

40Vin 2 Outputs COT Buck Controller

TD1742A

General Description

The TD1742A is a dual, constant on-time (COT) mode synchronous buck controller. Each channel has both high-side and low-side drivers allowing synchronous configuration using two external power-NMOS. It can operate in both Constant Current (CC) and Constant Voltage (CV) modes. It enables system designers to complete the suite of various end equipment's power bus regulators with a cost effective, low component count, and low standby current solution. The main control loops of the TD1742A use the cot mode control which provides a very fast transient response with no external compensation components. The constant on-time control supports seamless transition between PWM (pulse width modulation mode at higher load conditions and PFM (Pulse Frequency Modulation) operation at light loads. The PFM operation allows the TD1742A to maintain high efficiency during lighter load conditions. The device provides convenient and efficient operation with input voltages from 7.5V to 40V. The TD1742A is available in a 4.0mm × 4.0mm 16 pin QFN package.

Features

- Vin: 7.5V to 40V
- Vout: 1.2V to $V_{in} \times 98\%$
- CC/CV Mode Control
- PFM Mode for Increased Light Load Efficiency
- Hiccup mode 1-2S when SCP/OVP occur
- Protection
 - Output short protection: reduce input current to less than 20mA(RMS)
 - OVP(output Over-Voltage Protection)
 - Output FB short protection
 - Temperature shut down(OTP).
- Adjustable Output Cable Resistance Compensation
- Duty: 0~98%(Toff_min=100ns, Deadtime=25~35ns)
- Switching Frequency: 150KHz(+/-25k)
- Integrated MOSFET Driver.
- OVP: When $V_{fb} > 140\% \times V_{REF}$, open discharge switch ($V_{out1/2}$). Discharge current > 50mA
- QFN-16 Package

Pin Configurations

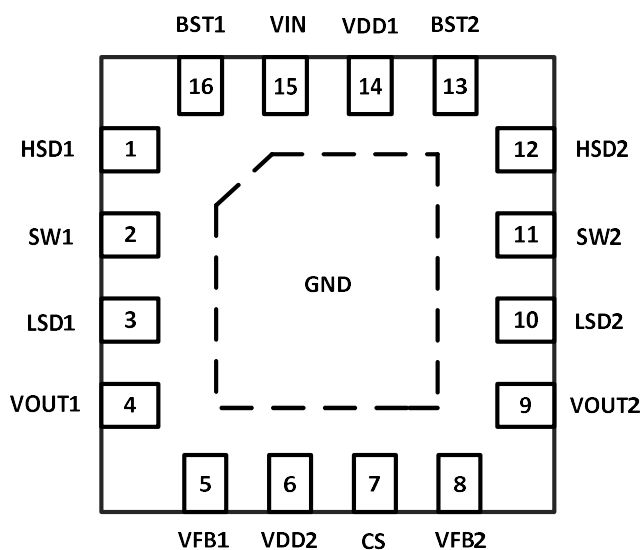


Figure1 Pin Configuration of TD1742A (Top View)

Applications

- Car Charger
- PD adapter
- High-Brightness Lighting
- General-Purpose DC/DC Controller

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Pin Description

Pin Number	Pin Name	Description
1	HSD1	Channel1 High Side Driver
2	SW1	Channel1 Inductor terminal.
3	LSD1	Channel1 Low Side Driver
4	VOUT1	Channel1 VOUT feedback
5	VFB1	Channel1 Feedback input with reference to 1.20V. It can set output voltage.
6	VDD2	Internal 5V power supply, a 4.7uF capacitor is connected between this pin and GND.
7	CS	Current sense pin.
8	VFB2	Channel2 Feedback input with reference to 1.20V. It can set output voltage.
9	VOUT2	Channel2 VOUT feedback
10	LSD2	Channel2 Low Side Driver
11	SW2	Channel2 Inductor terminal.
12	HSD2	Channel2 High Side Driver
13	BST2	Channel2 Internal High Side Driver Power Bias which is typically 5V above Vin. A typical 0.1uF capacitor is used connecting between BST and SW pins.
14	VDD1	This pin is power driver.
15	VIN	Supply input
16	BST1	Channel1 Internal High Side Driver Power Bias which is typically 5V above Vin. A typical 0.1uF capacitor is used connecting between BST and SW pins.
	GND	Ground pin.

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Function Block

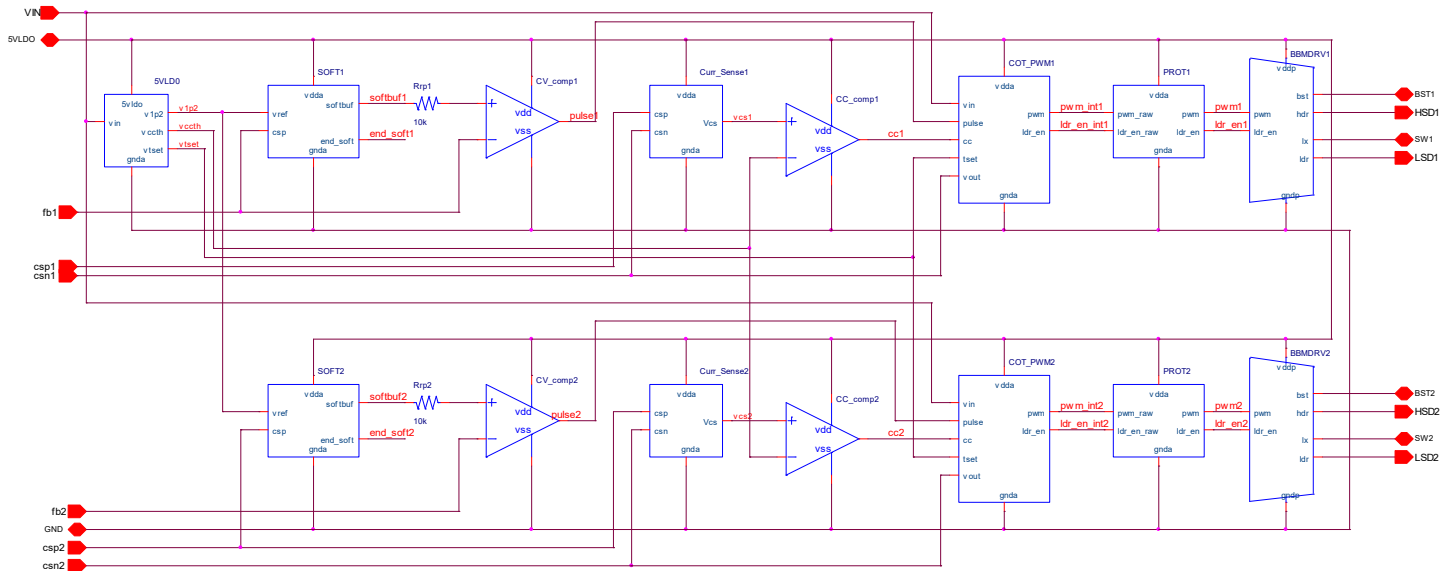


Figure 2 Function Block Diagram of TD1742A

Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
VIN	Supply Input Voltage	-0.3 to +43	V
	SW to GND	-1 to VIN+1	V
	BST, HSD to SW	VSW-0.3 to VSW+6	V
	VDD, VFB1-2, LSD1-2 to GND	-0.3 to +6	V
	VCS to GND	-0.3 to +0.3	V
ESD	HBM (Human Body Mode)	2K	V
θJA	Thermal Resistance from Junction to ambient	40	°C/W

Recommended Operating Conditions

Symbol	Parameter	Rating			Unit
		Min.	Typ.	Max.	
VIN	Supply Voltage	7.5	-	40	V
IOUT	Output current range	-	-	15	A
TOP	Operating Temperature	-40	-	85	°C
TSTG	Storage Temperature Range	-65	-	150	°C

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T _J	Junction Temperature	-40	-	150	°C
T _{SDR}	Maximum Lead Soldering Temperature, 10 Seconds	260			°C

Electrical Characteristics

(V_{IN}=12V, T_A=25°C (unless otherwise specified). MOSFET use TDM3436)

Symbol	Characteristic	Test conditions	Min	Typ	Max	Unit
V _{IN}	Supply Voltage		7.5	-	40	V
I _{IN}	Supply Input Current	V _{out} =5V, No load	-	1.1	1.9	mA
VIN UVLO						
V _{UP}	VIN UVLO Turn ON	VIN Rising	5.0	5.5	6.0	V
V _{HYS}	VIN UVLO Hysteresis	VIN Falling	-	1.0	-	V
Feedback voltage						
V _{FB1/2}	Feedback voltage		1.176	1.20	1.224	V
	Tolerance		-2	-	2	%
Soft Start						
	Soft Start time		-	0.7	-	ms
Frequency						
F _{SW}	Switch frequency		125	150	175	KHz
T _{ON}	Minimum On-Time		-	150	-	ns
D	Duty cycle		-	-	98	%
Current sense						
V _{CC}	CC threshold		46.5	50	53.5	mV
I _{FB}	Cable compensation Current	V _{in} =12V, Cout1-2=40mv	-	4.0	-	uA
HDR & LDR Drivers						
T _{RH}	HDR Rising Time		-	10	-	ns
T _{FH}	HDR Falling Time		-	10	-	ns
T _{RL}	LDR Rising Time		-	10	-	ns
T _{FL}	LDR Falling Time		-	10	-	ns
T _{LH}	Dead Time		-	30	-	ns
T _{HL}	Dead Time		-	30	-	ns
Thermal Shutdown (OTP)						
T _{SD}	Temperature Rising		-	150	-	°C
T _{HYS}	OTP Hysteresis		-	20	-	°C

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Typical Application Circuit

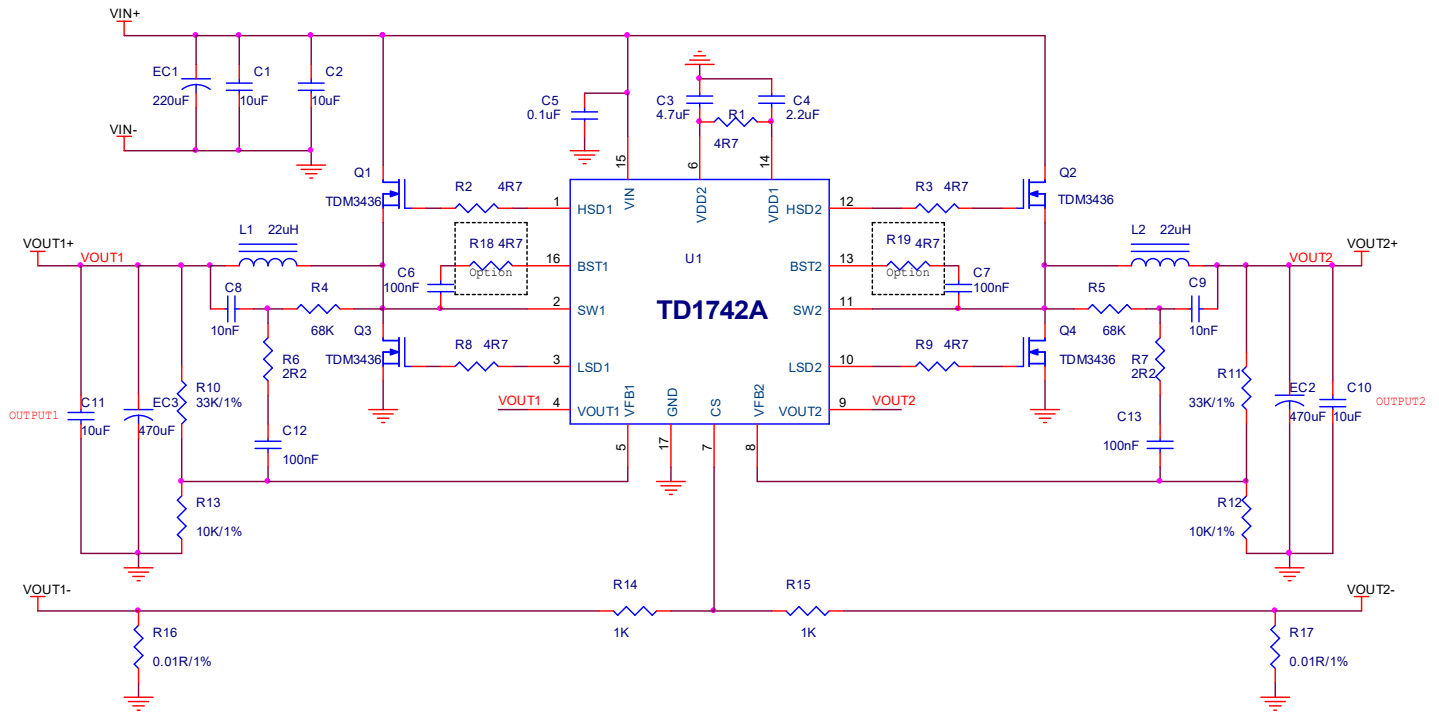


Figure 3 2-outputs with CC

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Function Description

TD1742A operates in a constant on time control to regulate the output voltage. When the feedback voltage FB lower than the VREF, turns on the high side power MOSFET. Ton calculator decides the high-side MOSFET on time. When the power switch is off, it remains off until the FB lower is than VREF.

CC/CV Mode Control

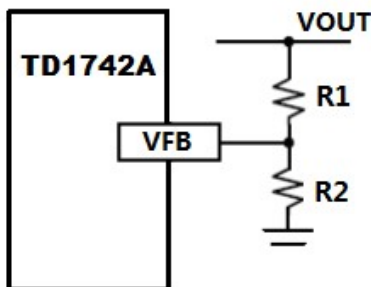
TD1742A provides CC/CV function. The Constant output Current control Mode and Constant output Voltage control Mode.

Output Voltage Setting

VFB is the feedback pin and connected to the non-inverting of error amplifier input. The output voltage is adjustable from 1.2V to $V_{in} \times 98\%$ with a resistor-divider connected with VFB GND and converter's output. Using 1% or better resistors for the resistor-divider is recommended.

The output voltage is determined by the equation:

$$V_{OUT} = V_{FB} \times (1 + R1/R2) = 1.2V \times (1 + R1/R2)$$



R1 can program the cable compensation.

Constant Current setting

Adjust the sense resistor (Rs) can set the constant current value. $I_{cc} = 0.05/R_s$

Output Cable Resistance Compensation

To compensate for resistive voltage drop across the charger's output cable, it integrates a simple, user-programmable cable

voltage drop compensation using the impedance at the FB pin. By choosing different R1, we can get different cable voltage drop compensation values.

$$V_c = R1 \times V_{cs} \times 9/100000$$

FB UVP

For TD1742A, Hiccup Mode of Under Voltage Protection (UVP) is provided. If cc mode is triggered or over short current protection (SCP) occur, the output voltage will be pulled down quickly. When the FB pin voltage falls down to 0.15V, the controller will enter hiccup mode by disabling the converter and restarts soft-start after a predefined interval until the under-voltage condition is removed.

Over Temperature Protection (OTP)

TD1742A provides over temperature protection (OTP). The OTP will shut down the converter when junction temperature exceeds 150°C. Once the junction temperature cools down by approximately 30°C, the controller will resume.

Over Voltage Protection(OVP)

TD1742A provides over voltage protection (OVP). When V_{FB} reaches 140% of the normal value, IC will turn off the upside MOS. Recover V_{FB} to 120% of the normal value, IC will restart soft start.

Output Inductor Selection

The inductor value (L) determines the inductor ripple current, and affects the load transient response. Higher inductor value reduces the inductor's ripple current and induces lower output ripple voltage. The ripple current and ripple voltage can be approximated by:

$$L = V_{OUT} \times (V_{IN} - V_{OUT}) / F_{SW} \times I_{RIPPLE} \times V_{IN}$$

Where

F_{SW} : the switching frequency of the regulator;

V_{IN}/V_{OUT} : input voltage/output voltage;

I_{RIPPLE} is the inductor ripple current and

$$I_{RIPPLE} = (0.3 - 0.5) I_{OUT}$$

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Input Capacitor

A low ESR capacitor is highly recommended. Since large current flows in and out of this capacitor during switching, its ESR also affects efficiency.

The input capacitance should be higher than 22μF. The best choice is the ceramic type, however, low ESR tantalum or electrolytic types may also be used. The input capacitor should be placed close to the VIN and GND pins of the IC, with the shortest traces possible. In the case of tantalum or electrolytic types, they can be further away if a small parallel 1μF ceramic capacitor is placed right next to the IC.

Output Capacitor

The output capacitor is required to maintain the DC output voltage and the ESR of the capacitor dominates the impedance at the switching frequency. The ramp voltage generated from the ESR is high enough to stabilize the system. A minimum ESR value around 20mΩ is required to ensure stable operation of the converter and a 220μF (or more) polymer/electrolytic capacitor are recommended.

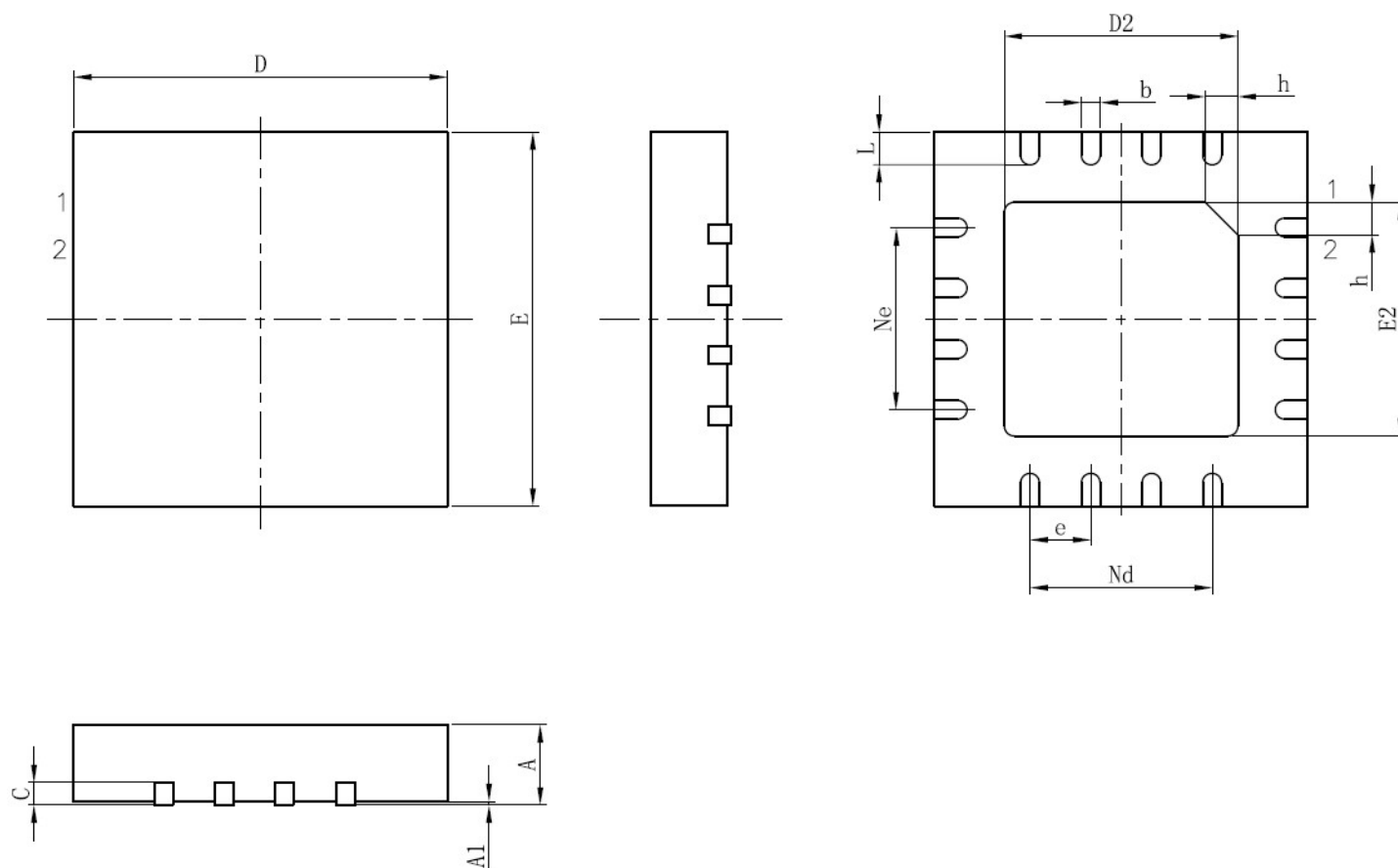
Layout Consideration

In order to ensure the proper operation of the regulator, the following layout suggestion must be pay attention to:

- **C4, C3 must be close to VDD1, VDD2 and GND pins.**
- Decoupling capacitors, the resistor-divider, and boost capacitor should be close to their pins.
- Place the source of high-side MOSFET and the drain of the low-side MOSFET as close as possible. Minimizing the impedance with wide layout plane between the two pads reduces the voltage bounce of the node. In addition, the large layout plane between the drain of the MOSFETs(VIN and SW nodes) can get better heat sinking.
- The input bulk capacitors should be close to the drain of the high-side MOSFET, and the output capacitor should be close to the loads. The input capacitor's ground should be close to the grounds of the output capacitor and low-side MOSFET.
- Locate the resistor-divider close to the FB pin to minimize the high impedance. In addition, FB pin traces can't be close to the switching signal traces (HSD, LSD, BST, and SW).

Package Information

QFN16L Package Outline Dimensions



Symbol		A	A1	b	c	D	D2	e	Ne	Nd	E	E2	L	h
Milli meter	MIN	0.70	-	0.25	0.18	3.90	2.10	0.65 BSC	1.95 BSC	1.95 BSC	3.90	2.10	0.45	0.30
	NOM	0.75	0.02	0.30	0.20	4.00	2.20				4.00	2.20	0.55	0.35
	MAX	0.80	0.05	0.35	0.25	4.10	2.30				4.10	2.30	0.65	0.40

Design Notes