5V-Adjustable High-PSRR Low-Noise LDO MD7682 Series

CMOS Voltage Regulator With ON/OFF Switch 2A

PRODUCT DESCRIPTION

MD7682 series are highly accurate, low-noise, high power supply rejection ratio (PSRR), low-dropout voltage regulator (LDO) with high output current capability manufactured in CMOS processes. It can deliver up to 2A of current while consuming 60μA of quiescent current. Internal circuitry includes a reference voltage generator, an error amplifier, driver transistor, over-current protection circuit, short-circuit protection circuit, thermal shutdown circuit and a phase compensation circuit. The MD7682 operates by default as a fixed output voltage regulator (default output voltage: 5V) while usage of an external resistor divider allows adjustable out voltages as low as 0.7V. Additional features include enable function, and current limit adjustable.

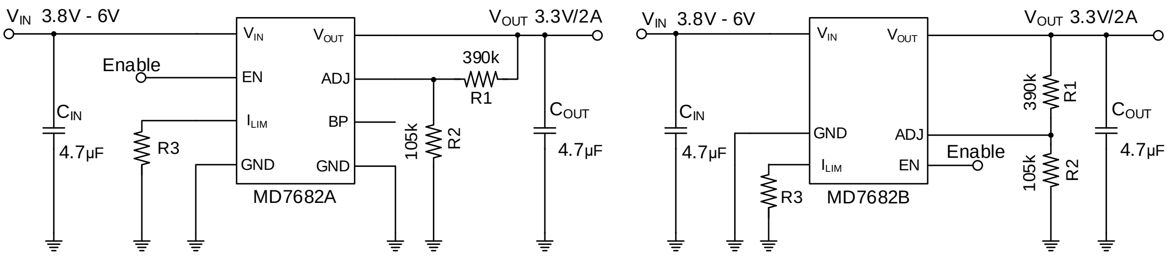
APPLICATIONS

- Smart wearer
- Long-life battery-powered devices
- Portable mobile devices, such as mobile phones, cameras, and so on
- Wireless communication equipment

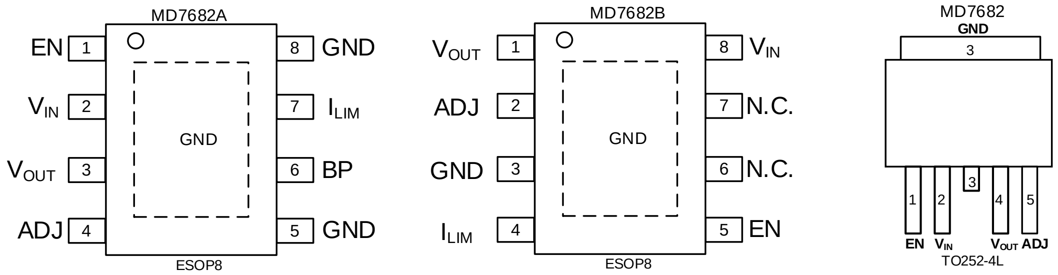
FEATURES

- Highly Accurate: ±2％
- Low Quiescent Current: 65μA
- Dropout Voltage: 250mV@3.3V/2A
- Maximum Output Current: 2A
- Input Voltage Range: 2~6V
- Output Voltage Noise: 100μVrms@V_{OUT}=3.3V
- High PSRR:75dB@1kHz
- Temperature Stability: ±40ppm/℃
- ON/OFF Logic = Enable High
- Standby Current: 10nA
- Addition function: Reverse Current Protection Output Voltage adjustable, Current Limit adjustable
- C_{OUT} Discharge Circuit when EN Disable is Active
- Protections Circuits: Current Limit, Short Circuit, and Thermal Protections
- Output Capacitor: Low ESR Ceramic Capacitor Compatible, above 2.2uF.
- RoHS compliant "Green"/Halogen Free 8-pin Exposed pad SOIC (ESOP8) and 4-pin TO252 packages

TYPICAL APPLICATION CIRCUIT:



PIN CONFIGURATION (TOP VIEW)



PRODUCT SELECTIONS

Type	Fixed Output Voltage（note 1*）	ADJ	Accuracy （note 2*）	Package （note 3*）	MARKING (note 4*）
MD7682A50SF4	5V	Yes	±2%	ESOP8	7682A
MD7682B50SF4	5V	Yes	±2%	ESOP8	7682B
MD7682E50UB2	5V	Yes	±2%	TO252-4L	7682

Notes:

1* Customer can request to customize the output voltage ranged from 1.2V to 5V if desired voltage is not found in the selections.

2* Customer can request customization of accuracy requirement.

3* Customer can request customization of package choice.

4* Please pay attention to the MARKING of the product package type.

PIN DESCRIPTION

Name	ESOP8 (MD7682A)	ESOP8 (MD7682B)	TO252-4L (MD7682)	Description
VOUT	3	1	4	Regulator Output pin.
ADJ	4	2	5	Adjustable Pin. Output Voltage can be set by external feedback resistors when using a resistive divider. Or, connect ADJ to GND for V_{OUT} = 5V, set by internal feedback resistors.
GND	5,8	3	3	Ground Signal
EN	1	5	1	Enable Pin. Minimum 1.6V to enable the device. Maximum 0.4V to shutdown the device.
VIN	2	8	2	Power Input Pin. Must be closely decoupled to GND pin with a 4.7μF or greater ceramic capacitor.
BP	6	-	-	Bypass pin. Connect a 1μF capacitor to GND to reduce output noise. Bypass pin can be left floating if unnecessary.
I_{LIM}	7	4	-	Current Limit Adjustment
N.C.	-	6,7	-	None Connection (Used to connect GND or OPEN state.)
GND	Exposed Pad	Exposed Pad	-	Connect to GND.

ABSOLUTE MAXIMUM RATINGS

(Unless otherwise indicated: Ta=25℃)

PARAMETER	SYMBOL	RATINGS		UNITS
Input Voltage	V_{IN}	-0.3 ~ 7		V
Enable Voltage	V_{EN}	-0.3 ~ 7		
Output Voltage	V_{OUT}	-0.3 ~ V_{IN}+0.3		
Power Dissipation	P_D	Internally Limited		
Thermal Resistance	$R_{\theta JB}$(1)	ESOP8	80	℃/W
		TO252-4	60	
Operating Ambient Temperature	T_{opr}	-40 ~ +85		℃
Storage Temperature	T_{stg}	-40 ~ +125		
ESD Protection	ESD HBM	4000		V

Note: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device.

(1) Mounted on JEDEC standard 4layer (2s2p) PCB test board

ELECTRICAL CHARACTERISTICS

Unless otherwise indicated, V_{IN} = V_{OUT} + 1V, C_{IN} = 4.7µF, C_{OUT} = 4.7µF, C_{BYP}=1µF, T_J = 25°C.

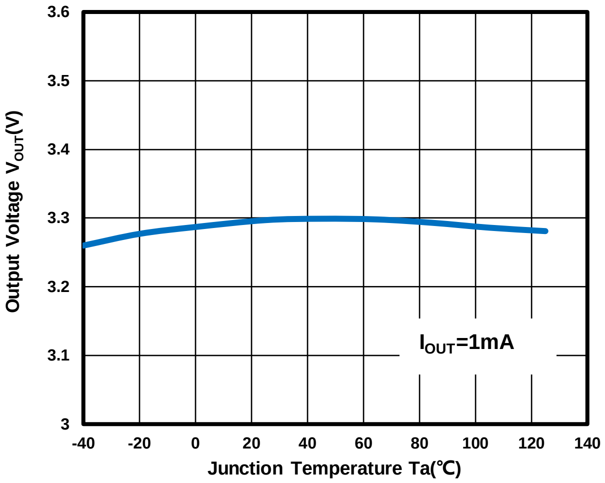
PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Input Voltage	V_{IN}		2		6	V
Output Voltage Tolerance	$V_{OUT(S)}$ [*1]	I_{OUT}=1mA	-2		+2	%
Continuous Output Current	I_{OUT}	V_{IN}>2.3V	2			A
Ground Current	I_{GND}	V_{EN}=V_{IN}, no load		65		µA
		V_{EN}=V_{IN}, I_{OUT}=100mA		410		
Shutdown Current	I_{SHUT}	V_{EN}=0		0.01		µA
Output Current Limit	I_{LIM}			3		A
Current Fold Back				1		
Dropout Voltage [*2]	V_{DROP} [*2]	V_{EN}=V_{IN}, I_{OUT}=2A, V_{OUT}=1.8V		380	500	mV
		V_{EN}=V_{IN}, I_{OUT}=2A, V_{OUT}=3.3V		250	370	
		V_{EN}=V_{IN}, I_{OUT}=2A, V_{OUT}=5V		240	360	
Line Regulation		$V_{OUT(S)}$+1V≤V_{IN}=V_{EN}≤6V I_{OUT}=1mA		3	15	mV
Load Regulation	ΔV_{OUT2}	V_{IN}=V_{EN}=$V_{OUT(S)}$+1.0V 1mA≤I_{OUT}≤2A		10	20	mV
Temperature Stability	$\frac{\Delta V_{OUT}}{\Delta T_a \bullet V_{OUT(S)}}$	V_{IN}=V_{EN}=$V_{OUT(S)}$+1.0V I_{OUT}=1mA -40℃≤T_A≤125℃		±40		ppm/℃
Reference Voltage Tolerance			0.686	0.7	0.714	V
ADJ Pin Current		V_{ADJ} = V_{REF}		10		nA
ADJ Pin Threshold			0.05	0.1	0.2	V
Enable Turn-On Threshold		Output ON	1.6			V
Enable Turn-Off Threshold		Output OFF			0.4	V
Shutdown Pin Current				0.1	0.5	µA
Shutdown Exit Delay Time				0		µs
Max Output Discharge Resistance to GND during Shutdown				22		Ω
Reverse Current	I_{REV} [*3]	V_{IN}=0V, V_{EN}=2V, V_{OUT}=5.5V		0.10	0.5	µA
V_{OUT} Sink Current at Reverse condition	I_{REVS} [*4]	V_{IN}=V_{EN}=5V, V_{OUT}=5.5V		0.14	0.5	µA
Power Supply Ripple Rejection	PSRR	f=1kHz, I_{OUT}=10mA		75		dB
		f=10kHz, I_{OUT}=10mA		57		
		f=100kHz, I_{OUT}=10mA		46		
		f=1MHz, I_{OUT}=10mA		55		
Output Noise Voltage	V_{OUTN}	V_{OUT}=3.3V f=10Hz ~100KHz		100		μV_{RMS}
Thermal Shutdown Temperature	T_{SD}	I_{OUT}=1mA		160		℃
Thermal Shutdown Hysteresis	T_{SD_HYS}			25		℃

Notes：

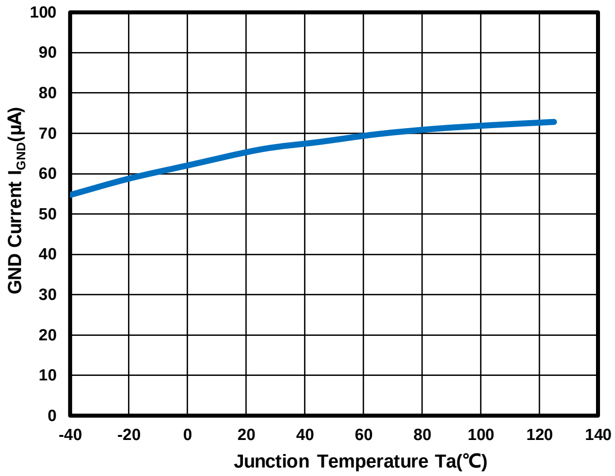
1. $V_{OUT(S)}$: Output voltage when V_{IN}=V_{OUT}+1V, I_{OUT}=1 mA.
2. V_{DROP}=V_{IN1} -（$V_{OUT(S)}$× 0.98）where V_{IN1} is the input voltage when V_{OUT} = $V_{OUT(S)}$× 0.98.
3. I_{REV}: reverse current shows the current flowing from the V_{OUT} terminal to V_{IN} terminal.
4. I_{REVS}: reverse flow during the V_{OUT} pin sink current shows the current flowing from the V_{OUT} pin to the V_{SS} terminal.

TYPICAL PERFORMANCE CHARACTERISTICS

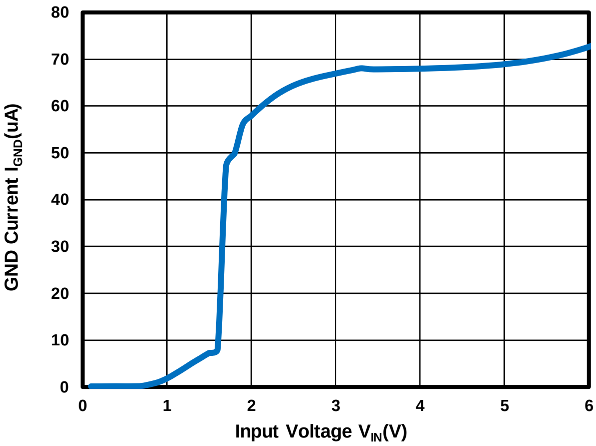
Test Conditions: $V_{IN}=V_{OUT}+1.0V$, C_{IN} = 4.7μF, C_{OUT} = 4.7μF, T_A=25℃, unless otherwise indicated.



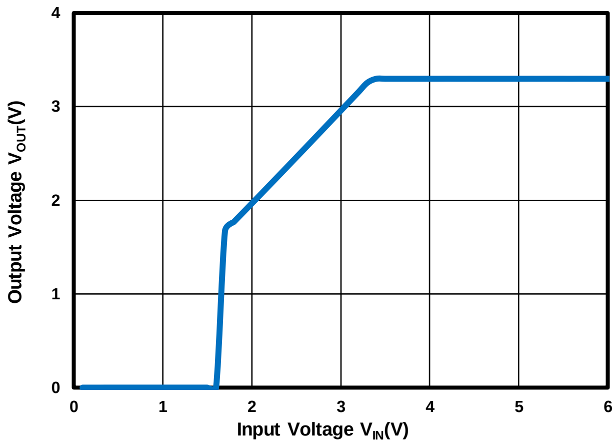
Output Voltage vs Temperature at VOUT=3.3V



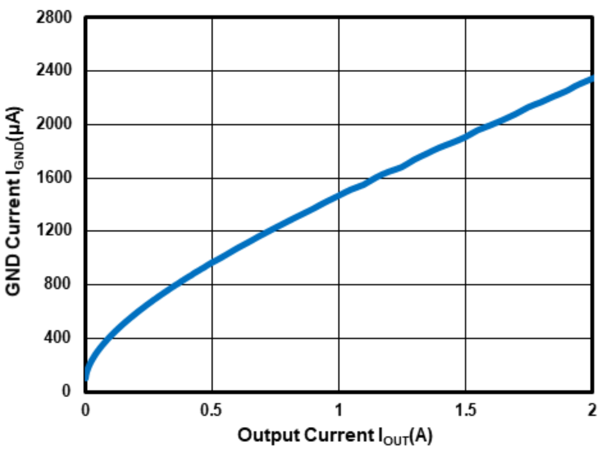
GND Current vs Temperature at V_{OUT}=3.3V



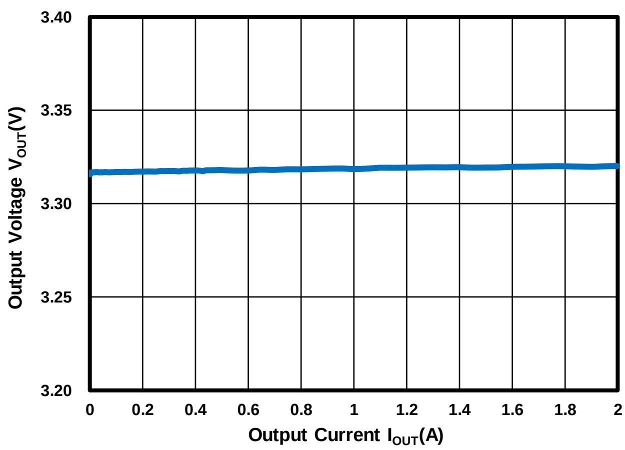
GND Current vs Input Voltage at V_{OUT}=3.3V



Output Voltage vs Input Voltage at V_{OUT}=3.3V



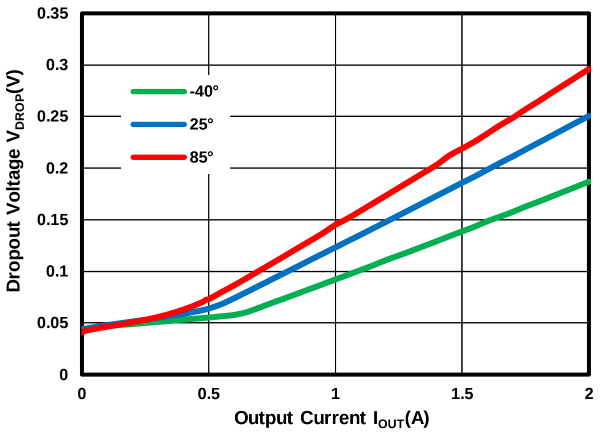
GND Current vs Output Current at V_{OUT}=3.3V



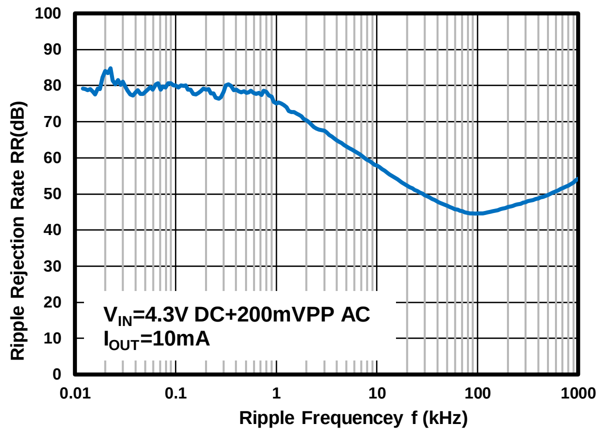
Output Voltage vs Output Current at V_{OUT}=3.3V

TYPICAL PERFORMANCE CHARACTERISTICS(CONTINUTED)

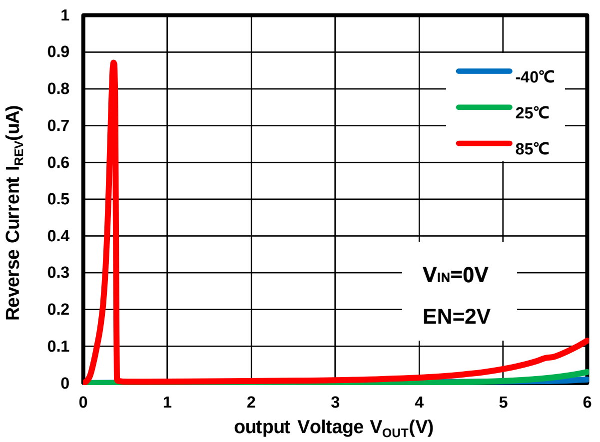
Test Conditions: $V_{IN}=V_{OUT}+1.0V$, $C_{IN}=4.7\mu F$, $C_{OUT}=4.7\mu F$, $T_A=25℃$, unless otherwise indicated.



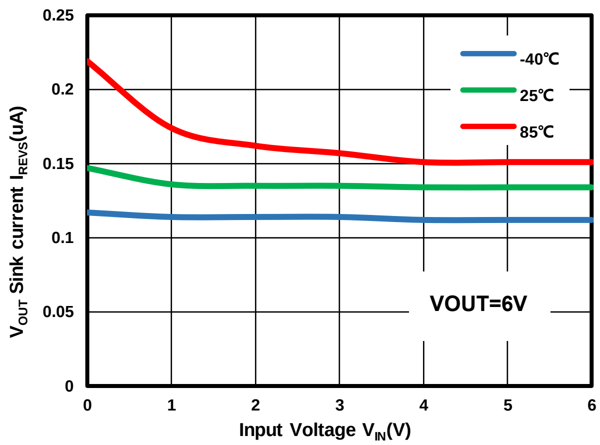
Dropout Voltage vs Output Current at V_{OUT}=3.3V



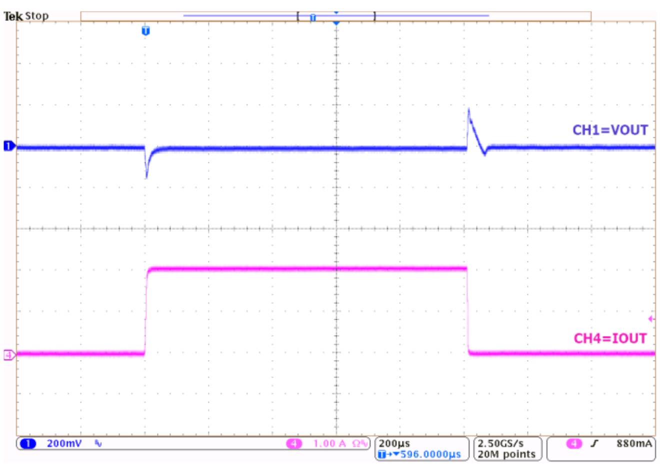
Power Supply Rejection Ratio at V_{OUT}=3.3V



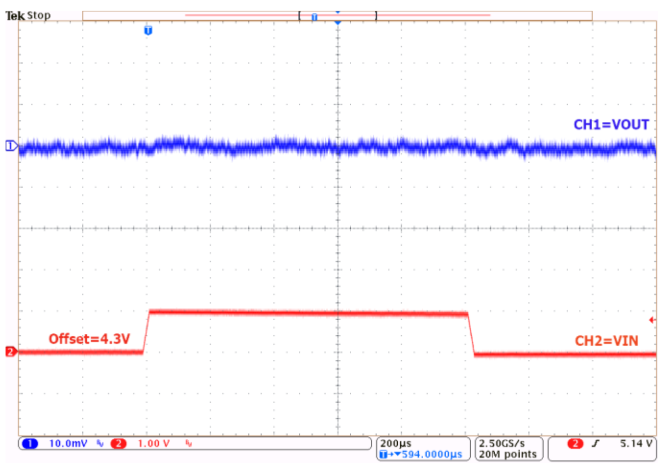
Reverse Current vs Output Voltage



V_{OUT} Sink Current vs Input Voltage



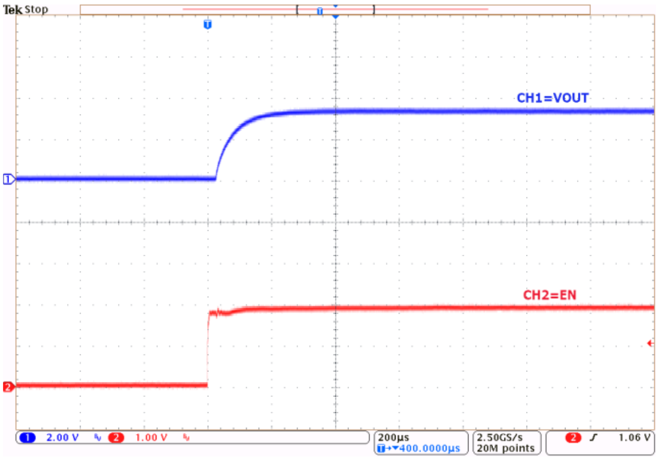
Load Transient at V_{OUT}=3.3V
(I_{OUT}=10mA~2A~10mA)



Line Transient at V_{OUT}=3.3V
(I_{OUT}=10mA)

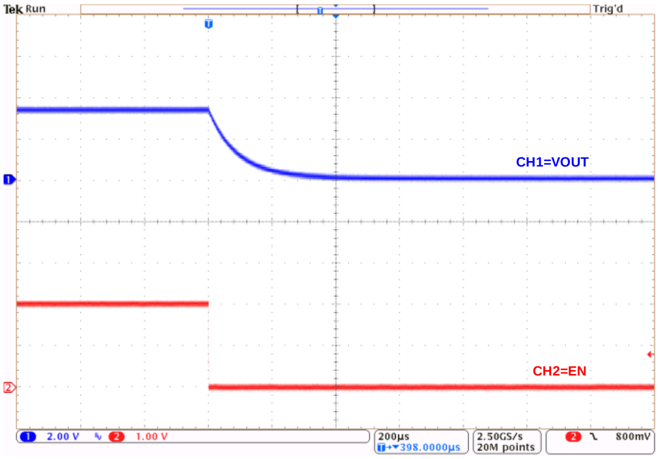
TYPICAL PERFORMANCE CHARACTERISTICS(CONTINUTED)

Test Conditions: $V_{IN}=V_{OUT}+1.0V$, $C_{IN}=4.7\mu F$, $C_{OUT}= 4.7\mu F$, $T_A=25℃$, unless otherwise indicated.



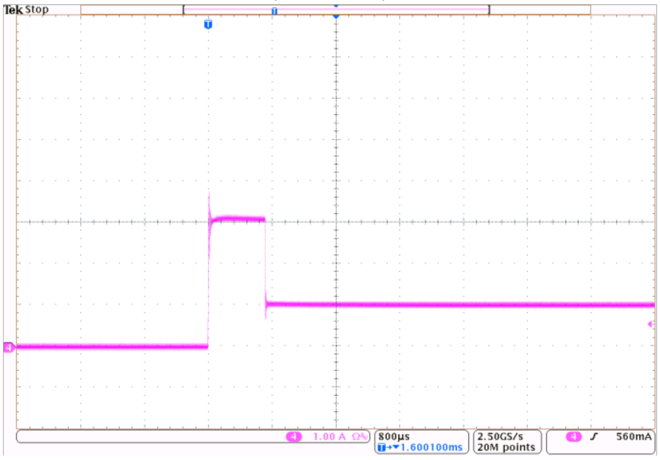
Enable Startup at $V_{OUT}=3.3V$

($I_{OUT}=0mA$)



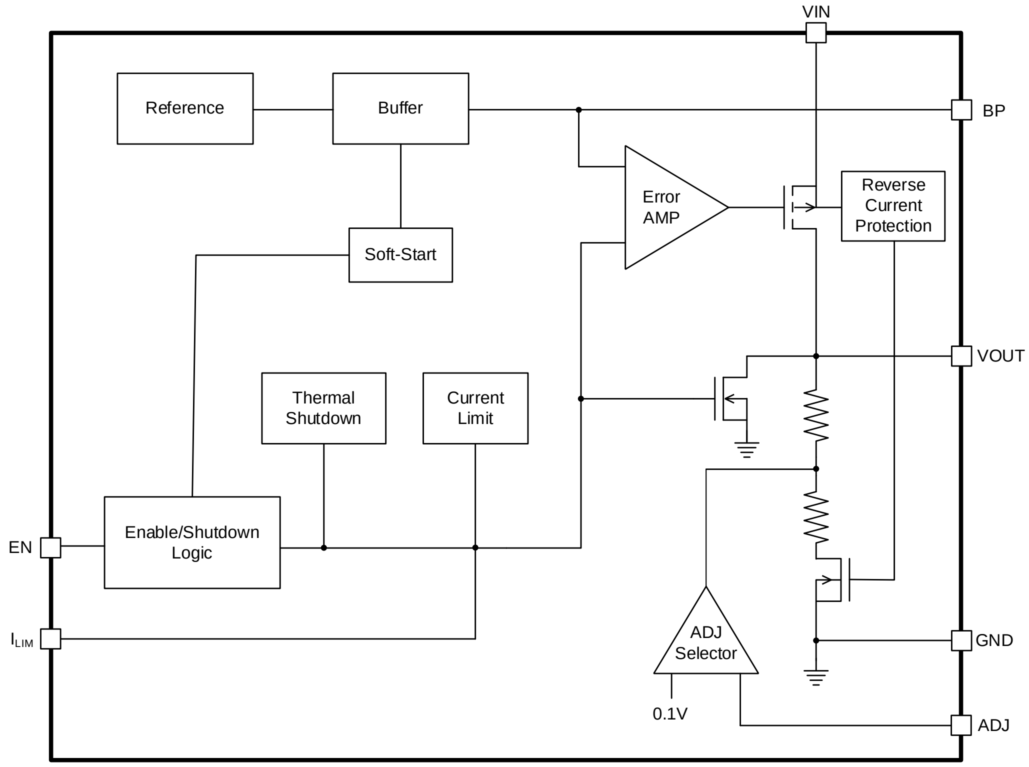
Enable Shutdown at $V_{OUT}=3.3V$

($I_{OUT}=0mA$)



Output Current Fold-back at $V_{OUT}=3.3V$

BLOCK DIAGRAM



THEORY OF OPERATION

The MD7682 is a low-dropout voltage regulator with low quiescent current, low noise and high PSRR. It can support load current up to 2A. It incorporates current-limit and thermal protection features.

SHUTDOWN

By connecting EN pin to GND, the MD7682 can be shutdown to reduce the supply current to 0.01μA (typ.). In this mode, the output voltage of MD7682 is equal to 0V.

CURRENT LIMIT and SHORT CIRCUIT PROTECTION

The MD7682 includes current limit protection feature, which monitors and controls the maximum output current. If the output is overloaded or shorted to ground, this can protect the device from being damaged. When output is shorted to ground, current limit will be adjusted to about 25% of the rated current limit to protect the device.

THERMAL PROTECTION

The MD7682 includes a thermal protection feature that protects the IC by turning off the pass transistor when the maximum junction temperature T_J exceed 160℃.

POWER DISSIPATION

The power dissipation across the device can be calculated as:

$$P_D = I_{OUT} * (V_{IN} - V_{OUT})$$

The total junction temperature is calculated as:

$$T_J = T_A + (P_D * \theta_{JA})$$

where, T_J is the junction temperature, T_A is the ambient temperature and θ_{JA} is the thermal resistance between junction to ambient. There is a temperature rise associated with this power dissipated while operating in a given ambient temperature. If the calculated junction temperature exceeds maximum junction temperature specification, then the built-in thermal protection feature is triggered as described previously. To insure reliable performance, the maximum allowable power dissipation for a given ambient temperature must be considered and it can be calculated as follows:

$$P_{D(MAX)} = (T_{J(MAX)} - T_A)/\theta_{JA}$$

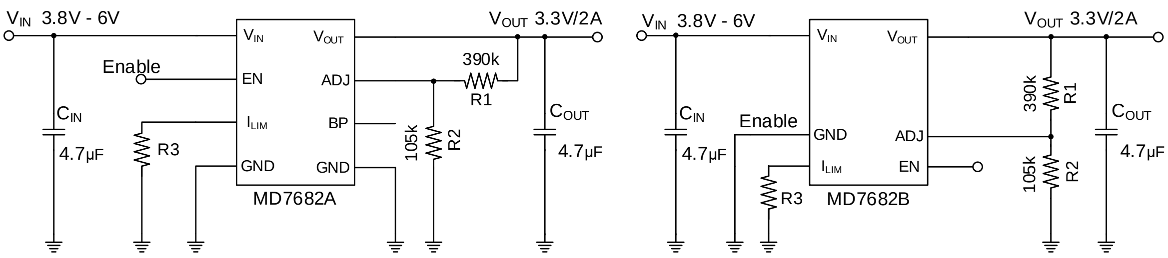
where, $T_{J(MAX)}$ is the maximum junction temperature, T_A is the ambient temperature and θ_{JA} is the thermal resistance between junction to ambient. In order to insure the best thermal flow, proper mounting of the IC is required.

INPUT & OUTPUT CAPACITORS

MD7682 is optimized for use with ceramic capacitors. In order to ensure stability of the device, please place an output ceramic capacitor of 4.7μF or bigger at the V_{OUT} pin and GND pin as close as possible. An input capacitor of 4.7μF is recommended. X5R or X7R ceramic capacitors are recommended as they have the best temperature and voltage characteristics. If the impedance of the power supply is high, which is caused by forgetting installing input capacitor or installing too small value capacitor, the oscillation may occur.

When large output current switching (>500mA) are required in the application, a greater value of Input/Output capacitors (⩾10 μF) would be recommended to ensure the device to operate smoothly.

TYPICAL APPLICATION SCHEMATIC



PROGRAMMING THE OUTPUT VOLTAGE

MD7682's internal feedback resistors set the output voltage V_{OUT} to 5V when the ADJ pin is connected to GND. Alternatively; the output voltage is adjustable via the external feedback resistor network R1 and R2 by calculating the following formula:

$$V_{OUT} = V_{REF} * (1 + \frac{R1}{R2})$$

where, V_{REF} is the reference voltage set internally at 0.7V nominal.

NOISE BYPASS CAPACITOR (For MD7682A)

A 1μF bypass capacitor at BP pin can reduce output voltage noise. This pin can be left floating if it is unnecessary.

CURRENT LIMIT EXTERNAL ADJUSTMENT FUNCTION

By connecting a resistor to the current limit external adjustment pin (I_{LIM}), the current limit can be set to any value. By the following equation, the current limit value can be set to any value within a range of 300mA to 3000mA (TYP.).

$$I_{LIM} = \frac{293.59}{R_{LIM}} + 0.0635$$

Initial value of the current limit is set to 3000mA (TYP.) on IC inside. Please be sure to use the current limit external control terminal (I_{LIM}) are connected by either 0Ω short to GND terminal on the substrate. When the I_{LIM} pin is open, the switch transistor is forcibly turned off.

Table. Current Limit Setting List

$I_{LIM(T)}$ (mA)	$R_{LIM(T)}$ (kΩ)	(E96) Resistor(kΩ)
300	1241.4	1200
400	872.5	866
500	672.6	665
600	547.2	549
700	461.3	464
800	398.6	392
900	351	348
1000	313.5	309
1100	283.3	280
1200	258.3	255
1300	237.4	237
1400	219.7	215
1500	204.4	205
1600	191.1	191

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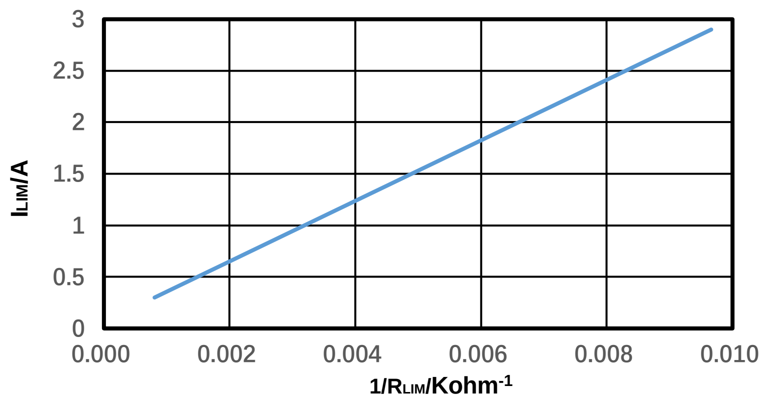
$I_{LIM(T)}$ (mA)	$R_{LIM(T)}$ (kΩ)	(E96) Resistor(kΩ)
1700	179.4	178
1800	169.1	169
1900	159.9	158
2000	151.6	150
2100	144.2	143
2200	137.4	137
2300	131.3	130
2400	125.7	124
2500	120.5	121
2600	115.8	115
2700	111.4	110
2800	107.3	107
2900	103.5	100
3000	I_{LIM} shorted to GND	

MD7682 Current Limit (I_{LIM}) vs External Resistor (R_{LIM})



LAYOUT CONSIDERATION

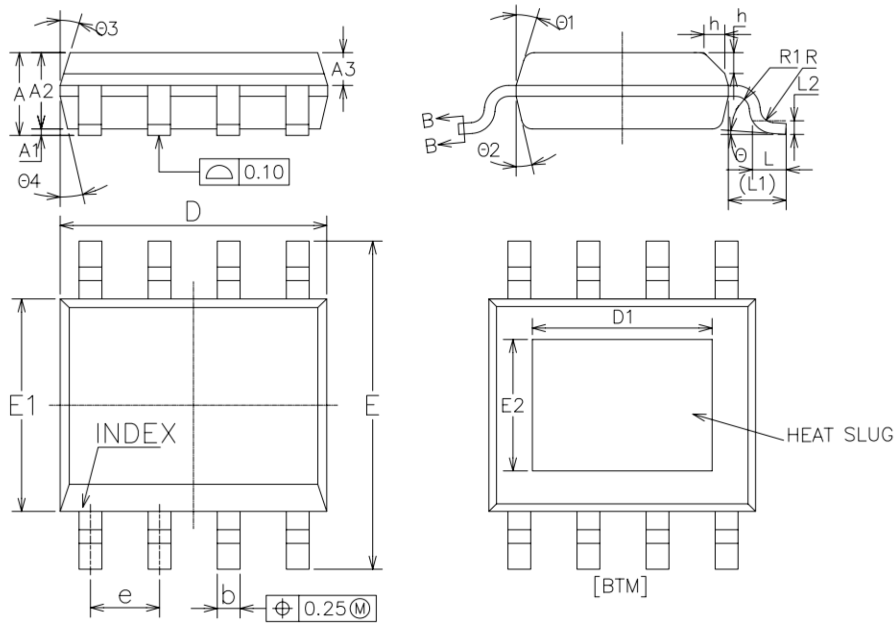
1. Connect the bottom-side pad to a large ground plane for good thermal conductivity and to reduce the thermal resistance of the device.
2. The input Capacitor C_{IN} and output capacitor C_{OUT} must be placed as close as possible to the pins V_{IN} and V_{OUT} respectively.
3. Use short wires to connect the power supply to pins V_{IN} and GND on the board.

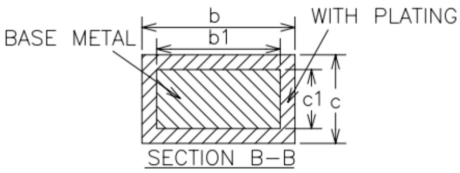
Notes on Use

1. The input capacitor (C_{IN}) and the output capacitor (C_{OUT}) should be placed to the as close as possible with a shorter wiring.
2. If the impedance of the power supply is high, which is caused by forgetting installing input capacitor or installing too small value capacitor, the oscillation may occur.
3. Please pay attention to the operation conditions of input and output voltage and load current, such that the power consumption in the IC should not exceed the allowable power consumption of the package even though the chip has short circuit protection.
4. IC has a built-in anti-static protection (ESD) circuit, but please do not add excessive stress to the IC.

PACKAGING INFORMATION

ESOP8 PACKAGE OUTLINE DIMENSIONS



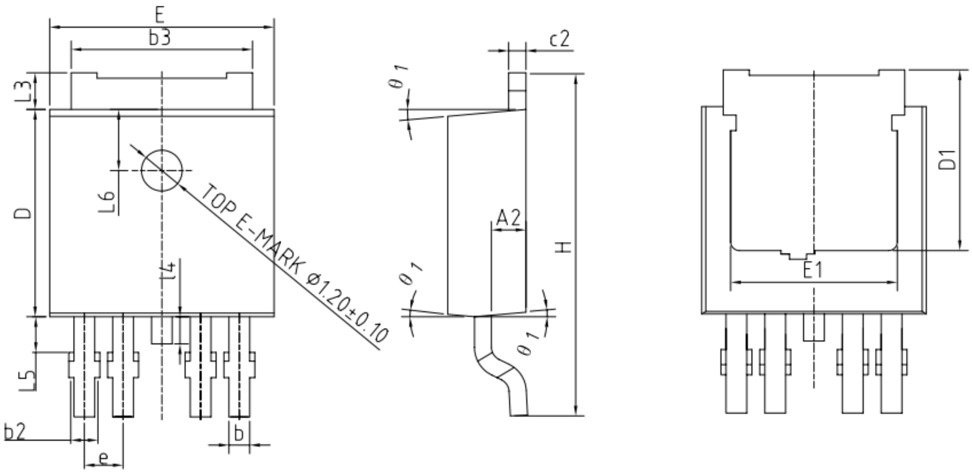


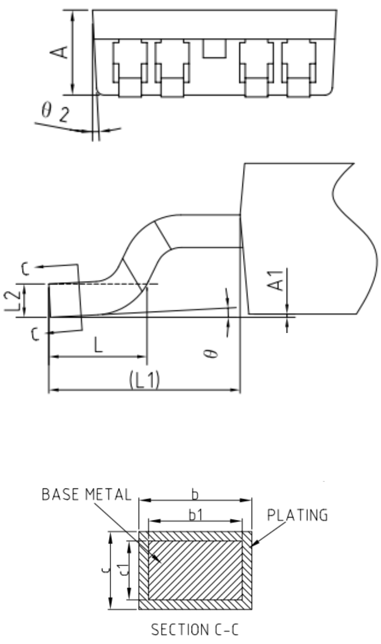
COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL		MIN	NOM	MAX
A		1.35	1.55	1.70
A1		0	0.10	0.15
A2		1.25	1.40	1.65
A3		0.50	0.60	0.70
b		0.38	–	0.51
b1		0.37	0.42	0.47
c		0.17	–	0.25
c1		0.17	0.20	0.23
D		4.80	4.90	5.00
D1	Option 1	3.10	3.30	3.50
	Option 2	2.09	2.29	2.49
E		5.80	6.00	6.20
E1		3.80	3.90	4.00
E2	Option 1	2.20	2.40	2.60
	Option 2	2.09	2.29	2.49
e		1.17	1.27	1.37
L		0.45	0.60	0.80
L1			1.04REF	
L2			0.25BSC	
R		0.07	–	–
R1		0.07	–	–
h		0.30	0.40	0.50
Θ		0°	–	8°
Θ1		15°	17°	19°
Θ2		11°	13°	15°
Θ3		15°	17°	19°
Θ4		11°	13°	15°

PACKAGING INFORMATION(CONTINUTED)

TO252-4L PACKAGE OUTLINE DIMENSIONS





COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	2.20	2.30	2.38
A1	0	–	0.10
A2	0.90	1.00	1.10
b	0.57	–	0.70
b1	0.56	0.61	0.66
b2	0.57	–	0.86
b3	5.23	5.33	5.44
c	0.50	–	0.56
c1	0.50	0.51	0.52
c2	0.50	–	0.56
D	6.00	6.10	6.20
D1	5.00	–	–
E	6.50	6.60	6.70
E1	4.70	–	–
e		1.14BSC	
H	9.80	10.10	10.40
L	1.40	1.50	1.70
L1		2.90REF	
L2		0.51BSC	
L3	0.90	–	1.25
L4	0.60	0.80	1.00
L5	0.90	–	1.50
L6		1.80REF	
θ	0°	–	8°
θ1	3°	5°	7°
θ2	1°	3°	5°