

## 24V, 3A, High Efficiency Synchronous Step-Down Converter in SOT563

### DESCRIPTION

ETA1653 is a wide input range, high-efficiency and high frequency DC-to-DC step-down switching regulator, capable of delivering up to 3A 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, ETA1653 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. An OVP function protects the IC itself and its downstream system against input voltage surges. With this OVP function, the IC can stand off input voltage as high as 24V, making it an ideal solution for industrial applications such as LCD TV, Set Top Box, Portable TV, etc. ETA1653 is available in SOT563 package.

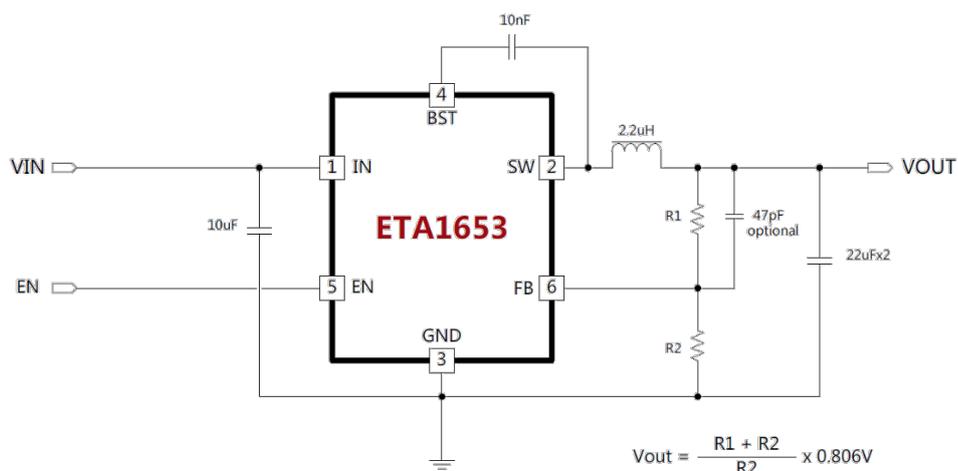
### FEATURES

- ◆ Wide Input Range: 4.5V-17V
- ◆ 24V Standoff Input Voltage
- ◆ 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 3A
- ◆ No External Compensation Needed
- ◆ Thermal Shutdown and UVLO
- ◆ Available in SOT563 Package

### APPLICATIONS

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

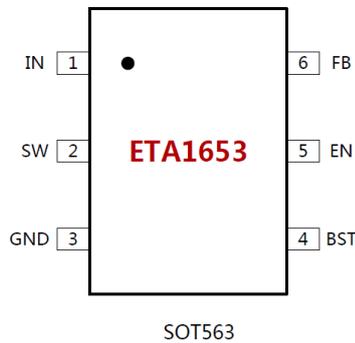
### TYPICAL APPLICATION



### ORDERING INFORMATION

PART No.	PACKAGE	TOP MARK	Pcs/Reel
ETA1653FSG	SOT563	DTYW	5000

## 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, SW, EN Voltage.....	-0.3V to 25V
BST Voltage .....	-0.3V to SW+6V
FB Voltage .....	-0.3V to 6V
Operating Temperature Range .....	-40°C to 85°C
Storage Temperature Range .....	-55°C to 150°C
Thermal Resistance	$\theta_{JA}$ $\theta_{JC}$
SOT563.....	110.....50..... °C/W
Lead Temperature (Soldering 10sec) .....	260°C
ESD HBM (Human Body Mode) .....	2KV
ESD CDM (Charged Device Mode) .....	1KV

## 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		17	V
Input UVLO	Rising, Hysteresis=450mV		4.05		V
Input OVP	Rising, Hysteresis=0.9V		18.4		V
Input Supply Current	$V_{FB}=0.85V$ , no switching		177		$\mu A$
Input Shutdown Current			7	14	$\mu A$
FB Voltage		0.794	0.806	0.818	V
FB Input Current			0	1	$\mu A$
Switching Frequency			700		kHz
Maximum Duty Cycle			87		%
Short Circuit Hiccup Time	On Time		1.4		mS
	Off Time		4.2		mS
FB Hiccup Threshold			0.6		V
High Side Switch On Resistance			85		m $\Omega$
Low Side Switch On Resistance			38		m $\Omega$
High Side Current Limit			4.5		A
SW Leakage Current	$IN=SW=12V$			10	$\mu A$
EN Rising Threshold	Rising,	1	1.2	1.4	V
EN Falling Threshold	Falling	0.9	1.1	1.3	V
EN Input Current	$V_{EN}=2V$		2	6	$\mu A$
Thermal Shutdown	Rising, Hysteresis =36°C		150		°C

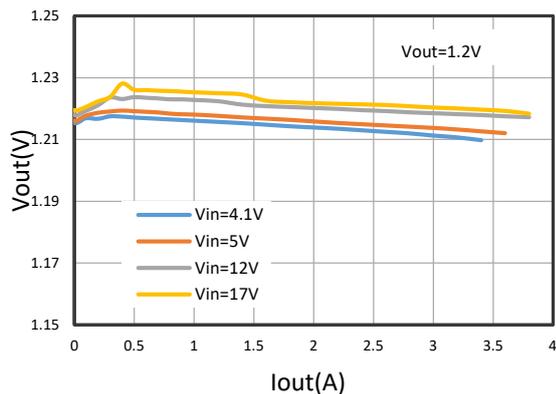
## PIN DESCRIPTION

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

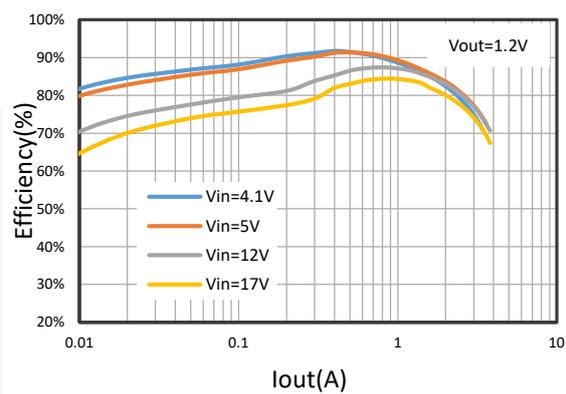
## TYPICAL CHARACTERISTICS

(Typical values are at  $T_A = 25^\circ\text{C}$  unless otherwise specified.)

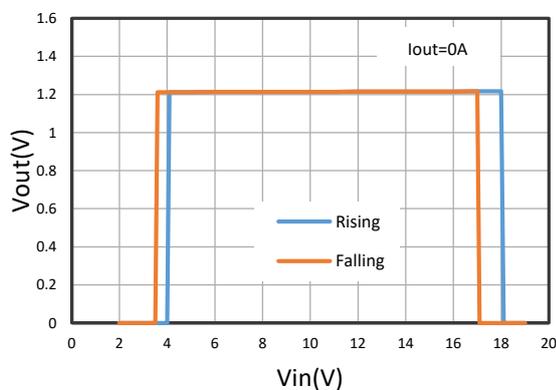
**Vout Vs. Iout**



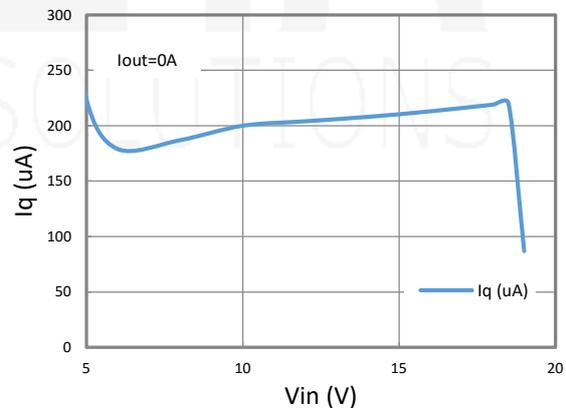
**Eff Vs. Iout**



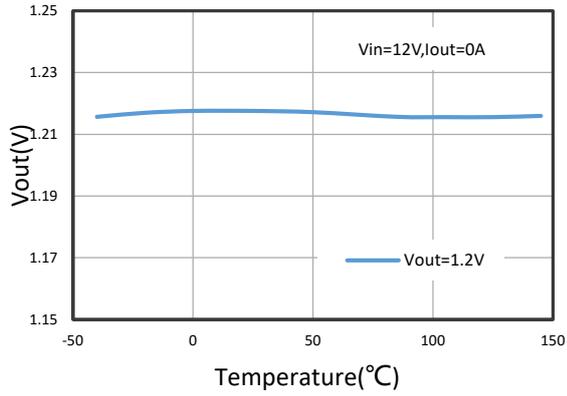
**UVLO&OVP**



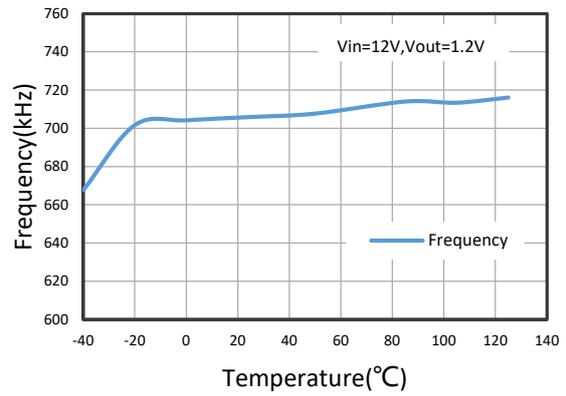
**Iq Vs. Vin**



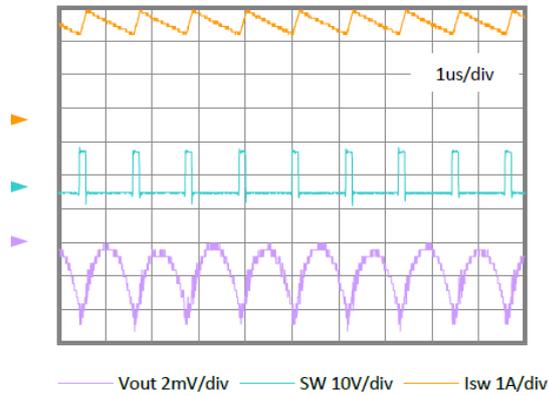
**Vout Vs. Temp**



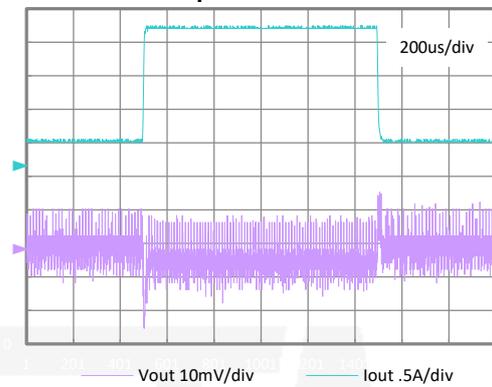
**Freq Vs. Temp**



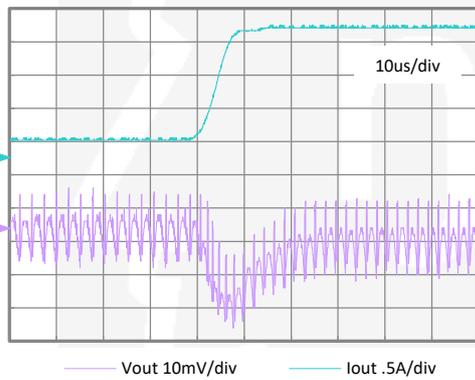
**Waveform Iout 3A**



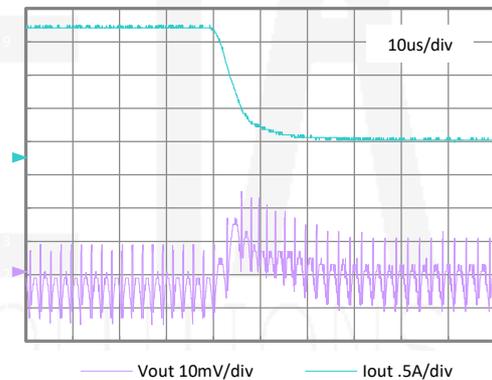
**1.2V Load Step 0.3A-2A-0.3A Vin=12V**



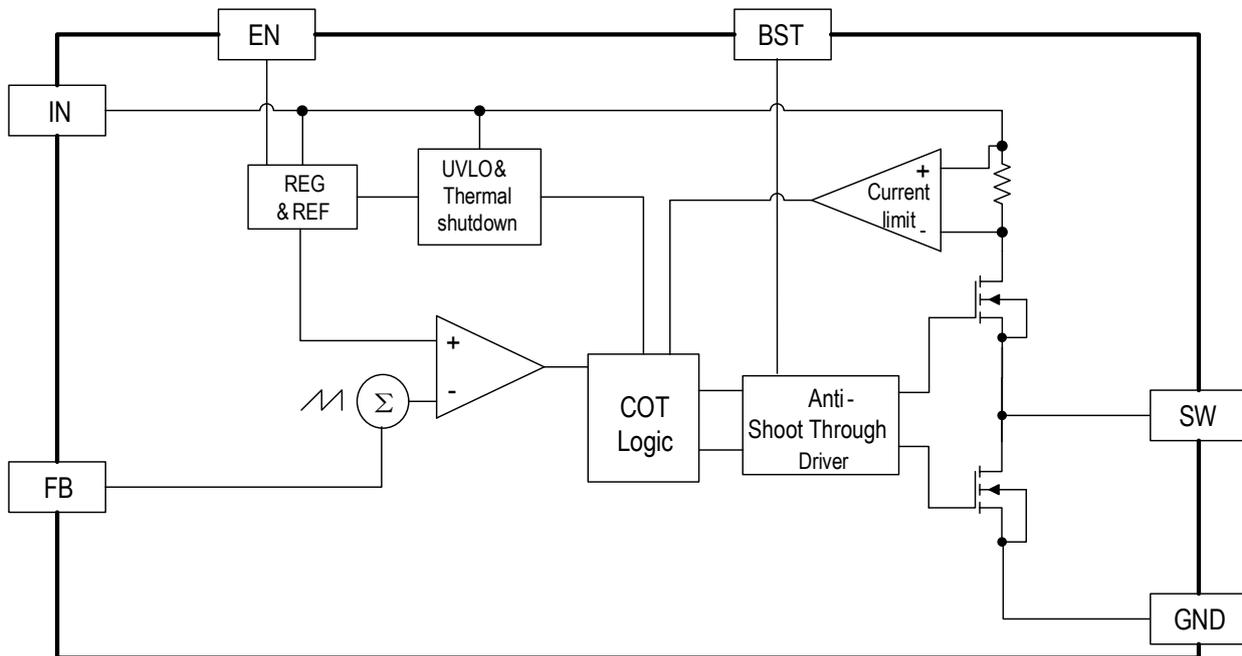
**1.2V Load Step rising 0.3A-2A Vin=12V**



**1.2V Load Step falling 2A-0.3A Vin=12V**



## FUNCTIONAL BLOCK DIAGRAM



## FUNCTIONAL DESCRIPTION

The ETA1653 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.

ETA1653 is a wide input range, high-efficiency and high frequency DC-to-DC step-down switching regulator, capable of delivering up to 3A 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. ETA1653 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 ETA1653 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*

ETA1653 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 (0.6V), the ETA1653

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 150°C, allowing the device to cool down. When the junction temperature cools to approximately 110°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 ETA1653 regulator is programmed using an external resistor divider. The output voltage is calculated using below equation.

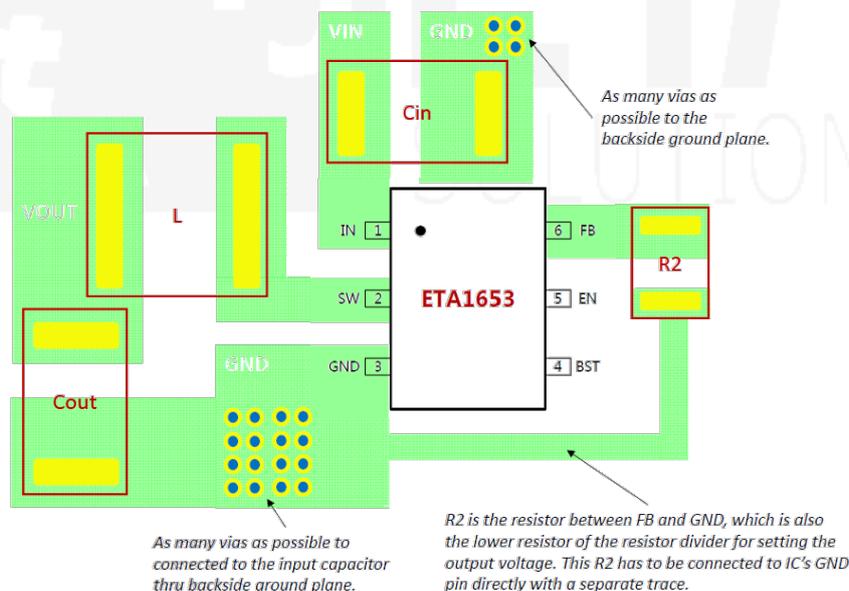
$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_1}{R_2}\right)$$

Where: VREF =0.806V typically (the internal reference voltage)

Resistors R2 has to be between 1kOhm to 20kOhm and thus R1 is calculated by following equation.

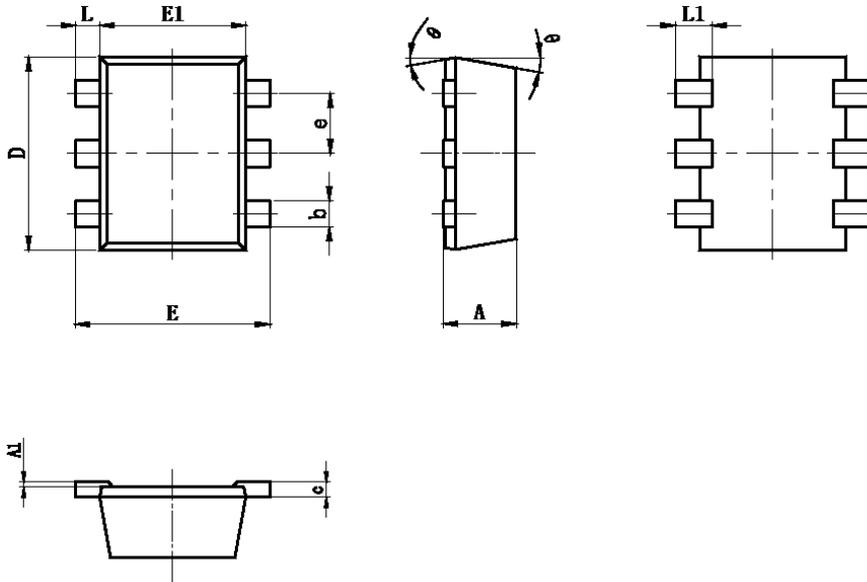
$$R_1 = \left(\frac{V_{OUT}}{V_{REF}} - 1\right) \times R_2$$

## PCB LAYOUT GUIDE



PACKAGE OUTLINE

Package: SOT563



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.525	0.600	0.021	0.024
A1	0.000	0.050	0.000	0.002
e	0.450	0.550	0.018	0.022
c	0.090	0.180	0.004	0.007
D	1.500	1.700	0.059	0.067
b	0.170	0.270	0.007	0.011
E1	1.100	1.300	0.043	0.051
E	1.500	1.700	0.059	0.067
L	0.100	0.300	0.004	0.012
L1	0.200	0.400	0.008	0.016
θ	9° REF.		9° REF.	