Ultra-Low R_{ON} with Slew Rate Controlled Load Switch

General Description

The ET3562 is a small, ultra-low R_{ON} load switch with controlled turn on. The device contains a low R_{ON} N-Channel MOSFET that can operate over an input voltage range of 1.0 V to 5.5 V and switch currents of up to 3A. An integrated charge pump biases the NMOS switch in order to achieve a low switch ON-Resistance.

The switch is controlled by an on/off input (ON), which is capable of interfacing directly with low-voltage GPIO control signals. An internal reverse voltage comparator disables the power-switch when the output voltage (V_{OUT}) is driven higher than the input voltage (V_{IN}) by V_{RCP}, to quickly stop the flow of current towards the input side of the switch. Reverse current protection is always active, even when the power-switch is disable.

The ET3562 contains a 300Ω on-chip load resistor for quick output discharge when the device is turn off.

The ET3562 is available in a small, space-saving WLCSP4 package and is characterized for operation over the free air temperature range of -40°C to 85°C.

Features

- Input Voltage Range: 1.0V to 5.5V
- Ultra-Low On-Resistance
  - -- R_{ON} = 35mΩ @ V_{IN} = 5.5V
  - -- R_{ON} = 36mΩ @ V_{IN} = 3.3V
  - -- R_{ON} = 37mΩ @ V_{IN} = 1.8V
  - -- R_{ON} = 49mΩ @ V_{IN} = 1.0V
- 3A Maximum Continuous Switch Current
- Low Threshold 1.2V GPIO Control Input
- Controlled Slew Rate to Avoid Inrush Current
- ESD Protected: 4kV HBM, 2kV CDM
- Part No. and Package

Part No.	Package	MSL
ET3562	WLCSP4(0.86mm*0.86mm*0.5mm)	Level 1

Applications

- Smartphone
- Notebook Computer and Ultra-book
- Tablet PC Computer
- Solid State Drive (SSD)
- DTV/IP Set Top Box
- POS Terminal and Media Gateway

Pin Configuration

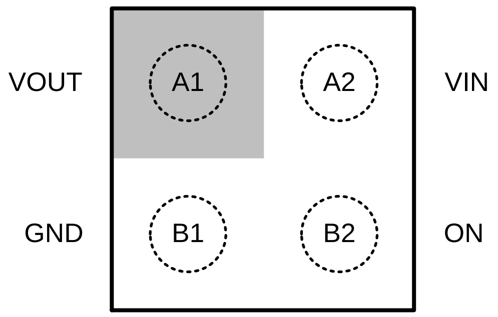


Fig 1. Top View

Pin Function

Pin	Name	Description
A1	VOUT	Switch Output
A2	VIN	Supply Input: Input to the Power Switch
B1	GND	Ground
B2	ON	ON/OFF Control, Active HIGH Compatible

Block Diagram

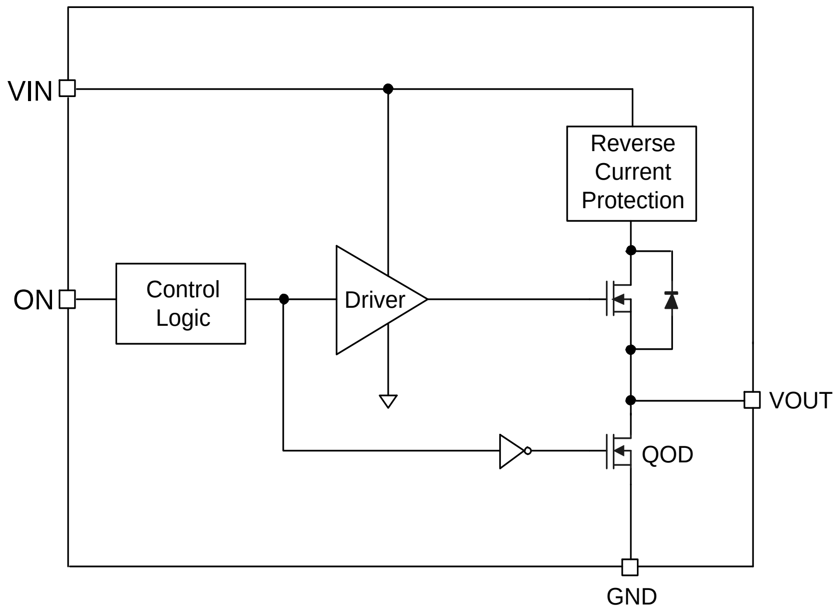


Fig 2. Block Diagram

Functional Description

ON/OFF Control

The ON pin controls the switch. The ON pin is compatible with standard GPIO logic threshold. It can be used with any micro-controller with 1.2V,1.8V,2.5V,3.3V or 5.5V GPIO.

Table 1. Function Table

ON pin state	V_{IN} to V_{OUT}
L	Off
H	On

Reverse Current Protection

The device monitor V_{IN} and V_{OUT} voltage levels. When the reverse current voltage threshold (VRCP) is exceeded, the switch is disabled, so as to prevent any reverse current flow to V_{IN}. This feature is particularly useful when the outputs of ET3562 need to be driven by another voltage source.

Application Information

Input Capacitor

It is recommended to place a capacitor (C_{IN}) between VIN and GND pins of ET3562. This capacitor helps to limit the voltage drop on the input voltage supply when the switch turns ON into a discharged load capacitor. A 1µF ceramic capacitor that is placed close to the IC pins is usually sufficient. Higher values of C_{IN} can be used to further reduce the voltage drop in high current applications.

Output Capacitor

It is recommended to place a capacitor (C_{OUT}) between VOUT and GND pins of ET3562. This capacitor acts as a low pass filter along with the switch ON-resistance to remove any voltage glitches coming from the input voltage source. It is generally recommended to have C_{IN} greater than C_{OUT} so that once the switch is turned ON, C_{OUT} can charge up to V_{IN} without V_{IN} dropping significantly. A 0.1µF ceramic capacitor that is placed close to the IC pins is usually sufficient.

Standby Power Reduction

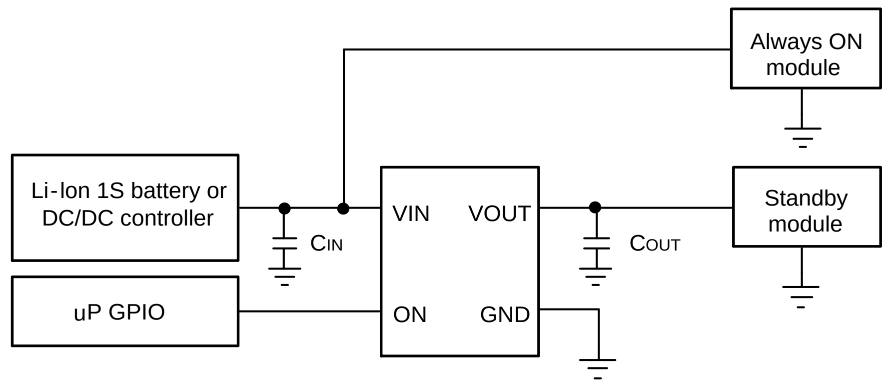


Fig3. Typical Application

Any end equipment that is being powered from the battery has a need to reduce current consumption in order to keep the battery charged for a longer time. ET3562 helps to accomplish this by turning off the supply to the modules that are in standby state and hence significantly reduces the leakage current overhead of the standby modules, shows in Fig3.

Power Supply Sequencing Without a GPIO Input

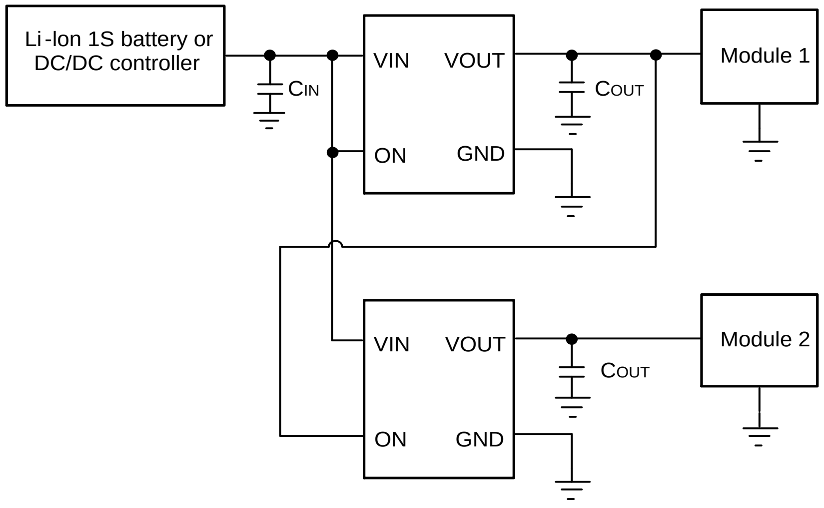


Fig 4. Power Supply Sequencing Without a GPIO Input

In many end equipments, there is a need to power up various modules in a predetermined manner. ET3562 can solve the problem of power sequencing without adding any complexity to the overall system. Fig4 shows the configuration required for powering up two modules in a fixed sequence. The output of the first load switch is tied to the enable of the second load switch, so when Module 1 is powered the second load switch is enabled and Module 2 is powered.

Typical Application

ET3562 is an ultra-low ON-resistance, 3A integrated load switch that is capable of interfacing directly with 1S battery in portable consumer devices such as smartphones, tablets etc. Its wide input voltage range (1.0V to 5.5V) makes it suitable to be used for lower voltage rails as well inside different end equipments to accomplish power sequencing, inrush current control and reducing leakage current in subsystems that are in standby mode.

Fig5 shows the typical application circuit of ET3562.

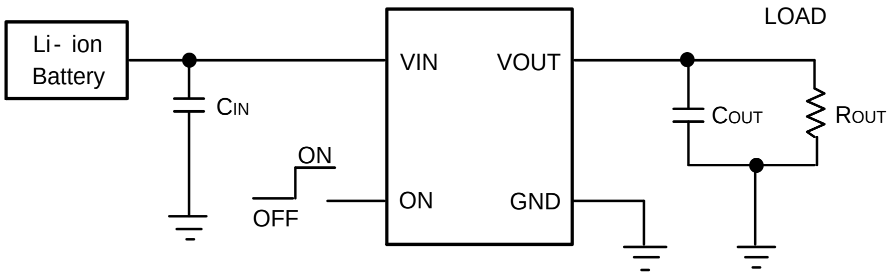


Fig 5. Typical Application Circuit

Detailed Design Procedure

Power Supply Recommendations

The device is designed to operate with a V_{IN} range of 1.0V to 5.5 V. This supply must be well regulated and placed as close to the device terminal as possible with the recommended 1μF bypass capacitor.

If the supply is located more than a few inches from the device terminals, additional bulk capacitance may be required in addition to the ceramic bypass capacitors. If additional bulk capacitance is required, an electrolytic, tantalum, or ceramic capacitor of 10μF may be sufficient.

Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted)

Symbol	Parameter	Rating	Unit
V_{IN}	Input voltage range	-0.3 to 6.0	V
V_{OUT}	Output voltage range	-0.3 to 6.0	V
V_{ON}	ON pin voltage range	-0.3 to 6.0	V
I_{MAX}	Maximum continuous switch current	3	A
T_{J_MAX}	Maximum junction temperature	150	°C
T_{STG}	Storage temperature range	-65 to 150	°C
V_{ESD}	Human-body model (HBM)	±4000	V
	Charged-device model (CDM)	±2000	V

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{IN}	Input voltage range	1.0	5.5	V
V_{OUT}	Output voltage range	0	5.5	V
V_{ON}	ON pin voltage range		V_{IN}	V
T_A	Operating free air temperature range	-40	85	°C
C_{IN}	Input capacitor	1 (1)		uF

Note1: Refer to the application section

Electrical Characteristics

(Unless otherwise noted, V_{IN}=1.0 to 5.5V, T_A=-40 to +85°C; typical values are at T_A=25°C)

Symbol	Parameter	Conditions	T_A = -40°C to 85°C			Unit
			Min	Typ	Max	
V_{IN}	Input Voltage Range		1.0[(2)]		5.5	V
I_{IN}	Quiescent Current	I_{OUT} = 0mA, V_{ON}=V_{IN} = 5.5V		0.47	5.0	uA
		I_{OUT} = 0mA, V_{ON}=V_{IN} = 3.3V		0.33	5.0	
		I_{OUT} = 0mA, V_{ON}=V_{IN} = 1.8V		0.27	5.0	
		I_{OUT} = 0mA, V_{ON}=V_{IN} = 1.0V		0.17	5.0	
I_{IN_OFF}	Off supply Current	R_L = 1MΩ, V_{IN} = 5.5V, V_{ON} = 0V		0.14	3.0	uA
		R_L = 1MΩ, V_{IN} = 3.3V, V_{ON} = 0V		0.08	3.0	
		R_L = 1MΩ, V_{IN} = 1.8V, V_{ON} = 0V		0.05	3.0	
		R_L = 1MΩ, V_{IN} = 1.0V, V_{ON} = 0V		0.02	3.0	
$I_{IN(Leakage)}$	Leakage Current	V_{OUT}=0V, V_{IN} = 5.5V, V_{ON} = 0V		0.14	3.0	uA
		V_{OUT}=0V, V_{IN} = 3.3V, V_{ON} = 0V		0.08	3.0	
		V_{OUT}=0V, V_{IN} = 1.8V, V_{ON} = 0V		0.05	3.0	
		V_{OUT}=0V, V_{IN} = 1.0V, V_{ON} = 0V		0.02	3.0	
R_{ON}	On-Resistance	V_{IN} = 5.5V, I_{OUT} = -200mA		35	62	mΩ
		V_{IN} = 3.3V, I_{OUT} = -200mA		36	65	
		V_{IN} = 1.8V, I_{OUT} = -200mA		37	65	
		V_{IN} = 1.0V, I_{OUT} = -200mA		49	80	
R_{PD}	Output Pull Down Resistance	V_{IN} = 3.3V, V_{ON}= 0V, V_{OUT}= 1.0V		300	500	Ω
I_{ON}	ON Pin Leakage Current	V_{IN} = V_{ON} = 1.0V to 5.5V		2	150	nA
V_{RCP}	Reverse Current Voltage Threshold	V_{IN} = 1.0V to 5.5V		65	100	mV
$I_{RCP(leak)}$	Reverse Current Protection Leakage After Reverse Current Event	V_{OUT} - V_{IN}>V_{RCP}		0.04	3	uA
V_{IH}	High-level input voltage, ON	V_{IN} = 1.0V to 5.5V	0.9			V
V_{IL}	Low-level input voltage, ON	V_{IN} = 1.0V to 5.5V			0.4	V

Note2: When V_{IN} <1.5V,we suppose to set V_{ON} ≥1.5V,which can reduce R_{ON}.

Switching Characteristics

Symbol	Parameter	Conditions	T_A = -40°C to 85°C			Unit
			Min	Typ	Max	
V_{IN}=5.0V,T_A = +25°C, unless otherwise noted.						
t_{ON}	Turn-On time	R_L=10Ω,C_L=0.1uF	800	1400	1900	us
t_{OFF}	Turn-Off time	R_L=10Ω,C_L=0.1uF	3	10	20	
t_R	V_{OUT} rise time	R_L=10Ω,C_L=0.1uF	500	900	1350	
t_F	V_{OUT} fall time	R_L=10Ω,C_L=0.1uF	0.5	2.1	10	
V_{IN}=3.3V,T_A = +25°C, unless otherwise noted.						
t_{ON}	Turn-On time	R_L=10Ω,C_L=0.1uF	650	1200	1700	us
t_{OFF}	Turn-Off time	R_L=10Ω,C_L=0.1uF	3	10	20	
t_R	V_{OUT} rise time	R_L=10Ω,C_L=0.1uF	400	800	1200	
t_F	V_{OUT} fall time	R_L=10Ω,C_L=0.1uF	0.5	2.1	10	
V_{IN}=1.5V,T_A = +25°C, unless otherwise noted.						
t_{ON}	Turn-On time	R_L=10Ω,C_L=0.1uF	500	1000	1500	us
t_{OFF}	Turn-Off time	R_L=10Ω,C_L=0.1uF	3	8	20	
t_R	V_{OUT} rise time	R_L=10Ω,C_L=0.1uF	400	800	1500	
t_F	V_{OUT} fall time	R_L=10Ω,C_L=0.1uF	0.5	2.1	10	

Switching Waveform

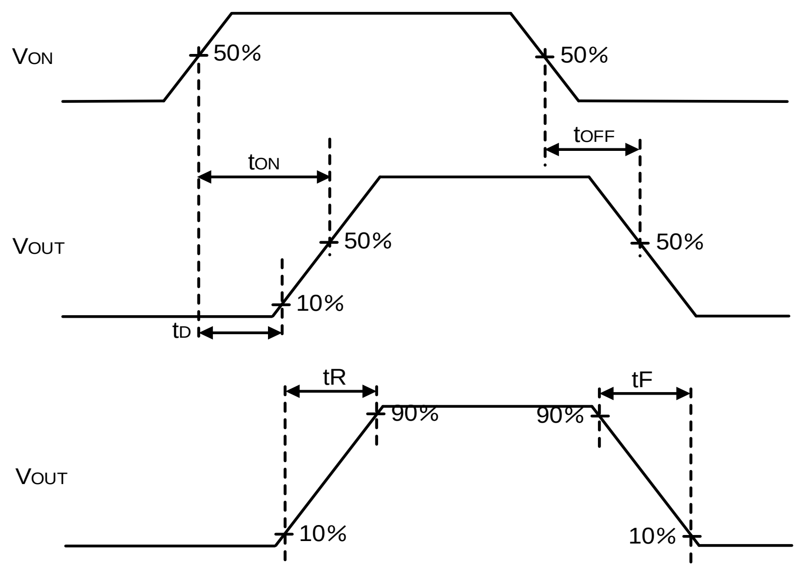
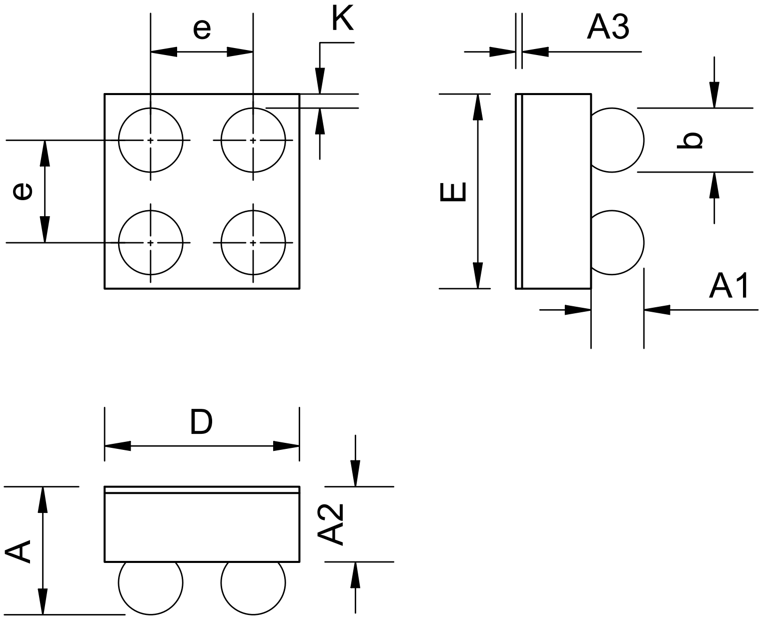


Fig 6. Timing Diagram

Package Dimension

WLCSP4

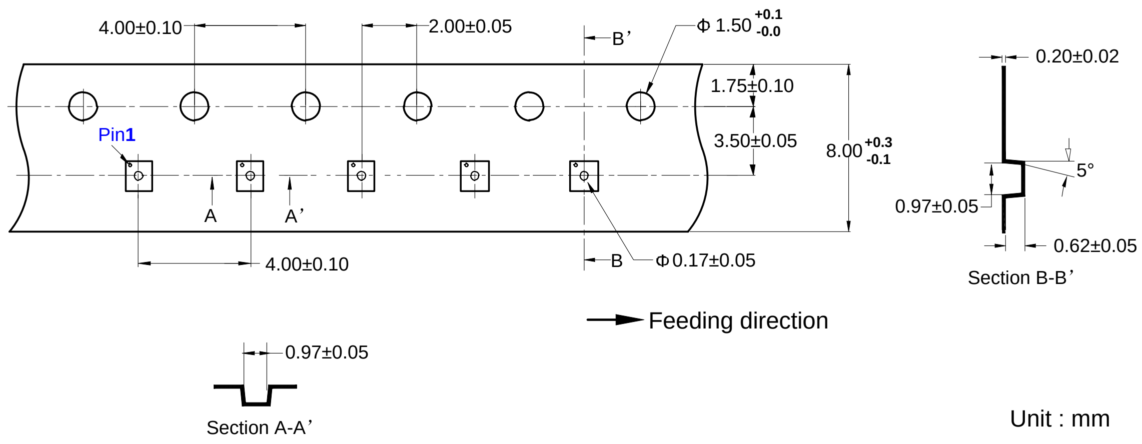


COMMON DIMENSIONS

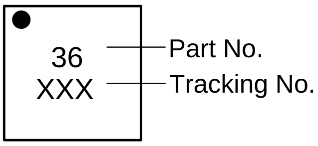
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	0.447	0.500	0.553
A1	0.175	0.200	0.225
A2	0.250	0.275	0.300
A3	0.022	0.025	0.028
b	0.240	0.265	0.290
D	0.830	0.860	0.890
E	0.830	0.860	0.890
e	0.500BSC		
K	0.0475REF		

Tape



Marking



Revision History and Checking Table

Version	Date	Revision Item	Modifier	Function & Spec Checking	Package & Tape Checking
0.0	2023-11-14	Initial Version	Tugz	Luh	Liujy
0.1	2024-01-24	Update EC Table	Tugz	Luh	Liujy
1.0	2024-03-27	Official Version Change V_{IN} 1.2V to 1.0V	Tugz	Luh	Liujy