Features

- 2.5V to 5.5V Input Voltage Range
- Fixed 1MHz Switching Frequency
- Current-Mode Boost Regulator
- Integrated 22V/1.4A 500mΩ FET
- Internal Soft Start
- High Efficiency
- Minimal External Components
- Feedback Voltage 1.23V
- Over Voltage Protection
- RoHS Compliant
- Low Profile TSOT23-5 Packages

Applications

- TFT LCD Panel Backlights
- Tablet PCs
- Digital Cameras
- GPS Receivers
- PDAs, Handheld Computers
- Cellular Phones

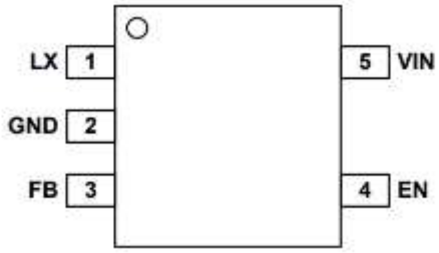
Descriptions

The EC6705 is a high perfomance step-up converter that operates at a fixed switching frequency 1MHz. The high switching frequency allows the use of small inductors and fast transient response. The integrated N-channel FET has a typical current limit of 1.4A and can support output voltages up to 22V. The feedback voltage is 1.23V.

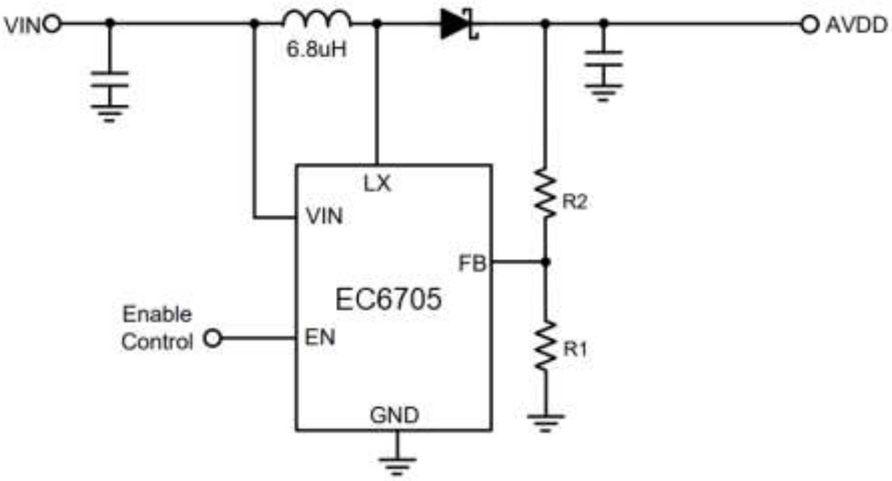
To minimize the inrush current a built-in soft start circuit is contained. To minimize the external component count EC6705 also provides the internal compensation. The loop response is optimized for fast transient panel loading. The EC6705 is available in a thin TSOT23-5 green package.

TSOT23-5 Pin Configuration

(Top View)



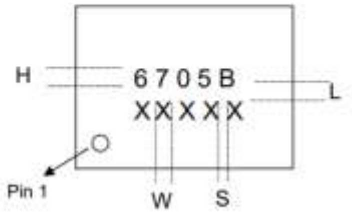
Typical Application Diagram



Ordering Information

Part Number	Package
EC6705T2R	TSOT23-5

Marking Spec

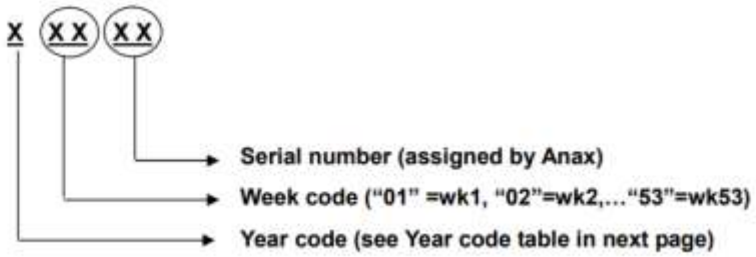


6705B: Product code
XXXXX: Date code

Package	W	S	H	L	Remark
TSOT-23-5	0.25	0.1	0.5	0.2	Tolerance: ± 20% or 0.2mm

W: Character's Width
S: Character's Spacing
H: Character's Height
L: Row Spacing

Note:
Date code: XXXXX (assigned by Anax)



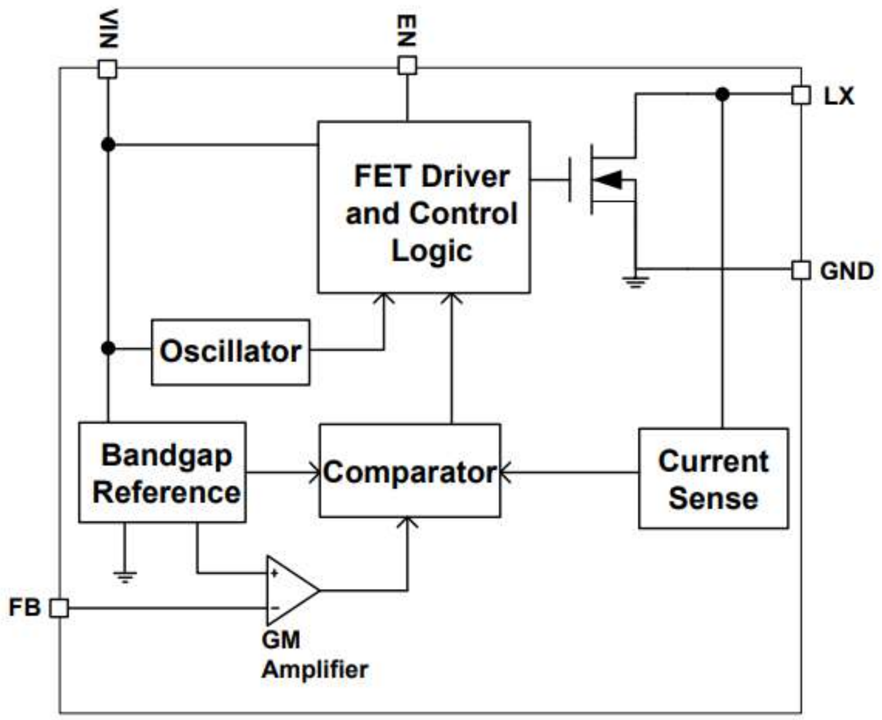
Year		Year Code
2009	2024	A
2010	2025	B
2011	2026	C
2012	2027	D
2013	2028	E
2014	2029	F
2015	2030	G
2016	2031	H
2017	2032	J
2018	2033	K
2019	2034	L
2020	2035	M
2021	2036	N
2022	2037	P
2023	2038	Q

P.S. The Year code will be rolling again by 15 years cycle.

Pin Description

Number	Name	Pin Description
1	LX	Boost converter switching node. (Drain of the internal NMOS switch)
2	GND	Ground Pin.
3	FB	Feedback pin.
4	EN	Enable pin.
5	VIN	Input voltage supply pin. Must be locally bypassed.

Block Diagram



Absolute Maximum Ratings

Input Supply Voltage, VIN	-0.3V to 6V
Voltages on LX	-0.3V to 27V
Voltages on FB	-0.3V to 6V
Voltages on EN	-0.3V to 6V
Storage temperature range	-65°C to 150°C
Lead temperature (soldering, 10s maximum)	260°C
ESD, Human body mode	2kV
ESD, Machine mode	200V

Note1: All voltages are referenced to ground with GND pin grounded.

Note2: "ABSOLUTE MAXIMUM RATINGS" indicate limits beyond which permanent damage to the device may occur. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. For guaranteed specifications and test conditions, see the "ELECTRICAL SPECIFICATIONS".

Recommended Operation Conditions

Junction temperature range	-40°C to 125°C
Ambient temperature range	-40°C to 85°C

Power Dissipation Ratings

Package	Thermal Resistance, Θ_{JA}	Power Rating (T_A < 25 °C)	Power Rating (25 < T_A < 85 °C)	Power Rating (T_A = 85°C)
TSOT23-5	250°C /W	400mW	(125 - T_A) / 250 W	160mW

Electrical Specifications

(V_{IN}= V_{EN} = 3.3V, T_A = +25℃, unless otherwise noted.)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Operating Input Voltage	V_{IN}		2.5		5.5	V
Shutdown Current	I_{SD}	V_{EN}=0V		1	4	μA
Operation Current	I_Q	V_{FB}=1.1V, switching		1	2	mA
		V_{FB}=1.5V, no switching		400	600	μA
VIN Under Voltage Lockout	V_{UVLO}	V_{IN} Rising		2.2		V
		Hysteresis		100		mV
EN Threshold Voltage	V_{IL}	V_{EN} Falling	0.5			V
	V_{IH}	V_{EN} Rising			1.4	V
EN Sink Current	I_{IH}			1		μA
Switching Frequency	f_{SW}			1		MHz
Maximum Duty Cycle		V_{FB}=0V	90			%
Soft Start Time	T_{SS}			8		ms
Feedback Reference Voltage	V_{FB}		1.21	1.23	1.25	V
FB Input Bias Current	I_{FB}	V_{FB}=0.1V		-300		nA
Line Regulation		VIN=2.5V to 5.5V		1		%
Load Regulation		1mA to 20mA		1		%
LX ON-Resistance	R_{ON}			0.5		Ω
LX Leakage Current	I_{LX_LEAK}	V_{LX}=20V		10		μA
Over Voltage Protection Threshold	V_{OVP}			22		V
Over Current Threshold	I_{OCP}			1.4		A
FB Fault Trip Level (UVP Level)		V_{FB} Falling		0.95		V
FB Fault Delay (UVP Delay)	T_{UVP}			64		ms
Overstress Thermal Shutdown	T_{OTP}			160		℃
		Hysteresis		20		

Application Information

The EC6705 is designed in a current mode, fixed-frequency pulse-width modulation (PWM) boost converter to provide a step-up voltage. The device operates well with a variety of external components.

The Boost Converter

The current-mode boost converter is designed for output voltage up to 22V with a fixed switching frequency 1MHz. During the switch on-period, T_{ON}, the synchronous FET connects one end of the inductor to ground, therefore increasing the inductor current. After the FET turns off, the inductor switching node, LX, is charged to a positive voltage by the inductor current. The freewheeling diode turns on and the inductor current flows to the output capacitor.

The converter operates in the continuous conduction mode (CCM) when the average input current IIN is at least one-half of the inductor peak-to-peak ripple current, ΔI_{LPP}.

$$I_{IN} \geq \frac{\Delta I_{LPP}}{2}$$

$$\Delta I_{LPP} = \frac{(AVDD - V_{IN}) \times V_{IN}}{L \times F_{OSC} \times AVDD}$$

The output voltage, AVDD, is determined by the duty cycle, D, of the power FET on-time and the input voltage, VIN.

$$AVDD = \frac{V_{IN}}{1 - D}$$

The average load current, ILOAD, can be calculated from the power conservation law.

$$\eta \times V_{IN} \times I_{IN} = AVDD \times I_{LOAD}$$

where η is the power conversion efficiency. For a lower load current, the inductor current would decay to zero during the free-wheeling period and the output node would be disconnected from the inductor for the remaining portion of the switching period. The converter would operate in the discontinuous conduction mode (DCM).

Current mode control is well known for its robustness and fast transient response. An inner current feedback loop sets the on-time and the duty cycle such that the current through the inductor equals to the current computed by the compensator. This loop acts within one switching cycle. A slope compensation ramp is added to suppress sub-harmonic oscillations. An outer voltage feedback loop subtracts the voltage on the FB pin from the internal reference voltage and feeds the difference to the compensator operational transconductance (Gm) amplifier. This amplifier is compensated by an internal compensator network which is optimized for the transient response and loop stability of panel loading.

Output Voltage Setting

The output voltage AVDD is specified by the resistive divider connected from the FB pin to ground and the output of the converter, which follows below equation:

$$AVDD = V_{FB} \times (1 + \frac{R2}{R1})$$

Where the V_{FB} = 1.23V

Output Capacitor Selection

The output voltage ripple due to converter switching is determined by the output capacitor total capacitance, C_{OUT}, and the output capacitor total effective series resistance, ESR.

$$AVDD_{RIPPLE} = \frac{D \times I_{LOAD}}{F_{OSC} \times C_{OUT}} + I_{PK} \times ESR$$

$$I_{PK} = I_{IN} + \frac{\Delta I_{LPP}}{2}$$

The first ripple component can be reduced by increasing C_{OUT}. Changing C_{OUT} may require adjustment of compensation R and C in order to provide adequate phase margin and loop bandwidth.

The second ripple component can be reduced by selecting low-ESR ceramic capacitors and using several smaller capacitors in parallel instead of just one large capacitor.

Inductor Selection

To prevent magnetic saturation of the inductor core the inductor has to be rated for a maximum current larger than I_{PK} in a given application. Since the chip provides current limit protection of 1.4A, it is generally recommended that the inductor be rated at least for 1.4A.

Selection of the inductor requires trade-off between the physical size (footprint x height) and its electrical properties (current rating, inductance, resistance). Within a given footprint and height, an inductor with larger inductance typically comes with lower current rating and often larger series resistance. Larger inductance typically requires more turns on the winding, a smaller core gap or a core material with a larger relative permeability. An inductor with a larger physical size has better electrical properties than a smaller inductor.

It is desirable to reduce the ripple current ΔILPP in order to reduce voltage noise on the input and output capacitors. In practice, the inductor is often much larger than the capacitors and it is easier and cheaper to increase the size of the capacitors. The ripple current Δ_{ILPP} is then chosen the largest possible while at the same time not degrading the maximum input and output current that the converter can operate with before reaching the current limit of the chip or the rated current of the inductor.

$$I_{PK} = I_{IN} + \frac{\Delta I_{LPP}}{2} \le I_{MAX}$$

For example, Δ_{ILPP} could be set to 20% of I_{MAX}.

Over Current Protection

The EC6705 has Over-Current Protection (OCP) that limits the peak inductor current in every switching cycle. It prevents current from suddenly increasing to damage the inductor and diode. Once the inductor current exceeds the current limit, the internal switch turns off immediately and shortens the duty cycle. The output voltage drops if the over-current condition occurs. Current limit is affected by the input voltage, duty cycle, and inductor value.

Under Voltage Protection

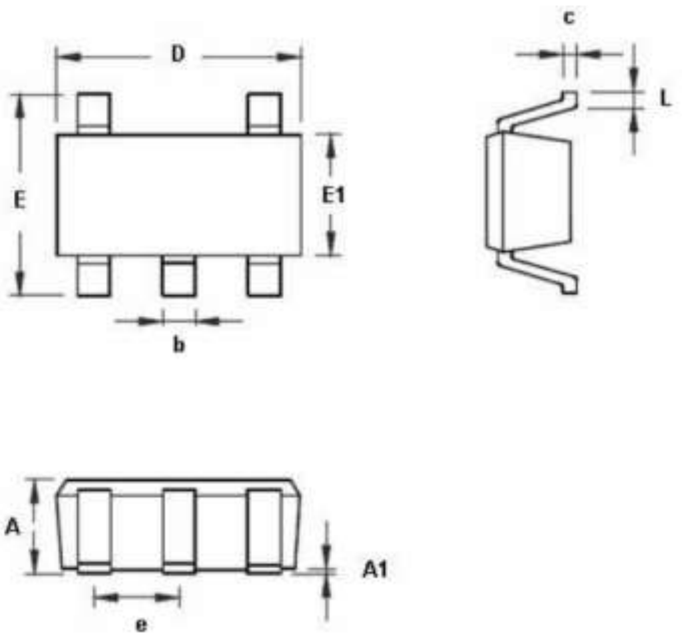
During steady-state operation, if the feedback voltage pin FB is below 0.95V of the nominal value, the EC6705 activates an internal fault timer. If any condition indicates a continuous fault for the fault timer duration (64ms typ), the IC sets the fault latch to shut down its output except the reference. Once the fault condition is removed, cycle the VIN (below the UVLO falling threshold) to clear the fault latch and reactivate the device. The fault-detection circuit is disabled during the soft-start ramp.

Over Temperature Protection

The EC6705 boost converter provides Over Temperature Protection to prevents excessive power dissipation from overheating the IC. When the junction temperature exceeds T_J = 160°C, a thermal sensor activates the fault protection, which shuts down the output. To resume normal function, the temperature must cool down to by 20°C and the IC power cycled.

Package Outline Drawing

(TSOT23- 5L)



DIMENSION	MIN (mm)	MAX (mm)
A	0.700	0.900
A1	0.000	0.100
b	0.300	0.500
c	0.080	0.220
D	2.750	3.050
E1	1.450	1.750
E	2.600	3.000
e	0.950 BSC	
L	0.300	0.600

Notes:
1) All dimensions are in millimeters.