EPSON

SCI7654M0A/C0A

DC/DC Converter

- Double/Triple/Quadruple Boosting
- 95% Excellent Power Conversion Efficiency
- Built-in Voltage Regulator

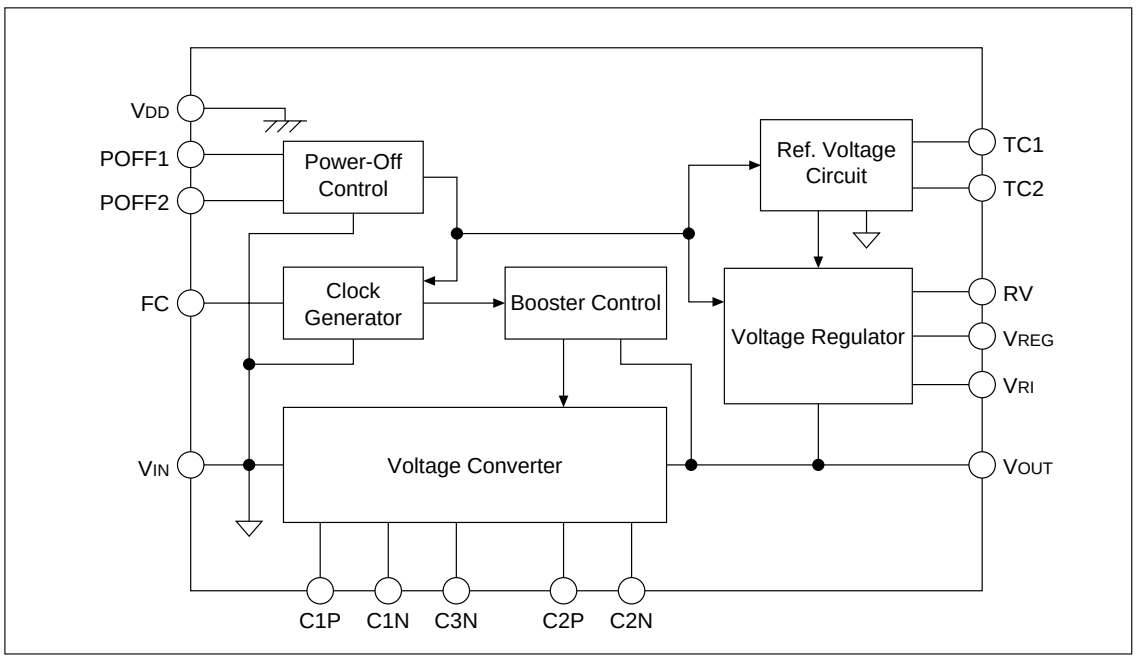
DESCRIPTION

The SCI7654 is a highly efficient, but low power-consumption DC-to-DC converter based on the advanced CMOS technologies. It can generate an output voltage double/triple/quadruple times higher than the input (in negative direction) if 4/3/2 external capacitors are attached.
With a built-in voltage regulator, the SCI7654 can provide a stable output by setting the DC/DC output to any voltage via two external resistors. This is optimum to the LCD panel power supply as the stable output can have the negative temperature gradient required for an LCD panel.

FEATURES

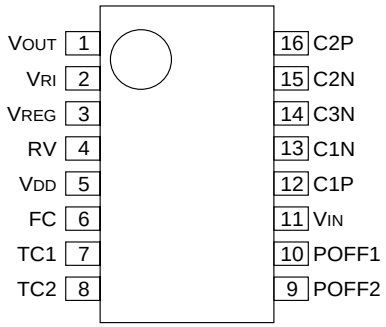
- An input voltage can be boosted double/triple/quadruple to negative potential.
- Input voltages: –2.4 to –5.5V (quadruple boosting), –2.4 to –7.3V (triple boosting), –2.4 to –11.0V (double boosting)
- Excellent vol tage conversion efficiency: 95% (Typ.)
- Large output current: 20 mA (Max.) during quadruple boosting
- Built-in voltage regulator (for stable voltage output)
- Built-in reference voltage source for accurate regulation: –1.5 ±0.05V (CT0)
- Regulator output voltage temperature gradient function: –0.04, –0.15, –0.35, –0.55%/˚C
- Low current consumption: 130 µA (Typ.)
- Low standby current: 5.0 µA (Max.)
- Built-in oscillator circuit
- 5/6-time voltage boosting in negative potential by serial connection
- Package: SCI7654M0A SSOP2-16pin (plastic), SCI7654C0A DIP-16pin (plastic)

BLOCK DIAGRAM



PIN CONFIGURATION

SSOP2-16pin/DIP-16pin



PIN DESCRIPTION

Pin No.	Pin Name	Function
1	VOUT	Voltage output
2	VRI	Regulator input
3	VREG	Regulator output
4	RV	Input for regulator output voltage adjustment
5	VDD	Input voltage pin (Positive)
6	FC	Internal clock rate switch input, and clock input in serial/parallel connection (Common input pin)
7	TC1	Input for regulator output temperature gradient setup (1)
8	TC2	Input for regulator output temperature gradient setup (2)
9	POFF2	Power-off control input (2)
10	POFF1	Power-off control input (1)
11	VIN	Input voltage pin (Negative)
12	C1P	Common double and quadruple boosting capacitor positive pin
13	C1N	Double boosting capacitor negative pin
14	C3N	Quadruple boosting capacitor negative pin
15	C2N	Triple boosting capacitor negative pin
16	C2P	Triple boosting capacitor positive pin

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Min.	Max.	Unit	Remark
Input Power Voltage	V_{IN}	-26.0/N	V_{DD} +0.3	V	N=Boosting time; at V_{IN} pin
Input Pin Voltage	V_I	V_{IN} -0.3	V_{DD} +0.3	V	POFF1, POFF2 TC1, TC2, FC pins
Output Pin Voltage 1	V_{0C1}	V_{IN} -0.3	V_{DD} +0.3	V	At C1P and C2P pins
Output Pin Voltage 2	V_{OC2}	2 × V_{IN} -0.3	V_{IN} +0.3	V	At C1N pin
Output Pin Voltage 3	V_{OC3}	3 × V_{IN} -0.3	2 × V_{IN} +0.3	V	At C2N pin
Output Pin Voltage 4	V_{OC4}	4 × V_{IN} -0.3	3 × V_{IN} +0.3	V	At C3N pin
Regulator Input Power Voltage	V_{RI}	N × V_{IN} -0.3	V_{DD} +0.3	V	N=Boosting time; at V_{RI} pin
Regulator Input Pin Voltage	V_{RV}	N × V_{IN} -0.3	V_{DD} +0.3	V	N=Boosting time; at RV pin
Output Voltage	V_0	N × V_{IN} -0.3	V_{DD} +0.3	V	N=Boosting time; at V_{OUT} and V_{REG} pins
Input Current	I_{IN}	—	80	mA	At V_{IN} pin
Output Current	I_{OUT}	—	N≤4: 20 N>4: 80/N	mA	N=Boosting time; at V_{OUT} and V_{REG} pins
Allowable Loss	P_d	—	210	mW	—
Operating Temperature	T_{opr}	-30	85	˚C	—
Storage Temperature	T_{stg}	-55	150	˚C	—
Soldering Temperature and Time	T_{sol}	—	260•10	˚C·S	Temperature at leads

ELECTRICAL CHARACTERISTICS

(Unless otherwise designated: Ta=–30°V to +85°C, V_{DD}=0V, V_{IN}=–5.0V)

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Input Power Voltage 1	V_{IN1}	During quadruple boosting	-5.5	—	-2.4	V
Input Power Voltage 2	V_{IN2}	During triple boosting	-7.3	—	-2.4	V
Input Power Voltage 3	V_{IN3}	During double boosting	-11		-2.4	V
Input Power Voltage N	V_{INN}	During large-time boosting using external diodes	-22/N	—	-2.4	V
Boost Startup Input Power Voltage	V_{STA}	N=Boosting time, I_{OUT}<200 μA, FC=VDD	-22/N	—	-2.4	V
Booster Output Voltage	V_{OUT}	—	-22	—	—	V
Regulator Input Voltage	V_{RI}	—	-22	—	-2.4	V
Regulator Output Voltage	V_{REG}	I_{REG}=0, V_{RI}=-22V,	—	—	-2.4	V
		R_{RV}=1MΩ				
Booster Output Impedance	R_{OUT}	$I_{OUT=10mA}$, during quadruple boosting	—	200	300	Ω
Booster Power Conversion Efficiency	P_{eff}	I_{OUT}=2 mA; during quadruple boosting; C1, C2, C3, C_{OUT}=10μF Tantalum	—	95	—	%
Booster Operating Current Consumption 1	I_{OPR1}	FC=V_{DD}, POFF1=V_{IN}, POFF2=V_{DD}; during no loading; C1, C2, C3, C_{OUT}=10μF Tantalum	—	130	220	μA
Booster Operating Current Consumption 2	I_{OPR2}	FC=V_{IN}, POFF1=V_{IN}, POFF2=V_{DD}; during no loading; C1, C2, C3, C_{OUT}=10μF Tantalum	—	520	880	μA
Regulator Operating Current Consumption	I_{OPVR}	V_{RI}=-20 V, during no loading, R_{RV}=1 MΩ	—	10	15	μA

ELECTRICAL CHARACTERISTICS (continued)

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Static Current	I_Q	POFF1=V_{IN}, POFF2=V_{IN}, FC=V_{DD}	—	—	5.0	μA
Input Leakage Current	I_{LIN}	At POFF1, POFF2, FC, TC1, TC2 pins	—	—	0.5	μA
Stable Output Saturation Resistance	R_{SAT} (*1)	0<I_{REG}<20mA RV=V_{DD} Ta=25˚C	—	10	20	Ω
Stable Output Voltage Stability	DV_R (*2)	-20V<V_{RI}<-10V, I_{REG}=1mA V_{REG}=-15V Ta=25˚C	—	0.2	—	%/V
Stable Output Load Variation	DV_0 (*3)	V_{RI}=-20V V_{REG}=-15V Ta=25˚C 0<I_{REG}<20mA	—	30	50	mV
Reference Voltage (Ta = 25°C)	V_{REF0}	TC1 = V_{DD}, TC2 = V_{DD}	-1.55	-1.50	-1.45	V
	V_{REF1}	TC1 = V_{DD}, TC2 = V_{IN}	-1.70	-1.50	-1.30	V
	V_{REF2}	TC1 = V_{IN}, TC2 = V_{DD}	-1.90	-1.50	-1.10	V
	V_{REF3}	TC1 = V_{IN}, TC2 = V_{IN}	-2.15	-1.50	-0.85	V
Reference Voltage Temperature Coefficient (*4) (*5)	CT_0	TC1 = V_{DD}, TC2 = V_{DD}, SSO package	-0.07	-0.04	0	%/˚C
	CT_1	TC1 = V_{DD}, TC2 = V_{IN}, SSO package	-0.25	-0.15	-0.07	%/˚C
	CT_2	TC1 = V_{IN}, TC2 = V_{DD}, SSO package	-0.45	-0.35	-0.20	%/˚C
	CT_3	TC1 = V_{IN}, TC2 = V_{IN}, SSO package	-0.75	-0.55	-0.30	%/˚C
Input Voltage Level	V_{IH}	V_{IN} =-2.0V to -5.5V At POFF1, POFF2, FC, TC1, TC2 pins	0.2V_{IN}	—	—	V
	V_{IL}	V_{IN} =-2.0V to -5.5V At POFF1, POFF2, FC, TC1, TC2 pins	—	—	0.8V_{IN}	V
Capacitance of Booster Capacitors	C_{MAX}	Capacitors C_1, C_2, C_3	—	—	47	μF

$$(*1)\ R_{SAT} = \frac{\Delta(V_{REG} - V_{OUT})}{\Delta I_{REG}}$$

$$(*2)\ V_R = \frac{\Delta V_{REG}}{\Delta V_{OUT} \cdot V_{REG}}$$

$$(*3)\ R_0 = \frac{\Delta V_{REG}}{\Delta I_{REG}}$$

$$(*4)\ CT = \frac{|V_{REF}(50^\circ C)| - |V_{REF}(0^\circ C)|}{50^\circ C - 0^\circ C} \times \frac{100}{|V_{REF}(25^\circ C)|}$$

(*5) The reference voltage temperature coefficient of each chip product may vary depending on the used molding materials. Perform the temperature test before use.

FUNCTIONAL DESCRIPTION

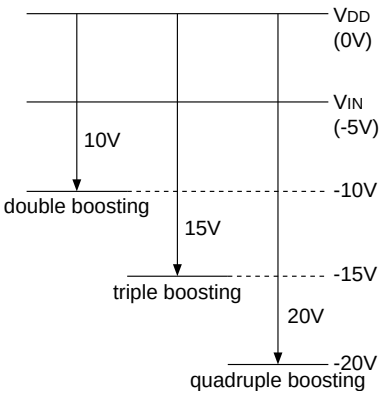
Clock Generator Circuit

As the SCI7654 has a built-in clock generator circuit, it requires no external source at all. The clock rate changes depending on the FC pin signal level, and the Low Output or High Output mode can be selected. This allows a frequency selection according to the current capacitance and load current when the booster output impedance changes depending on the clock rate and external booster capacitance.

FC pin	Mode	Clock Rate	Current Consumption	Output Ripple
H (V_{DD})	Low Output	4.0 kHz (Typ.)	I_{OP}	V_{RP}
L (V_{IN})	High Output	16.0 kHz (Typ.)	Approx. 4 times of I_{OP}	Approx. 1/4 time of V_{RI}

Voltage Converter Circuit

The voltage converter receives a clock from the clock generator, and boosts the V_{IN} input power voltage quadruple, triple or double. Four converter circuits are required for quadruple boosting, three converts are required for triple boosting, and dual converters are required for double boosting.



Voltage step-up diagram (during -5V input)

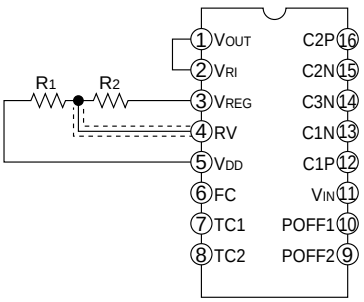
Reference Voltage Circuit

The SCI7654 has a built-in reference voltage circuit for the voltage regulator. The temperature coefficient of reference voltage can be changed using pins TC1 and TC2, and a voltage having one of four types of temperature gradients can be output at V_{REG} pin for LCD driving.

Mode	TC1	TC2	Reference Voltage, V_{REF} (V)			Temperature Coefficient, CT (%/˚C)		
			Min.	Typ.	Max.	Min.	Typ.	Max.
CT0	H(V_{DD})	H(V_{DD})	-1.55	-1.5	-1.45	-0.07	-0.04	0
CT1	H	L(V_{IN})	-1.70	-1.5	-1.30	-0.25	-0.15	-0.07
CT2	L(V_{IN})	H	-1.90	-1.5	-1.10	-0.45	-0.35	-0.20
CT3	L	L	-2.15	-1.5	-0.85	-0.75	-0.55	-0.30

●Voltage Regulator Circuit

The circuit receives a voltage from VRI pin, stabilizes it, and outputs at any voltage. The output is adjustable with a ratio of R1 and R2 external divider resistors. Although the sum of divider resistors is desirable to be minimum to prevent an interference due to external noise, 100 to 1 megohms are recommended as the current consumption may be increased by the divider resistors.



●Power Off Control

The SCI7654 has an automatic power-off function, and can turn on or off each function depending on the external signals entered in POFF1 and POFF2 pins.

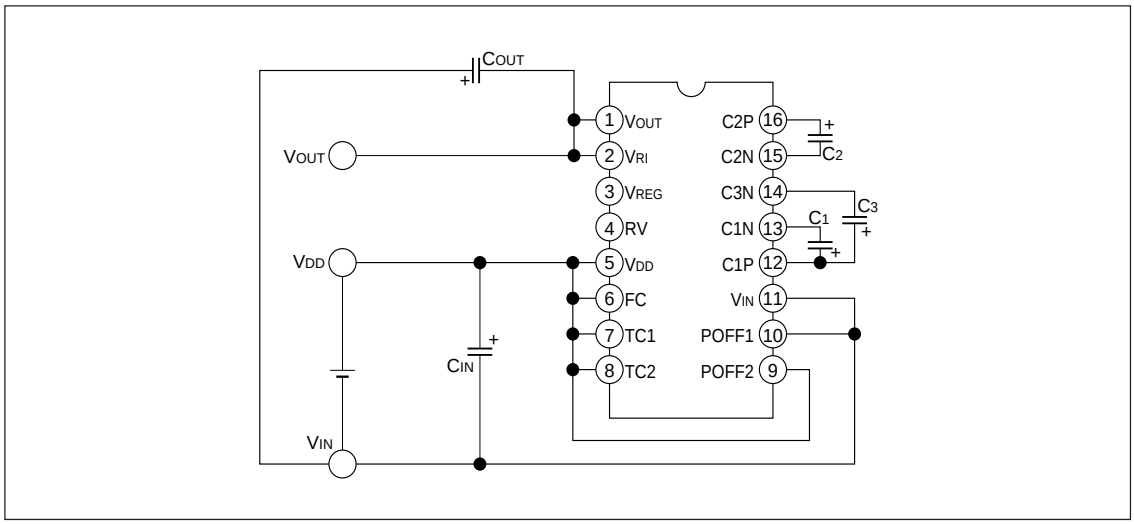
Mode	POFF1	POFF2	Function Status			
			Oscillator	Booster	Regulator	Description
PS1	H(VDD)	L(VIN)	ON	ON	ON	All circuits are turned ON.
PS2	L	L	OFF	OFF (*1)	OFF (*2)	All circuits are turned OFF.
PS3	H	H	OFF	ON	ON	Slave side (booster and regulator) in parallel connection
PS4	L	H	ON	ON	OFF	Master side (for booster only) in parallel connection; first stage in serial connection (*3)

*1 When the booster circuit is OFF, approximately VIN +0.6V voltage appears at VOUT pin.
*2 When the regulator is OFF, the VREG pin is set to the high-impedance status.
*3 The mode selected depends on the line connection at the second stage of serial connection.

REFERENCE CIRCUIT EXAMPLE

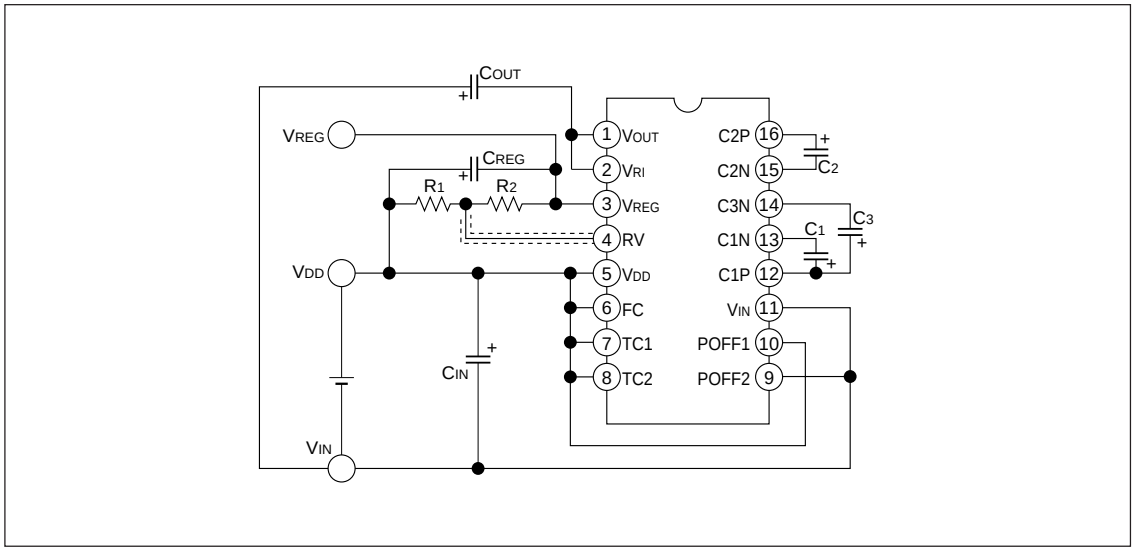
Four-time booster circuit

This example drives the booster circuit only, boosts the VIN input voltage four times in negative direction, and outputs it at the VOUT pin. However, this does not have a voltage regulator and the voltage at VOUT pin may have a ripple.



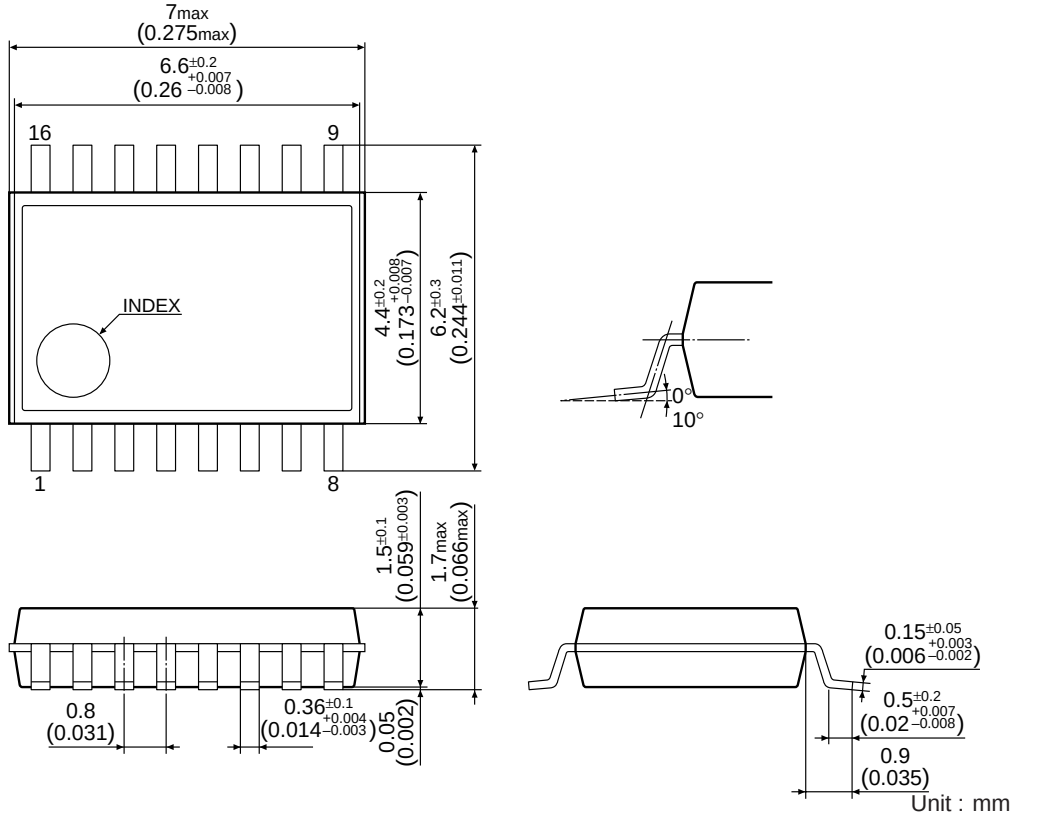
Four-time booster and regulator circuits

This example receives a boost output from VOUT pin, stabilizes it via the voltage regulator circuit, and outputs a voltage having the temperature gradient at VREG pin via the temperature gradient selector circuit.

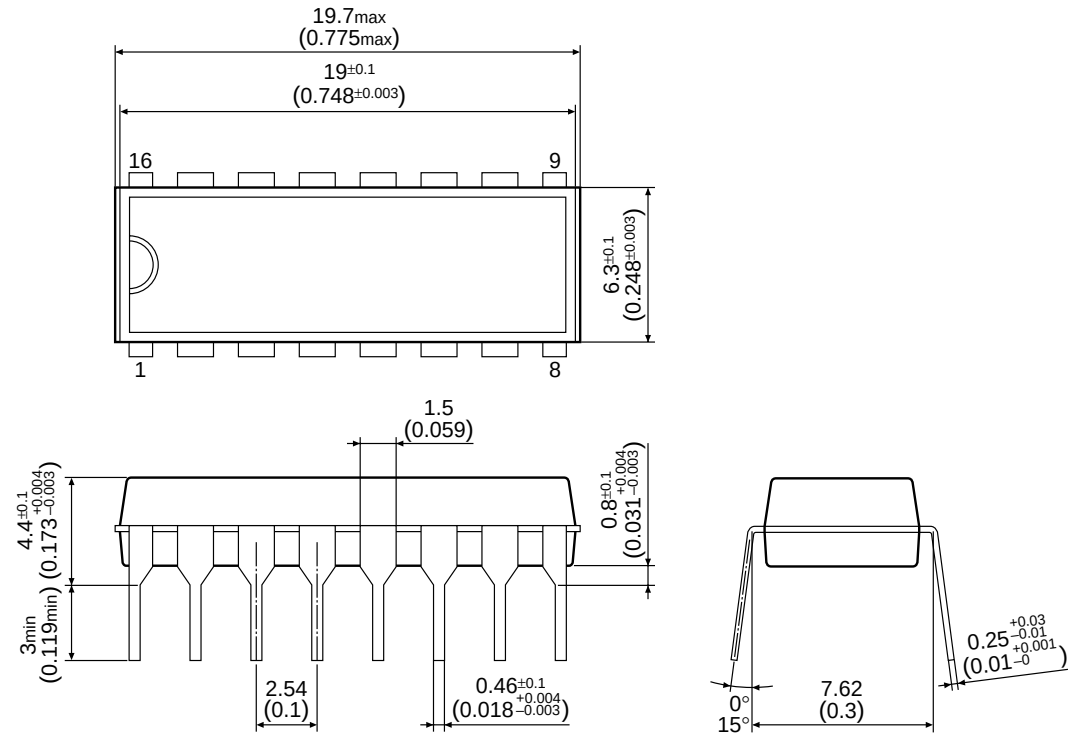


PACKAGE DIMENSIONS

Plastic SSOP2-16pin



Plastic DIP-16pin



Unit : mm
(inch)

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