.2	1*22
5	110	15	47	4.7	1*22

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 switch current limit. 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:

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

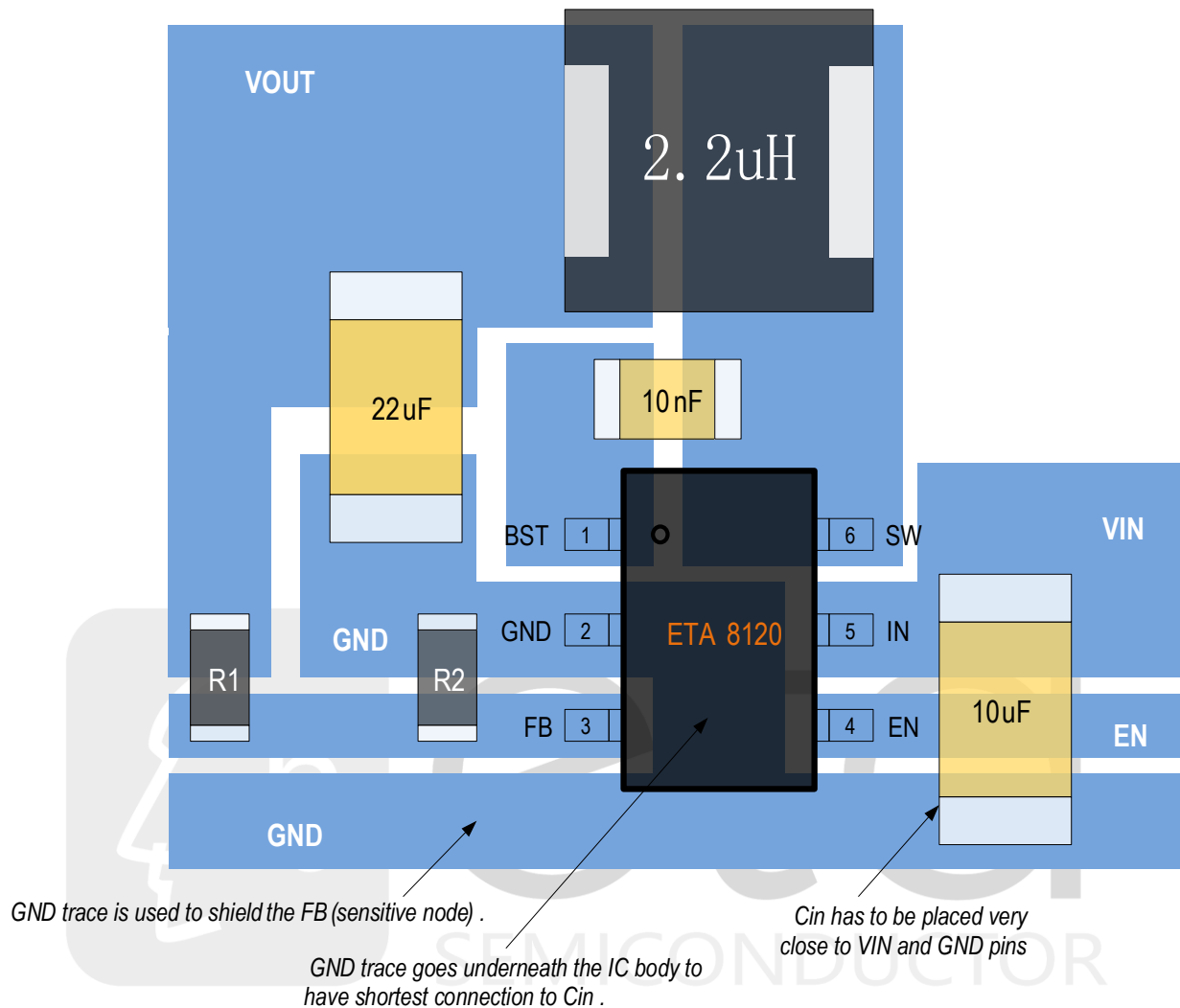
To achieve better load transient response, larger output capacitors can be used. However, the maximum output capacitor limit should also be considered. If the output capacitance value is too high, the output voltage cannot reach the set value during soft start. The maximum output capacitor value C_{OUT_MAX}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

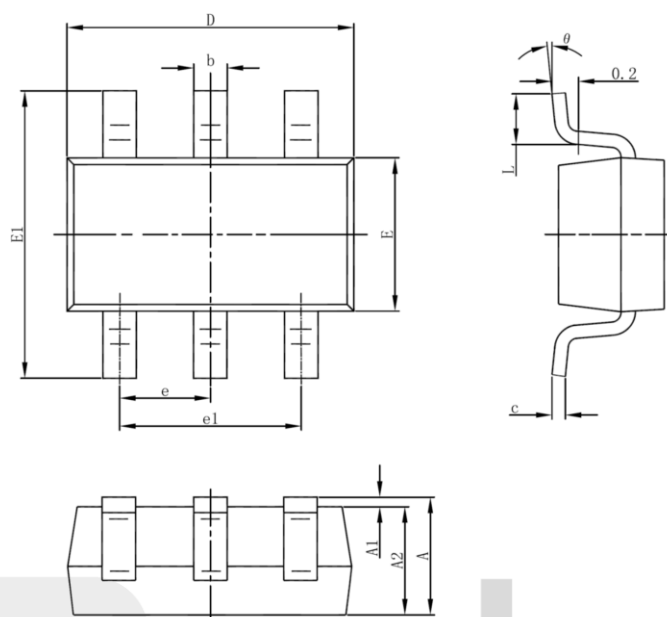


PCB LAYOUT GUIDE



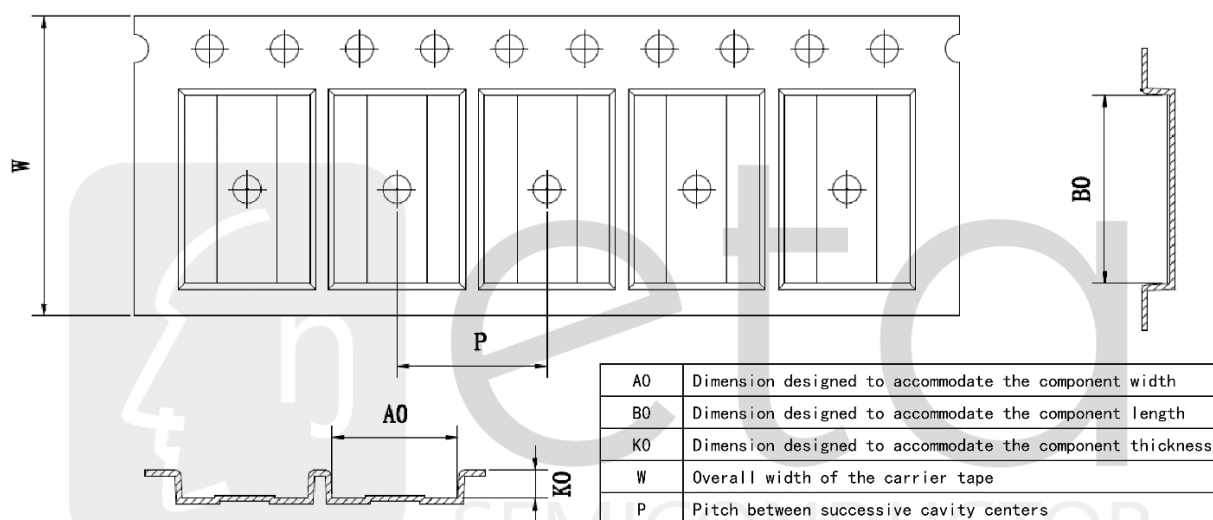
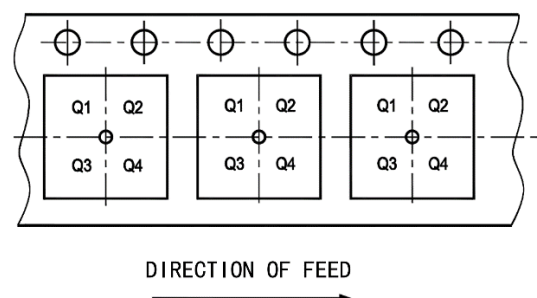
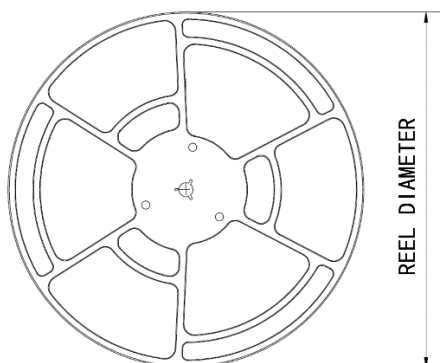
PACKAGE OUTLINE

Package: SOT23-6



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
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
ETA8120S2G	SOT23-6	6	3000	180	9.5	3.17	3.23	1.37	4	8	Q3