18V, 5A, COT mode Synchronous Buck Converter

EA8275

Datasheet

General Description

The EA8275 is a synchronous buck converter using Fixed On-Time Control Technology (COT). The main control loop of EA8275 adopts COT mode control, which can use low ESR ceramic capacitors to achieve fast transient response without external compensation components. Under the condition of 1.05V output, the 0 to 5A load jump Dropout voltage is only 50mV. The fixed on-time control technology can work in PWM mode under heavy load conditions and PFM mode under light load conditions, and can achieve seamless transition between the two modes, so that EA8275 can maintain high efficiency under light load conditions. The EA8275 operates from an input voltage range of 4.5V to 18V. The output voltage is programmable between 0.765 V and 6V. It has functions such as over-temperature protection, under-voltage protection, cycle-by-cycle current limiting and short-circuit Hiccup protection. The EA8275 is available in an 8-pin ESOP8 package and is designed to operate over a temperature range of –40°C to 85°C.

Features

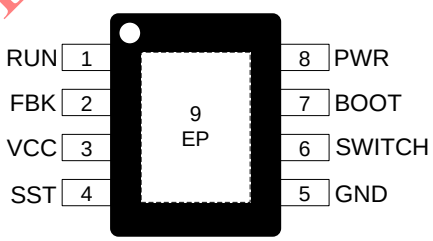
- COT mode Operation
- Fast Transient Response
- MLCC Capacitor for Output is Available
- Low Output Ripple
- 4.5V to 18V Input Voltage Range
- Output Range from 0.765V to 6V
- 5A Continuous Load Current
- Fixed 700KHz Switching Frequency
- Internal Compensation
- Adjustable Soft-Start Function
- Cycle-by-Cycle Current Limit
- Auto Recovery Hiccup Mode Short Circuit Protection
- Auto Recovery OTP Protection
- Available in SOP-8 (with EP) Package

Applications

- Netcom Products
- LCD TVs and Flat TVs
- Notebooks

Pin Configurations

(TOP VIEW)



SOP-8 (with EP)

Pin Description

Pin Name	Function Description	Pin No.
RUN	The device turns on/turns off control input. The EA8275 on/off state can be controlled by RUN pin voltage level. Connect RUN pin to PWR pin with a 150KΩ pull up resistor for automatic startup.	1
FBK	Feedback input. Connect FBK pin and GND pin with voltage dividing resistors to set the output voltage.	2
VCC	Bias Supply output. Connect VCC pin and GND pin with a 0.1uF capacitor.	3
SST	Soft-Start input. Connect SST pin and GND pin by a ceramic capacitor. It can be used to set the soft-start time.	4
GND	Ground pin.	5
SWITCH	Internal MOSFET switching output. Connect SWITCH pin with a low pass filter circuit to obtain a stable DC output voltage.	6
BOOT	The power input of the internal high side N-MOSFET gate driver. Connect a 100nF ceramic capacitor from BOOT pin to SWITCH pin.	7
PWR	The EA8275 power input pin. Recommended to use two 10uF MLCC capacitors between PWR pin and GND pin. It can also use electrolytic capacitors, but need to add a 0.1uF ceramic capacitor as close to the PWR pin as possible to avoid noise interference.	8
EP	Exposed Pad. Make sure that the EP has good soldering with the GND plane of the PCB surface to achieve the desired cooling effect.	9

Function Block Diagram

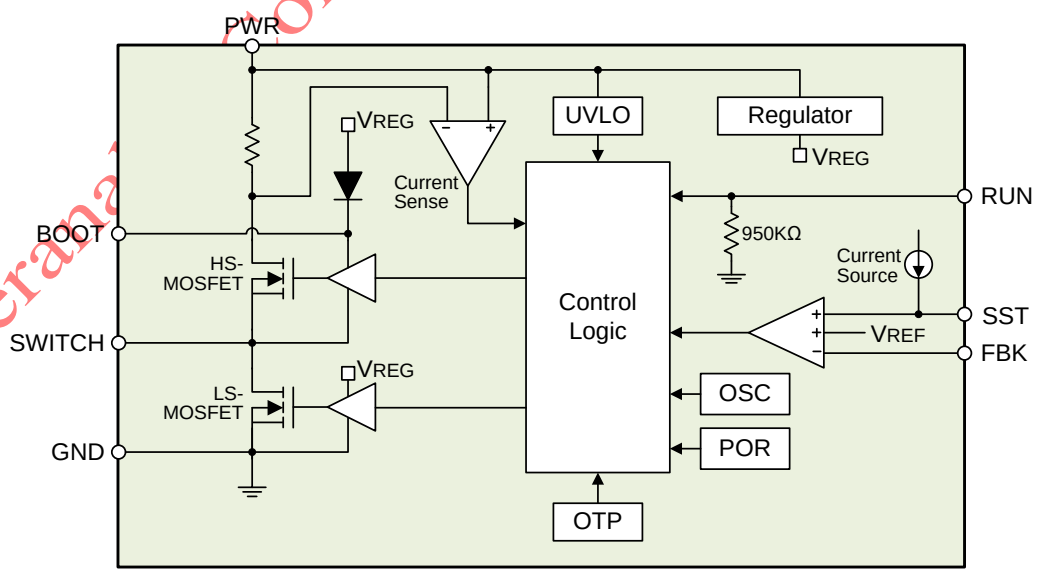


Figure 1. EA8275 internal function block diagram

Absolute Maximum Ratings

Parameter	Value
Input Voltage (V_{PWR})	-0.3V to +19V
RUN Pin Input Voltage (V_{RUN})	-0.3V to +19V
BOOT Pin Voltage (V_{BOOT})	V_{SWITCH}-0.3V to V_{SWITCH}+6.5V
SWITCH Pin Voltage (V_{SWITCH}, 10ns transient)	-1V to +21V
All Other Pins Voltage	-0.3V to +6.5V
Maximum Junction Temperature (T_{Jmax})	-40°C to +150°C
Lead Temperature (Soldering, 10 sec)	+260°C
Storage Temperature Range (T_S)	-55°C to +150°C
ESD (HBM)	2KV

Note (1):Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. Exposure to "Absolute Maximum Ratings" conditions for extended periods may affect device reliability and lifetime.

Package Thermal Characteristics

Parameter	Value
SOP-8 (with EP) Thermal Resistance (θ_{JC})	14°C/W
SOP-8 (with EP) Thermal Resistance (θ_{JA})	65°C/W
SOP-8 (with EP) Power Dissipation at T_A=25°C (P_{Dmax})	1.92W

Note (1): P_{Dmax} is calculated according to the formula: $P_{DMAX}=(T_{JMAX}-T_A)/\theta_{JA}$.

Recommended Operating Conditions

Parameter	Value
Input Voltage (V_{PWR})	+4.5V to +18V
RUN Pin Input Voltage (V_{RUN})	-0.3V to +18V
Output Voltage (V_{OUT})	+0.765V to +6V

Electrical Characteristics

V_{PWR}=12V, T_A=25°C, unless otherwise noted

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage	V_{PWR}		4.5		18	V
Shutdown Supply Current	I_{SD}	V_{RUN} = 0V		3.6	10	uA
Quiescent Current	I_Q	V_{RUN} = 2V, V_{FBK} = 105% V_{REF}, I_{LOAD} = 0A		400	800	uA
UVLO Threshold	V_{UVLO}	V_{PWR} Rising		3.75		V
UVLO Hysteresis	$V_{UV-HYST}$			320		mV
Output Load Current	I_{LOAD}				5	A
Reference Voltage	V_{REF}	4.5V ≤ V_{PWR} ≤ 18V	0.75	0.765	0.780	V
Switching Frequency	F_{SW}			700		KHz
High Side MOSFET On-Resistance	$R_{DS(ON)-HM}$			65		mΩ
Low Side MOSFET On-Resistance	$R_{DS(ON)-LM}$			35		mΩ
High Side MOSFET Current Limit	I_{LIM-HM}		6	6.5		A
RUN Pin Input Low Voltage	V_{RUN-L}				0.6	V
RUN Pin Input High Voltage	V_{RUN-H}		1.6			V
High Side MOSFET Minimum On Time	T_{ONMIN}	V_{OUT} = 1.05V		120		ns
High Side MOSFET Minimum Off Time	T_{OFFMIN}	V_{FBK} = 0.7V		260		ns
VCC Regulator Voltage	V_{CC}	0mA < I_{CC} < 5mA	4.8	5.0	5.2	V
VCC Regulator Current	I_{CC}	V_{PWR} = 5V		60		mA
SST Charge Current	I_{SST}	V_{SST} = 1V		6		uA
Thermal Shutdown Threshold	T_{OTP}			170		°C
Thermal Shutdown Hysteresis				40		°C

Note (1): MOSFET on-resistance specifications are guaranteed by correlation to wafer level measurements.
(2): Thermal shutdown specifications are guaranteed by correlation to the design and characteristics analysis.

Application Circuit Diagram

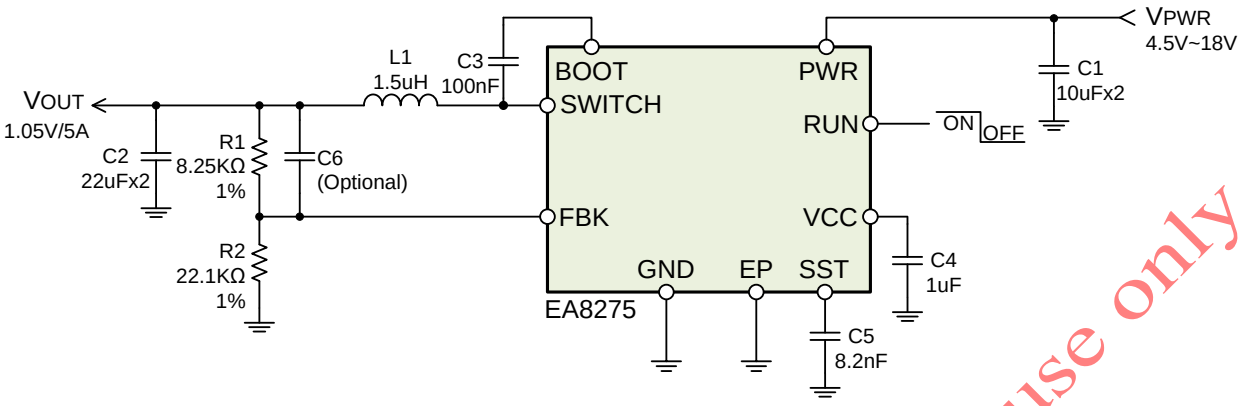


Figure 2. Typical application circuit diagram

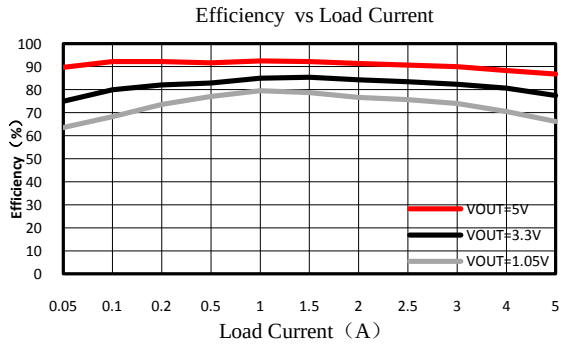
Ordering Information

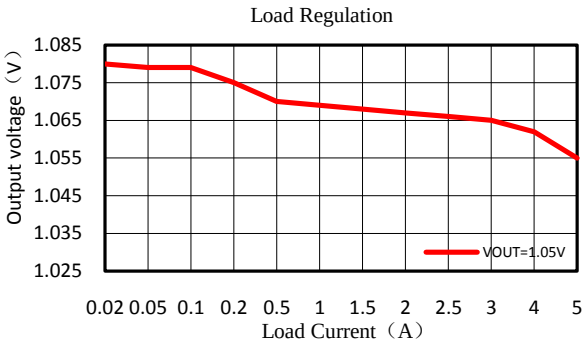
Part Number	Package Type	Packing Information
EA8275P8R	SOP-8(with EP)	Tape & Reel / 2500

Note (1):"P8": Package type code.
(2):"R": Tape & Reel.

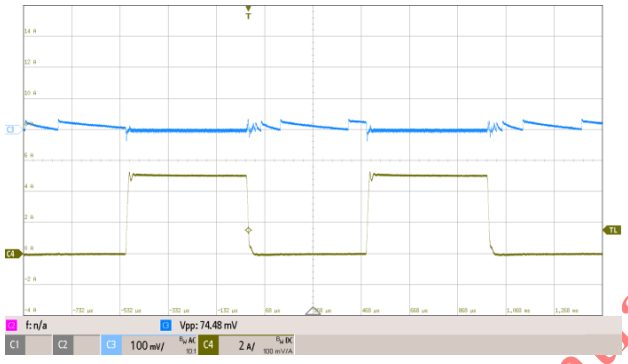
Typical Operating Characteristics

V_{PWR}=12V, V_{OUT}=1.05V, L1=1.5uH, C1=10Fx2, C2=22uFx2, T_A=25°C, unless otherwise noted





CH3: $V_{OUT\ (AC)}$ CH4: I_{LOAD}

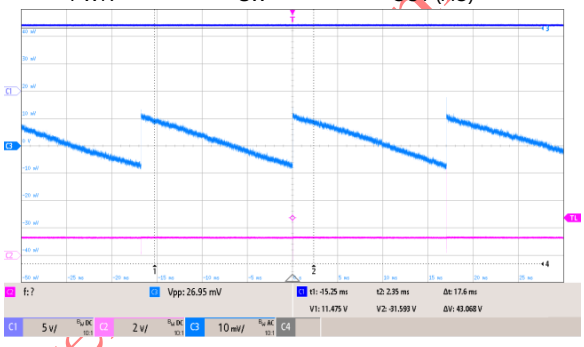


I_{LOAD} = 0A to 5A Transient Response Waveform

CH1: V_{RUN} CH3: V_{OUT}

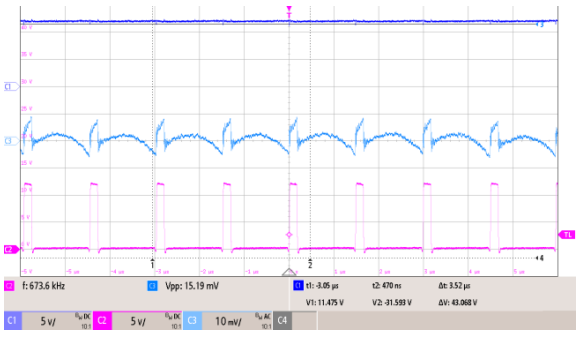
I_{OUT} = 1A Power On Waveform

CH1: V_{PWR} CH2: V_{SW} CH3: $V_{OUT\ (AC)}$



I_{LOAD} = 0A Switching Waveform

CH1: V_{PWR} CH2: V_{SW} CH3: $V_{OUT\ (AC)}$



I_{LOAD} = 5A Switching Waveform

Functional Description

The EA8275 is a 5A synchronous buck converter in COT mode. It integrates two N-type MOSFETs. The COT control mode has excellent transient response capability, and the chip does not require additional external compensation devices. A dedicated internal circuit design allows the use of low-ESR ceramic capacitors on the periphery. The chip adopts pseudo-constant frequency control and works at a working frequency of approximately 700KHz.

Soft-Start Function

The soft-start time is adjustable, when the RUN pin goes high, the 6uA current starts to charge the SS capacitor. Make sure that the output voltage remains smoothly controlled during start-up. The formula for calculating the soft-start time is shown in below. The V_{FBK} voltage is 0.765 V and the SST pin source current is 6 μA.

$$tss(ms)=\frac{C_{SST}(nF)xV_{FBK}x1.1}{I_{SST}(\mu A)}=\frac{C_{SST}(nF)x0.765x1.1}{6}$$

Over-Current & Short-Circuit Protection

The EA8275 has over-current protection and short-circuit protection functions, and adopts the control method of valley current limit. With the lower LS MOSFET turned on, the inductor current is monitored, and when the inductor current reaches the valley setpoint, the device enters overcurrent protection mode. At the same time, the output voltage drops. When the VFB voltage is lower than 75% of the reference value, the chip will be in a short-circuit protection state, that is, enter the hiccup mode, the chip will disable the output power stage, and soft-start restart.

Application Information

Enable Control

The EA8275 use RUN pin to control the regulator turns on / turns off. When the RUN pin input voltage is higher than 1.6V(typ.), the EA8275 enters the operating mode. Drive the RUN pin input voltage lower than 0.6V to ensure the EA8275 into shutdown mode, as shown in Figure3. When the device works in the shutdown mode, the shutdown supply current is less than 10uA. The EA8275 also provides automatic startup function as shown in Figure 4. Connect RUN pin and PWR pin with a 150KΩ resistor, when the PWR supply input voltage increasing and higher than RUN pin threshold voltage, the EA8275 will enter operating mode automatically.

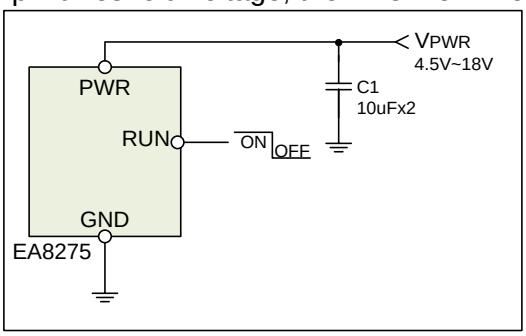


Figure 3. Enable control by RUN pin voltage

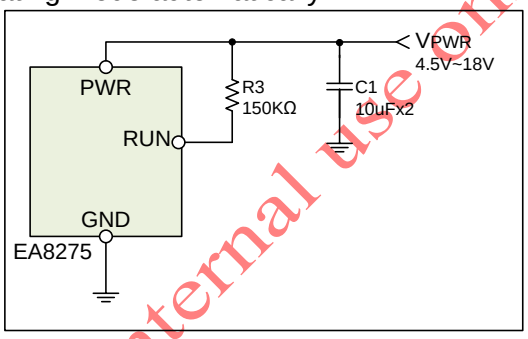


Figure 4. Automatic startup application circuit

Output Voltage Setting

The EA8275 output voltage can be set via a resistor divider (R1, R2). The output voltage is calculated by following equation:

$$V_{OUT} = 0.765 \times \frac{R1}{R2} + 0.765\ V$$

The following table lists common output voltage and the corresponding R1, R2 resistance value for reference.

Output Voltage	R1 Resistance	R2 Resistance	C6 Capacitor	Resistance Tolerance
5V	124KΩ	22.1KΩ	22pF	1%
3.3V	73.2KΩ	22.1KΩ	22pF	1%
1.8V	30.1KΩ	22.1KΩ	22pF	1%
1.2V	12.7KΩ	22.1KΩ	NC	1%
1.05V	8.25 KΩ	22.1KΩ	NC	1%
1V	6.81	22.1KΩ	NC	1%

Input / Output Capacitors Selection

The input capacitors are used to suppress the noise amplitude of the input voltage and provide a stable and clean DC input to the device. Because the ceramic capacitor has low ESR characteristic, so it is suitable for input capacitor use. It is recommended to use X5R or X7R MLCC capacitors in order to have better temperature performance and smaller capacitance tolerance. In order to suppress the output voltage ripple, the MLCC capacitor is also the best choice. The suggested part numbers of input / output capacitors are as follows:

Vendor	Part Number	Capacitance	Edc	Parameter	Size
TDK	C2012X5R1C106K	10uF	16V	X5R	0805
TDK	C3216X5R1E106K	10uF	25V	X5R	1206
TDK	C2012X5R0J226K	22uF	6.3V	X5R	0805
TDK	C3216X5R1A226M	22uF	10V	X5R	1206

Output Inductor Selection

The output inductor selection mainly depends on the amount of ripple current through the inductor ΔI_L. Large ΔI_L will cause larger output voltage ripple and loss, but the user can use a smaller inductor to save cost and space. On the contrary, the larger inductance can get smaller ΔI_L and thus the smaller output voltage ripple and loss. But it will increase the space and the cost. The inductor value can be calculated as:

$$L = \frac{V_{PWR} - V_{OUT}}{\Delta I_L \times F_{SW}} \times \frac{V_{OUT}}{V_{PWR}}$$

The following table lists common output voltage and the corresponding L inductance value for reference.

Output Voltage	L Inductance Value
5V	3.3uH
3.3V	2.2uH
1.8V	1.5uH
1.2V	1.0uH ~ 1.5uH
1.05V	1.0uH ~ 1.5uH
1V	1.0uH ~ 1.5uH

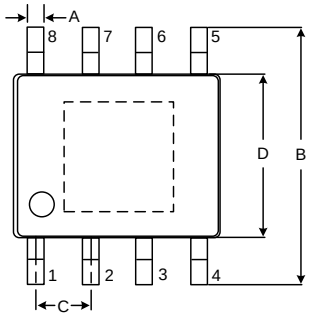
PCB Layout Recommendations

For EA8275 PCB layout considerations, please refer to the following suggestions in order to get good performance.

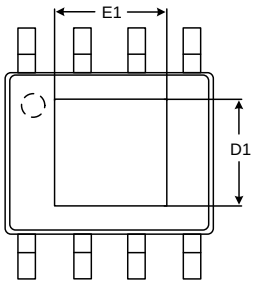
- The area close to the EA8275 should be paved as much as possible to ensure heat dissipation.
- The bottom area directly under the IC should be the dedicated ground area. The floor area should be as large as possible. Additional internal layers can be dedicated to ground planes and connected to the top layer via vias.
- Make sure that the input switch current loop is as small as possible.
- Make sure the SWITCH node size is as small and short as possible to minimize parasitic capacitance and inductance, and to minimize radiated emissions.
- Keep the PWR and GND traces as wide as possible.
- The VCC capacitor should be placed as close as possible to the pin and connected to GND.
- The voltage feedback loop should be as short as possible, preferably with a grounded shield around it.
- Cin should be as close as possible to the PWR pin.

Package Information

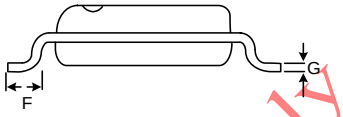
SOP-8(with EP) Package



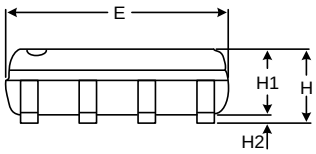
Top View



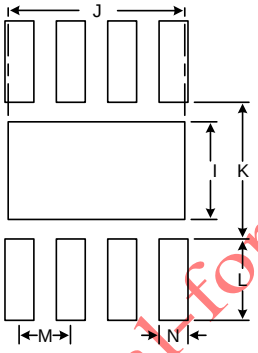
Bottom View



Front View



Side View



Recommended Layout Pattern

Unit: mm

Symbol	Dimension Min	Dimension Max	Symbol	Dimension Typ
A	0.32	0.52	I	1.60
B	5.79	6.20	J	5.50
D	3.79	4.00	K	3.00
D1	2.16	2.42	L	2.00
E	4.81	5.01	M	1.27
E1	3.05	3.51	N	0.72
C	1.19	1.35		
F	0.41	1.27		
G	0.17	0.25		
H	1.26	1.71		
H1	1.26	1.56		
H2	0.00	0.15		