MF302-10

EPSON

SCI7000 Series POWER SUPPLY IC

TECHNICAL MANUAL

ENERGY SAVING EPSON

SEIKO EPSON CORPORATION

NOTICE

SCI 7000 Series

POWER SUPPLY IC

Technical Manual

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Introduction

This book describes SEIKO EPSON's full line of power supply ICs and includes a complete set of product specifications. Also included are sections on quality assurance and packaging.

We suggest that you use the selector guide beginning on the following page to choose the IC or IC series that most closely matches your application. You can then use the detailed product descriptions in subsequent sections to confirm device specifications and characteristics.

Please contact your local SEIKO EPSON sales representative for further information or assistance on these or other products.

Selection Guide

DC/DC Converter

Part number	Features	Package
SCI7660C0B	• Supply voltage conversion IC. • It effectively converts input voltage into two levels in positive potential or negative potential (millipedes by 1 the in reverse polarity and doubles in the same polarity). • Power conversion efficiency: 95%, as standard.	DIP-8pin
SCI7660M0B		SOP4-8pin

DC/DC Converter and Voltage Regulator

Part number	Features	Package
SCI7661C0B	• Supply voltage conversion IC. • If effectively converts input voltage in for levels in positive potential or negative potential (millipedes by 1 or doubles in the reverse polarity and doubles or triples in the same polarity). • Power conversion efficiency: 95%, as standard. • It is capable of selecting temperature gradient for LCD power supply.	DIP-14pin
SCI7661M0B/MBB		SOP5-14pin SSOP2-16pin
SCI7654C0A	• Supply voltage conversion IC. • It effectively converts input voltage in for levels in negative potential. • Power conversion efficiency: 95%, as standard. • It is capable of selecting temperature gradient for LCD power supply.	DIP-16pin
SCI7654M0A		SSOP2-16pin

Voltage regulator

Part number	Features	Package
SCI7810YAA	• 6.00V positive output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin
SCI7810YBA	• 5.00V positive output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin
SCI7810YMA	• 4.50V positive output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin
SCI7810YPA	• 4.00V positive output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin
SCI7810YKA	• 3.90V positive output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin
SCI7810YNA	• 3.50V positive output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin
SCI7810YTA	• 3.30V positive output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin
SCI7810YCA	• 3.20V positive output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin
SCI7810YDA	• 3.00V positive output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin
SCI7810YRA	• 2.80V positive output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin
SCI7810YLA	• 2.60V positive output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin

Selection Guide

Part number	Features	Package
SCI7810YFA	• 2.20V positive output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin
SCI7810YGA	• 1.80V positive output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin
SCI7810YHA	• 1.50V positive output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin
SCI7910YBA	• –5.00V negative output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin
SCI7910YPA	• –4.00V negative output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin
SCI7910YDA	• –3.00V negative output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin
SCI7910YGA	• –1.80V negative output voltage regulator. • Low operating current (typ 1.5 uA). • Input voltage stability (typ 0.1%/V).	SOT89-3pin

DC/DC Switching regulator

Part number	Features	Package
SCI7631MHA	• Step-up switching regulator (from 1.5V to 2.2V). • Low operating voltage (0.9V at minimum). • Low operating current • High precision voltage detection function and battery backup function. • Built-in CR oscillator circuit. • Power-on clear function.	SOP3-8pin
SCI7631MLA	• Step-up switching regulator (from 1.5V to 2.4V). • Low operating voltage (0.9V at minimum). • Low operating current • High precision voltage detection function and battery backup function. • Built-in CR oscillator circuit. • Power-on clear function.	SOP3-8pin
SCI7631MBA	• Step-up switching regulator (from 1.5V to 3.0V). • Low operating voltage (0.9V at minimum). • Low operating current • High precision voltage detection function and battery backup function. • Built-in CR oscillator circuit. • Power-on clear function.	SOP3-8pin
SCI7631MKA	• Step-up switching regulator (from 1.5V to 3.5V). • Low operating voltage (0.9V at minimum). • Low operating current • High precision voltage detection function and battery backup function. • Built-in CR oscillator circuit. • Power-on clear function.	SOP3-8pin
SCI7631MAA	• Step-up switching regulator (from 1.5V to 5.0V). • Low operating voltage (0.9V at minimum). • Low operating current • High precision voltage detection function and battery backup function. • Built-in CR oscillator circuit. • Power-on clear function.	SOP3-8pin

Selection Guide

Part number	Features	Package
SCI7638MHA	• Step-up switching regulator (from 1.5V to 2.2V). • Low operating voltage (0.9V at minimum). • Low operating current. • Built-in CR oscillator circuit. • High precision voltage detection. • Output voltage response compensation. • Temperature characteristics of output voltage for LCD panel (-4.5mV/C).	SOP3-8pin
SCI7638MLA	• Step-up switching regulator (from 1.5V to 2.4V). • Low operating voltage (0.9V at minimum). • Low operating current. • Built-in CR oscillator circuit. • High precision voltage detection. • Output voltage response compensation. • Temperature characteristics of output voltage for LCD panel (-4.0mV/C).	SOP3-8pin
SCI7633MBA	• Step-up switching regulator (from 1.5V to 3.0V). • Low operating voltage (0.9V at minimum). • Low operating current. • Built-in crystal oscillator circuit. • Equipped with crystal oscillator output pin.	SOP3-8pin

Voltage detector

Part number	Features	Package
SCI7720YTA	• Voltage detection (Typ 4.00V). • Output format: N-ch open drain. • Low operating power (Typ 2.0 uA, V_{DD} = 5.0V).	SOP89-3pin
SCI7720YFA	• Voltage detection (Typ 2.65V). • Output format: N-ch open drain. • Low operating power (Typ 2.0 uA, V_{DD} = 3.0V).	SOP89-3pin
SCI7720YCA	• Voltage detection (Typ 2.15V). • Output format: N-ch open drain. • Low operating power (Typ 2.0 uA, V_{DD} = 3.0V).	SOP89-3pin
SCI7720YNA	• Voltage detection (Typ 1.90V). • Output format: N-ch open drain. • Low operating power (Typ 2.0 uA, V_{DD} = 3.0V).	SOP89-3pin
SCI7720YBA	• Voltage detection (Typ 1.15V). • Output format: N-ch open drain. • Low operating power (Typ 1.5 uA, V_{DD} = 1.5V).	SOP89-3pin
SCI7720YYA	• Voltage detection (Typ 1.10V). • Output format: N-ch open drain. • Low operating power (Typ 1.5 uA, V_{DD} = 1.5V).	SOP89-3pin
SCI7720YAA	• Voltage detection (Typ 1.05V). • Output format: N-ch open drain. • Low operating power (Typ 1.5 uA, V_{DD} = 1.5V).	SOP89-3pin
SCI7720YVA	• Voltage detection (Typ 0.95V). • Output format: N-ch open drain. • Low operating power (Typ 1.5 uA, V_{DD} = 1.5V).	SOP89-3pin
SCI7721YLA	• Voltage detection (Typ 5.00V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 6.0V).	SOP89-3pin
SCI7721YKA	• Voltage detection (Typ 4.80V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 5.0V).	SOP89-3pin

Part number	Features	Package
SCI7721Y2A	• Voltage detection (Typ 4.60V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 5.0V).	SOP89-3pin
SCI7721YJA	• Voltage detection (Typ 4.40V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 5.0V).	SOP89-3pin
SCI7721YMA	• Voltage detection (Typ 4.20V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 5.0V).	SOP89-3pin
SCI7721YTA	• Voltage detection (Typ 4.00V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 5.0V).	SOP89-3pin
SCI7721Y3A	• Voltage detection (Typ 3.50V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 4.0V).	SOP89-3pin
SCI7721YHA	• Voltage detection (Typ 3.20V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 4.0V).	SOP89-3pin
SCI7721YGA	• Voltage detection (Typ 3.00V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 4.0V).	SOP89-3pin
SCI7721YRA	• Voltage detection (Typ 2.80V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 3.0V).	SOP89-3pin
SCI7721YFA	• Voltage detection (Typ 2.65V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 3.0V).	SOP89-3pin
SCI7721YEA	• Voltage detection (Typ 2.55V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 3.0V).	SOP89-3pin
SCI7721YSA	• Voltage detection (Typ 2.35V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 3.0V).	SOP89-3pin
SCI7721YPA	• Voltage detection (Typ 2.25V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 3.0V).	SOP89-3pin
SCI7721YCA	• Voltage detection (Typ 2.15V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 3.0V).	SOP89-3pin
SCI7721YFB	• Voltage detection (Typ 2.65V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 3.0V).	SOP89-3pin
SCI7721YCB	• Voltage detection (Typ 2.15V). • Output format: COMS. • Low operating power (Typ 2.0 uA. V_{DD} = 3.0V).	SOP89-3pin
SCI7722YDB	• Voltage detection (Typ. 1.25V). • Output format: P-ch open drain. • Low operating power (Typ 1.5 uA. V_{DD} = 1.5V).	SOP89-3pin

SCI7660 Series
POWER SUPPLY IC

1. DC/DC Converter

DESCRIPTION

The SCI7660 Series is a highly efficient CMOS DC/DC converter for doubling an input voltage. This power-saving IC allows portable computers and similar hand-held equipment to operate from a single power supply, even when they incorporate LSIs that operate at voltages different from those of logic circuits, for example, LCD drivers and analog LSIs.
The SCI7660C0B is available in 8-pin plastic DIPs, and the SCI7660M0B, in 8-pin plastic SOPs.

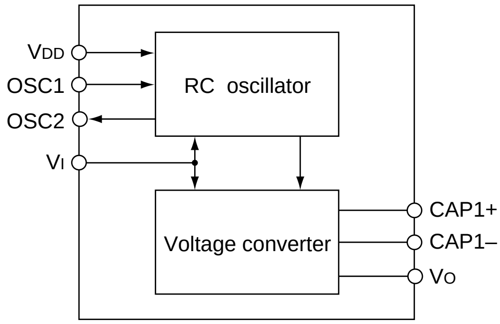
FEATURES

- 95% (typ.) conversion efficiency
- Two output voltages, V_O, relative to V_{DD} and V_I
- 30mA maximum output current at 5V
- Two-in-series configuration doubles negative output voltage.
- Low operating voltage
- On-chip RC oscillator
- 8-pin plastic DIP and 8-pin plastic SOP

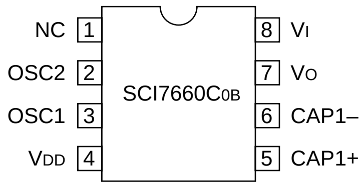
APPLICATIONS

- Fixed-voltage power supplies for battery-operated equipment
- Power supplies for pagers, memory cards, calculators and similar hand-held equipment
- Fixed-voltage power supplies for medical equipment
- Fixed-voltage power supplies for communications equipment
- Uninterruptable power supplies

BLOCK DIAGRAM



PIN CONFIGURATION



PIN DESCRIPTION

Number	Name	Description
1	NC	No connection
2	OSC2	Resistor connection. Open when using external clock
3	OSC1	Resistor connection. Clock input when using external clock
4	V_{DD}	Positive supply (system V_{CC})
5	CAP1+	Positive charge-pump connection
6	CAP1–	Negative charge-pump connection
7	V_O	×2 multiplier output
8	V_I	Negative supply (system ground)

SPECIFICATIONS

Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Input voltage range	V_I	–10.0 to 0.5	V
Output voltage range	V_O	Min. –20.0	V
Power dissipation	P_D	300 (DIP)	mW
		150 (SOP)	
Operating temperature range	T_{opr}	–40 to 85	˚C
Storage temperature range	T_{stg}	–65 to 150	˚C
Soldering temperature(for 10s). See note.	T_{sol}	260	˚C

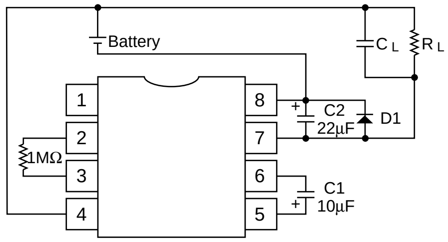
Note:
Temperatures during reflow soldering must remain within the limits set out in LSI Device Precautions. Never use solder dip to mount SCI7000 series power supply devices.

Recommended Operating Conditions

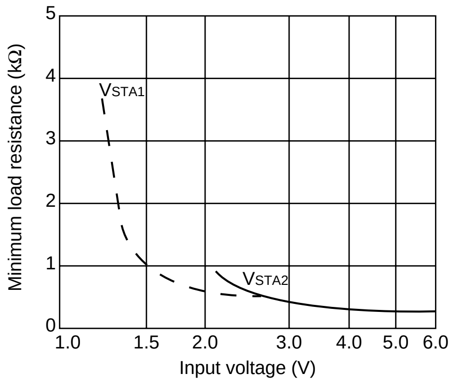
V_{DD} = 0V, Ta = –40 to 85˚C unless otherwise noted

Parameter	Symbol	Condition	Rating			Unit
			Min.	Typ.	Max.	
Oscillator startup voltage	V_{STA}	R_{OSC} = 1MΩ, $C_1/C_2 \leq 1/20$, $C_2 \geq 10\mu F$, Ta = –40 to 85˚C See note 1.	—	—	–1.5	V
		R_{OSC} = 1MΩ	—	—	–2.2	
Oscillator shutdown voltage	V_{STP}	R_{OSC} = 1MΩ	–1.5	—	—	V
Load resistance	R_L		R_L min See note 2.	—	—	Ω
Output current	I_O		—	—	30.0	mA
Clock frequency	f_{OSC}		10.0	—	30.0	kHz
RC oscillator network resistance	R_{OSC}		680	—	2,000	kΩ
Capacitance	C_1, C_2		3.3	—	—	µF

Notes:
1. The recommended circuit configuration for low-voltage operation (when V_I is between –1.2V and –2.2V) is shown in the following figure. Note that diode D1 should have a maximum forward voltage of 0.6V with 1.0mA forward current.
2. R_L min can be varied depending on the input voltage.



3. R_L min is a function of V_I.

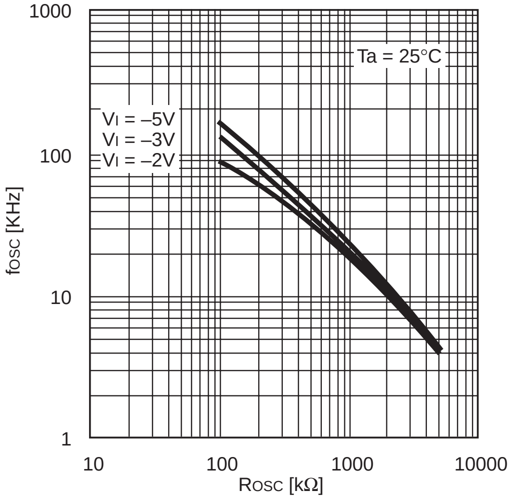


Electrical Characteristics

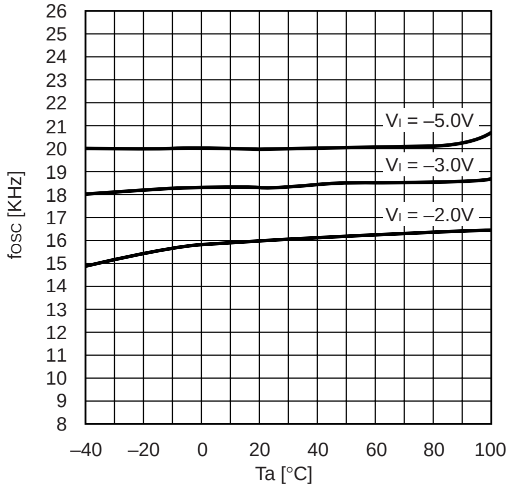
V_{DD} = 0V, Ta = –40 to 85˚C unless otherwise noted

Parameter	Symbol	Condition	Rating			Unit
			Min.	Typ.	Max.	
Input voltage	V_I		–8.0	—	–1.5	V
Output voltage	V_O		–16.0	—	—	V
Multiplier current	I_{opr}	R_L = ∞, R_{OSC} = 1MΩ V_I = –5V	—	20	30	µA
Quiescent current	I_Q	R_L =∞, V_I = –8V	—	—	2.0	µA
Clock frequency	f_{OSC}	R_{OSC} = 1MΩ, V_I = –5V	16	20	24	kHz
Output impedance	R_O	I_O = 10mA, V_I = –5V	—	75	100	Ω
Multiplication efficiency	Peff	I_O = 5mA, V_I = –5V	90	95	—	%
OSC1 Input leakage current	I_{LKI}	V_I = –8V	—	—	2.0	µA

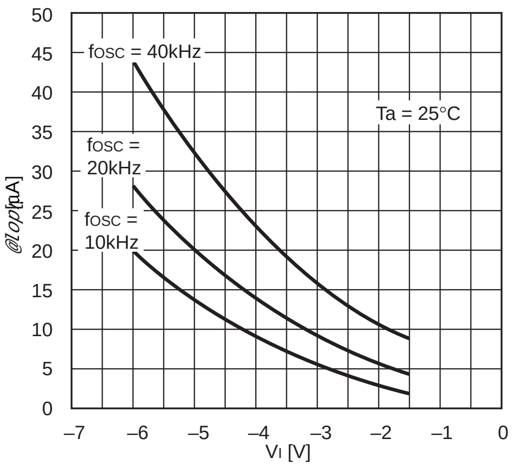
Typical Performance Characteristics



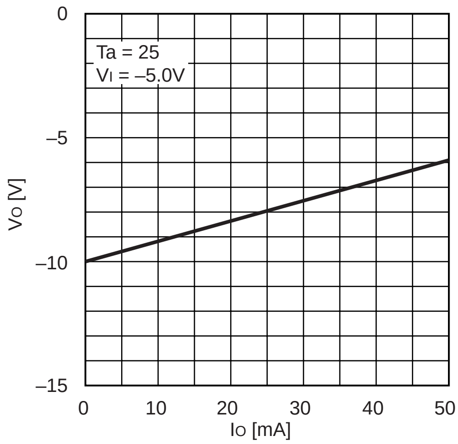
Clock frequency vs. External resistance



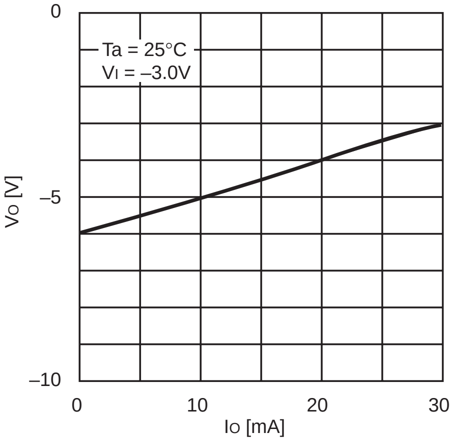
Clock frequency vs. Ambient temperature



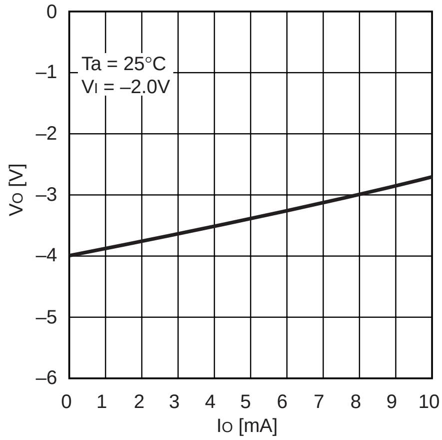
Multiplier current vs. Input voltage



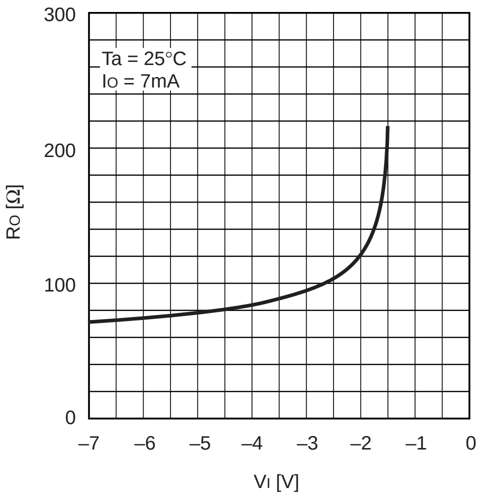
Output voltage vs. Output current



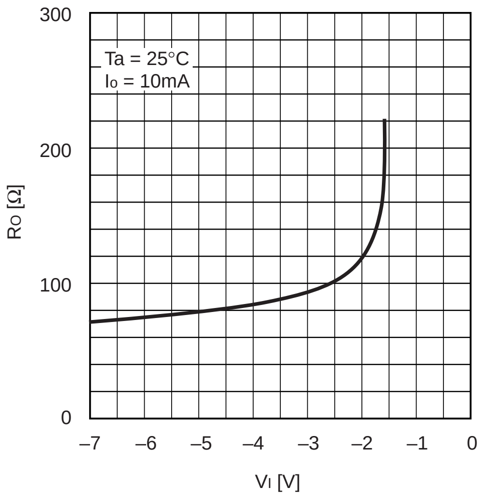
Output voltage vs. Output current



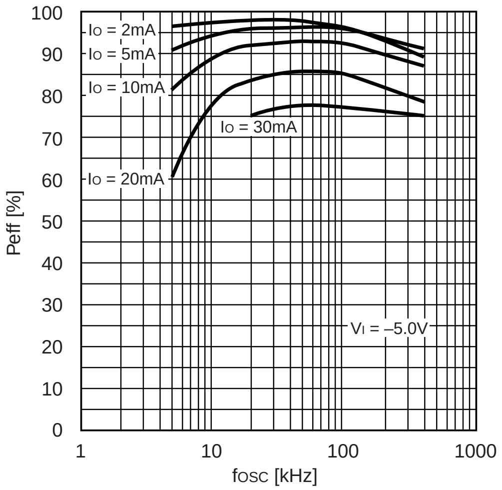
Output voltage vs. Output current



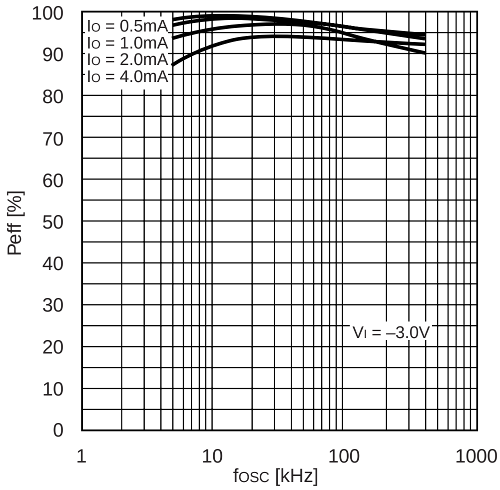
Output impedance vs. Input voltage



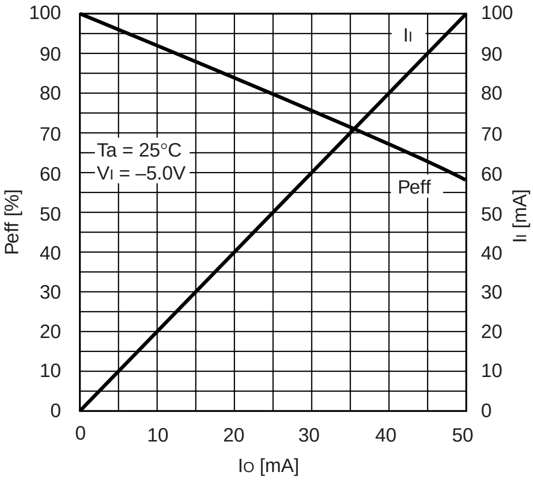
Output impedance vs. Input voltage



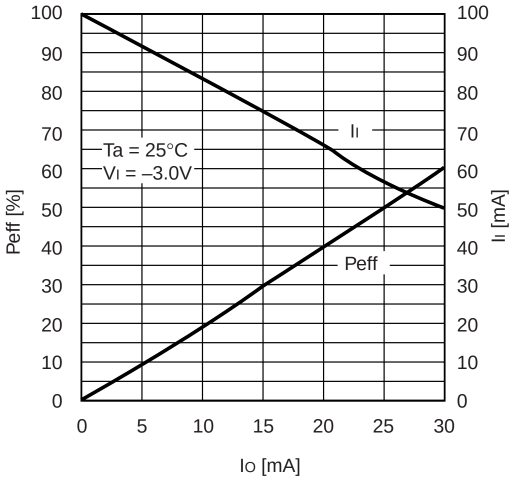
Multiplication efficiency vs. Clock frequency



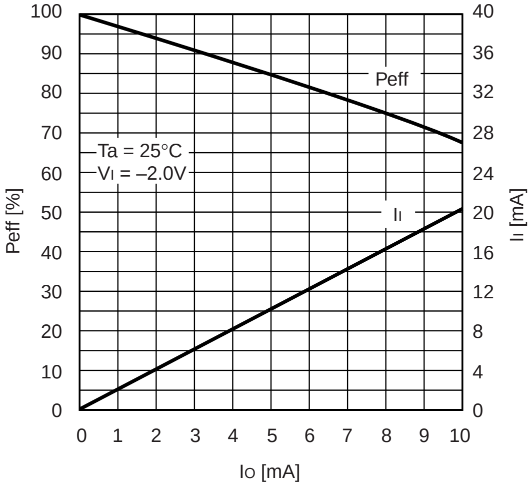
Multiplication efficiency vs. Clock frequency



Multiplication efficiency/input current vs. Output current



Multiplication efficiency/input current vs. Output current

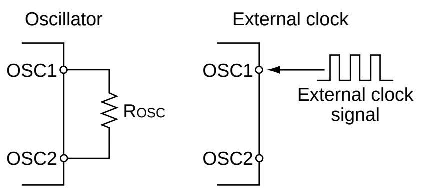


Multiplication efficiency/input current vs. Output current

FUNCTIONAL DESCRIPTION

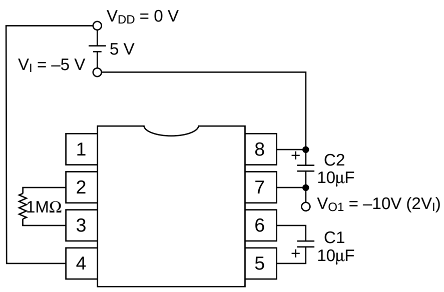
RC Oscillator

The on-chip RC oscillator network frequency is determined by the external resistor, ROSC, connected between OSC1 and OSC2. This oscillator can be disabled in favor of an external clock by leaving OSC2 open and applying an external clock signal to OSC1.

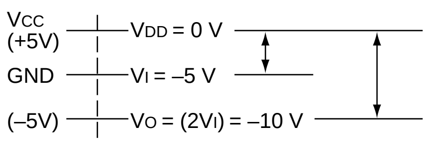


Voltage Multiplier

The voltage multiplier uses the clock signal from the oscillator to double the input voltage. This requires two external capacitors—a charge-pump capacitor, C1, between CAP1+ and CAP1–, and a smoothing capacitor, C2, between VI and VO.



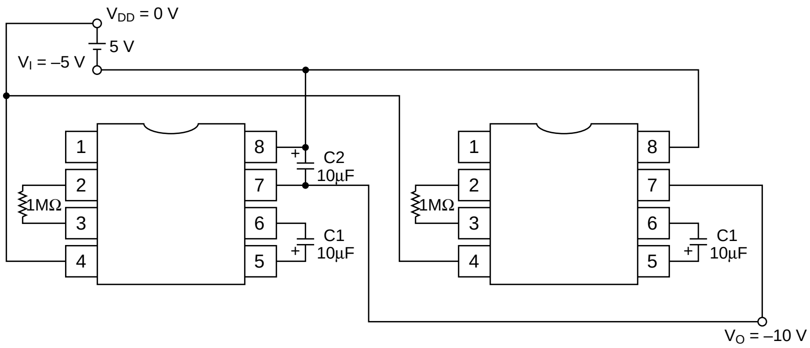
Doubled potential levels



TYPICAL APPLICATIONS

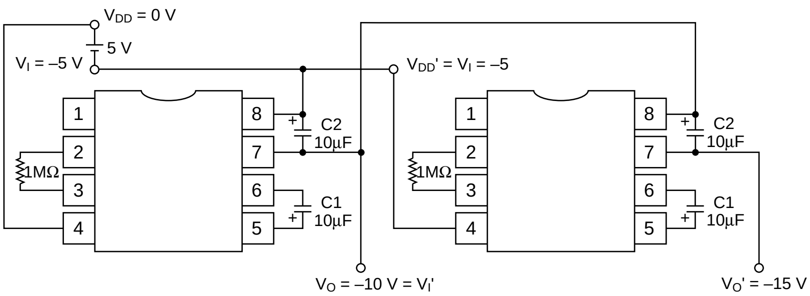
Parallel Connection

Connecting two or more chips in parallel reduces the output impedance by 1/*n*, where *n* is the number of devices used.

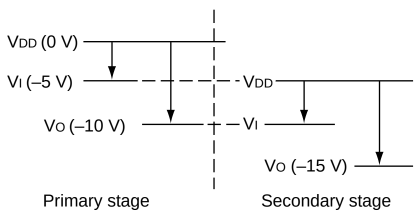


Serial Connection

Connecting two or more chips in series obtains a higher output voltage than can be obtained using a parallel connection, however, this also raises the output impedance.

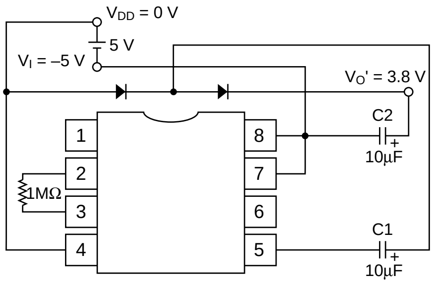


Potential levels



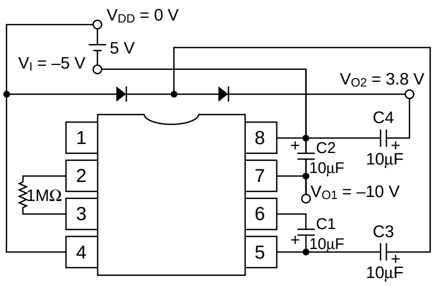
Positive Voltage Conversion

Diodes can be added to a circuit connected in parallel to make a negative voltage positive.

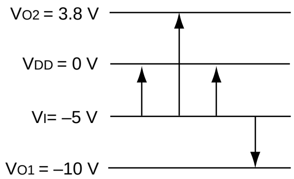


Simultaneous Voltage Conversion

Combining a multiplier circuit with a positive voltage conversion circuit generates both –10 and 3.8 V outputs from a single input.



Potential levels



SCI7661 Series / SCI7654 Series POWER SUPPLY IC

2.

DC/DC Converter
& Voltage Regulator

DESCRIPTION

The SCI7661 Series is a highly effecient CMOS DC/DC converter for doubling or tripling an input voltage. It incorporates an on-chip voltage regulator to ensure stable output at the specified voltage. The SCI7661 Series offers a choice of three, optional temperature gradients for applications such as LCD panel power supplies. The SCI7661C0B is available in 14-pin plastic DIPs, the SCI7661M0B, in 14-pin plastic SOPs, and the SCI7661MBB in 16-pin plastic SSOPs.

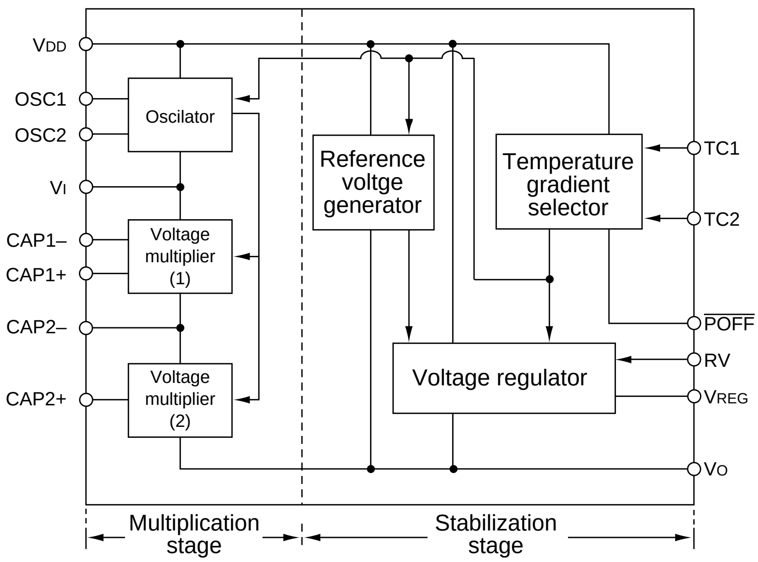
FEATURES

- 95% (Typ.) conversion efficiency
- Up to four output voltages, V_O, relative to the input voltage, V_I
- On-chip voltage regulator
- 20mA maximum output current at V_I = –5V
- Three temperature gradients—0.1, 0.4 and 0.6%/°C
- External shut-down control
- 2µA maximum output current when shut-down
- Two-in-series configuration doubles negative output voltage.
- On-chip RC oscillator
- SCI7661C0B .... pladtic DIP-14 pin
  SCI7661M0B .... pladtic SOP5-14 Pin
  SCI7661MBB .... pladtic SSOP2-16 pin

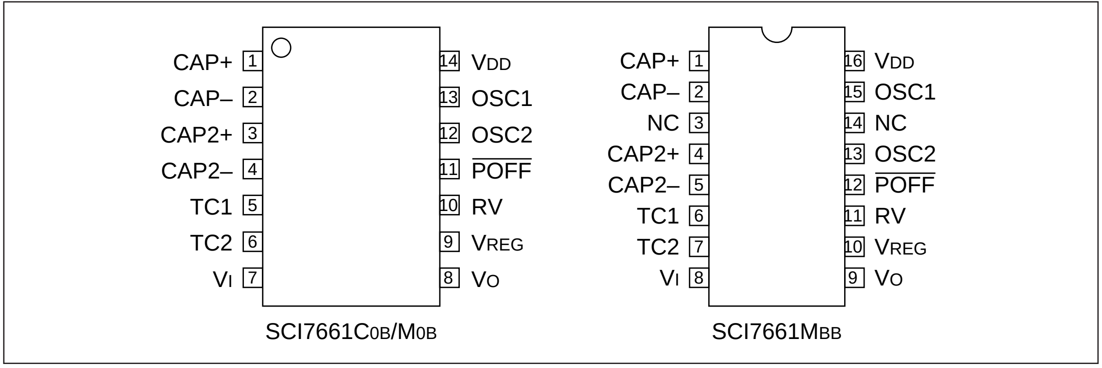
APPLICATIONS

- Power supplies for LCD panels
- Fixed-voltage power supplies for battery-operated equipment
- Power supplies for pagers, memory cards, calculators and similar hand-held equipment
- Fixed-voltage power supplies for medical equipment
- Fixed-voltage power supplies for communications equipment
- Power supplies for microcomputers
- Uninterruptable power supplies

BLOCK DIAGRAM



PIN CONFIGURATION



PIN DESCRIPTION

Number	Name	Description
1	CAP1+	Positive charge-pump connection for ×2 multiplier
2	CAP1–	Negative charge-pump connection for ×2 multiplier
3	CAP2+	Positive charge-pump connection for ×3 multiplier
4	CAP2–	Negative charge-pump connection for ×3 multiplier or ×2 multiplier output
5	TC1	Temperature gradient selects
6	TC2	
7	V_I	Negative supply (system ground)
8	V_O	×3 multiplier output
9	V_{REG}	Voltage regulator output
10	R_V	Voltage regulator output adjust
11	$\overline{POFF}$	Voltage regulator output ON/OFF control
12	OSC2	Resistor connection. Open when using external clock
13	OSC1	Resistor connection. Clock input when using external clock
14	V_{DD}	Positive supply (system V_{CC})

SPECIFICATIONS

Absolute Maximum Ratings

Items	Codes	Ratings	Units	Remarks
Input supply voltage	$V_I - V_{DD}$	–20/N to V_{DD} + 0.3	V	N = 2: Boosting to a double voltage N = 3: Boosting to a triple voltage
Input terminal voltage	$V_I - V_{DD}$	V_I – 0.3 to V_{DD} + 0.3	V	OSC1, OSC2, $\overline{\text{POFF}}$
		V_O – 0.3 to V_{DD} + 0.3	V	TC1, TC2, RV
Output voltage	$V_O - V_{DD}$	–20 to V_{DD} + 0.3	V	V_O Note 3)
		V_O to V_{DD} + 0.3	V	V_{REG} Note 3)
Allowable dissipation	Pd	Max. 300	mW	
Working temperature	Topr	–40 to 85	°C	Plastic package
Storage temperature	Tstg	–55 to 150	°C	
Soldering temperature and time	Tsol	260°C 10 s (at leads)	–	

Notes

1. Using the IC under conditions exceeding the aforementioned absolute maximum ratings may lead to permanent destruction of the IC. Also, if an IC is operated at the absolute maximum ratings for a longer period of time, its functional reliability may be substantially deteriorated.
2. All the voltage ratings are based on V_{DD} = 0V.
3. The output terminals (V_O,V_{REG}) are meant to output boosted voltage or stabilized boosted voltage. They, therefore, are not the terminals to apply an external voltage. In case the using specifications unavoidably call for application of an external voltage, keep such voltage below the voltage ratings given above.

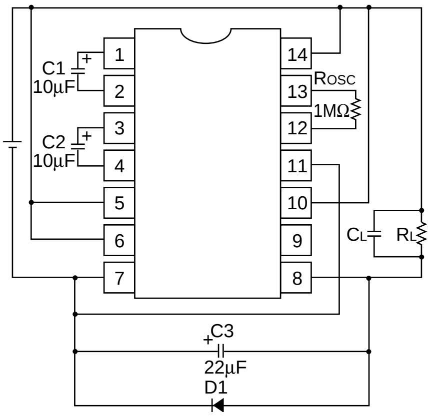
Reconmmended Operating Conditions

V_{DD} = 0V, Ta = –40 to 85˚C unless otherwise noted

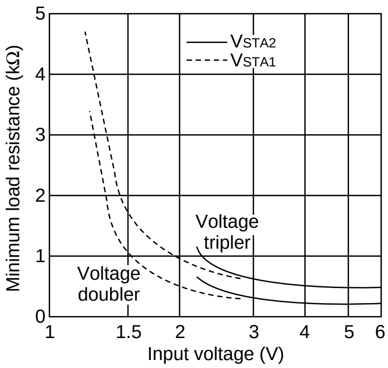
Parameter	Symbol	Conditions	Rating			Unit
			Min.	Typ.	Max.	
Oscillator startup voltage	V_{STA}	R_{OSC} =1MΩ C_3 = 10 µF, C_L/C_3 ≤ 1/20, Ta = –40 to 85˚C. See note 1.	–	–	–1.8	V
		R_{OSC} = 1MΩ	–	–	–2.2	
Oscillator shutdown voltage	V_{STP}	R_{OSC} = 1MΩ	–1.8	–	–	V
Load resistance	R_L		R_L min. See note 2.	–	–	Ω
Output current	I_O		–	–	20.0	mA
Clock frequency	f_{OSC}		10.0	–	30.0	kHz
RC oscillator network resistance	R_{OSC}		680	–	2,000	kΩ
Capacitance	C_1, C_2, C_3		3.3	–	–	µF
Stabilization voltage sensing resis-tance	R_{RV}		100	–	1,000	kΩ

Notes

1. The recommended circuit configuration for low-valtage operation (when V_I is between –1.2V and –2.2V) is shown in the following figure. Note that diode D1 should have a maximum forward voltage of 0.6V with 1.0mA forward current.
2. R_L min can be varied depending on the input voltage.



3. R_L min is a function of V_1



Electrical Characteristics

V_{DD} = 0V, V_1 = –5V, Ta = –40 to 85°C unless otherwise noted

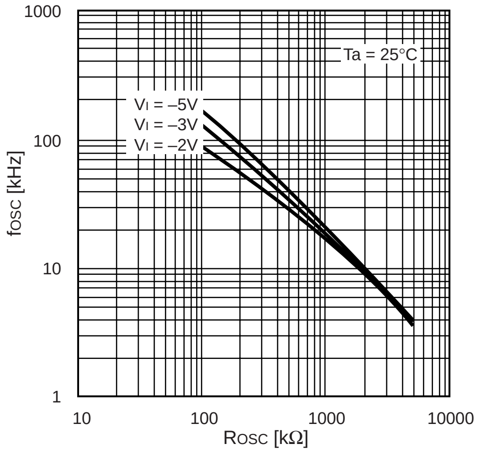
Parameter	Symbol	Conditions	Rating			Unit
			Min.	Typ.	Max.	
Input voltage	V_I		–6.0	–	–1.8	V
Output voltage	V_O		–18.0	–	–	V
Regulator voltage	V_{REG}	R_L = ∞, R_{RV} = 1MΩ, V_O = –18V	–18.0	–	–2.6	V
Stabilization circuit operating voltage	V_O		–18.0	–	–3.2	V
Multiplier current	Iopr1	R_L = ∞, R_{OSC} = 1MΩ	–	40	80	µA
Stabilization current	Iopr2	R_L = ∞, R_{RV} = 1MΩ, V_O = –15V	–	5.0	12.0	µA
Quiescent current	I_Q	TC2 = TC1 = V_O, R_L = ∞	–	–	2.0	µA
Clock frequency	f_{OSC}	R_{OSC} = 1MΩ	16.0	20.0	24.0	kHz

Parameter	Symbol	Conditions	Rating			Unit
			Min.	Typ.	Max.	
Output impedance	R_O	I_O = 10mA	–	150	200	Ω
Multiplication efficiency	Peff	I_O = 5mA	90.0	95.0	–	%
Stabilization output voltage differential	$\frac{\Delta V_{REG}}{\Delta V_O \cdot V_{REG}}$	V_O = –18 to –8V, V_{REG} = –8V, R_L = ∞, Ta = 25˚C	–	0.2	–	%/V
Stabilization output load differential	$\frac{\Delta V_{REG}}{\Delta I_O}$	V_O = –15V, V_{REG} = –8V, Ta = 25˚C, I_O = 0 to 10µA, TC1 = V_{DD}, TC2 = V_O	–	5.0	–	Ω
Stabilization output saturation resistance	R_{SAT}	$R_{SAT} = \Delta(V_{REG} - V_O)/\Delta I_O$, I_O = 0 to 10µA, R_V = V_{DD}, Ta = 25˚C	–	8.0	–	Ω
Reference voltage	V_{RV}	RC2 = V_O, TC1 = V_{DD}, Ta = 25˚C	–2.3	–1.5	–1.0	V
		TC2 = TC1 = V_O, Ta = 25˚C	–1.7	–1.3	–1.1	
		TC2 = V_{DD}, TC1 = V_O, Ta = 25˚C	–1.1	–0.9	–0.8	
Temperature gradient	C_T	See note.	–0.25	–0.1	–0.01	%/˚C
			–0.5	–0.4	–0.3	
			–0.7	–0.6	–0.5	
$\overline{POFF}$, TC1, TC2, OSC1, and RV input leakage current	I_{LKI}		–	–	2.0	µA

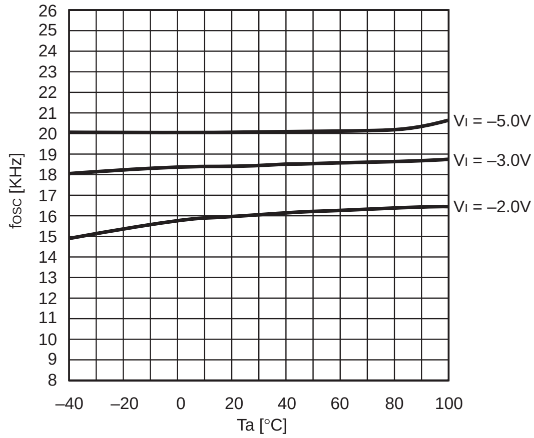
Note

$$C_T = \frac{|V_{REG}(50°C)| - |V_{REG}(0°C)|}{50°C - 0°C} \times \frac{100}{|V_{REG}(25°C)|}$$

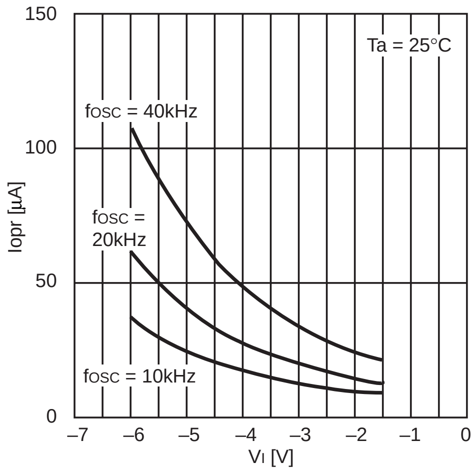
Typical Performance Characteristics



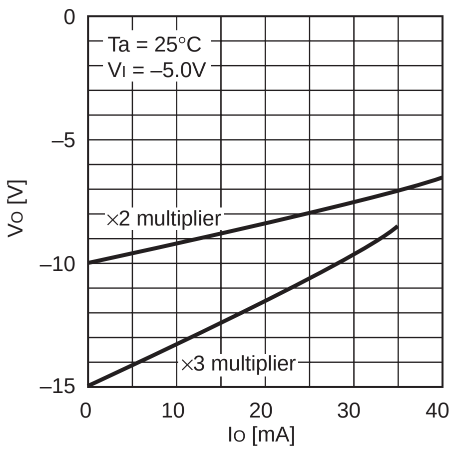
Clock frequency vs. External resistance



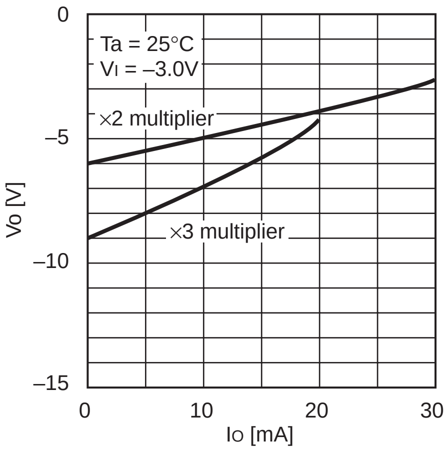
Clock frequency vs. Ambient temperature



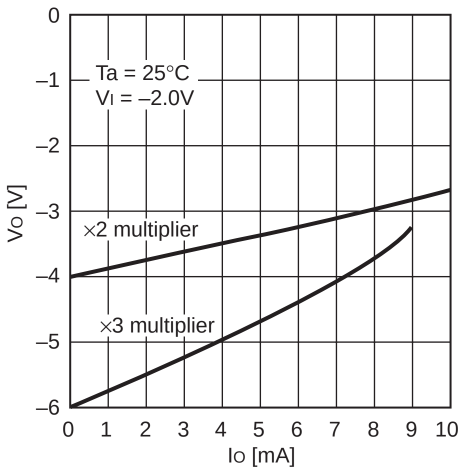
Multiplier current vs. Input voltage



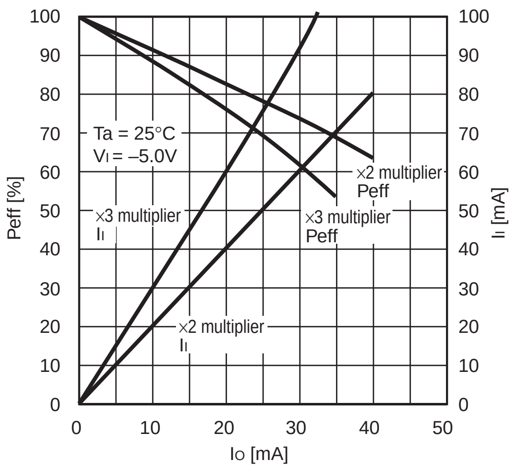
Output voltage vs. Output current



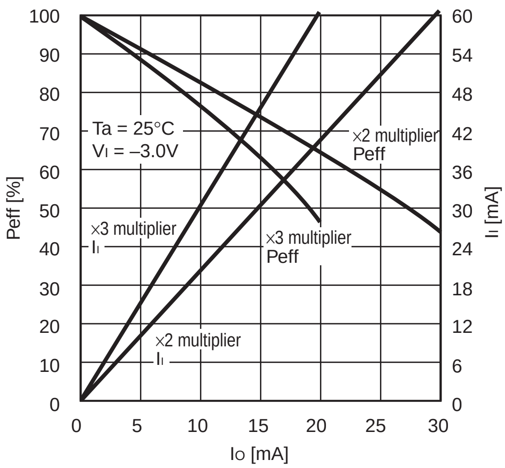
Output voltage vs. Output current



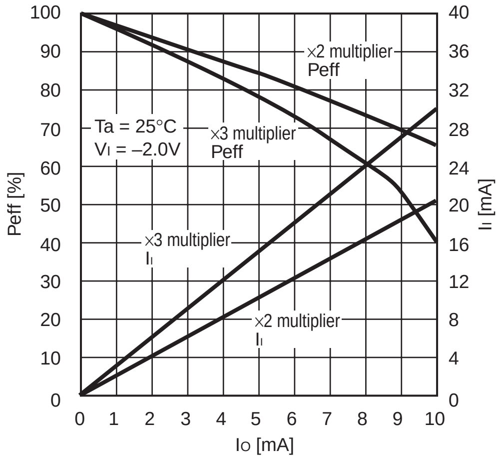
Output voltage vs. Output current



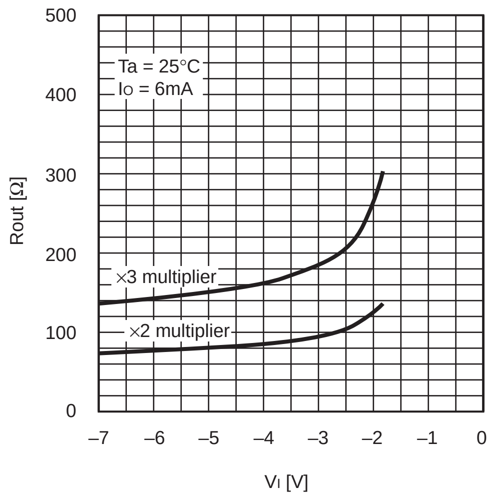
Multiplication efficiency/input current vs. Output current



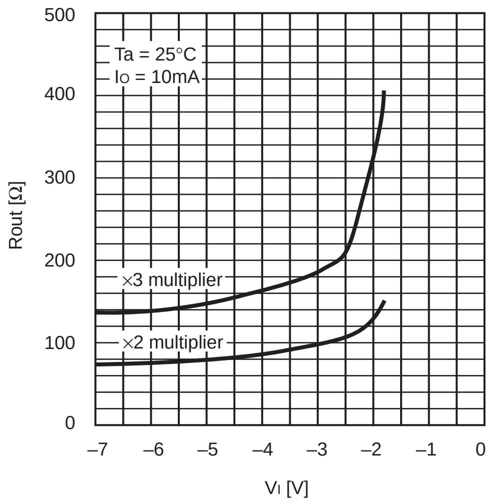
Multiplication efficiency/input current vs. Output current



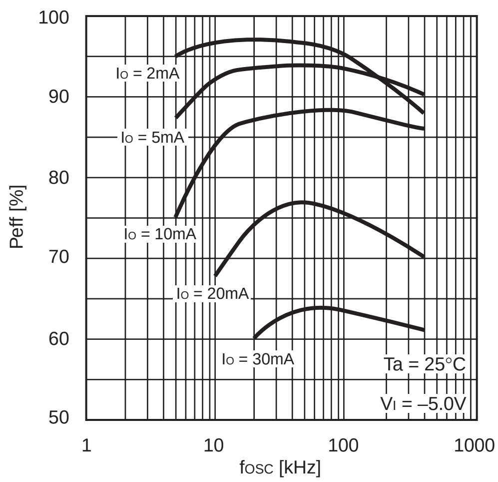
Multiplication efficiency/input current vs. Output current



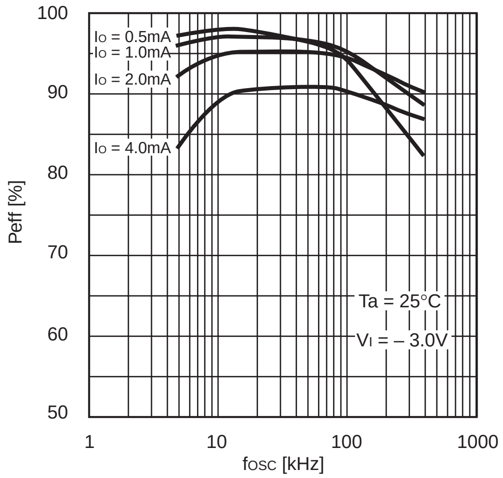
Output impedance vs. Input voltage



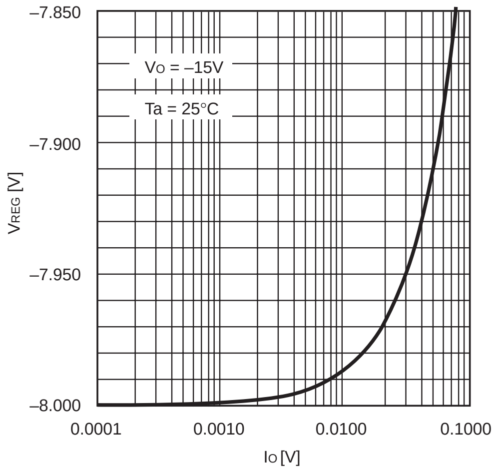
Output impedance vs. Input voltage



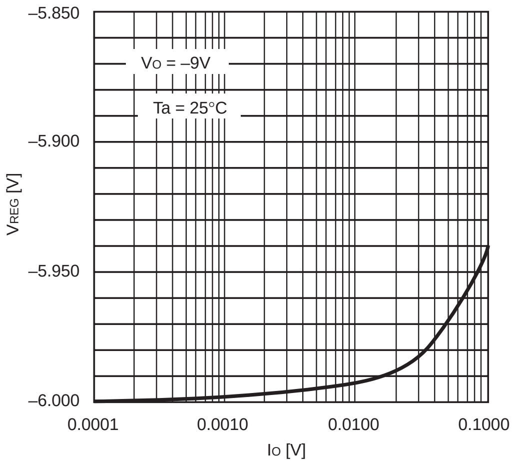
Multiplication efficiency vs. Clock frequency



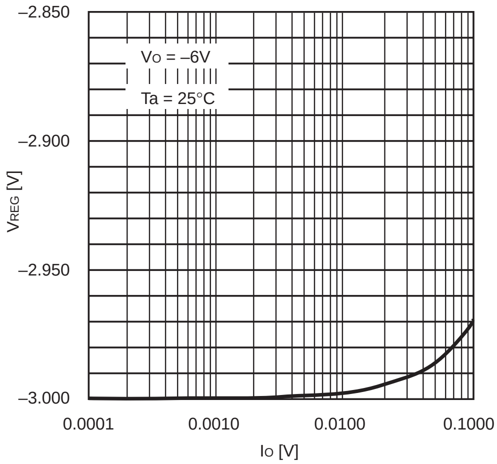
Multiplication efficiency vs. Clock frequency



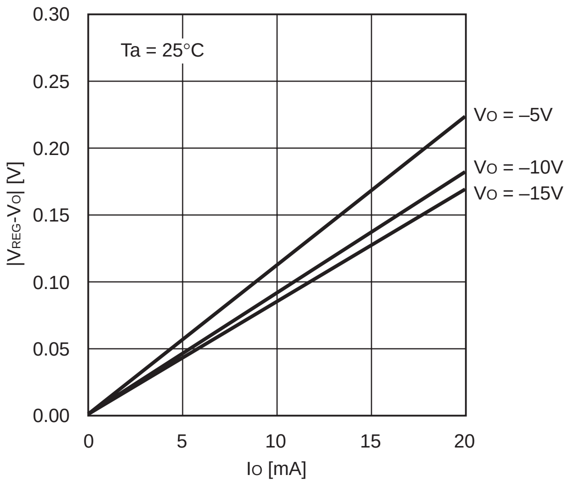
Output voltage vs. Output current



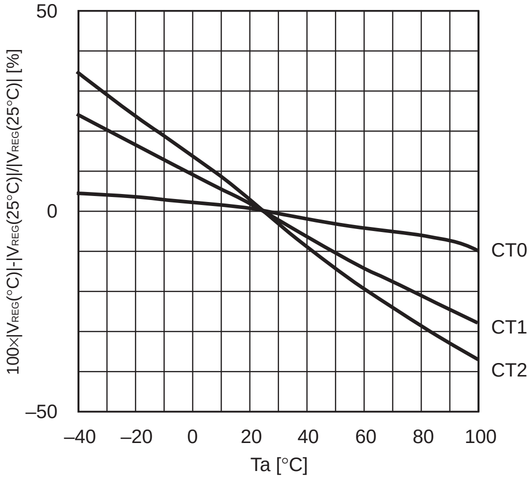
Output voltage vs. Output current



Output voltage vs. Output current



Regulator voltage vs. Output current



Regulator output stability ratio vs. Ambient temperature

Temperature Gradient Control

The SCI7661C0B offers a choice of three temperature gradients which can be used to adjust the voltage regulator output in applications such as power supplies for driving LCDs.

$\overline{POFF}$	TC2	TC1	Temperature gradient (%/°C) See note 2.	Voltage regulator output	RC osciliator	Remarks
See note 1.						
1 (V_{DD})	LOW (V_O)	LOW (V_O)	–0.4	ON	ON	
1	LOW	HIGH (V_{DD})	–0.1	ON	ON	
1	HIGH (V_{DD})	LOW	–0.6	ON	ON	
1	HIGH	HIGH	–0.6	ON	OFF	Serial connection
0 (V_1)	LOW	LOW	–	OFF (high impedance)	OFF	
0	LOW	HIGH	–	OFF (high impedance)	OFF	
0	HIGH	LOW	–	OFF (high impedance)	OFF	
0	HIGH	HIGH	–	OFF (high impedance)	OFF	Multiplier operational

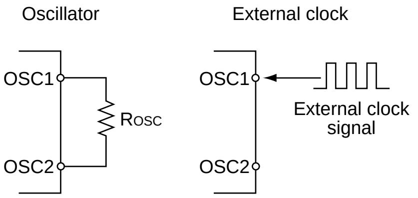
Notes

1. The definition of LOW for $\overline{POFF}$ differs from that for TC1 and TC2.
2. The temperature gradient affects the voltage between V_{DD} and V_{REG}.

FUNCTIONAL DESCRIPTION

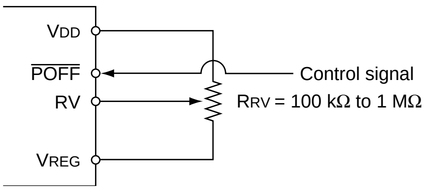
Oscillator

The on-chip RC oscillator network frequency is determined by the external resistor, ROSC, connected between OSC1 and OSC2. This oscillator can be disabled in favor of an external clock by leaving OSC2 open and applying an external clock signal to OSC1.



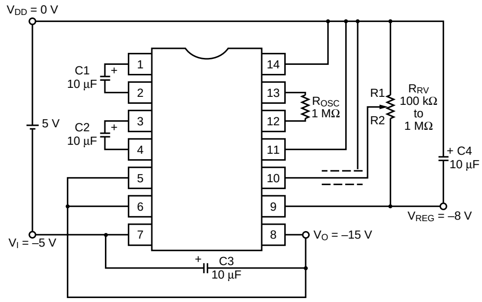
Reference Volatge Generator and Voltage Regulator

The reference voltage generator supplies a reference voltage to the voltage regulator to control the output. This voltage can be switched ON and OFF.

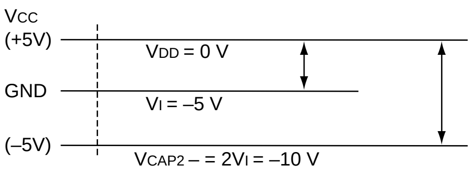


Voltage Multiplier

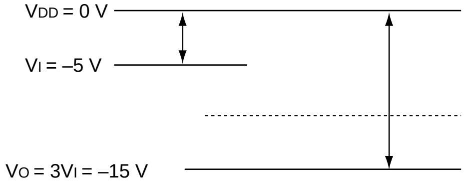
The voltage multiplier uses the clock signal from the oscillator to double or triple the input voltage. This requires three external capacitors–two charge-pump capacitors between CAP1+ and CAP1– and CAP2+ and CAP2–, respectively, and a smoothing capacitor between VI and VO.



Double voltage potential levels



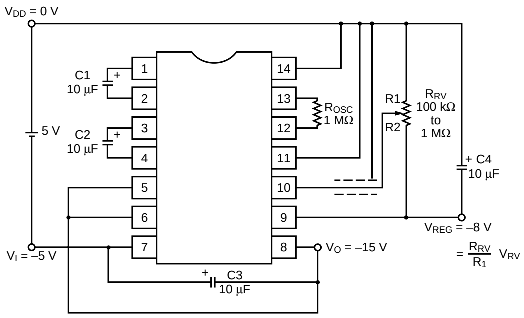
Tripled voltage potential levels



TYPICAL APPLICATIONS

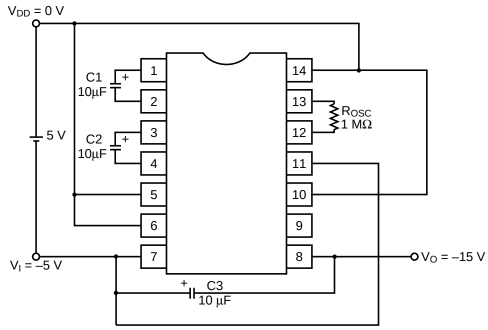
Voltage Tripler with Regulator

The following figure shows the circuit required to triple the input voltage, regulate the result and add a temperature gradient of –0.4%/°C. Note that the high input impedance of RV requires appropriate noise countermeasures.



Converting a Voltage Tripler to a Voltage Doubler

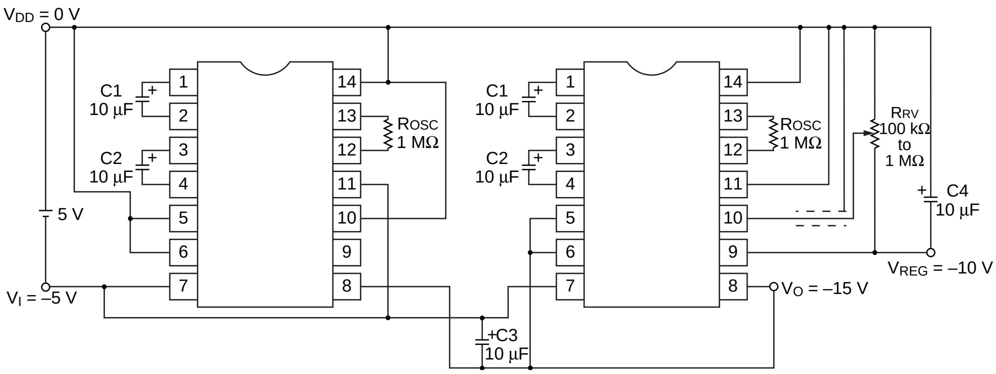
To convert this curcuit to a voltage doubler, remove capacitor C2 and short circuit CAP2– to VO.



Parallel Connection

Connecting two or more chips in parallel reduces the output impedance by 1/*n*, where *n* is the number of devices used.

Only the single output smoothing capacitor, C3, is required when any number of devices are connected in parallel. Also, the voltage regulator in one chip is sufficient to regulate the combined output.



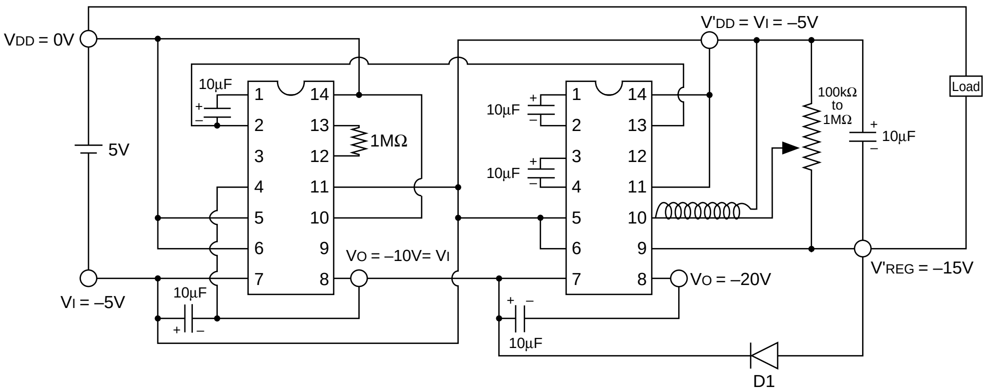
Serial Connection

Connecting two or more chips in series obtains a higher output voltage than can be obtained using a parallel connection, however, this also raises the output impedance.

<Precautions when connecting loads>

In case of series connections, when connecting loads between the first stage V_{DD} (or other potential of the second stage V_{DD} or up) and the second stage V_{REG} as shown in Fig. 2-13, be cautions about the following point.

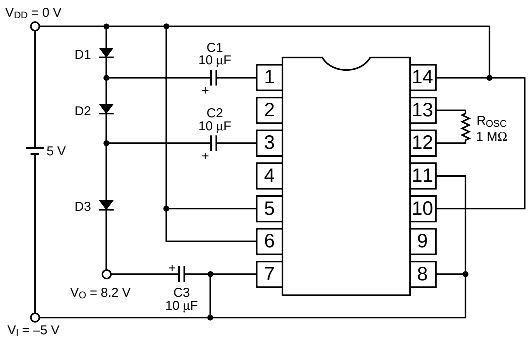
* When normal output is not occurring at the V_{REG} terminal such as at times of starting up or when turning the V_{REG} off by Poff signals, if current flows into the second stage V_{REG} terminal through the load from the first stage V_{DD} (or other potential of the second stage V_{DD} or up) to cause a voltage exceeding the absolute maximum rating for the second stage V_{DD} at the V_{REG} terminal, normal operation of the IC may be hampered. Consequently, When making a series connection, insert a diode D1 between the second stage V_I and V_{REG} as shown in Fig. 2-13 so that a voltage exceeding the second stage V_{DD} or up may not be applied to the V_{REG} terminal.



Positive Voltage Conversion

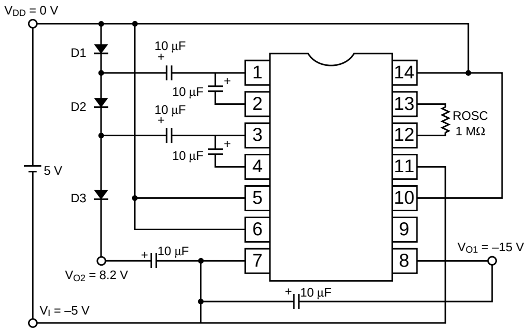
Adding diodes converts a negative voltage to a positive one.
To convert the voltage tripler shown earlier to a voltage doubler, remove C2 and D2, and short circuit D3. Small Schottky diodes are recommended for all three diodes. The resulting voltage is lowered by V_F, the voltage drop in the forward direction for each diode used. For example, if V_{DD} = 0V, V_I = –5V, and V_F = 0.6V, the resulting voltages would be as follows.

- For a voltage tripler,
  $V_O = 10 - (3 \times 0.6) = 8.2V$
- For a voltage doubler,
  $V_O = 5 - (2 \times 0.6) = 3.8V$



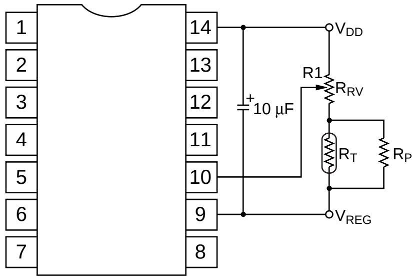
Simultaneous Voltage Conversion

Combining a standard voltage tripler circuit with one for positive voltage conversion generates both –15 and 8.2V outputs from a single input, however, it also raises the output impedance.
A voltage doubler generates –10 and 3.8V outputs.

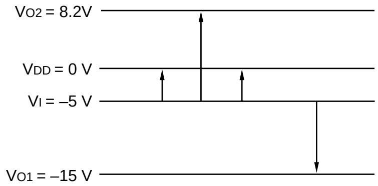


Using an External Gradient

The SCI7661C0B/M0B offers three built-in temperature gradients— –0.1, –0.4 and –0.6%/°C.
To set the gradient externally, place a thermistor, R_T, in series with the variable resistor, R_{RV}, used to adjust the output voltage.



Potential levels



DESCRIPTION

The SCI7654 C0A/M0A is a CMOS process, charge-pumping DC/DC converter and voltage regulator featuring the very high efficiency but low power consumption. An addition of four, three, or two external capacitors can generate four-, three- or two-time output voltage in negative direction than the input voltage. Also, the built-in voltage regulator can set any output voltage of DC/DC converter and can output the regulated voltage using two external resistances. As the regulator output can have a negative temperature gradient that is required for LCD panels, it is optimum for the LCD panel power supply.

FEATURES

- Charge-pumping, DC-to-DC converter (four-, three- or two-time negative boosting)
- Built-in voltage regulator (regulated voltage output circuit)
- High power conversion efficiency : 95%
- Low current consumption : 130 µA (V_I = –5.0 V during four-time boosting, Typ.)
- High output capacity : 20 mA (Max.)
- Input voltages : –2.4 to –5.5 V (during four-time boosting)
  : 2.4 to –7.3 V (during three-time boosting)
  : 2.4 to –11 V (during two-time boosting)
- DC/DC converter output voltage : |Input voltage| × 4 (Max.)
- Built-in reference voltage for high-precision regulator : 1.5 + –0.05 V (at CT0)
- Temperature gradient function of regulator output voltages : –0.04, –0.15, –0.35, –0.55 (%/°C)
- Low standby current (during power-off) : 5.0 µA
- Power-off by the external signal
- Full built-in oscillator circuit
- Lineup : SCI7654M0A, 16-pin SSOP
  : SCI7654C0A, 16-pin DIP

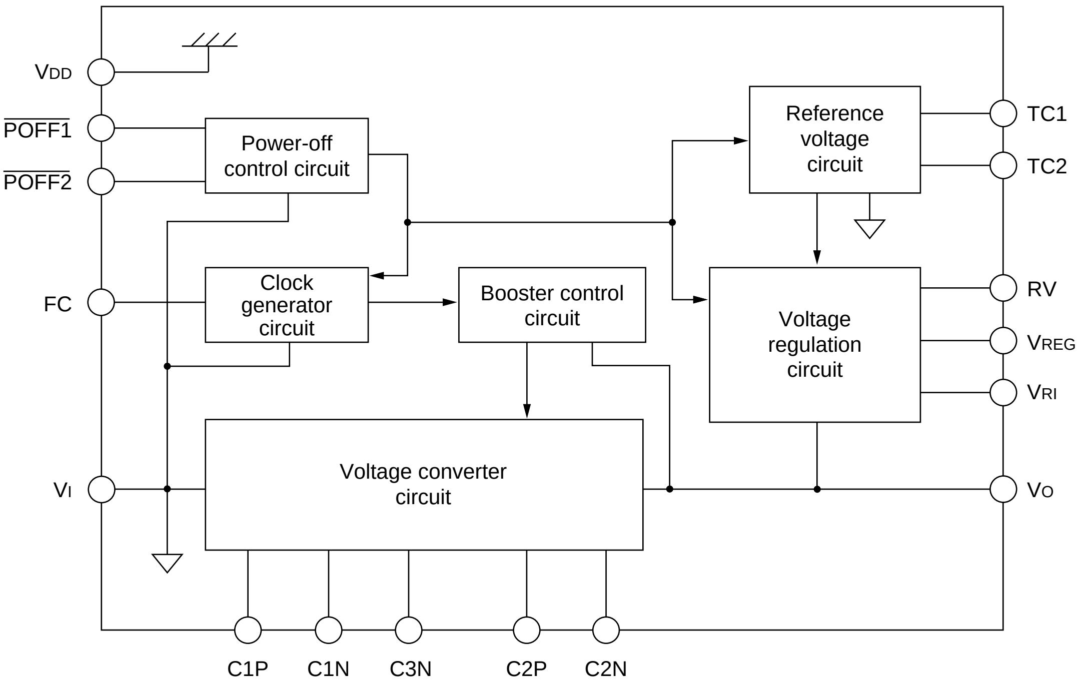
APPLICATIONS

- Power supply of medium- and small-capacity LCD panels
- Regulated power supply of battery driven devices

DC/DC Converter & Voltage Regulator

BLOCK DIAGRAM

Figure 2.1 Block diagram



PIN DESCRIPTION

Figure 2.2 SCI7654M0A/C0A pin assignment

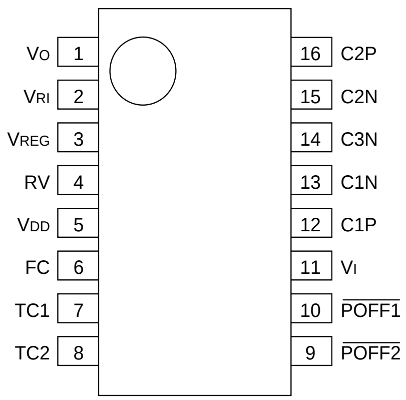


Table 2.1 Functions of the terminal

Pin name	Pin No.	PAD No.	Function
V_O	1	18	Four-time booster output
V_{RI}	2	19	Regulator input
V_{REG}	3	20	Regulator output
R_V	4	21	Regulator output voltage adjustment input
V_{DD}	5	22, 23	Power pin (positive)
FC	6	24	Internal clock frequency input, and clock input in serial/parallel connection
TC1	7	3	Regulator output temperature gradient setup input (1)
TC2	8	4	Regulator output temperature gradient setup input (2)
$\overline{\text{POFF2}}$	9	5	Power-off control input (2)
$\overline{\text{POFF1}}$	10	6	Power-off control input (1)
V_I	11	11, 12	Power voltage (negative)
C1P	12	13	Two- or four-time booster capacitor positive pin
C1N	13	14	Two-time booster capacitor negative pin
C3N	14	15	Four-time booster capacitor negative pin
C2N	15	16	Three-time booster capacitor negative pin
C2P	16	17	Three-time booster capacitor positive pin

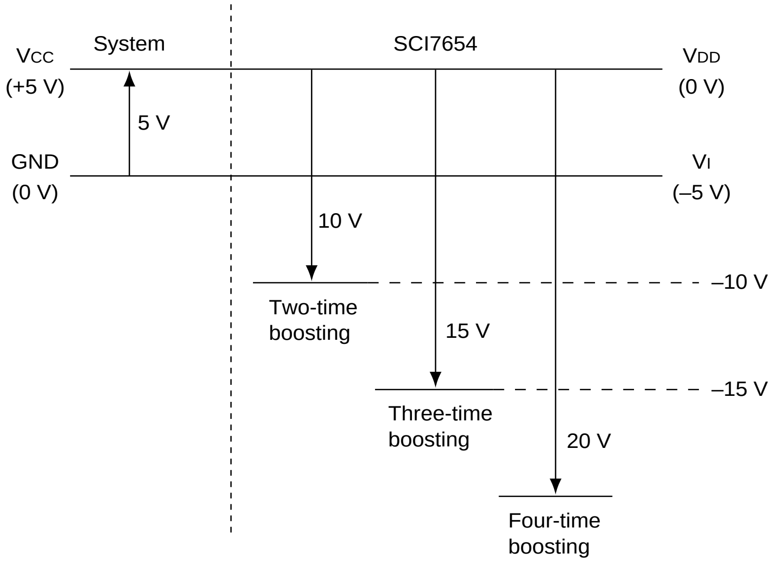
Table 2.2 Absolute maximum ratings

V_{DD} reference

Parameter	Symbol	Rating		Unit	Remarks
		Min.	Max.		
Input power voltage	V_I	–26.0/N	V_{DD} + 0.3	V	N = Boost time V_I pin
Input pin voltage	V_1	V_I – 0.3	V_{DD} + 0.3	V	$\overline{POFF1}$, $\overline{POFF2}$, TC1, TC2 and FC pins
Output pin voltage 1	V_{OC1}	V_I – 0.3	V_{DD} + 0.3	V	C1P and C2P pins
Output pin voltage 2	V_{OC2}	2 × V_I – 0.3	V_I + 0.3	V	C1N pin
Output pin voltage 3	V_{OC3}	3 × V_I – 0.3	2 × V_I + 0.3	V	C2N pin
Output pin voltage 4	V_{OC4}	4 × V_I – 0.3	3 × V_I + 0.3	V	C3N pin
Regulator input power voltage	V_{RI}	N × V_I – 0.3	V_{DD} + 0.3	V	N = Boost time, V_{RI} pin
Regulator input pin voltage	V_{RV}	N × V_I – 0.3	V_{DD} + 0.3	V	N = Boost time, RV pin
Output voltage	V_O	N × V_I – 0.3	V_{DD} + 0.3	V	N = Boost time V_O and V_{REG} pins
Input current	I_I		80	mA	V_I pin
Output current	I_O		N ≤ 4: 20 N > 4: 80/N	mA	N = Boost time V_O and V_{REG} pins
Allowable loss	Pd		210	mW	Ta ≤ 25°C
Operating temperature	Topr	–30	85	°C	
Storage temperature	Tstg	–55	150	°C	
Soldering temperature and time	Tsol		260 • 10	°C • S	At leads

Notes:
1. An operation exceeding the above absolute maximum ratings may cause a malfunction or permanent damage of devices. The device reliability may drop excessively even if the devices temporarily operate normally.
2. Electrical potential to peripheral systems:
   The SCI7654 common power supply has the highest potential (V_{DD}). The electrical potential given by this specification is based on V_{DD} = 0 V. Take care to avoid a potential problem during connection to a peripheral system.

Figure 2.3 Potential relationship



ELECTRICAL CHARACTERISTICS

Table 2.3 DC characteristics (1)

Ta = –30°C to +85°C, V_{DD} = 0 V, V_I = –5.0 V
unless otherwise noted

Parameter	Symbol	Characteristics	Min.	Typ.	Max.	Unit
Input power voltage	V_I	N = Boost time if CT0 is selected	–22/N		–2.4	V
		N = Boost time if CT1 is selected	–22/N		–2.4	V
		N = Boost time if CT2 is selected	–22/N		–2.4	V
		N = Boost time if CT3 is selected	–22/N		–2.4	V
Boost start input power voltage	V_{STA}	N = Boost time, FC = V_{DD} during no loading	–22/N		–2.4	V
Boost output voltage	V_O		–22			V
Regulator input voltage	V_{RI}		–22		–2.4	V
Regulator output voltage	V_{REG}	I_{REG} = 0, V_{RI} = –22 V R_{RV} = 1MΩ			–2.4	V

Table 2.3 DC characteristics (2)

Ta = –30°C to +85°C, V_{DD} = 0 V, V_I = –5.0 V
unless otherwise noted

Parameter	Symbol	Characteristics	Min.	Typ.	Max.	Unit
Boost output impedance	R_O	I_O = 10 mA, V_I = –5.0 V during 4-time boosting C1, C2, C3, C_O = 10 μF (tantalum)		200	300	Ω
		I_O = 10 mA, V_I = –3.0 V, Ta = 25°C during 4-time boosting C1, C2, C3, C_O = 10 μF (tantalum)		250	300	Ω
Boost power conversion efficiency	Peff	I_O = 2 mA, V_I = –5.0 V during 4-time boosting C1, C2, C3, C_O = 10 μF (tantalum)		95		%
		I_O = 2 mA, V_I = –3.0 V, Ta = 25°C during 4-time boosting C1, C2, C3, C_O = 10 μF (tantalum)		94		%
Booster operation current consumption 1	I_{opr1}	FC = V_{DD}, $\overline{POFF1}$ = V_I, $\overline{POFF2}$ = V_{DD}, V_I = –5.0 V during no loading C1, C2, C3, C_O = 10 μF (tantalum)		130	220	μA
		FC = V_{DD}, $\overline{POFF1}$ = V_I, $\overline{POFF2}$ = V_{DD}, V_I = –3.0 V, Ta = 25°C during no loading C1, C2, C3, C_O = 10 μF (tantalum)		90	150	μA
Booster operation current consumption 2	I_{opr2}	FC = V_I, $\overline{POFF1}$ = V_I, $\overline{POFF2}$ = V_{DD}, V_I = –5.0 V during no loading C1, C2, C3, C_O = 10 μF (tantalum)		520	880	μA
		FC = V_I, $\overline{POFF1}$ = V_I, $\overline{POFF2}$ = V_{DD}, V_I = –3.0 V, Ta = 25°C during no loading C1, C2, C3, C_O = 10 μF (tantalum)		360	600	μA
Regulator operation current consumption	I_{OPVR}	V_{RI} = –20 V, R_{RV} = 1 MΩ during no loading		10	15	μA
Static current	I_Q	$\overline{POFF1}$ = V_I, $\overline{POFF2}$ = V_I FC = V_{DD}			5.0	μA
Input leakage current	I_{LI}	Pins used: $\overline{POFF1}$, $\overline{POFF2}$, FC, TC1, TC2			0.5	μA
Regulated output saturation resistance	R_{SAT} (*1)	0 < I_{REG} < 20 mA R_V = V_{DD} Ta = 25°C		10	20	Ω
Regulated output voltage stability	ΔV_R (*2)	–20 V < V_{RI} < –10 V, I_{REG} = 1 mA V_{REG} = –9 V Ta = 25°C			0.2	%/V

Table 2.3 DC characteristics (3)

Ta = –30°C to +85°C, V_{DD} = 0 V, V_I = –5.0 V
unless otherwise noted

Parameter	Symbol	Characteristics	Min.	Typ.	Max.	Unit
Regulated output load variation	ΔV_O (*3)	V_{RI} = –20 V, V_{REG} = –15 V, Ta = 25°C setup 0 < I_{REG} < 20 mA		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_I	–1.70	–1.50	–1.30	V
	V_{REF2}	TC1 = V_I, TC2 = V_{DD}	–1.90	–1.50	–1.10	V
	V_{REF3}	TC1 = V_I, TC2 = V_I	–2.15	–1.50	–0.85	V
Reference voltage temperature coefficient (*4, *5)	CT0	TC1 = V_{DD}, TC2 = V_{DD}, SSOP product	–0.07	–0.04	0	%/°C
	CT1	TC1 = V_{DD}, TC2 = V_I, SSOP product	–0.25	–0.15	–0.07	%/°C
	CT2	TC1 = V_I, TC2 = V_{DD}, SSOP product	–0.45	–0.35	–0.20	%/°C
	CT3	TC1 = V_I, TC2 = V_I, SSOP product	–0.75	–0.55	–0.30	%/°C
Input voltage level	V_I	V_I = –2.4 to –5.5 V Pins used: $\overline{POFF1}$, $\overline{POFF2}$, FC, TC1, TC2	0.2 V_I			V
	V_{IL}	V_I = –2.4 to –5.5 V Pins used: $\overline{POFF1}$, $\overline{POFF2}$, FC, TC1, TC2			0.8 V_I	V
Booster capacitance	CMAX	Capacitors used: C1, C2 and C3			47	µF

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

*2 $\Delta V_R = \dfrac{V_{REG}\,(V_{RI} = -20\text{ V}) - V_{REG}\,(V_{RI} = -10\text{ V})}{\Delta V_{RI} \bullet V_{REG}\,(V_{RI} = -10\text{ V})}$

*3 $\Delta V_O = \dfrac{V_{REG}\,(I_{REG} = 20\text{ mA}) - V_{REG}\,(I_{REG} = 0\text{ mA})}{\Delta I_{REG}}$

*4 $CT = \dfrac{|\,V_{REF}\,(50°C)\,| - |\,V_{REF}\,(0°C)\,|}{50°C - 0°C} \times \dfrac{100}{|\,V_{REF}\,(25°C)\,|}$

*5 The reference voltage and temperature coefficient of the chip products may vary depending on the moldings used on each chip. Use these chips only after the temperature test.

Table 2.4 AC characteristics

V_{DD} = 0 V and V_I = –5.0 V
unless otherwise noted

Parameter	Symbol	Characteristics		Min.	Typ.	Max.	Unit
Internal clock frequency 1	f_{CL1}	FC = V_{DD}, $\overline{\text{POFF1}}$ = V_I $\overline{\text{POFF2}}$ = V_{DD} Pin used: C1P	Ta = 25°C	3.0	4.0	6.0	kHz
			Ta = –30°C to +85°C	2.0	4.0	7.0	kHz
Internal clock frequency 2	f_{CL2}	FC = V_I, $\overline{\text{POFF1}}$ = V_I $\overline{\text{POFF2}}$ = V_{DD} Pin used: C1P	Ta = 25°C	12.0	16.0	24.0	kHz
			Ta = –30°C to +85°C	8.0	16.0	28.0	kHz

EXPLANATION OF FUNCTIONS

Clock Generator Circuit

As the SCI7654 has a built-in clock generator circuit, no more parts are required for voltage boost control. The clock frequency changes according to the FC pin voltage level as defined on Table 2.5. Low Output mode or High Output mode is selectable. This allows frequency selection according to the used capacitance and load current as the boost output impedance changes depending on the clock frequency and external booster capacitance. However, the High Output mode has the current consumption approximately four times larger than the Low Output mode.

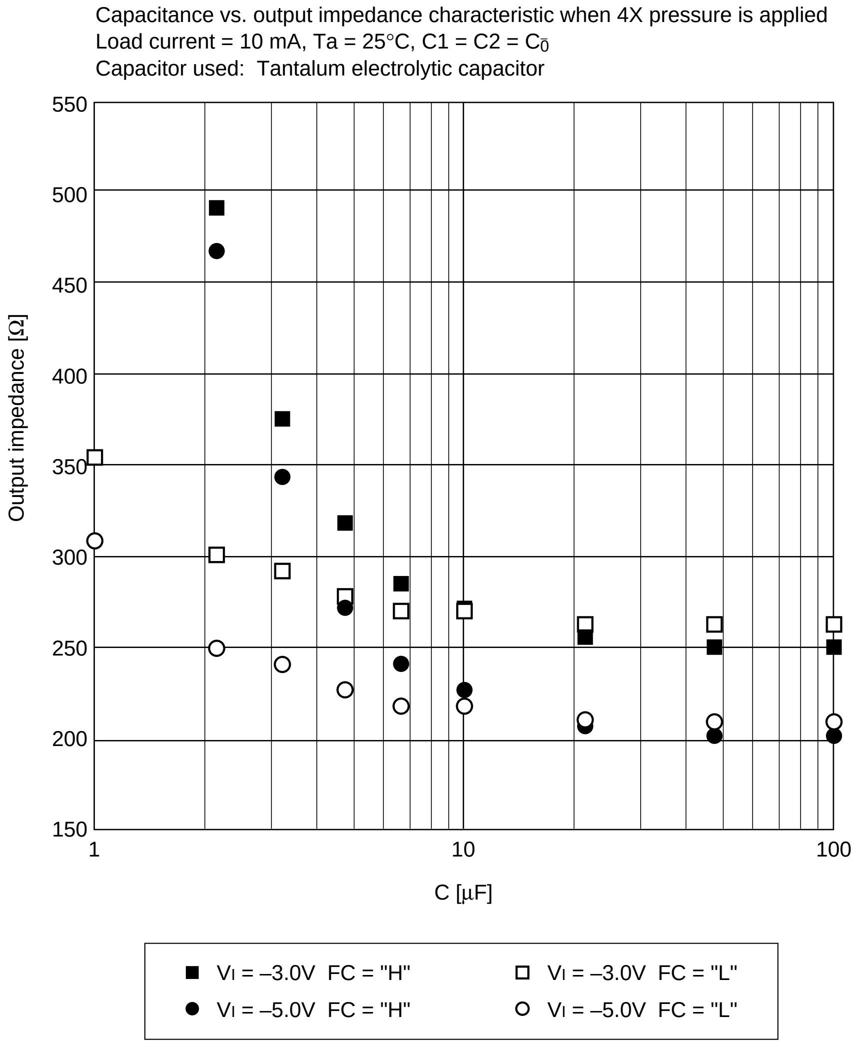
Table 2.5 FC pin setup

FC pin	Mode	Clock frequency	Characteristics			
			Current consumption	Output ripple	Output impedance	Capacitance
H (V_{DD})	Low Output	4.0 kHz (Typ.)	I_{OP} (*1)	V_{RR} (*2)	See Figure A1.	See Figure A1.
L (V_I)	High Output	16.0 kHz (Typ.)	I_{OP} × Approx. 4	V_{RI} × Approx. 1/4	See Figure A1.	See Figure A1.

*1 See the DC characteristics table for current consumption.
*2 See Section Page 2-32 for the output ripple definition and calculation.

Figure A1 Characteristic chart: Capacitance vs. output impedance when 4X pressure is applied

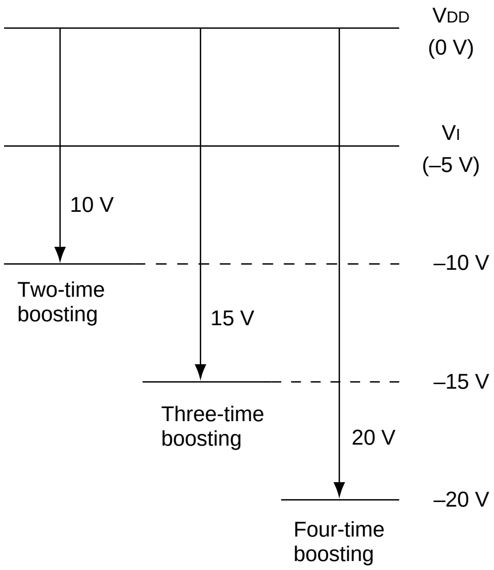
NOTE: This characteristic chart simply indicates an approximate trend in the characteristics, which may vary depending on evaluation environment, parts used, and other factors.



Voltage Converter

The voltage converter, consisting of a boost control circuit and a voltage converter circuit, receives clocks from the clock generator circuit and boosts the input power voltage (V_I) four, three or two times. During four-time boosting, however, the three-time and two-time boost outputs cannot be obtained simultaneously. Figure 2.4 gives the potential relationship during four-, three- and two-time boosting. The C2P pin is also used as the master clock output during parallel connection.

Figure 2.4 Electrical potentials during boosting (at -5V input)



Caution:

- When connecting a capacitor to the C1P, C2P, C1N, C2N, C3N, or V_O pin for voltage conversion, close the capacitor to the IC package as much as possible to minimize the wiring length.

Reference Voltage Circuit

The SCI7654 has a built-in reference voltage circuit for voltage regulation. The regulated voltage (explained in the next "voltage regulator circuit" section) is set depending on the division ratio between this reference voltage and the external resistance. The reference voltage can be used to change the temperature coefficient at pins TC1 and TC2. One of four states can be selected as listed on Table 2.6.

Table 2.6 Setup of reference voltage and temperature coefficient

Mode	TC1 (H = V_{DD}) (L = V_I)	TC2 (H = V_{DD}) (L = V_I)	Reference voltage, V_{REF} (V)			Temperature coefficient, CT (%/°C)		
			Min.	Typ.	Max.	Min.	Typ.	Max.
CT0	H	H	–1.55	–1.5	–1.45	–0.07	–0.04	0
CT1	H	L	–1.70	–1.5	–1.30	–0.25	–0.15	–0.07
CT2	L	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

Notes:
1. The reference voltage is given at Ta = 25°C.
2. The reference voltage and temperature coefficient of the chip products may vary depending on the moldings used on each chip. Use these chips only after the temperature test.

The temperature coefficient (CT) is defined by the following equation. The negative sign of the temperature coefficient (CT) means that the $|V_{REF}|$ value decreases when the temperature rises.

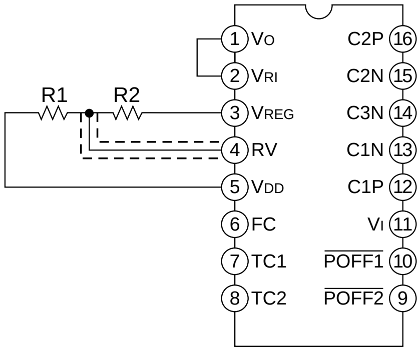
$$CT = \frac{|V_{REF}(50°C)| - |V_{REF}(0°C)|}{50°C - 0°C} \times \frac{100}{|V_{REF}(25°C)|}$$

Notes on TC1 and TC2 pin replacement:
- When replacing the TC1 and TC2 pins after power-on, always select the power-off mode ($\overline{POFF1} = \overline{POFF2} = V_I$) and replace them by each other.

Voltage Regulator Circuit

The voltage regulator circuit regulates a voltage entered in the V_{RI} pin and can output any voltage. It uses the series voltage regulation. As shown in Figure 2.5, the V_{RI} and V_O pins must be short-circuited by a jumper as short as possible except for larger time boosting by using external diodes.
As shown by equation (1), any output voltage can be set by the ratio of external division resistors R1 and R2. The sum of division resistance is recommended to be small as possible to avoid an external noise interference. As the current consumed by division resistors (equation (2)) flows, the 100 ohms to 1M ohms are recommended to use.
The temperature coefficient of the regulated voltage is equal to the temperature coefficient of the reference voltage that is explained in the "reference voltage circuit" section.

Figure 2.5 VREG setup and mounting notes



Setup:

- Relationship between V_{REG} and reference voltage

$$V_{REG} = \frac{R1 + R2}{R1} \times \text{(Reference voltage)} \qquad \cdots\cdots \text{Equation (1)}$$

- Current consumption of division resistors

$$I_{REG} = \frac{|V_{REG}|}{R1 + R2} \qquad \cdots\cdots \text{Equation (2)}$$

Setup example:

- To output V_{REG} = –18 V by four-time boosting if V_I = –5 V and V_O = –20 V

First, determine the total resistance of division resistors R1 and R2. If the current consumption is assumed to be 20 µA, the total resistance can be obtained from equation (2) as follows:

R1 + R2 = 12V ÷ 20 µA = 900 kΩ

If the reference voltage is -1.5 V, the division resistance ratio can be obtained from equation (1) as follows:

(R1 + R2) / R2 = (–18 V) ÷ (–1.5 V) = 12

Therefore, R1 and R2 are:

R1 = 75 kΩ
R2 = 825 kΩ

Changing the temperature coefficient:

- The temperature coefficient of the regulated voltage depends on the temperature coefficient of the reference voltage (if the division ratio of setup resistors does not depend on the temperature). It is necessary to change the temperature coefficient using thermistors, resistors or others to set any other temperature coefficient of the regulated voltage. The following explains how to calculate the V_{REG} voltage in temperature T.

$$V_{REG}(T) = \left\{1 + \frac{C_{TR2} \times R2\,(T0)}{C_{TR1} \times R1\,(T0)}\right\} \times C_{TREF} \times (T - T0) \times V_{REF}\,(T0) \qquad \cdots\cdots \text{Equation (3)}$$

T_0	: 25°C
C_{TR1}	: Temperature coefficient of resistor R1 (Ratio to the value at 25°C)
C_{TR2}	: Temperature coefficient of resistor R2 (Ratio to the value at 25°C)
C_{TREF}	: Temperature coefficient of internal reference voltage (%/°C)
R1 (T_0)	: R1 value (Ω) at 25°C
R2 (T_0)	: R2 value (Ω) at 25°C
V_{REF} (T_0)	: Internal reference voltage (V) at 25°C

If the temperature coefficient of R1 and R2 is identical in equation (3), the V_{REG} voltage depends on the temperature coefficient of internal reference voltage only.

Application notes on voltage regulator circuit:

- To satisfy the absolute maximum ratings of the SCI7654, the setup resistor(s) must be inserted between V_{DD} and V_{REG} pins of the SCI7654 that uses the voltage regulator. The SCI7654 IC itself may be degraded or destroyed if the R1 resistor is connected to pin V_{DD} of SCI7654 that does not use the regulator during serial connection.
- The regulation voltage adjustment input (pin RV) has the very high input impedance, and its noise insertion can drop the regulator stability. As shown in Figure 2.5, shield the cable between the division resistor and RV pin or use a cable as short as possible between them.

Power-off Control Function

The SCI7654 has the power-off function and turns on or off each circuit function when control signals are entered in the $\overline{\text{POFF1}}$ and $\overline{\text{POFF2}}$ pins from an external system (such as microprocessor) as defined on Table 2.7. This power-off function can also cut the reactive current in parallel connection and other application circuits.

To use the dual-state, power-off control (all ON and all OFF states) only, connect pin $\overline{\text{POFF2}}$ to pin V_I and use only pin $\overline{\text{POFF1}}$ for power-off control.

Table 2.7 Available combination of power-off control

Mode	$\overline{\text{POFF1}}$ (H = V_{DD}) (L = V_I)	$\overline{\text{POFF2}}$ (H = V_{DD}) (L = V_I)	Functions: Oscillator	Functions: Booster circuit	Functions: Regulator circuit	Applications
PS1	H	L	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 unit side of parallel connection (Booster and regulator)
PS4	L	H	On	On	Off	Master unit side of parallel connection (Booster only)

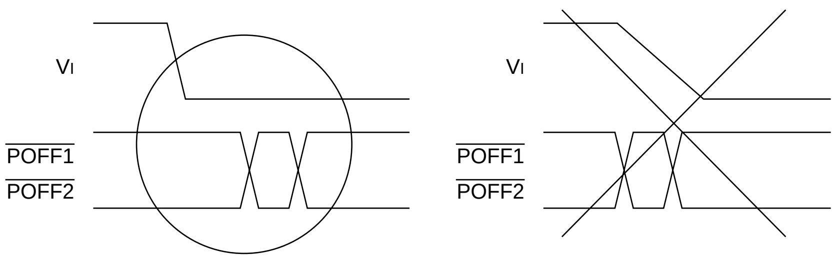
*1 When the booster circuit is off, approximately V_I + 0.6 V voltage appears at V_O pin.

*2 When the regulator is off, the V_{REG} pin becomes high-impedance state.

Application notes on power-off function:

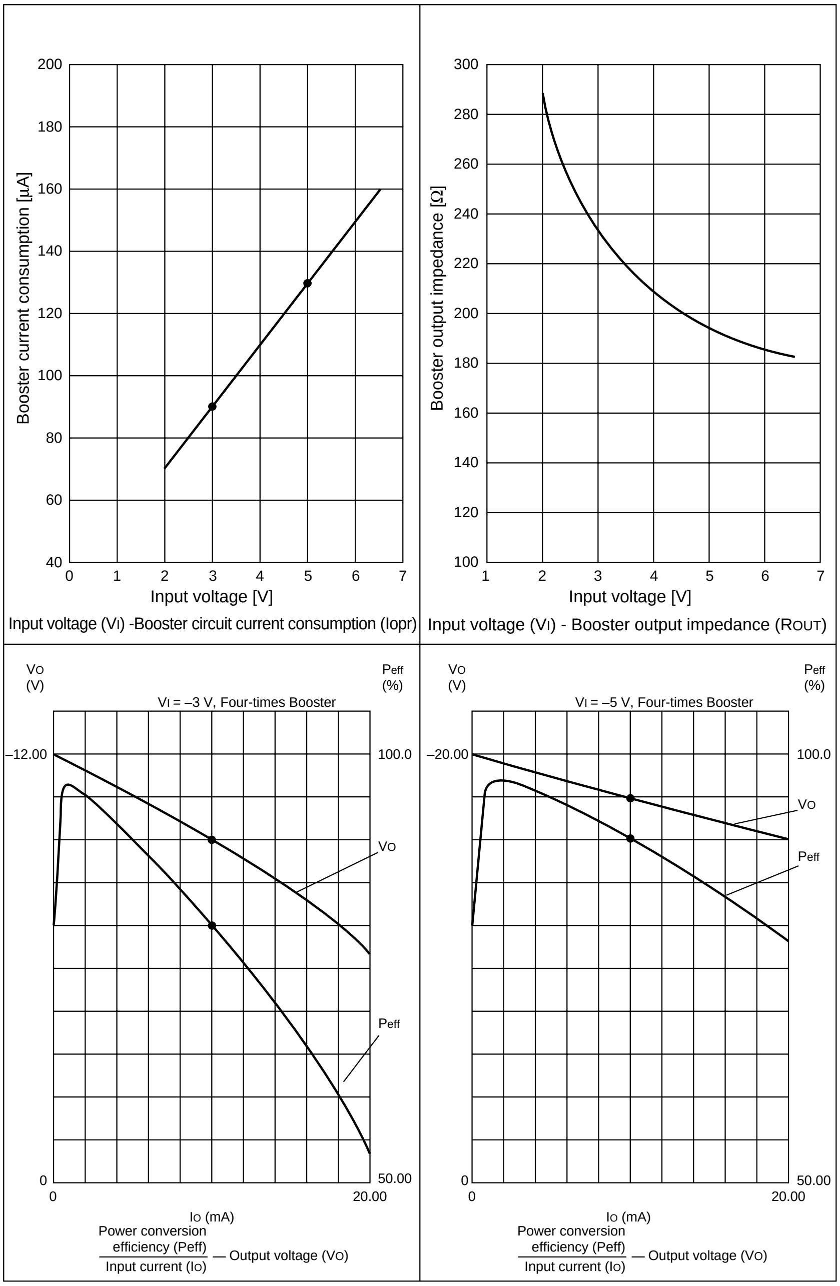
- When using external system signals for power-on control, start to control the power only when V_I voltage becomes stable after power-on. Unstable V_I voltage may destroy the IC permanently during on/off control.

Figure 2.6 Start timing of power-off control



CHARACTERISTICS GRAPHICS

Figure 2.7 Characteristics graphics

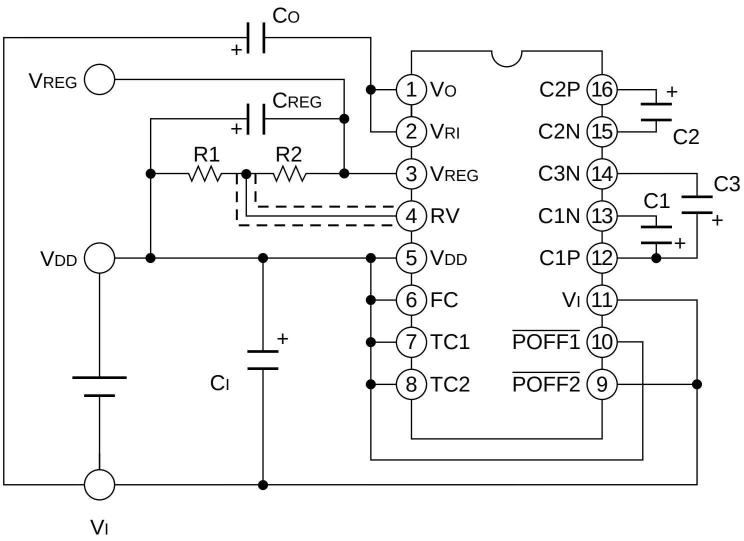


APPLICATION CIRCUIT EXAMPLES

Four-time Booster and Regulator

Figure 2.8 gives a wiring example of four-time booster and regulator that is the typical SCI7654 application. This example boosts the input voltage (VI) four times in negative direction, and outputs the regulated voltage at VREG pin.

Figure 2.8 Wiring example of 4-time booster and regulator



◊ Setup conditions of Figure 2.8
- Internal clock : On (Low Output mode)
- Booster circuit : On
- Regulator : On (if CT = –0.04%/°C)

◊ Power-off procedure
- Set the $\overline{\text{POFF1}}$ pin to logical low (VI) to turn off all circuits.

◊ Regulator
- For the regulator setup and notes, see the “voltage regulator circuit” section.

◊ Application in other setup conditions

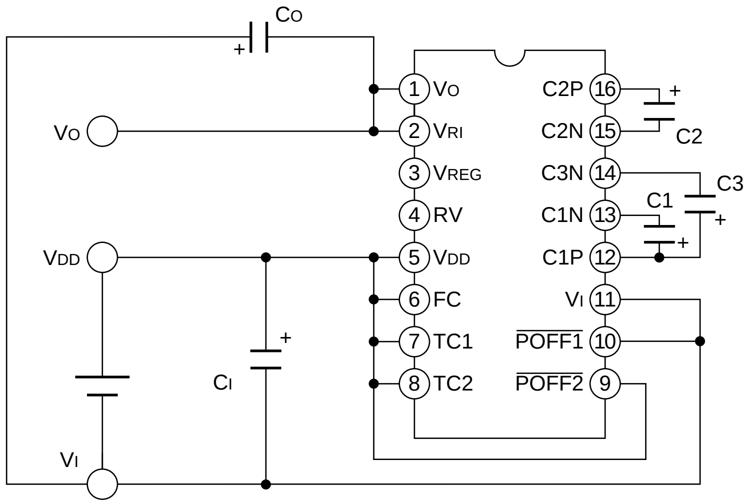
① When used in the High Output mode
- Connect the FC pin to the VI pin.

② When changing the temperature coefficient (CT)
- Change the TC1 and TC2 pin setup by following the definition of Table 2.7.

4-time Booster

Only the booster circuit operates, and it boosts the input voltage (V_I) four times in negative direction and outputs it at the V_O pin. As the regulator is not used, the voltage appearing at the V_O pin may contain ripple components. Figure 2.9 gives a wiring example.

Figure 2.9 Wiring example of 4-time booster

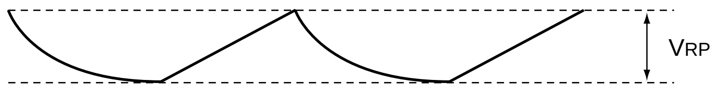


◇ Setup conditions of Figure 2.9
- Internal clock : On (Low Output mode)
- Booster circuit : On
- Regulator : Off

◇ Power-off procedure
- Set the $\overline{\text{POFF2}}$ pin to low (V_I) to turn off all circuits.

◇ Ripple voltage
- As the output at V_O pin is unstable, it can contain ripple components as shown in Figure 2.10. The ripple voltage (V_{RP}) increases according to the load current, and it can roughly be calculated by equation (4).

Figure 2.10 Ripple waveforms



$$V_{RP} = \frac{I_O}{2 \cdot f_{CL} \cdot C_O} + I_O \cdot R_{COUT} \quad \cdots\cdots \text{Equation (4)}$$

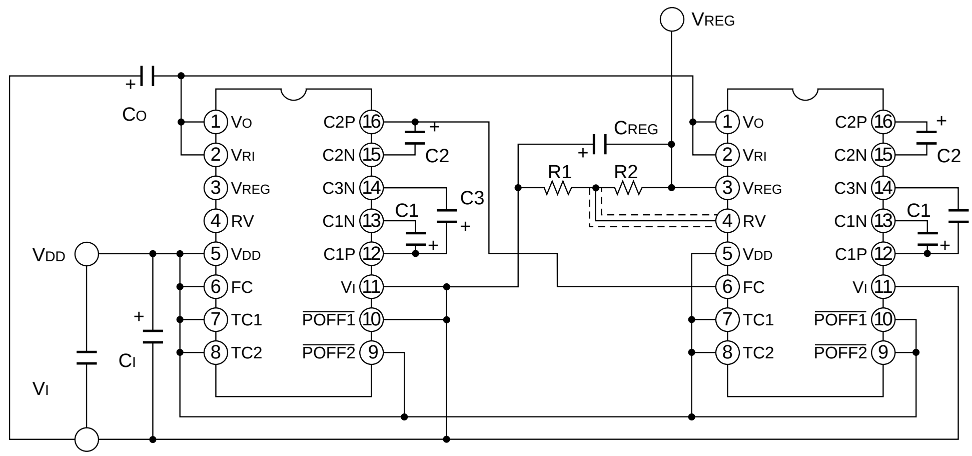
where,
I_O : Load current (A)
f_{CL} : Clock frequency (Hz)
R_{COUT} : Serial equivalent resistance (Ω) of output capacitor C_O

◊ Application in other setup conditions
① When used in the High Output mode
• Connect the FC pin to the V_I pin.

Parallel Connection (for Increased Boosting)

The parallel connection is useful for reduction of booster output impedance or reduction of ripple voltage. In the parallel connection of "n" lines, the booster output impedance can be reduced to approximately "1/n". Only the smoothing capacitor (C_O) for booster output can be used commonly in the parallel connection. When using the regulator, use only one of "n" SCI7654 chips which are in parallel connection. (If multiple regulators are operated in parallel mode, the reactive current consumption occurs.) Figure 2.11 gives a wiring example of 4-time booster and regulator where two SCI7654's are parallelly connected.

Figure 2.11 Parallel connection example



◊ Setup conditions of Figure 2.11

First stage		Second stage	
• Internal clock	: On (Low Output mode)	• Internal clock	: Off
• Booster circuit	: On	• Booster circuit	: On
• Regulator	: Off	• Regulator	: On (if CT = –0.04%/°C)

◊ Power-off procedure
- In Figure 2.11, when the $\overline{\text{POFF2}}$ pin of the first-stage SCI7654 is set to low (V_I), voltage boosting is stopped at the first and second stages. However, the regulator at the second stage does not stop. Therefore, the voltage that is approximately V_I appears at V_{REG} pin during $|V_{REG}| \geq |V_I|$ setup.
- To set the V_{REG} pin to high-impedance state, set both $\overline{\text{POFF1}}$ and $\overline{\text{POFF2}}$ pins to low at the first and second stages.

◊ Application in other setup conditions
① When used in the High Output mode
- Connect the FC pin of the first-stage SCI7654 to the V_I pin.

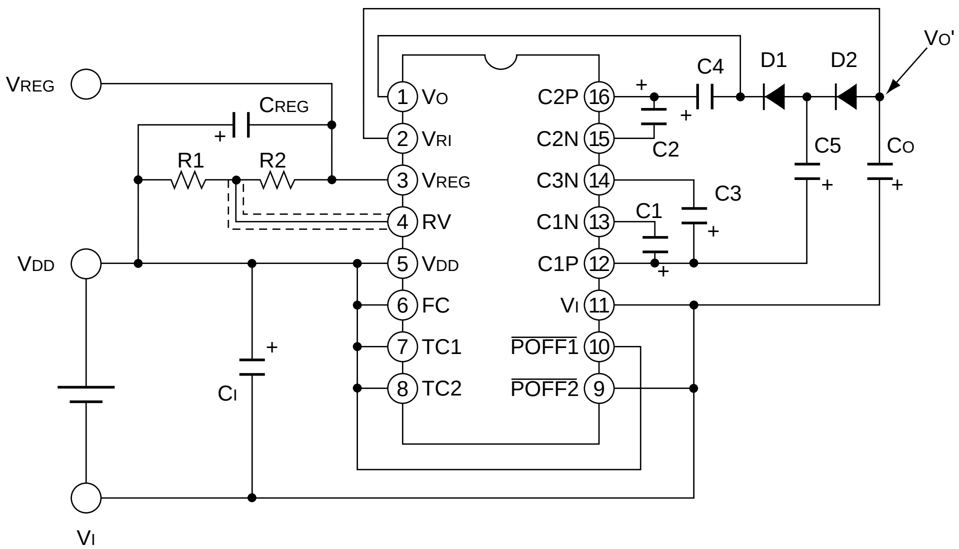
② When changing the temperature coefficient (CT)
- Change the TC1 and TC2 pin setup by following the definition of Table 2.7.

Larger Time Boosting Using Diodes

The SCI7654 can be configured to have the five-time or larger voltage boosting and regulation by adding external diodes. As the booster output impedance increases due to the diode forward voltage drop (V_F), the diodes having a smaller V_F are recommended to use.

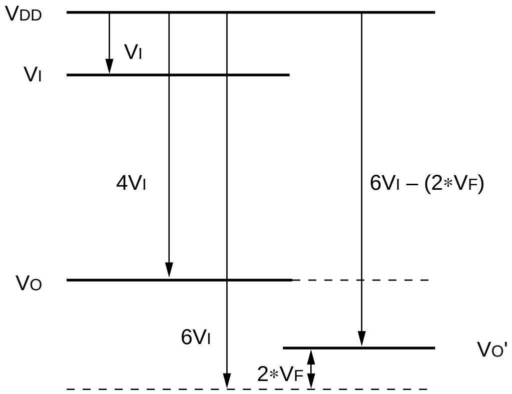
Figure 2.12 gives a wiring example of 6-time booster and regulator that use two diodes. The wiring between V_O and V_{RI} must be minimal. Figure 2.13 provides the potential relationship.

Figure 2.12 Wiring example for 6-time boosting using diodes



◊ Setup conditions of Figure 2.12
• Internal clock : On (Low Output mode)
• Booster circuit : On
• Regulator : On (if CT = –0.04%/°C)

Figure 2.13 Potential relationship during 6-time boosting using diodes



◊ Power-off procedure
• Set the $\overline{\text{POFF1}}$ pin to low (V_I) to turn off all circuits.

◊ Output voltages
• When diodes are used for voltage boosting, the characteristics of diodes directly affect on the voltage boosting characteristics. The forward voltage drop (V_F) of diodes can reduce the booster output voltage. As the example of Figure 2.12 uses two diodes, the drop of "V_F" voltage multiplied by two occurs as shown in Figure 2.13. The booster output voltage is expressed by equation (5).
To increase the $|V_O'|$ value, use the diodes having a smaller V_F.

$$| V_O' | = 6 \times | V_I | - 2 \times V_F \qquad \cdots\cdots \text{Equation (5)}$$

◊ Notes
① Input and output current conditions
To satisfy the input and output current ratings, limit the total current does not exceed the rated input current. The total current means the total boost time multiplied by the output load current. The example of Figure 2.12 has the maximum load current of 13.3 mA (= 80 mA divided by 6).

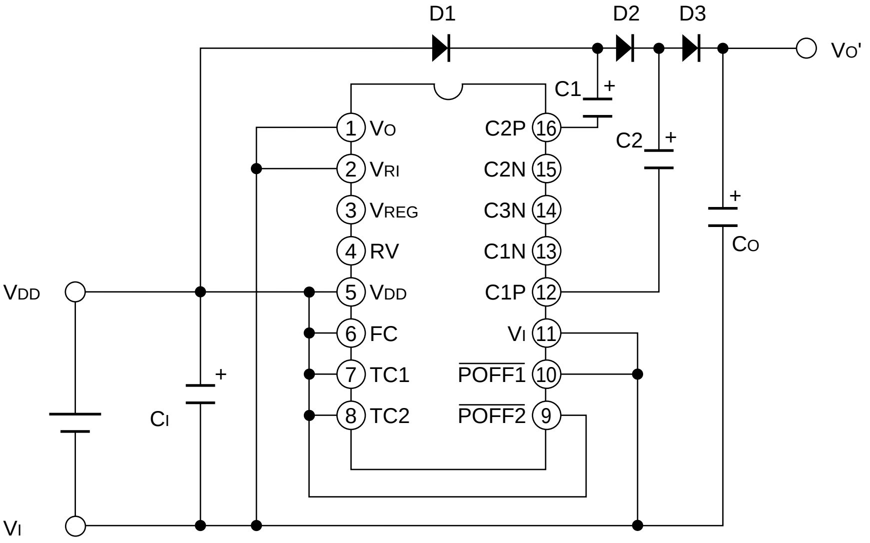
② Input and output voltage conditions
To satisfy the input and output voltage ratings, take care not to violate the electric potential relationship of higher time boosting using diodes. The example of Figure 2.12 must have the "V_I" that can satisfy the input voltage conditions during 6-time boosting (see Table 2.3).

◊ Application in other setup conditions
① When used in the High Output mode
Connect the FC pin to the V_I pin.
② When changing the temperature coefficient (CT)
Change the TC1 and TC2 pin setup by following the definition of Table 2.7.

Positive Voltage Conversion

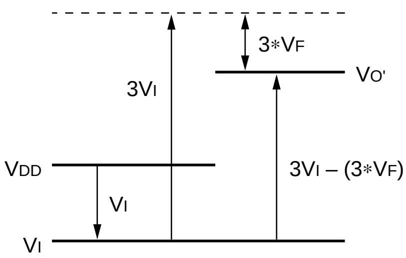
The SCI7654 can also boost up a voltage to the positive potential using external diodes. In such case, however, the regulator function is unavailable. Figure 2.14 gives a wiring example for three-time positive boosting, and Figure 2.15 provides its electrical potential relationship.

Figure 2.14 Wiring example of positive voltage conversion (3-time boosting)



◊ Setup conditions of Figure 2.14
- Internal clock : On (Low Output mode)
- Booster circuit : On
- Regulator : Off

Figure 2.15 Potential relationship during positive voltage conversion (3-time boosting)



◊ Power-off procedure
- Set the $\overline{\text{POFF2}}$ pin to low (V_I) to turn off all circuits.

◊ Two-time boosting
- To boost up a voltage two times, remove capacitor C1 and diode D1 of Figure 2.14, and connect the anode of diode D2 to the V_{DD} pin.

◊ Output voltages

- When diodes are used for voltage boosting, the characteristics of diodes directly affect on the voltage boosting characteristics. The forward voltage drop (V_F) of diodes can reduce the booster output voltage. As the example of Figure 2.14 uses three diodes, the drop of "V_F" voltage multiplied by three occurs. The booster output voltage is expressed by equation (5).
  To increase the $|V_O'|$ value, use the diodes having a smaller V_F.

$$|V_O'| = 3 \times |V_I| - (3 \times V_F) \qquad \cdot\cdot\cdot\cdot \text{ Equation (6)}$$

◊ Notes

① Input and output current conditions
To satisfy the input and output current ratings, take care to limit the input current below the ratings.

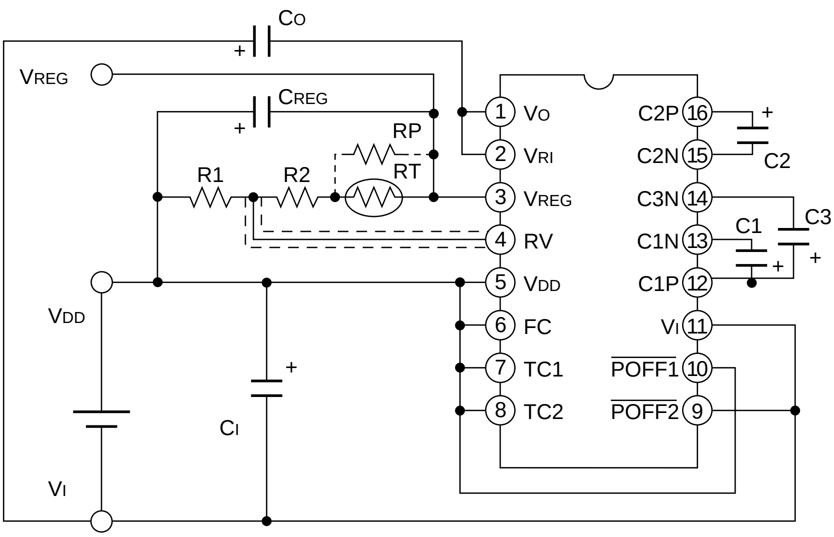
② Input and output voltage conditions
During forward voltage conversion, the input voltage ratings are the same as two-time negative voltage boosting (see Table 2.3).

◊ Application in other setup conditions
When used in the High Output mode, connect the FC pin to the V_I pin.

Wiring Example When Changing the Regulator Temperature Coefficient

The temperature coefficient of the regulator depends on the temperature coefficient of the internal reference voltage. To set another temperature coefficient, use a thermistor resistor or others as shown in Figure 2.16.

Figure 2.16 Wiring example when changing the regulator temperature coefficient



◊ Setup conditions of Figure 2.16
- Internal clock : On (Low Output mode)
- Booster circuit : On
- Regulator : On
- Thermistor resistor : RT

◊ Power-off procedure
- Set the $\overline{\text{POFF1}}$ pin to low (V_I) to turn off all circuits.

◊ Regulator temperature coefficient
- For the regulator setup and notes, see the “voltage regulator circuit” section of the function.
- The thermistor resistor (RT) has the non-linear temperature characteristics. To correct them to the linear characteristics, insert the RP as shown Figure 2.16.

◊ Application in other setup conditions
- When used in the High Output mode, connect the FC pin to the V_I pin.

3.

SCI7810Y Series/SCI7910Y Series POWER SUPPLY IC

Voltage Regulator

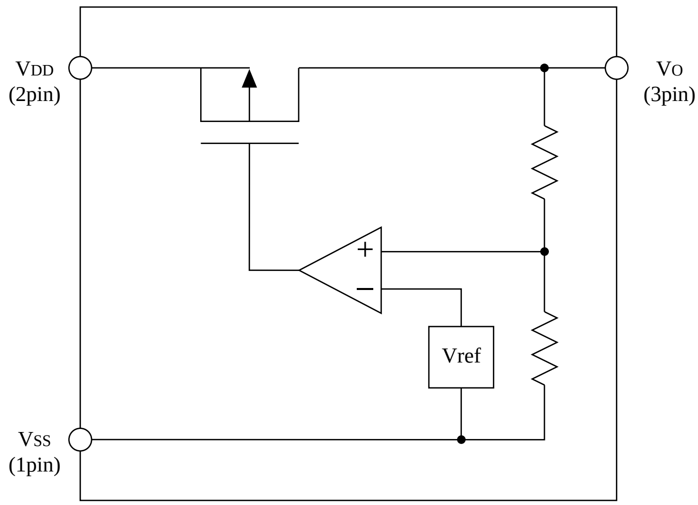
DESCRIPTION

The SCI7810Y series products are the fixed type positive voltage regulators being developed utilizing the CMOS silicon gate process. It is mainly consisted of the reference voltage circuit driven with low operating current, differential amplifier, transistor for output control and voltage setting resistor.
Output voltage is fixed on ICs. A wide variety of standard voltage products are prepared.
The package used is the SOT89-3 pins plastic package.

FEATURES

- A wide variety of lineups: 12 types are offered in the range of 2V to 6V.
- Low operating current: Typ. 1.5 μA (V_{DD} = 5.0V).
- Smaller difference between the input and output voltage: Typ. 0.02V (I_O = 10 mA, V_O = 5.0V).
- Built-in, highly stable reference voltage source: Typ. 1.0V.
- Smaller temperature factor on output voltage: Typ. –100 ppm/°C.
- Wider operating voltage range: Maximum 15V.

BLOCK DIAGRAM



MODEL CLASSIFICATION

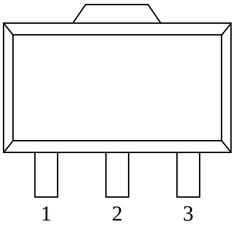
Product name	Output voltage		
	Min.	Typ.	Max.
SCI7810YAA	5.75	6.00	6.25
SCI7810YBA	4.90	5.00	5.10
SCI7810YMA	4.40	4.50	4.60
SCI7810YPA	3.90	4.00	4.10
SCI7810YKA	3.80	3.90	4.00
SCI7810YNA	3.43	3.50	3.57
SCI7810YTA	3.23	3.30	3.37
SCI7810YCA	3.13	3.20	3.27
SCI7810YDA	2.93	3.00	3.07
SCI7810YRA	2.73	2.80	2.87
SCI7810YLA	2.53	2.60	2.67
SCI7810YFA	2.15	2.20	2.25
SCI7810YGA	1.75	1.80	1.85
SCI7810YHA	1.45	1.50	1.55

PIN DESCRIPTION

Pin Function

Pin No.	Pin name	Pin function
1	V_{SS}	Input voltage pin (negative side)
2	V_{DD}	Input voltage pin (positive side)
3	V_O	Output voltage pin

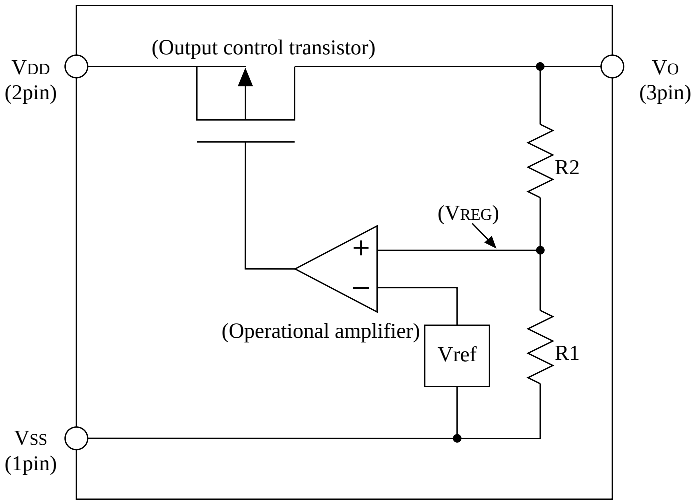
Pin Layout



DESCRIPTION OF FUNCTION

The SCI7810Y series products are the fixed type positive output voltage regulators. They employ the series regulation approach using CMOS transistors between the input and output for control of the output.
The voltage divided by the built-in resistors R1 and R2 (V_{REG}) is fed back to the operational amplifier and compared against the reference voltage (Vref). This process enables to control the gate voltage of the output control transistor so that stable output voltage (V_O) independent of input voltage is ensured. Output voltage is internally fixed and determined by the following formula.

$$V_O = \frac{R_1 + R_2}{R_1} \cdot Vref$$



ABSOLUTE MAXIMUM RATING

Parameter	Symbol	Rating	Unit
Input voltage	$V_{DD} – V_{SS}$	18	V
Output voltage	V_O	V_{DD} + 0.3 to V_{SS} – 0.3	
Output current	I_O	100	mA
Allowable dissipation	P_D	200	mW
Operating temperature	Topr	–30 to +85	°C
Storage temperature	Tstg	–65 to +150	
Soldering time Soldering temperature	Tsol	260°C 10 seconds (at lead)	—

ELECTRIC CHARACTERISTICS

SCI7810YAA

(Ta = –30°C to +85°C shall be assumed except where otherwise specified.)

Parameter	Symbol	Conditions (V_{SS} = 0.0v)	Min.	Typ.	Max.	Unit
Input voltage	V_I	————————	—	—	15	V
Output voltage	V_O	V_{DD} = 8.0V, I_O = –10mA Ta = 25°C	5.75	6.00	6.25	V
Operating current	I_{OP}	V_{DD} = 6.0V to 15.0V No load	—	1.5	5.0	µA
Voltage difference between input and output	$V_I – V_O$	V_O = 6.0V, I_O = –10mA	—	0.16	0.32	V
Output voltage temperature characteristics	$\frac{\Delta V_O}{V_O}$	————————	–300	–100	+100	ppm /°C
Input voltage stability	$\frac{dV_O}{dV_I \bullet V_O}$	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 7.0V to 15.0V I_O = –10mA	—	0.1	—	%/V
Load stability	ΔV_O	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 8.0V I_O = –1mA to –50mA	—	50	—	mV
Supply voltage regulation rejection ratio	PS_{RR}	V_{DD} = 8.0V, fin = 50kHz C_L = 10µF, I_O = –10mA	—	–40	—	dB

SCI7810YBA

(Ta = –30°C to +85°C shall be assumed except where otherwise specified.)

Parameter	Symbol	Conditions (V_{SS} = 0.0v)	Min.	Typ.	Max.	Unit
Input voltage	V_I	————————	—	—	15	V
Output voltage	V_O	V_{DD} = 7.0V, I_O = –10mA Ta = 25°C	4.90	5.00	5.10	V
Operating current	I_{OP}	V_{DD} = 5.0V to 15.0V No load	—	1.5	5.0	µA
Voltage difference between input and output	$V_I – V_O$	V_O = 5.0V, I_O = –10mA	—	0.17	0.34	V
Output voltage temperature characteristics	$\frac{\Delta V_O}{V_O}$	————————	–300	–100	+100	ppm /°C
Input voltage stability	$\frac{dV_O}{dV_I \bullet V_O}$	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 6.0V to 15.0V I_O = –10mA	—	0.1	—	%/V
Load stability	ΔV_O	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 7.0V I_O = –1mA to –50mA	—	50	—	mV
Supply voltage regulation rejection ratio	PS_{RR}	V_{DD} = 7.0V, fin = 50kHz C_L = 10µF, I_O = –10mA	—	–40	—	dB

SCI7810YMA

(Ta = –30°C to +85°C shall be assumed except where otherwise specified.)

Parameter	Symbol	Conditions (V_{SS} = 0.0v)	Min.	Typ.	Max.	Unit
Input voltage	V_I	————————	—	—	15	V
Output voltage	V_O	V_{DD} = 6.0V, I_O = –10mA Ta = 25°C	4.40	4.50	4.60	V
Operating current	I_{OP}	V_{DD} = 4.5V to 15.0V No load	—	1.5	5.0	µA
Voltage difference between input and output	$V_I – V_O$	V_O = 4.5V, I_O = –10mA	—	0.18	0.36	V
Output voltage temperature characteristics	$\frac{\Delta V_O}{V_O}$	————————	–300	–100	+100	ppm /°C
Input voltage stability	$\frac{dV_O}{dV_I \bullet V_O}$	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 6.0V to 15.0V I_O = –10mA	—	0.1	—	%/V
Load stability	ΔV_O	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 6.0V I_O = –1mA to –40mA	—	40	—	mV
Supply voltage regulation rejection ratio	PS_{RR}	V_{DD} = 6.0V, fin = 50kHz C_L = 10µF, I_O = –10mA	—	–40	—	dB

SCI7810YPA

(Ta = –30°C to +85°C shall be assumed except where otherwise specified.)

Parameter	Symbol	Conditions (V_{SS} = 0.0v)	Min.	Typ.	Max.	Unit
Input voltage	V_I	————————	—	—	15	V
Output voltage	V_O	V_{DD} = 6.0V, I_O = –10mA Ta = 25°C	3.90	4.00	4.10	V
Operating current	I_{OP}	V_{DD} = 4.0V to 15.0V No load	—	1.5	5.0	µA
Voltage difference between input and output	$V_I – V_O$	V_O = 4.0V, I_O = –10mA	—	0.19	0.38	V
Output voltage temperature characteristics	$\frac{\Delta V_O}{V_O}$	————————	–300	–100	+100	ppm /°C
Input voltage stability	$\frac{dV_O}{dV_I \bullet V_O}$	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 5.0V to 15.0V I_O = –10mA	—	0.1	—	%/V
Load stability	ΔV_O	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 6.0V I_O = –1mA to –40mA	—	40	—	mV
Supply voltage regulation rejection ratio	PS_{RR}	V_{DD} = 6.0V, fin = 50kHz C_L = 10µF, I_O = –10mA	—	–40	—	dB

SCI7810YKA

(Ta = –30°C to +85°C shall be assumed except where otherwise specified.)

Parameter	Symbol	Conditions (VSS = 0.0v)	Min.	Typ.	Max.	Unit
Input voltage	V_I	————	—	—	15	V
Output voltage	V_O	V_{DD} = 6.0V, I_O = –10mA Ta = 25°C	3.80	3.90	4.00	V
Operating current	I_{OP}	V_{DD} = 3.9V to 15.0V No load	—	1.5	5.0	µA
Voltage difference between input and output	$V_I - V_O$	V_O = 3.9V, I_O = –10mA	—	0.19	0.38	V
Output voltage temperature characteristics	$\frac{\Delta V_O}{V_O}$	————	–300	–100	+100	ppm /°C
Input voltage stability	$\frac{dV_O}{dV_I \bullet V_O}$	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 5.0V to 15.0V I_O = –10mA	—	0.1	—	%/V
Load stability	ΔV_O	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 6.0V I_O = –1mA to –40mA	—	40	—	mV
Supply voltage regulation rejection ratio	PS_{RR}	V_{DD} = 6.0V, fin = 50kHz C_L = 10µF, I_O = –10mA	—	–40	—	dB

SCI7810YNA

(Ta = –30°C to +85°C shall be assumed except where otherwise specified.)

Parameter	Symbol	Conditions (VSS = 0.0v)	Min.	Typ.	Max.	Unit
Input voltage	V_I	————	—	—	15	V
Output voltage	V_O	V_{DD} = 5.0V, I_O = –10mA Ta = 25°C	3.43	3.50	3.57	V
Operating current	I_{OP}	V_{DD} = 3.5V to 15.0V No load	—	1.5	5.0	µA
Voltage difference between input and output	$V_I - V_O$	V_O = 3.5V, I_O = –10mA	—	0.21	0.42	V
Output voltage temperature characteristics	$\frac{\Delta V_O}{V_O}$	————	–300	–100	+100	ppm /°C
Input voltage stability	$\frac{dV_O}{dV_I \bullet V_O}$	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 5.0V to 15.0V I_O = –10mA	—	0.1	—	%/V
Load stability	ΔV_O	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 5.0V I_O = –1mA to –30mA	—	30	—	mV
Supply voltage regulation rejection ratio	PS_{RR}	V_{DD} = 5.0V, fin = 50kHz C_L = 10µF, I_O = –10mA	—	–40	—	dB

SCI7810YTA

(Ta = –30°C to +85°C shall be assumed except where otherwise specified.)

Parameter	Symbol	Conditions (V_{SS} = 0.0v)	Min.	Typ.	Max.	Unit
Input voltage	V_I	———	—	—	15	V
Output voltage	V_O	V_{DD} = 5.0V, I_O = –10mA Ta = 25°C	3.23	3.30	3.37	V
Operating current	I_{OP}	V_{DD} = 3.3V to 15.0V No load	—	1.5	5.0	µA
Voltage difference between input and output	$V_I – V_O$	V_O = 3.3V, I_O = –10mA	—	0.22	0.44	V
Output voltage temperature characteristics	$\frac{\Delta V_O}{V_O}$	———	–300	–100	+100	ppm /°C
Input voltage stability	$\frac{dV_O}{dV_I \bullet V_O}$	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 4.0V to 15.0V I_O = –10mA	—	0.1	—	%/V
Load stability	ΔV_O	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 5.0V I_O = –1mA to –40mA	—	30	—	mV
Supply voltage regulation rejection ratio	PS_{RR}	V_{DD} = 5.0V, fin = 50kHz C_L = 10µF, I_O = –10mA	—	–40	—	dB

SCI7810YCA

(Ta = –30°C to +85°C shall be assumed except where otherwise specified.)

Parameter	Symbol	Conditions (V_{SS} = 0.0v)	Min.	Typ.	Max.	Unit
Input voltage	V_I	———	—	—	15	V
Output voltage	V_O	V_{DD} = 5.0V, I_O = –10mA Ta = 25°C	3.13	3.20	3.27	V
Operating current	I_{OP}	V_{DD} = 3.2V to 15.0V No load	—	1.5	5.0	µA
Voltage difference between input and output	$V_I – V_O$	V_O = 3.2V, I_O = –10mA	—	0.22	0.44	V
Output voltage temperature characteristics	$\frac{\Delta V_O}{V_O}$	———	–300	–100	+100	ppm /°C
Input voltage stability	$\frac{dV_O}{dV_I \bullet V_O}$	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 4.0V to 15.0V I_O = –10mA	—	0.1	—	%/V
Load stability	ΔV_O	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 5.0V I_O = –1mA to –30mA	—	30	—	mV
Supply voltage regulation rejection ratio	PS_{RR}	V_{DD} = 5.0V, fin = 50kHz C_L = 10µF, I_O = –10mA	—	–40	—	dB

SCI7810YDA

(Ta = –30°C to +85°C shall be assumed except where otherwise specified.)

Parameter	Symbol	Conditions (V_{SS} = 0.0v)	Min.	Typ.	Max.	Unit
Input voltage	V_I	———	—	—	15	V
Output voltage	V_O	V_{DD} = 5.0V, I_O = –10mA Ta = 25°C	2.93	3.00	3.07	V
Operating current	I_{OP}	V_{DD} = 3.0V to 15.0V No load	—	1.5	5.0	µA
Voltage difference between input and output	$V_I - V_O$	V_O = 3.0V, I_O = –10mA	—	0.23	0.46	V
Output voltage temperature characteristics	$\frac{\Delta V_O}{V_O}$	———	–300	–100	+100	ppm/°C
Input voltage stability	$\frac{dV_O}{dV_I \bullet V_O}$	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 4.0V to 15.0V I_O = –10mA	—	0.1	—	%/V
Load stability	ΔV_O	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 5.0V I_O = –1mA to –30mA	—	30	—	mV
Supply voltage regulation rejection ratio	PS_{RR}	V_{DD} = 5.0V, fin = 50kHz C_L = 10µF, I_O = –10mA	—	–40	—	dB

SCI7810YRA

(Ta = –30°C to +85°C shall be assumed except where otherwise specified.)

Parameter	Symbol	Conditions (V_{SS} = 0.0v)	Min.	Typ.	Max.	Unit
Input voltage	V_I	———	—	—	15	V
Output voltage	V_O	V_{DD} = 5.0V, I_O = –10mA Ta = 25°C	2.73	2.80	2.87	V
Operating current	I_{OP}	V_{DD} = 2.8V to 15.0V No load	—	1.5	5.0	µA
Voltage difference between input and output	$V_I - V_O$	V_O = 2.8V, I_O = –10mA	—	0.24	0.48	V
Output voltage temperature characteristics	$\frac{\Delta V_O}{V_O}$	———	–300	–100	+100	ppm/°C
Input voltage stability	$\frac{dV_O}{dV_I \bullet V_O}$	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 4.0V to 15.0V I_O = –10mA	—	0.1	—	%/V
Load stability	ΔV_O	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 5.0V I_O = –1mA to –30mA	—	30	—	mV
Supply voltage regulation rejection ratio	PS_{RR}	V_{DD} = 5.0V, fin = 50kHz C_L = 10µF, I_O = –10mA	—	–40	—	dB

SCI7810YLA

(Ta = –30°C to +85°C shall be assumed except where otherwise specified.)

Parameter	Symbol	Conditions (V_{SS} = 0.0v)	Min.	Typ.	Max.	Unit
Input voltage	V_I	———	—	—	15	V
Output voltage	V_O	V_{DD} = 5.0V, I_O = –10mA Ta = 25°C	2.53	2.60	2.67	V
Operating current	I_{OP}	V_{DD} = 2.6V to 15.0V No load	—	1.5	5.0	µA
Voltage difference between input and output	$V_I – V_O$	V_O = 2.6V, I_O = –10mA	—	0.25	0.50	V
Output voltage temperature characteristics	$\frac{\Delta V_O}{V_O}$	———	–300	–100	+100	ppm /°C
Input voltage stability	$\frac{dV_O}{dV_I \bullet V_O}$	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 4.0V to 15.0V I_O = –10mA	—	0.1	—	%/V
Load stability	ΔV_O	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 5.0V I_O = –1mA to –30mA	—	30	—	mV
Supply voltage regulation rejection ratio	PS_{RR}	V_{DD} = 5.0V, fin = 50kHz C_L = 10µF, I_O = –10mA	—	–40	—	dB

SCI7810YFA

(Ta = –30°C to +85°C shall be assumed except where otherwise specified.)

Parameter	Symbol	Conditions (V_{SS} = 0.0v)	Min.	Typ.	Max.	Unit
Input voltage	V_I	———	—	—	15	V
Output voltage	V_O	V_{DD} = 3.0V, I_O = –10mA Ta = 25°C	2.15	2.20	2.25	V
Operating current	I_{OP}	V_{DD} = 2.2V to 15.0V No load	—	1.5	5.0	µA
Voltage difference between input and output	$V_I – V_O$	V_O = 2.2V, I_O = –10mA	—	0.28	0.56	V
Output voltage temperature characteristics	$\frac{\Delta V_O}{V_O}$	———	–300	–100	+100	ppm /°C
Input voltage stability	$\frac{dV_O}{dV_I \bullet V_O}$	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 3.0V to 15.0V I_O = –10mA	—	0.1	—	%/V
Load stability	ΔV_O	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 3.0V I_O = –1mA to –30mA	—	20	—	mV
Supply voltage regulation rejection ratio	PS_{RR}	V_{DD} = 3.0V, fin = 50kHz C_L = 10µF, I_O = –10mA	—	–40	—	dB

SCI7810YGA

(Ta = –30°C to +85°C shall be assumed except where otherwise specified.)

Parameter	Symbol	Conditions (V_{SS} = 0.0v)	Min.	Typ.	Max.	Unit
Input voltage	V_I	————	—	—	15	V
Output voltage	V_O	V_{DD} = 3.0V, I_O = –10mA Ta = 25°C	1.75	1.80	1.85	V
Operating current	I_{OP}	V_{DD} = 2.2V to 15.0V No load	—	1.5	5.0	µA
Voltage difference between input and output	$V_I - V_O$	V_O = 1.8V, I_O = –1mA	—	35	90	V
Output voltage temperature characteristics	$\frac{\Delta V_O}{V_O}$	————	–300	–100	+100	ppm /°C
Input voltage stability	$\frac{dV_O}{dV_I \bullet V_O}$	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 3.0V to 15.0V I_O = –10mA	—	0.1	—	%/V
Load stability	ΔV_O	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 3.0V I_O = –1mA to –30mA	—	20	—	mV
Supply voltage regulation rejection ratio	PS_{RR}	V_{DD} = 3.0V, fin = 50kHz C_L = 10µF, I_O = –10mA	—	–40	—	dB

SCI7810YHA

(Ta = –30°C to +85°C shall be assumed except where otherwise specified.)

Parameter	Symbol	Conditions (V_{SS} = 0.0v)	Min.	Typ.	Max.	Unit
Input voltage	V_I	————	—	—	15	V
Output voltage	V_O	V_{DD} = 3.0V, I_O = –10mA Ta = 25°C	1.45	1.50	1.55	V
Operating current	I_{OP}	V_{DD} = 2.2V to 15.0V No load	—	1.5	5.0	µA
Voltage difference between input and output	$V_I - V_O$	V_O = 1.5V, I_O = –1mA	—	40	110	V
Output voltage temperature characteristics	$\frac{\Delta V_O}{V_O}$	————	–300	–100	+100	ppm /°C
Input voltage stability	$\frac{dV_O}{dV_I \bullet V_O}$	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 3.0V to 15.0V I_O = –10mA	—	0.1	—	%/V
Load stability	ΔV_O	Ta = –30°C to +85°C (At the same temperature level) V_{DD} = 3.0V I_O = –1mA to –10mA	—	20	—	mV
Supply voltage regulation rejection ratio	PS_{RR}	V_{DD} = 3.0V, fin = 50kHz C_L = 10µF, I_O = –10mA	—	–40	—	dB

EXAMPLES OF APPLIED CIRCUITS

Current Boost Circuit

Configuring the current boost circuit as shown in Figure 3-4 enables to create a voltage regulator that is capable of providing higher output current at lower operating current.

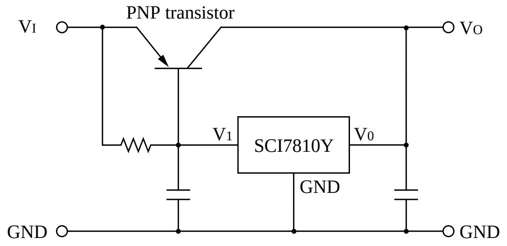


Figure 3-4 Current boost circuit

Variable Voltage Circuit 1

The SCI7810Y series consists of 3-pin regulators with fixed output voltage. Their output voltage, however, can be changed providing resistors externally as shown in Figure 3-5. In this case, the output voltage V_O is determined by the following formula.

$$V_O = \frac{R_1 + R_2}{R_2} V_r$$

But, this arrangement requires to provide bias current (I_B) enough to offset increased resistance on R1 that results from operating current (Iopr) of the SCI7810Y series.

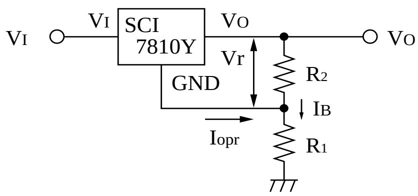


Figure 3-5 Providing resistors

Variable Voltage Circuit 2

It is also possible to increase output voltage using the SCI7810 series and diode, and configuring the circuit shown in Figure 3-6.

The circuit shown in Figure 3-6 takes into consideration of dispersion of the forward voltage V_F resulting from the circuit element, temperature and IC's operating current I_{SS}. This circuit is an example of using forward characteristic of the diode, but reverse voltage (Zener diode) can also be utilized depending on a given input voltage.

When you want to reduce I_{SS}-dependent dispersion of V_F or when I_{SS} is not sufficient as the diode bias current, think of externally adding the resistor R_1.

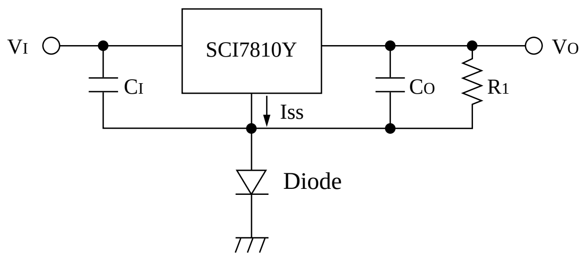


Figure 3-6

When Higher Input Voltage is Needed

When you want to apply an input voltage higher than the rating, add the regulator circuit in to the preceding stage so that the input voltage to the IC becomes less than the rating. See Figure 3-7.

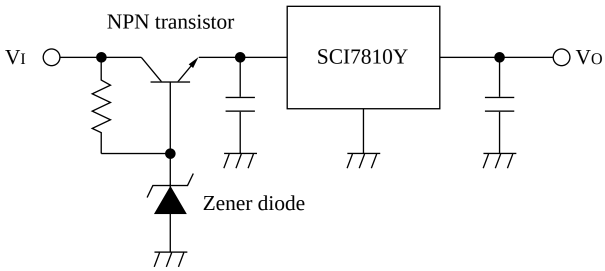


Figure 3-7

When Turning On or Off Output

The SCI7810Y series products are constantly in the operation mode, so applying an input voltage generates the specified output voltage. If, however, a SCI7810Y series product is connected to the external circuit configured with transistors and resistors (see Figure 3-8), its output voltage can be turned on or off.

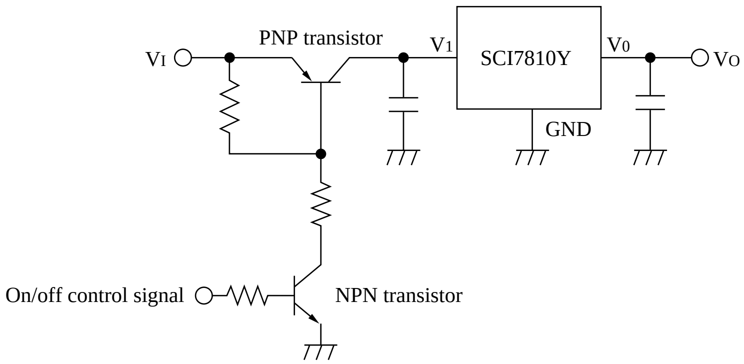


Figure 3-8

SCI7910Y Series CMOS Negative Voltage Regulators

DESCRIPTION

SCI7910Y series voltage regulators provide step-down and stabilization for an input voltage to a specified fixed voltage. The four devices in the series incorporate a precision, power-saving reference voltage generator, a transistorized differential amplifier and resistors for determining the output voltage.
The SCI7910Y series is available in 3-pin plastic SOT89s.

APPLICATIONS

- Fixed-voltage power supplies for battery-operated equipment such as portable video cassette recorders, video cameras and radios
- Fixed-voltage power supplies for communications equipment
- High-stability reference voltage generators

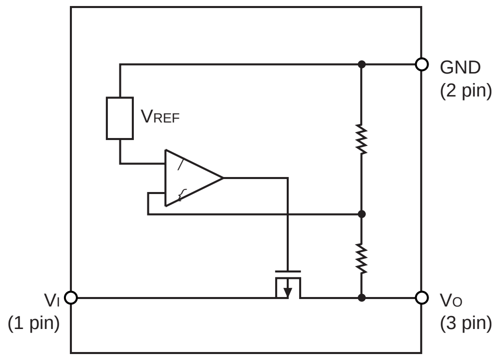
FEATURES

- Wide range of operating voltages
- 0.1%/V (Typ.) input stability
- On-chip reference voltage generator
- On-chip differential amplifier

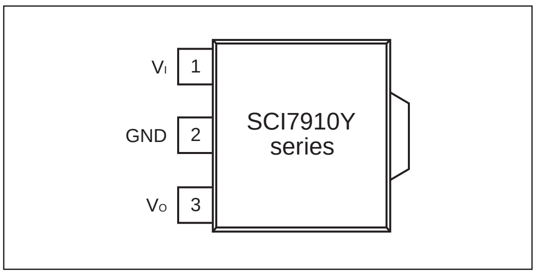
LINE-UP

Device	Voltage (V)		Current consumption (µA)	Operating temperature (°C)
	Input	Output		
SCI7910YHA	–15	–1.5	4.0	–40 to 85
SCI7910YGA		–1.8	4.0	
SCI7910YDA		–3.0	4.0	
SCI7910YPA		–4.0	4.0	
SCI7910YBA		–5.0	4.0	

BLOCK DIAGRAM



PIN CONFIGURATION



PIN DESCRIPTION

Number	Name	Description
1	V_I	Input voltage
2	GND	Ground
3	V_O	Output voltage

SPECIFICATIONS

Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Input voltage	V_I	–18	V
Output current	I_O	100	mA
Output voltage	V_O	GND + 0.3 to V_I – 0.3	V
Power dissipation	P_D	200	mW
Operating temperature range	Topr	–40 to 85	°C
Storage temperature range	Tstg	–65 to 150	°C
Soldering temperature (for 10 s). See note.	Tsol	260	°C

Note
Temperatures during reflow soldering must remain within the limits set out in LSI Device Precautions. Never use solder dip to mount SCI7000 series power supply devices.

Electrical Characteristics
SCI7910YHA

(Ta = –40°C to 85°C)

Parameter	Symbol	Conditions (GND = 0.0V)	Rating			Unit
			Min.	Typ.	Max.	
Input voltage	V_I	—	–15.0	—	—	V
Output voltage	V_O	V_I = –3.0V, I_O = 10mA Ta = 25°C	–1.57	–1.50	–1.43	V
Operating current	I_{OP}	V_I = –1.5V to –15V	—	4.0	18.0	µA
Input/output voltage differential	$\|V_I – V_O\|$	V_I = –1.5V, I_O = 5mA	—	0.25	0.60	V
Input voltage stabilization ratio	$\frac{dV_O}{dV_I \cdot V_O}$	V_I = –3.0V to –15.0V, I_O = 5mA	—	0.10	—	%/V
Output voltage drift	ΔV_O	V_I = –3.0V, I_O = 1mA to 5mA	—	20.0	—	mV

SCI7910YGA

(V_{DD} = 0V, Ta = –40°C to 85°C unless otherwise noted)

Parameter	Symbol	Conditions	Rating			Unit
			Min.	Typ.	Max.	
Input voltage	V_I	—	–15.0	—	—	V
Output voltage	V_O	V_I = –3.0V, I_O = 10mA Ta = 25°C	–1.87	–1.80	–1.73	V
Operating current	I_{DDO}	V_I = –1.8V to –15.0V	—	4.0	18.0	µA
Input/output voltage differential	$\|V_I - V_O\|$	V_I = –1.8V, I_O = 10mA	—	0.35	0.70	V
Input voltage stabilization ratio	$\frac{\|\Delta V_O\|}{\|\Delta V_I \bullet V_O\|}$	V_I = –3.0V to –15.0V, I_O = 10mA, Isothermal	—	0.10	—	%/V
Output voltage drift	ΔV_O	V_I = –3.0V, I_O = 1mA to 10mA, Isothermal	—	20.0	—	mV

SCI7910YDA

(V_{DD} = 0V, Ta = –40°C to 85°C unless otherwise noted)

Parameter	Symbol	Conditions	Rating			Unit
			Min.	Typ.	Max.	
Input voltage	V_I	—	–15.0	—	—	V
Output voltage	V_O	V_I = –5.0V, I_O = 10mA Ta = 25°C	–3.07	–3.00	–2.93	V
Operating current	I_{DDO}	V_I = –3.0V to –15.0V	—	4.0	18.0	µA
Input/output voltage differential	$\|V_I - V_O\|$	V_I = –3.0V, I_O = 10mA	—	0.23	0.46	V
Input voltage stabilization ratio	$\frac{\|\Delta V_O\|}{\|\Delta V_I \bullet V_O\|}$	V_I = –4.0V to –15.0V, I_O = 10mA, Isothermal	—	0.10	—	%/V
Output voltage drift	ΔV_O	V_I = –5.0V, I_O = 1mA to 30mA	—	30.0	—	mV

SCI7910YPA

(V_{DD} = 0V, Ta = –40°C to 85°C unless otherwise noted)

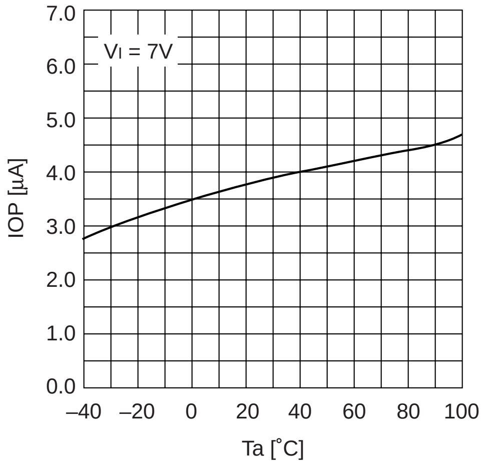
Parameter	Symbol	Conditions	Rating			Unit
			Min.	Typ.	Max.	
Input voltage	V_I	—	–15.0	—	—	V
Output voltage	V_O	V_I = –6.0V, I_O = 10mA Ta = 25°C	–4.10	–4.00	–3.90	V
Operating current	I_{DDO}	V_I = –4.0V to –15.0V	—	4.0	18.0	µA
Input/output voltage differential	$\|V_I - V_O\|$	V_I = –4.0V, I_O = 10mA	—	0.19	0.38	V
Input voltage stabilization ratio	$\frac{\|\Delta V_O\|}{\|\Delta V_I \bullet V_O\|}$	V_I = –5.0V to –15V, I_O = 10mA, Isothermal	—	0.10	—	%/V
Output voltage drift	ΔV_O	V_I = –7V, I_O = 1mA to 30mA	—	40.0	—	mV

SCI7910YBA

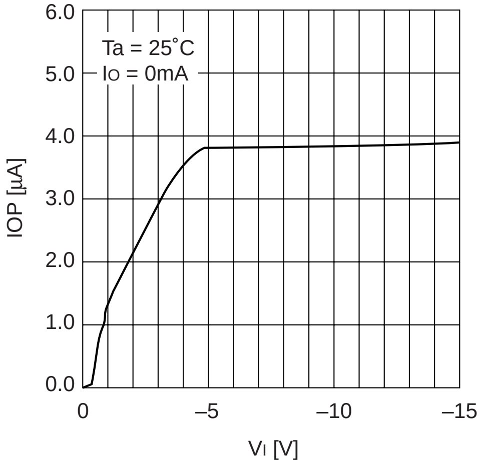
(V_{DD} = 0V, Ta = –40°C to 85°C unless otherwise noted)

Parameter	Symbol	Conditions	Rating			Unit
			Min.	Typ.	Max.	
Input voltage	V_I	—	–15.0	—	—	V
Output voltage	V_O	V_I = –7.0V, I_O = 10mA Ta = 25°C	–5.10	–5.00	–4.90	V
Operating current	I_{DDO}	V_I = –5.0V to –15.0V	—	4.0	18.0	µA
Input/output voltage differential	$\|V_I - V_O\|$	V_I = –5.0V, I_O = 10mA	—	0.17	0.34	V
Input voltage stabilization ratio	$\frac{\|\Delta V_O\|}{\|\Delta V_I \bullet V_O\|}$	V_I = –6.0V to –15.0V, I_O = 10mA, Isothermal	—	0.10	—	%/V
Output voltage drift	ΔV_O	V_I = –7.0V, I_O = 1mA to 50mA	—	50.0	—	mV

Typical Performance Characteristics
SCI7910YBA



IOP – Ta



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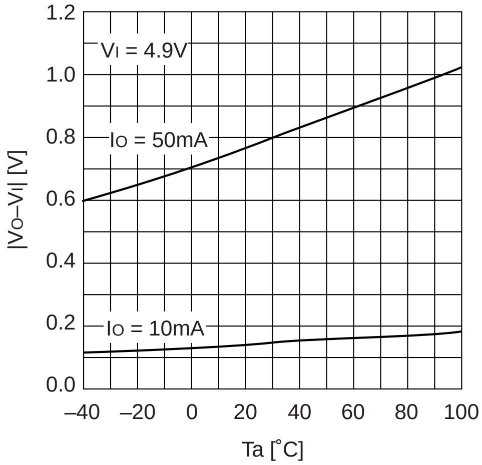
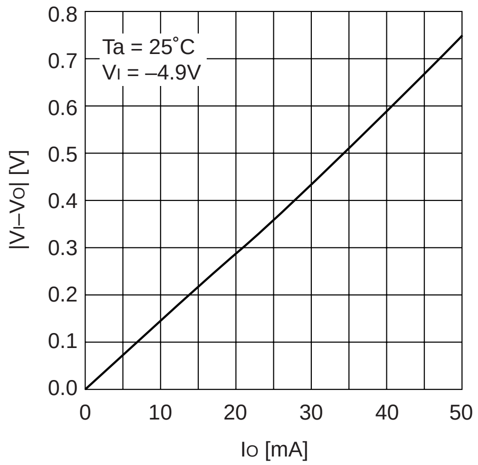


|VO – VI| – Ta



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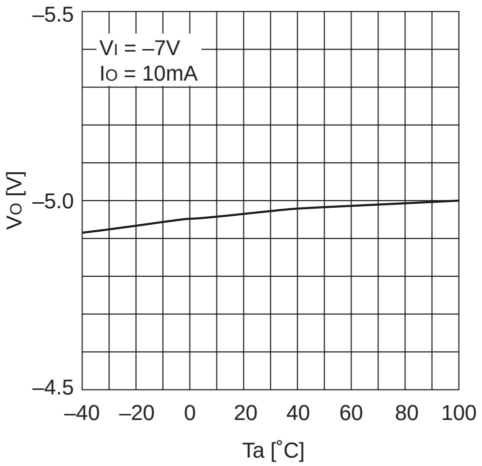

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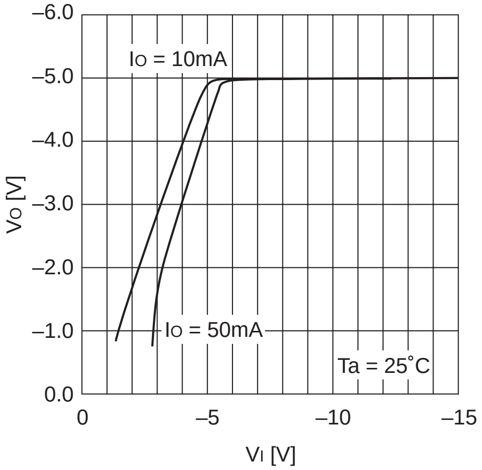
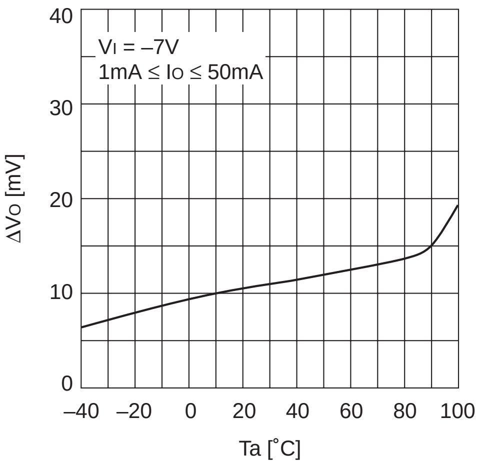
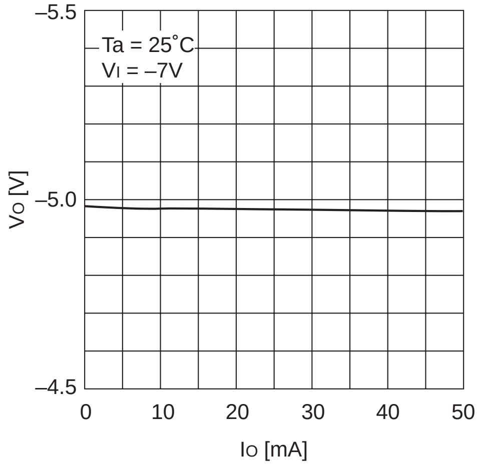


Vo – VI



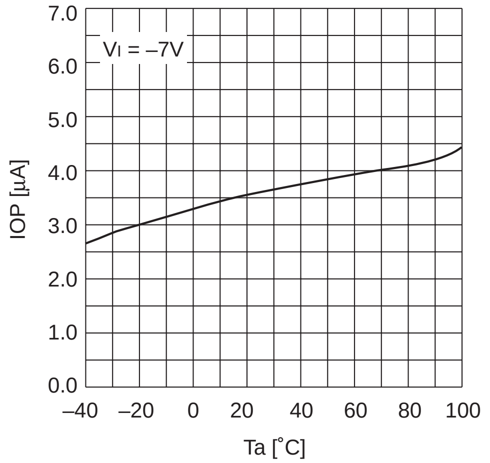
ΔVo – Ta



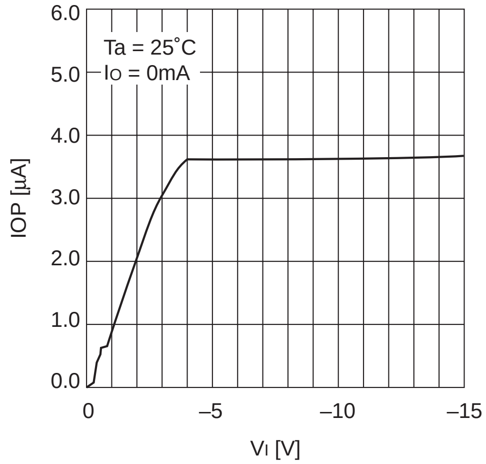
Vo – Io

Voltage Regulator

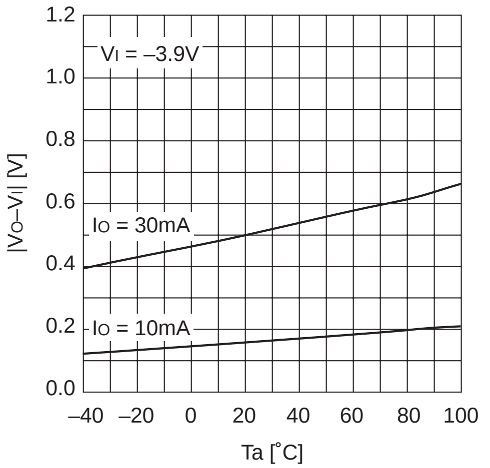
SCI7910YPA



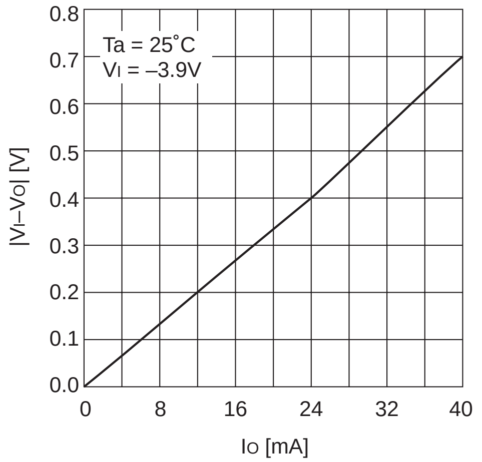
I_{OP} – Ta



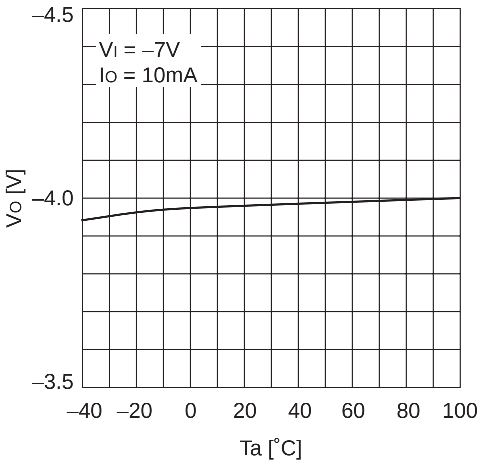
I_{OP} – V_I



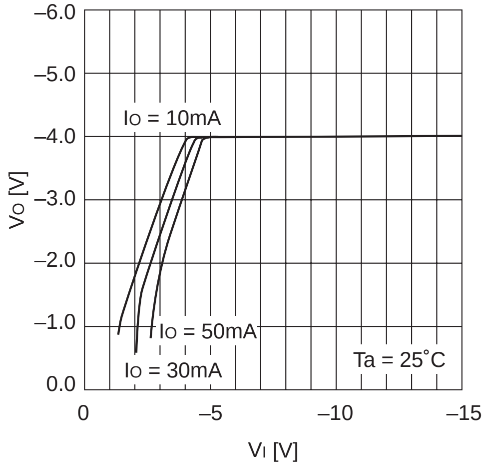
$|V_O – V_I|$ – Ta



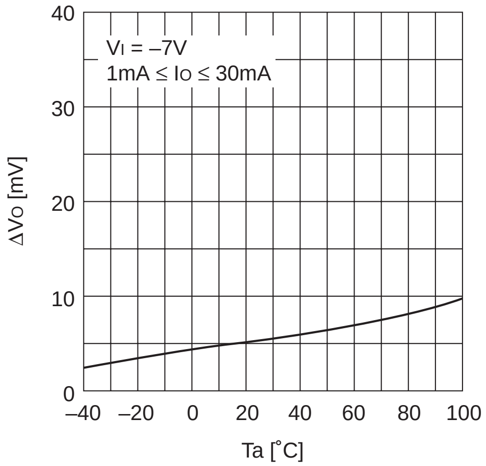
$|V_I – V_O|$ – I_O



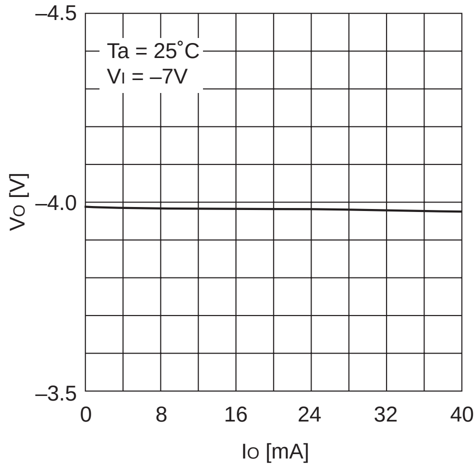
Vo – Ta



Vo – VI

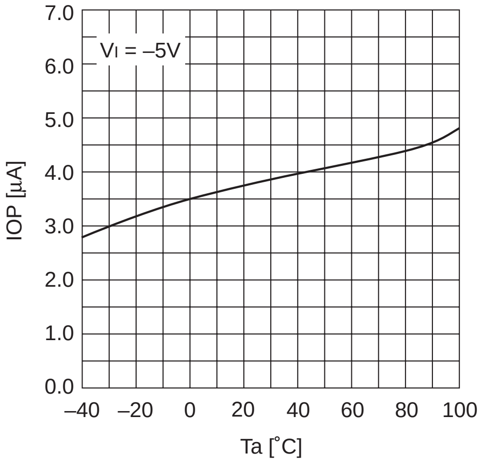


ΔVo – Ta



Vo – Io

SCI7910YDA



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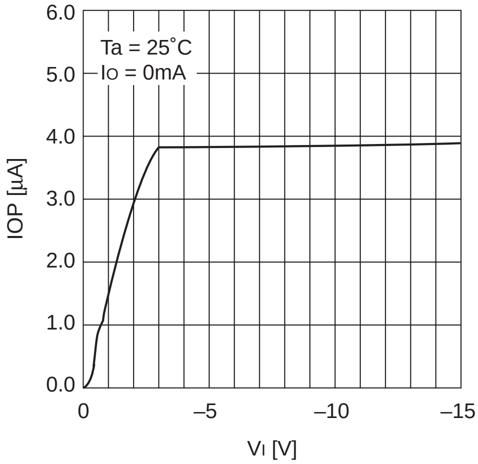

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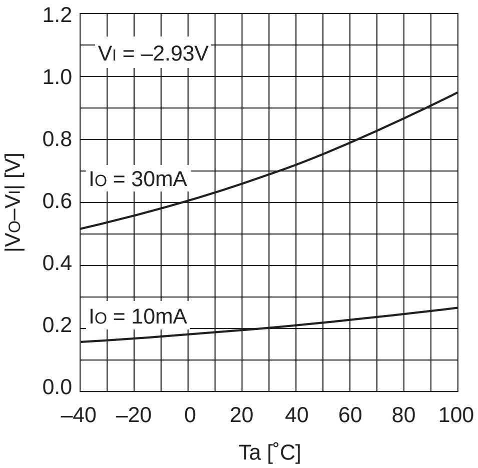
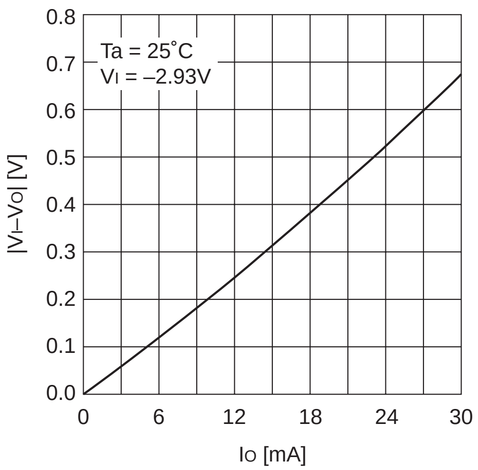
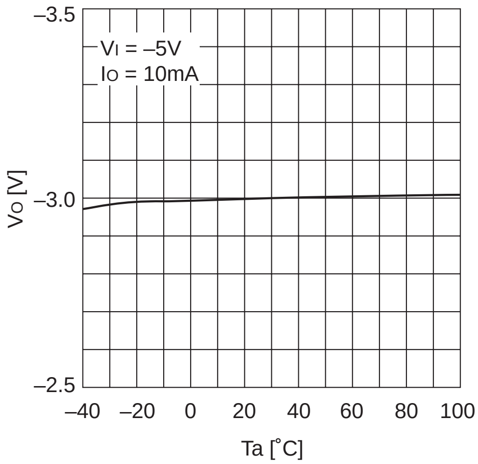


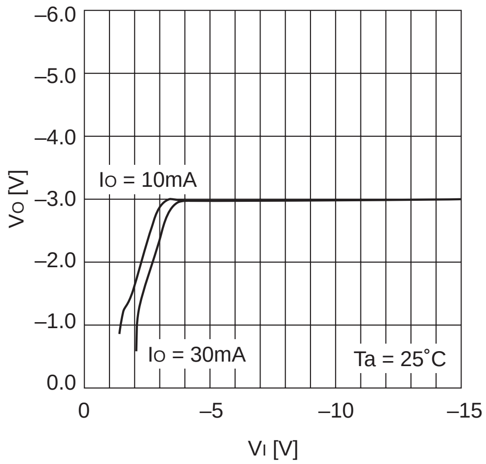
|Vo – VI| – Ta



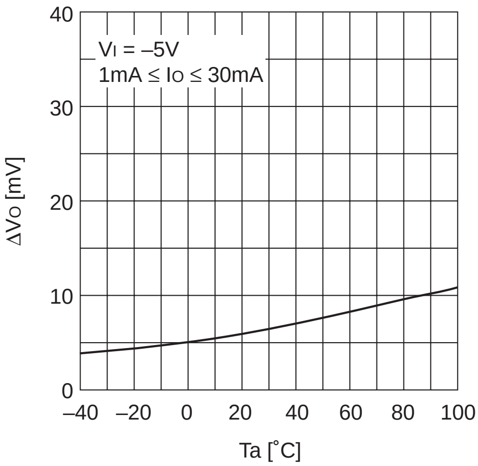
|VI – Vo| – Io



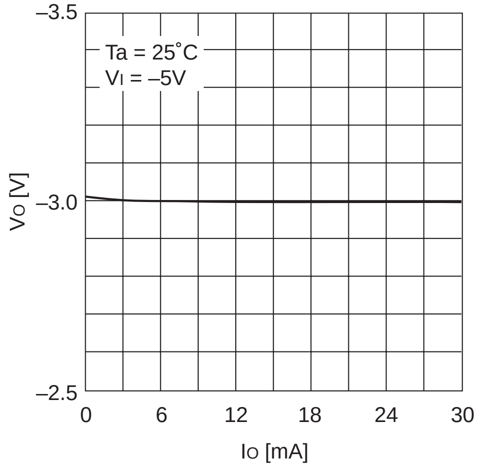
Vo – Ta



Vo – VI

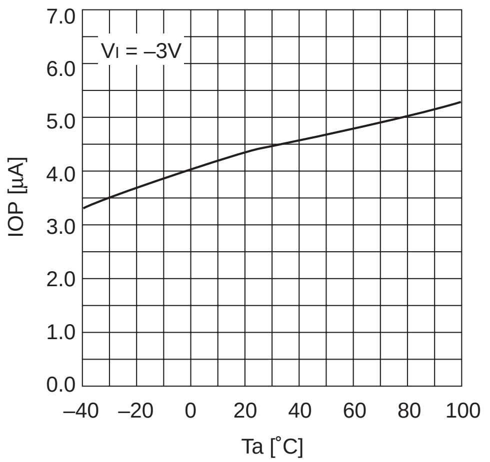


ΔVo – Ta

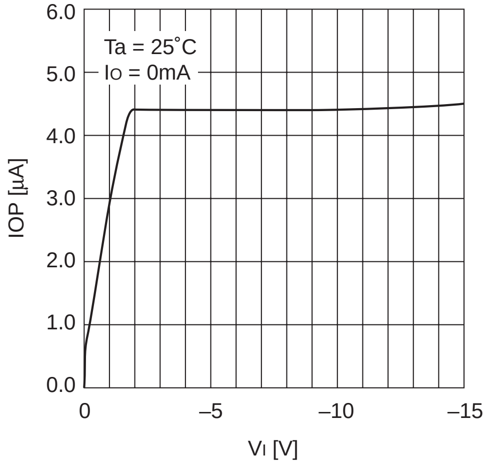


Vo – Io

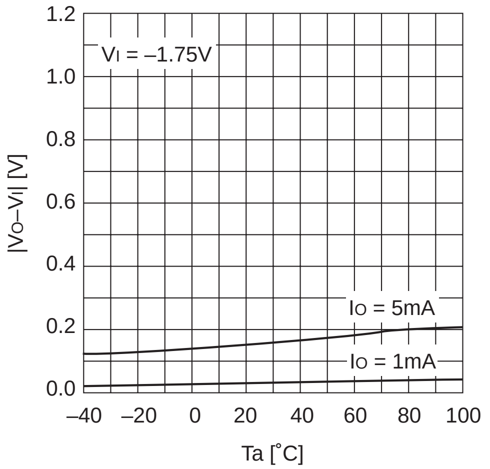
SCI7910YGA



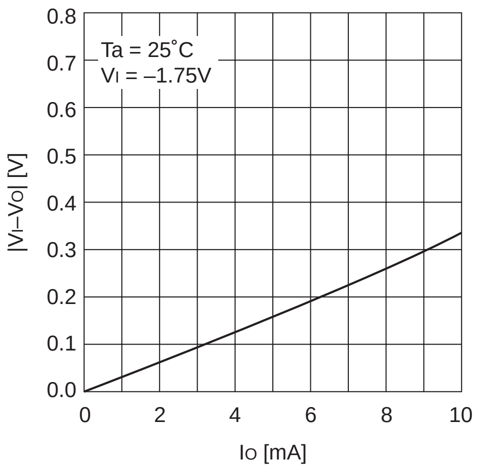
IOP – Ta



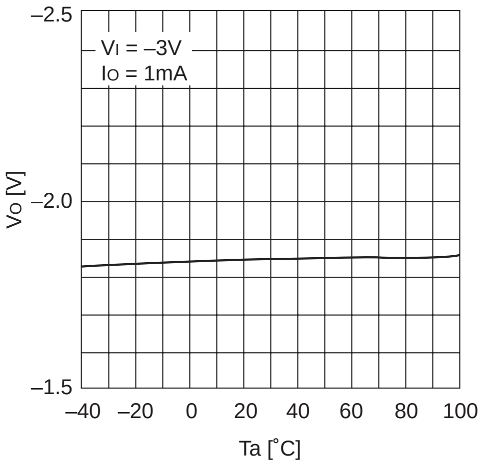
IOP – VI



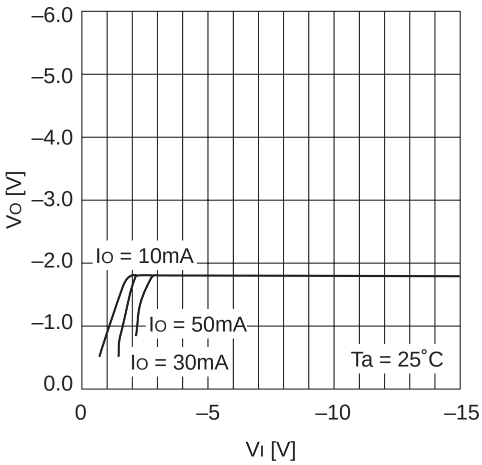
|Vo – VI| – Ta



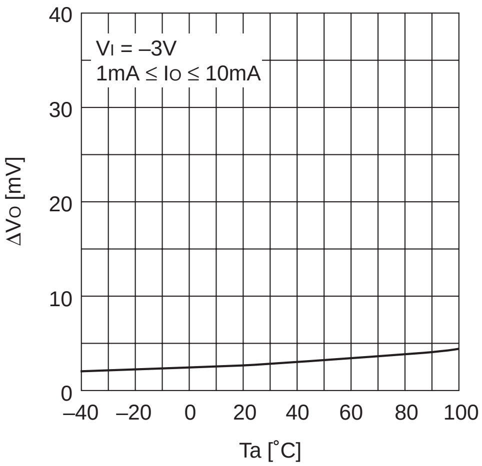
|VI – Vo| – Io



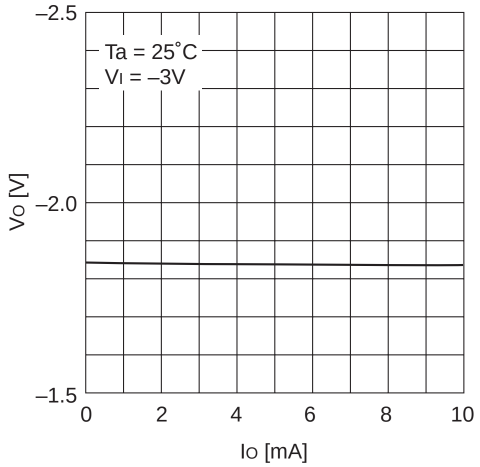
Vo – Ta



Vo – VI

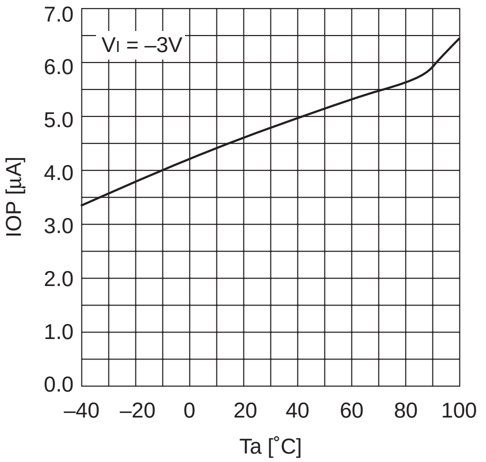


ΔVo – Ta

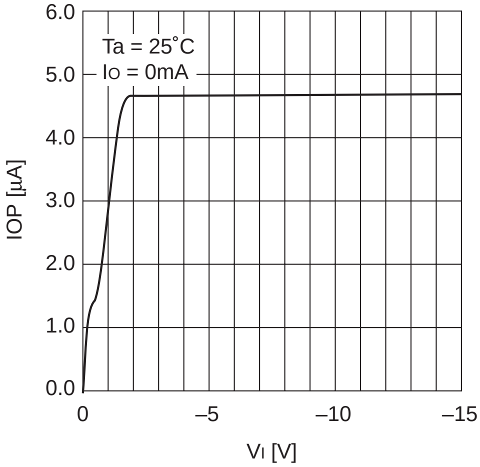


Vo – Io

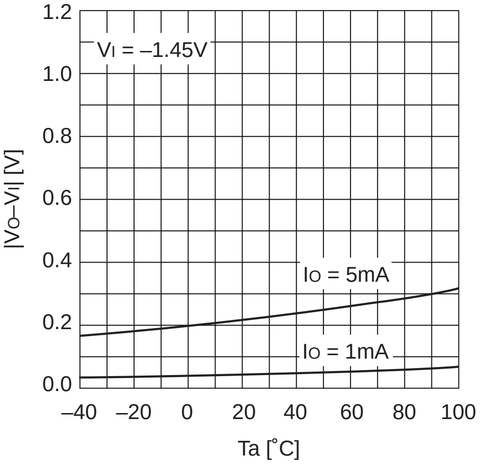
SCI7910YHA



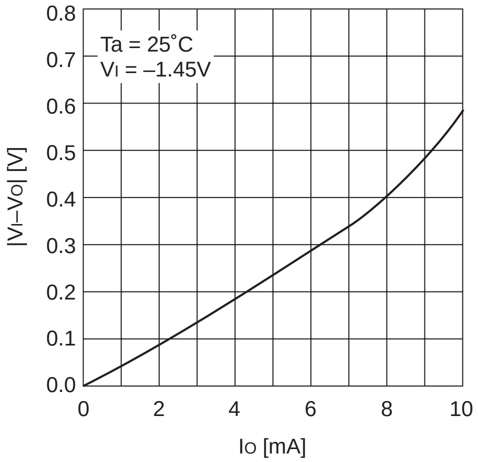
IOP – Ta



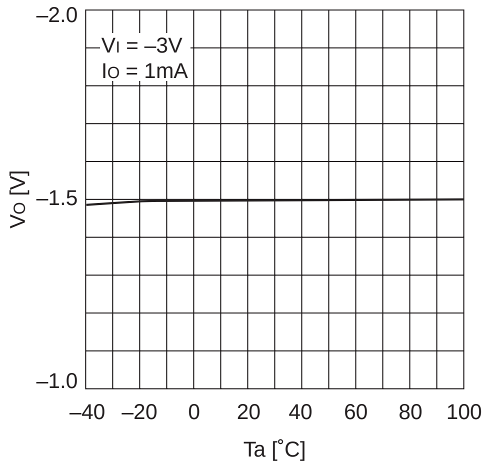
IOP – VI



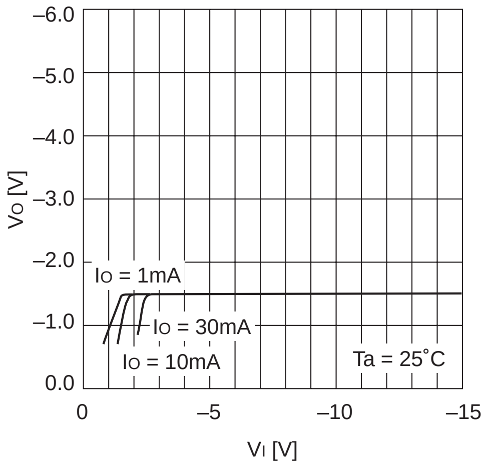
|Vo – VI| – Ta



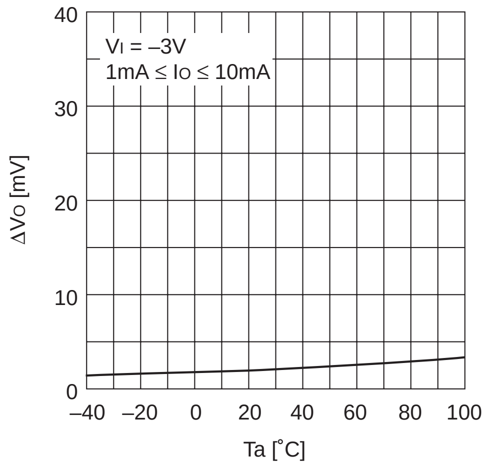
|VI – Vo| – Io



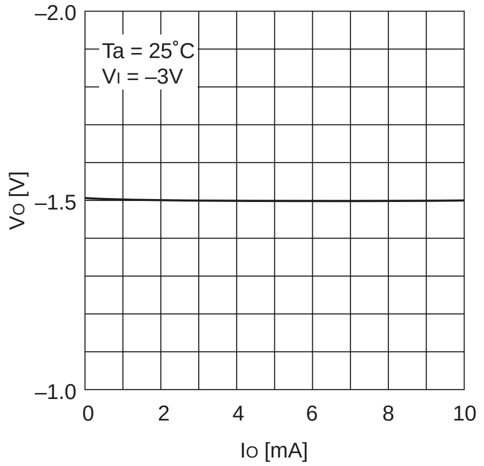
Vo – Ta



Vo – VI



ΔVo – Ta



Vo – Io

PACKAGE MARKINGS

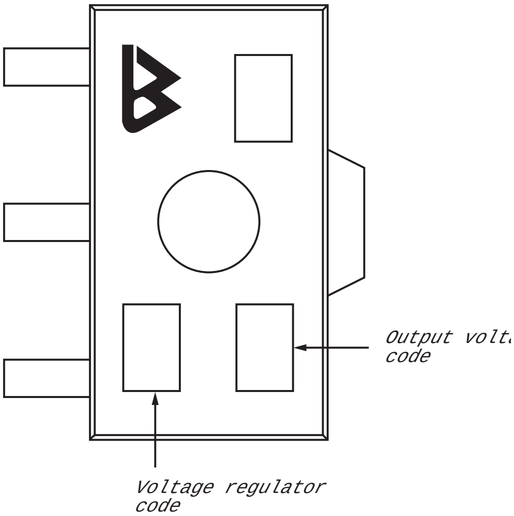
The markings on SCI7910Y series device packages use the following abbreviations.

Parameter	Code	Description
Output voltage code	B	5 V
	D	3 V
Voltage regulator code	P	Positive
	N	Negative

Note

The reflow furnace temperature profile requirements must be satisfied during package reflow. Avoid soldering on surface mount package (including SOT89) as it causes a quick temperature change of package and a device damage.

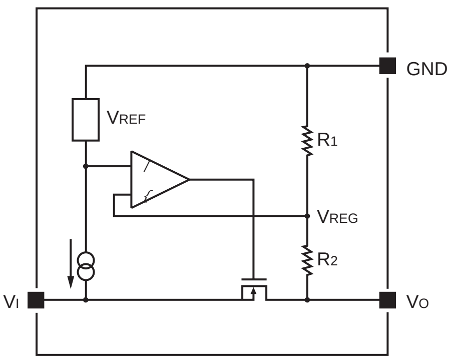
Marking locations



FUNCTIONAL DESCRIPTION

Basic Operation

The SCI7910Y series uses a 3-pin series regulator feedback loop. An operational amplifier compares V_{REG} from the voltage divider formed by R_1 and R_2, with V_{REF}. The amplifier output adjusts the output transistor gate bias to equalize the voltages and compensate for fluctuations in V_I.



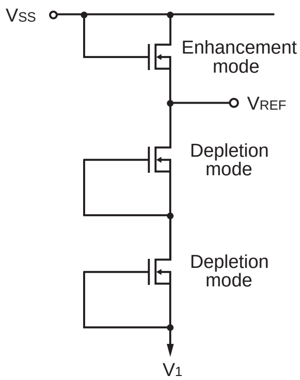
The following equation shows the relationship between V_O and V_{REF}.

$$V_O = \frac{R_1 + R_2}{R_1} V_{REF}$$

Internal Circuits

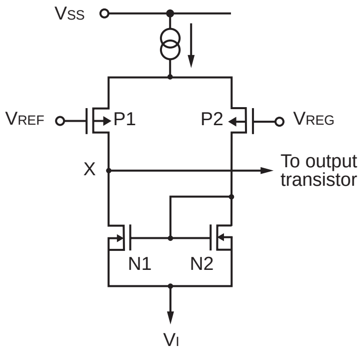
Reference voltage generator

The offset structure used in all three transistors results in a high breakdown voltage that ensures a stable reference voltage output over a wide range of input voltages.



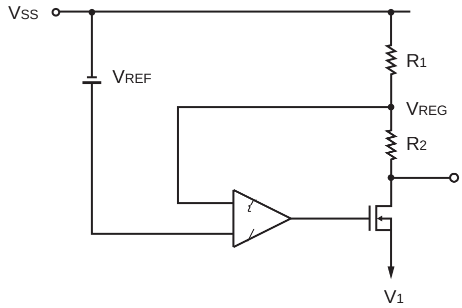
Differential amplifier

The built-in differential amplifier generates a potential at point X that adjusts the gate bias of the output transistor if there is any difference betweeen V_{REF} and V_{REG}.



Output transistor

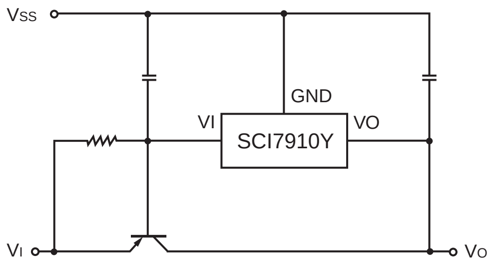
The output side of the p-channel MOS transistors in the output transistor circuit is connected to the voltage divider resistors in the feedback loop.



TYPICAL APPLICATIONS

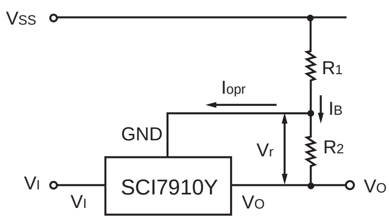
Current Booster

At the cost of a small increase in current consumption, the voltage is regulated while maintaining high current output.



External Voltage Converter

The following circuit raises the output voltage of a SCI7910Y series IC.

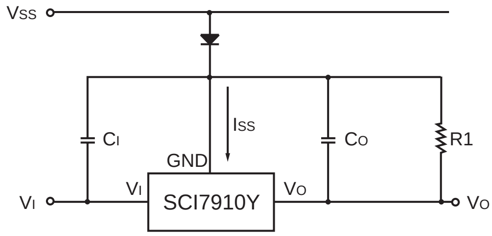


The following equation shows the relationship between the old and new voltages.

$$V_O = \frac{R_1 + R_2}{R_2} V_R$$

Note that the application must supply a bias current, I_B, high enough to offset the increase in voltage across R_1 due to Iopr.

An alternative circuit for raising the output voltage is shown in the following figure.



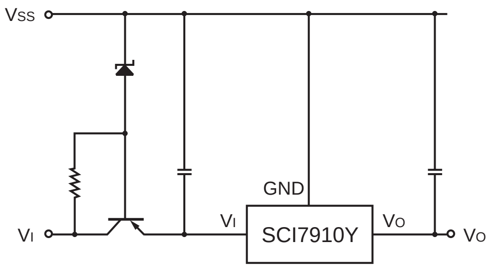
This configuration, however, introduces two design problems.

1. It reduces the output voltage by V_F, the forward voltage drop across the diode.
2. It is sensitive to fluctuations in V_F due to differences in diodes, operating temperatures and I_{SS}.

R1 helps reduce the affect of ISS on VF. It is also required when ISS is lower than the diode bias current. For certain input voltages, a Zener diode with the reverse polarity can be used.

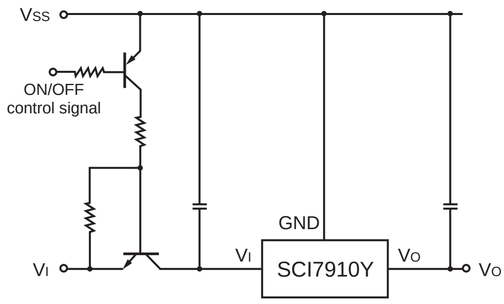
High Input Voltages

A preliminary regulator circuit is required to bring the input voltage within the SCI7910Y series rated range.



Switching output

SCI7910Y series devices are designed for continuous operation. An external switching circuit allows the regulated output to be switched ON and OFF.



Note) Temperatures during reflow soldering must remain within the limits set out under LSI Device Precautions in this catalog. Do not immerse QFP and SOT89 packages during soldering, as the rapid temperature gradient during dipping can cause damage.

SCI7630 Series
POWER SUPPLY IC

4.

DC/DC Switching Regulators

The SCI7630 series of CMOS switching regulators comprises nine series—the SCI7631, SCI7638 series featuring built-in RC oscillators, the SCI7633 series requiring external crystal oscillators.

SCI7631, SCI7638 Series CMOS Switching Regulators

DESCRIPTION

The SCI7631, SCI7638 series of CMOS switching regulators provide input voltage step-up and regulation to a specified fixed voltage using an external coil. The devices in these series incorporate precision, low-power reference voltage generators and transistors for driving an internal comparator. They feature low power consumption, low operating voltages, voltage detection and standby operation.

The devices offer a range of fixed output voltages, from 2.0 to 5.0V. The SCI7631 series features battery backup and power-on clear, the SCI7638 series features power-on clear and response compensation, the SCI7638 series offer an output voltage temperature characteristic for driving an LCD. They are available in 8-pin SOP3s.

FEATURES

- 0.9V (Min.) operating voltage
- 10µA (Typ.) maximum current consumption
- Standby operation
- 3µA (Typ.) standby current consumption
- 1.05 ±0.05V high-accuracy voltage detection
- Battery backup (available on SCI7631 series)
- On-chip RC oscillator
- Power-on clear (available on SCI7631 and SCI7638 series)
- Output voltage temperature characteristic for driving an LCD (available on SCI7638 series)
- 8-pin SOP3

APPLICATIONS

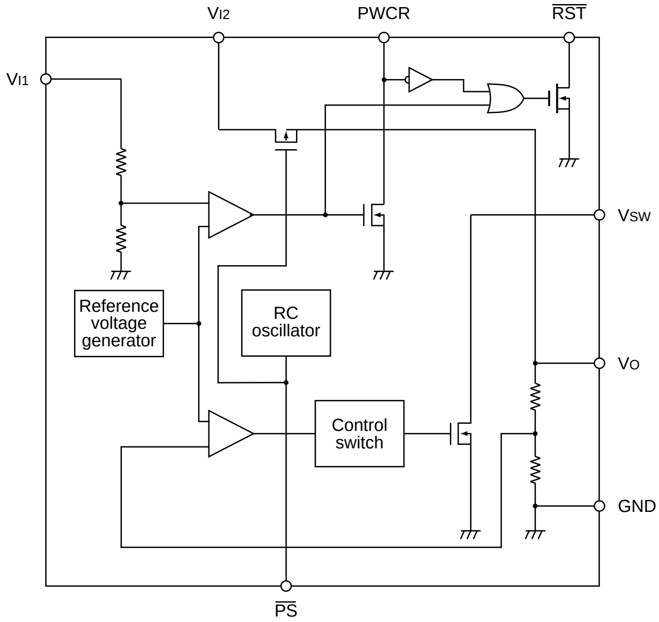
- Fixed-voltage power supplies for battery-operated equipment such as portable video cassette recorders, video cameras and radios
- Power supplies for pagers, memory cards, calculators and similar hand-held equipment
- Fixed-voltage power supplies for medical equipment
- Fixed-voltage power supplies for communications equipment
- Power supplies for microcomputers
- Uninterruptable power supplies
- LCD panel supplies

LINE-UP

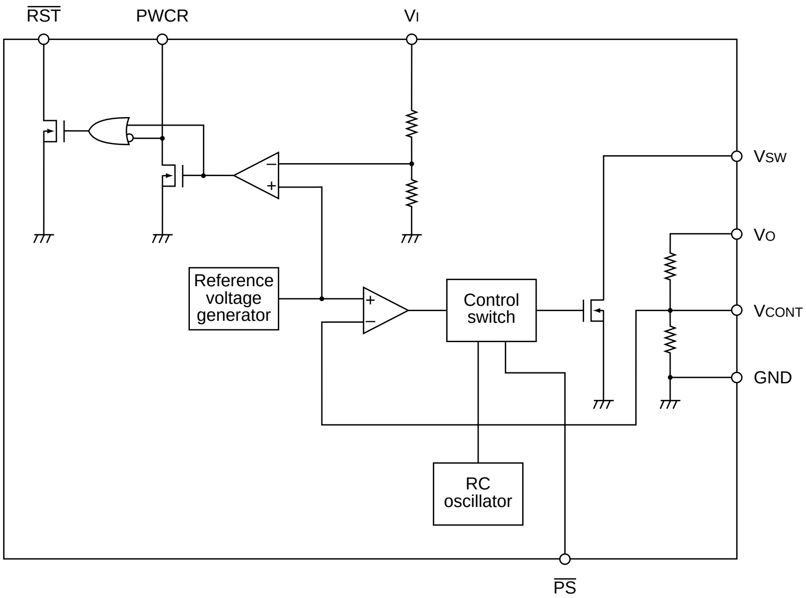
<table>
<tr><th rowspan="2">Device</th><th colspan="2">Voltage (V)</th><th rowspan="2">Multiplication frequency source</th><th rowspan="2">Voltage detection</th><th rowspan="2">Power-on clear</th><th rowspan="2">Battery backup</th><th rowspan="2">Response compensation</th><th rowspan="2">Output voltage temperature characteristic</th><th rowspan="2">Package</th></tr>
<tr><th>Input</th><th>Output</th></tr>
<tr><td>SCI7631MLA</td><td rowspan="4">1.5 (0.9 min.)</td><td>2.4</td><td rowspan="4">On-chip RC oscillator</td><td rowspan="6">Yes</td><td rowspan="6">Yes</td><td rowspan="4">Yes</td><td rowspan="4">No</td><td rowspan="4">No</td><td>SOP3-8pin</td></tr>
<tr><td>SCI7631MBA</td><td>3.0</td><td>SOP3-8pin</td></tr>
<tr><td>SCI7631MKA</td><td>3.5</td><td>SOP3-8pin</td></tr>
<tr><td>SCI7631MAA</td><td>5.0</td><td>SOP3-8pin</td></tr>
<tr><td>SCI7638MHA</td><td rowspan="2">1.5 (0.9 min.)</td><td>2.2</td><td rowspan="2">On-chip RC oscillator</td><td rowspan="2">No</td><td rowspan="2">Yes</td><td>–4.5 mV/˚C</td><td>SOP3-8pin</td></tr>
<tr><td>SCI7638MLA</td><td>2.4</td><td>–4.0 mV/˚C</td><td>SOP3-8pin</td></tr>
</table>

BLOCK DIAGRAMS

SCI7631 Series

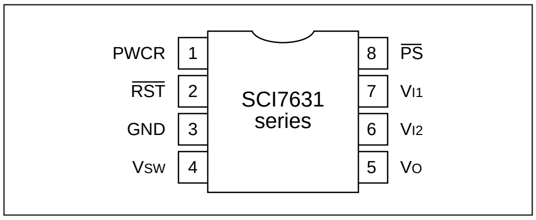


SCI7638 Series

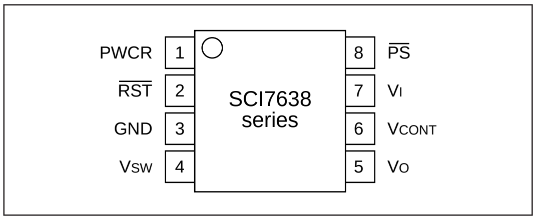


PIN CONFIGURATIONS

SCI7631 Series



SCI7638 Series



PIN DESCRIPTIONS

SCI7631 Series

Number	Name	Description
1	PWCR	Power-on clear. See note 1.
2	$\overline{RST}$	Reset signal output. See note 1.
3	GND	Ground
4	V_{SW}	External inductor drive
5	V_O	Output votlage
6	V_{I2}	Backup input voltage
7	V_{I1}	Step-up input voltage
8	$\overline{PS}$	Power save. See note 2.

Notes

1. See voltage detection and power-on clear in the functional description.
2. See standby mode and battery backup in the functional description.

SCI7638 Series

Number	Name	Description
1	PWCR	Power-on clear. See note 1.
2	$\overline{RST}$	Reset signal output. See note 1.
3	GND	Ground
4	V_{SW}	External inductor drive
5	V_O	Output votlage
6	V_{CONT}	Comparator input
7	V_{I1}	Step-up input voltage
8	$\overline{PS}$	Power save. See note 2.

Notes

1. See voltage detection and power-on clear in the functional description.
2. See standby mode and battery backup in the functional description.

SPECIFICATIONS

Absolute Maximum Ratings

SCI7631 series

Parameter	Symbol	Rating	Unit
Input voltage	V_{I1}	7	V
Output current	I_O	100	mA
Output voltage	V_O	7	V
Power dissipation	P_D	200 (SOP3) 300 (DIP)	mW
Operating temperature range	Topr	–30 to 85	˚C
Storage temperature range	Tstg	–65 to 150	˚C
Soldering temperature (for 10 s). See note.	Tsol	260	˚C

Notes

Temperatures during reflow soldering must remain within the limits set out in LSI Device Precautions. Never use solder dip to mount SCI7000 series power supply devices.

SCI7638 series

Parameter	Symbol	Rating	Unit
Input voltage	V_{I1}	7	V
Output current	I_O	100	mA
Output voltage	V_O	7	V
Power dissipation	P_D	200 (SOP3) 300 (DIP)	mW
Operating temperature range	Topr	–30 to 85	˚C
Storage temperature range	Tstg	–65 to 150	˚C
Soldering temperature (for 10 s). See note.	Tsol	260	˚C

Parameter	Symbol	Rating	Unit
Input voltage	V_I	7	V
Output voltage	V_O	7	V
Power dissipation	P_D	250	mW
Operating temperature range	Topr	–30 to 85	˚C
Storage temperature range	Tstg	–65 to 150	˚C

Notes

Temperatures during reflow soldering must remain within the limits set out in LSI Device Precautions. Never use solder dip to mount SCI7000 series power supply devices.

Electrical Characteristics

SCI7631MLA

V_{SS} = 0V, Ta = 25 ˚C unless otherwise noted

Parameter	Symbol	Condition	Rating			Unit
			Min.	Typ.	Max.	
Input voltage	V_{I1}	$V_O > V_{I2}$	0.9	—	1.8	V
	V_{I2}		0.9	—	1.8	V
Output voltage	V_O	V_{I1} = 1.5V	2.32	2.40	2.48	V
Detection voltage	V_{DET}		1.00	1.05	1.10	V
Detection voltage hysteresis ratio	ΔV_{DET}		—	5	—	%
Operating current	I_{DDO}	V_{I1} = 1.5V, I_O = 1.0mA	—	7	35	µA
Standby current	I_{DDS}	V_{I1} = 1.5V	—	3	10	µA
Switching transistor ON resistance	R_{SWON}	V_{I1} = 1.5V, V_O = 2.4V, V_{SW} = 0.2V	—	7	14	Ω
Switching transistor leakage current	I_{SWQ}	V_{I1} = 1.5V, V_O = 1.5V, V_{SW} = 7.0V	—	—	0.5	µA
Backup switch ON resistance	R_{BSON}	V_{I1} = 1.0V, V_{I2} = 1.5V, I_O = 1.0mA	—	100	250	Ω
Backup switching leakage current	I_{BSQ}	V_{I1} = 1.0V, V_O = 2.4V, V_{I2} = 2.0V	—	—	0.1	µA
$\overline{RST}$ LOW-level output current	I_{OL}	V_{I1} = 0.9V, V_{DS} = 0.2V	0.05	0.15	—	mA
$\overline{PS}$ pull-up current	I_{IH}	V_{I1} = 1.5V	—	—	0.5	µA
Multiplication clock frequency	f_{CLK}	V_{I1} = 1.5V	25	35	45	kHz

SCI7631MBA

V_{SS} = 0V, Ta = 25 ˚C unless otherwise noted

Parameter	Symbol	Condition	Rating			Unit
			Min.	Typ.	Max.	
Input voltage	V_{I1}	$V_O > V_{I2}$	0.9	—	2.0	V
	V_{I2}		0.9	—	2.0	V
Output voltage	V_O	V_{I1} = 1.5V	2.90	3.00	3.10	V
Detection voltage	V_{DET}		1.00	1.05	1.10	V
Detection voltage hysteresis ratio	ΔV_{DET}		—	5	—	%
Operating current	I_{DDO}	V_{I1} = 1.5V, I_O = 1.0mA	—	8	40	µA
Standby current	I_{DDS}	V_{I1} = 1.5V	—	3	10	µA
Switching transistor ON resistance	R_{SWON}	V_{I1} = 1.5V, V_O = 3.0V, V_{SW} = 0.2V	—	6	12	Ω
Switching transistor leakage current	I_{SWQ}	V_{I1} = 1.5V, V_O = 1.5V, V_{SW} = 7.0V	—	—	0.5	µA
Backup switch ON resistance	R_{BSON}	V_{I1} = 1.0V, V_{I2} = 2.0V, I_O = 1.0mA	—	70	160	Ω
Backup switching leakage current	I_{BSQ}	V_{I1} = 1.0V, V_O = 3.0V, V_{I2} = 2.0V	—	—	0.1	µA
$\overline{RST}$ LOW-level output current	I_{OL}	V_{I1} = 0.9V, V_{DS} = 0.2V	0.05	0.15	—	mA
$\overline{PS}$ pull-up current	I_{IH}	V_{I1} = 1.5V	—	—	0.5	µA
Multiplication clock frequency	f_{CLK}	V_{I1} = 1.5V	30	40	50	kHz

SCI7631MKA

V_{SS} = 0V, Ta = 25 ˚C unless otherwise noted

Parameter	Symbol	Condition	Rating			Unit
			Min.	Typ.	Max.	
Input voltage	V_{I1}	$V_O > V_{I2}$	0.9	—	2.0	V
	V_{I2}		0.9	—	2.0	V
Output voltage	V_O	V_{I1} = 1.5V	3.40	3.50	3.60	V
Detection voltage	V_{DET}		1.00	1.05	1.10	V
Detection voltage hysteresis ratio	ΔV_{DET}		—	5	—	%
Operating current	I_{DDO}	V_{I1} = 1.5V, I_O = 1.0mA	—	8	40	µA
Standby current	I_{DDS}	V_{I1} = 1.5V	—	3	10	µA
Switching transistor ON resistance	R_{SWON}	V_{I1} = 1.5V, V_O = 3.5V, V_{SW} = 0.2V	—	6	12	Ω
Switching transistor leakage current	I_{SWQ}	V_{I1} = 1.5V, V_O = 1.5V, V_{SW} = 7.0V	—	—	0.5	µA
Backup switch ON resistance	R_{BSON}	V_{I1} = 1.0V, V_{I2} = 2.0V, I_O = 1.0mA	—	70	160	Ω
Backup switching leakage current	I_{BSQ}	V_{I1} = 1.0V, V_O = 3.5V, V_{I2} = 2.0V	—	—	0.1	µA
$\overline{RST}$ LOW-level output current	I_{OL}	V_{I1} = 0.9V, V_{DS} = 0.2V	0.05	0.15	—	mA
$\overline{PS}$ pull-up current	I_{IH}	V_{I1} = 1.5V	—	—	0.5	µA
Multiplication clock frequency	f_{CLK}	V_{I1} = 1.5V	30	40	50	kHz

SCI7631MAA

V_{SS} = 0V, Ta = 25 ˚C unless otherwise noted

Parameter	Symbol	Condition	Rating			Unit
			Min.	Typ.	Max.	
Input voltage	V_{I1}	$V_O > V_{I2}$	0.9	—	2.0	V
	V_{I2}		0.9	—	2.0	V
Output voltage	V_O	V_{I1} = 1.5V	4.80	5.00	5.20	V
Detection voltage	V_{DET}		1.00	1.05	1.10	V
Detection voltage hysteresis ratio	ΔV_{DET}		—	5	—	%
Operating current	I_{DDO}	V_{I1} = 1.5V, I_O = 1.0mA	—	10	50	µA
Standby current	I_{DDS}	V_{I1} = 1.5V	—	3	10	µA
Switching transistor ON resistance	R_{SWON}	V_{I1} = 1.5V, V_O = 5.0V, V_{SW} = 0.2V	—	5	10	Ω
Switching transistor leakage current	I_{SWQ}	V_{I1} = 1.5V, V_O = 1.5V, V_{SW} = 7.0V	—	—	0.5	µA
Backup switch ON resistance	R_{BSON}	V_{I1} = 1.0V, V_{I2} = 3.0V, I_O = 1.0mA	—	50	100	Ω
Backup switching leakage current	I_{BSQ}	V_{I1} = 1.0V, V_O = 5.0V, V_{I2} = 3.0V	—	—	0.1	µA
$\overline{RST}$ LOW-level output current	I_{OL}	V_{I1} = 0.9V, V_{DS} = 0.2V	0.05	0.15	—	mA
$\overline{PS}$ pull-up current	I_{IH}	V_{I1} = 1.5V	—	—	0.5	µA
Multiplication clock frequency	f_{CLK}	V_{I1} = 1.5V	35	45	55	kHz

SCI7638MHA

V_{SS} = 0V, Ta = 25 ˚C unless otherwise noted

Parameter	Symbol	Condition	Rating			Unit
			Min.	Typ.	Max.	
Input voltage	V_{I1}		0.9	—	2.0	V
Output voltage	V_O	V_{I1} = 1.5V	2.10	2.20	2.30	V
Output voltage temperature gradient	Kt		–5.5	–4.5	–3.5	mV/˚C
Detection voltage	V_{DET}		1.00	1.05	1.10	V
Detection voltage hysteresis ratio	ΔV_{DET}		—	5	—	%
Operating current	I_{DDO}	V_{I1} = 1.5V, I_O = 1.0mA	—	7	35	µA
Standby current	I_{DDS}	V_{I1} = 1.5V	—	3	10	µA
Switching transistor ON resistance	R_{SWON}	V_{I1} = 1.5V, V_O = 2.2V, V_{SW} = 0.2V	—	7	14	Ω
Switching transistor leakage current	I_{SWQ}	V_{I1} = 1.5V, V_O = 1.5V, V_{SW} = 7.0V	—	—	0.5	µA
$\overline{RST}$ LOW-level output current	I_{OL}	V_{I1} = 0.9V, V_{OL} = 0.2V	0.05	0.15	—	mA
$\overline{PS}$ pull-up current	I_{IH}	V_{I1} = 1.5V	—	—	0.5	µA
Multiplication clock frequency	f_{CLK}	V_{I1} = 1.5V	25	35	45	kHz

Switching Regulator

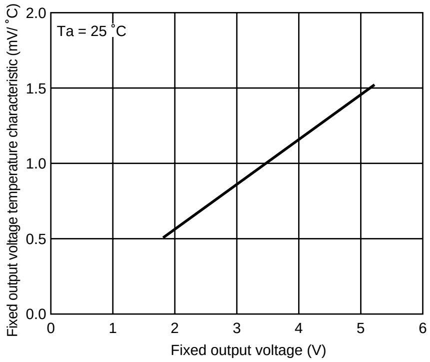
SCI7638MLA

V_{SS} = 0V, Ta = 25 ˚C unless otherwise noted

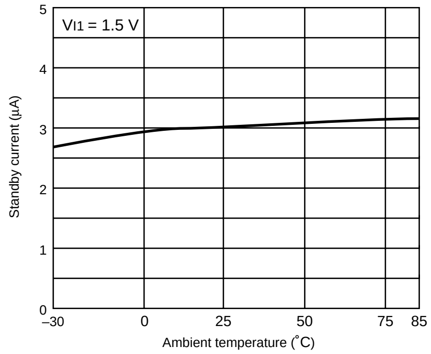
Parameter	Symbol	Condition	Rating			Unit
			Mmin.	Typ.	Max.	
Input voltage	V_{I1}		0.9	—	2.0	V
Output voltage	V_O	V_{I1} = 1.5V	2.30	2.40	2.50	V
Output voltage temperature gradient	Kt		–5.5	–4.0	–3.5	mV/˚C
Detection voltage	V_{DET}		1.00	1.05	1.10	V
Detection voltage hysteresis ratio	ΔV_{DET}		—	5	—	%
Operating current	I_{DDO}	V_{I1} = 1.5V, I_O = 1.0mA	—	7	35	µA
Standby current	I_{DDS}	V_{I1} = 1.5V	—	3	10	µA
Switching transistor ON resistance	R_{SWON}	V_{I1} = 1.5V, V_O = 2.4V, V_{SW} = 0.2V	—	7	14	Ω
Switching transistor leakage current	I_{SWQ}	V_{I1} = 1.5V, V_O = 1.5V, V_{SW} = 7.0V	—	—	0.5	µA
$\overline{RST}$ LOW-level output current	I_{OL}	V_{I1} = 0.9V, V_{OL} = 0.2V	0.05	0.15	—	mA
$\overline{PS}$ pull-up current	I_{IH}	V_{I1} = 1.5V	—	—	0.5	µA
Multiplication clock frequency	f_{CLK}	V_{I1} = 1.5V	25	35	45	kHz

Typical Performance Characteristics

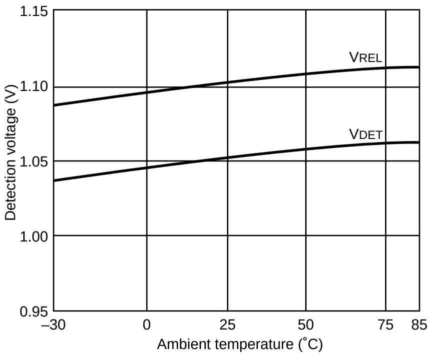
Fixed-output voltage temperature characteristic



Standby current vs. ambient temperature

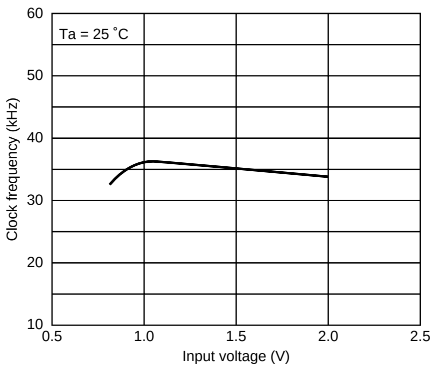


Detection voltage vs. ambient temperature

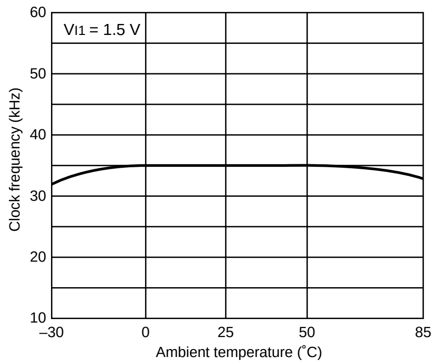


SCI7638MHA and SCI7638MLA

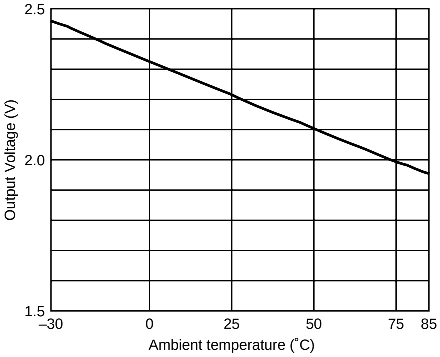
Clock frequency VS. Input voltage



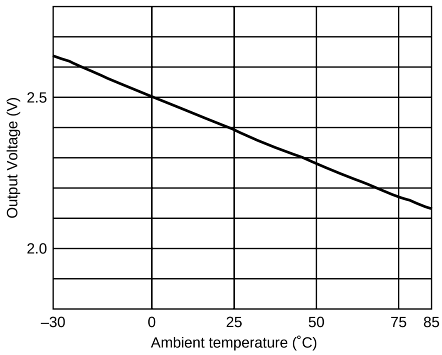
Clock frequency vs. ambient temperature



Output voltage vs. ambient temperature (SCI7638MHA)

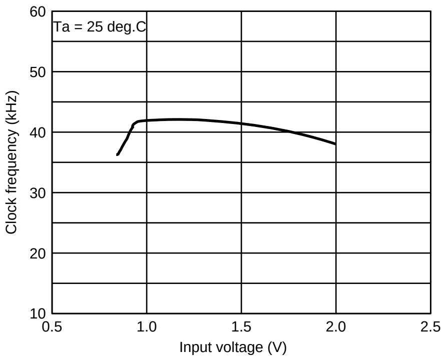


Output voltage vs. ambient temperature (SCI7638MLA)

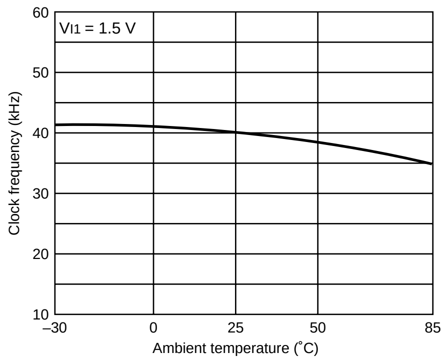


SCI7631MBA, SCI7631MKA

Clock frequency vs. input voltage

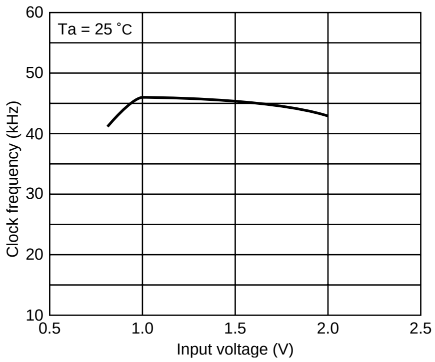


Clock frequency vs. ambient temperature

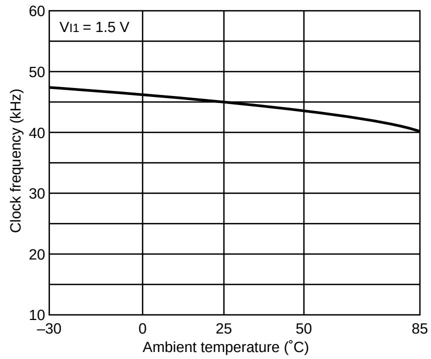


SCI7631MAA

Clock frequency vs. input voltage

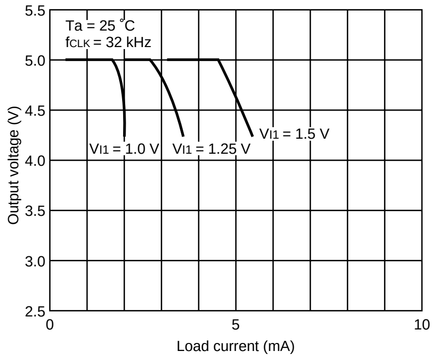


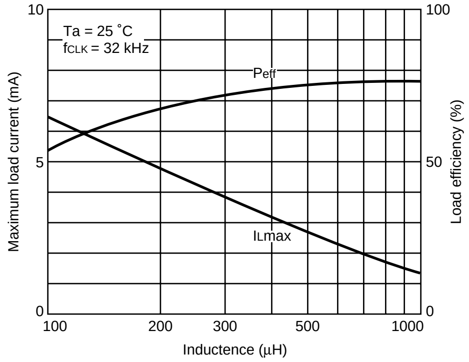
Clock frequency vs. ambient temperature



Load Characteristics

SCI7631MAA





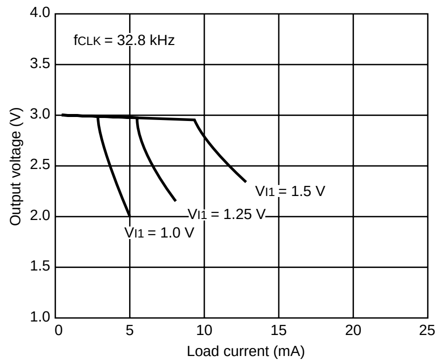
Notes

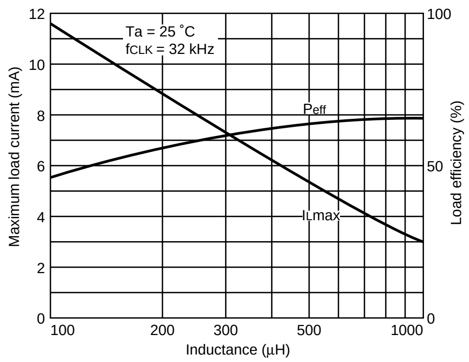
Inductor: TDK NLF453232-221k (220µH)
Diode: Shindengen DINS4 Schottky barrier diode
Capacitor: NEC MSUB20J106M (10µF)

Notes

1. V_{I1} = 1.5V
2. Inductor: TDK NLF453232 series
   Diode: Shindengen DINS4 Schottky barrier diode
   Capacitor: NEC MSUB20J106M (10µF)

SCI7631MBA





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Capacitor: NEC MSUB20J106M (10µF)

Notes

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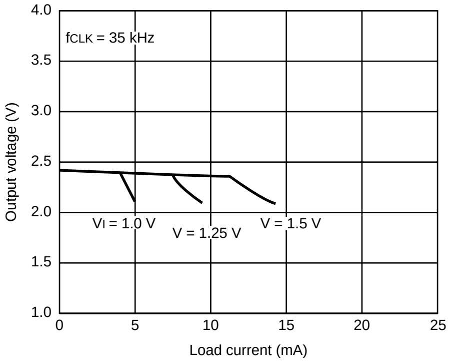
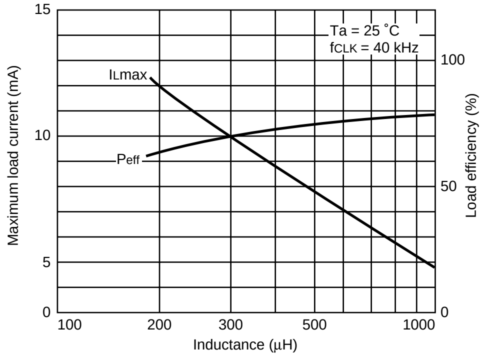
   Diode: Shindengen DINS4 Schottky barrier diode
   Capacitor: NEC MSUB20J106M (10µF)

SCI7638MLA





Notes

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Diode: Shindengen DINS4 Schottky barrier diode
Capacitor: NEC MSUB20J106M (10µF)

Notes

1. V_{I1} = 1.5V
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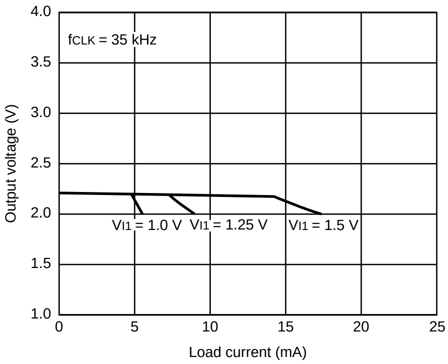
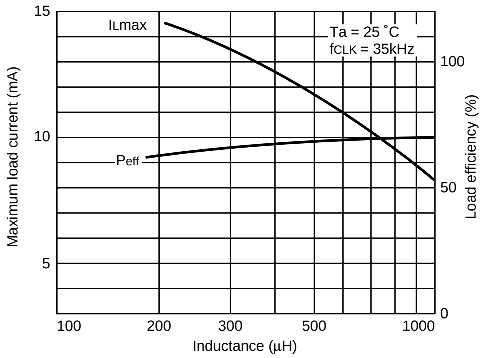
   Diode: Shindengen DINS4 Schottky barrier diode
   Capacitor: NEC MSUB20J106M (10µF)

SCI7638MHA





Notes

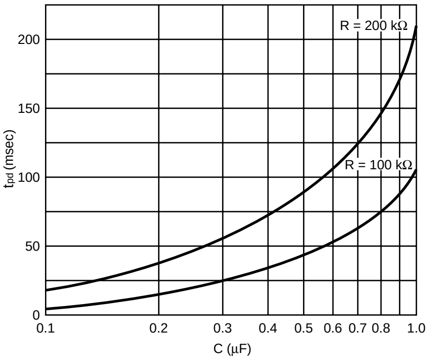
Inductor: TDK NLF453232-221k (220µH)
Diode: Shindengen DINS4 Schottky barrier diode
Capacitor: NEC MSUB20J106M (10µF)

Notes

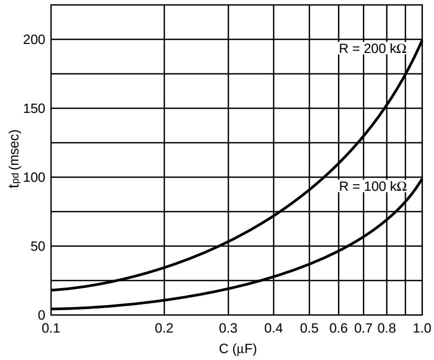
1. V_{I1} = 1.5V
2. Inductor: TDK NLF453232 series
   Diode: Shindengen DINS4 Schottky barrier diode
   Capacitor: NEC MSUB20J106M (10µF)

Reset delays

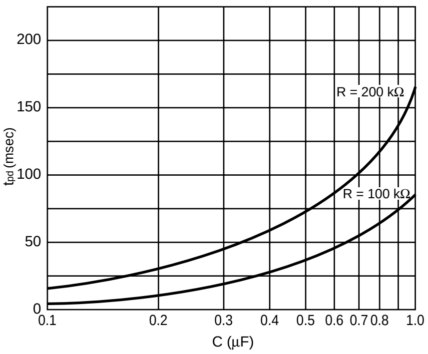
SCI7631MAA



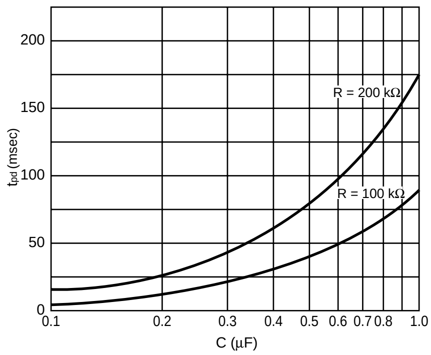
SCI7631MKA



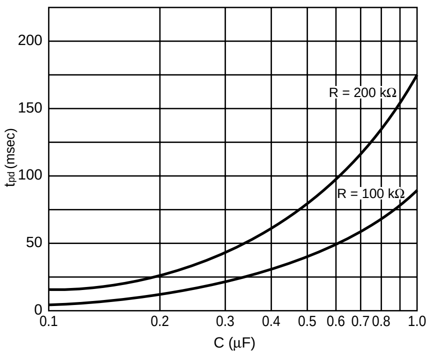
SCI7631MBA



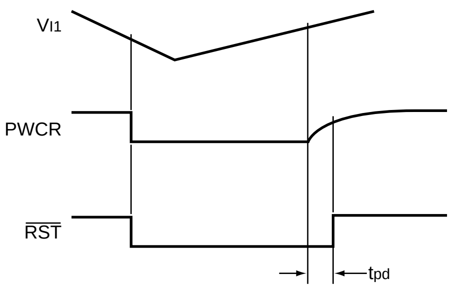
SCI7631MLA and SCI7638MLA



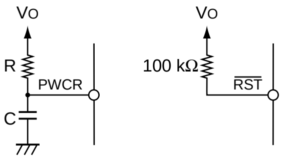
SCI7638MHA



Timing diagram

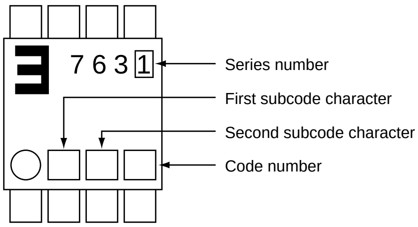


Measurement circuit



PACKAGE MARKINGS

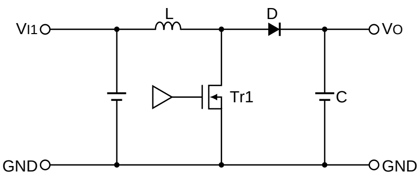
SCI7631, SCI7638 series device packages use the following markings.



FUNCTIONAL DESCRIPTION

Basic Voltage Booster Operation

TR1 switches ON and OFF at half the frequency of the clock pulses from the built-in RC oscillator. When the transistor is ON, the circuit stores energy in L. When it is off, this energy flows through D to change C.

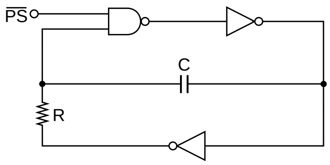


Internal Circuits

RC oscillator

The SCI7631, SCI7638 series use a built-in RC oscillator to drive the voltage booster circuit. The circuit is supplied by V_{I1}. All circuit components are on-chip and thus the drive frequency is set internally. To ensure 50% duty, this frequency is twice that used by the voltage booster circuit.

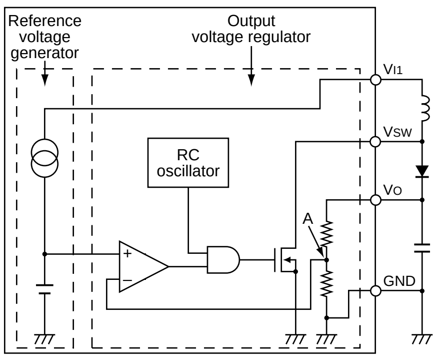
When $\overline{PS}$ is LOW, the oscillator is disabled and the chip is in standby mode.



Reference voltage generator and output voltage regulator

The reference voltage generator regulates V_{I1} to generate a votlage for the voltage regulator and voltage detection circuits.

The voltage regulator regulates the boosted output votlage. This is determined by the level at point A between the two resistors connecting V_O and GND. These series use an on-chip resistor to set the output at a specified voltage.



Note

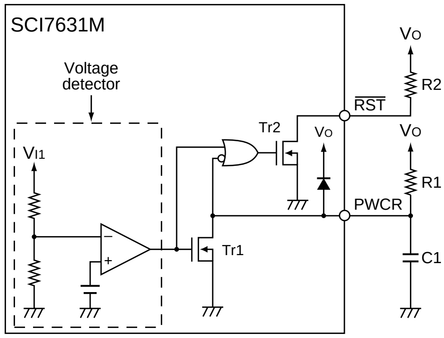
In step-up voltage operation, the ripple voltage created by the switching operation is large relative to the output voltage described above. This ripple voltage is affected by external components and load conditions. The user is advised to check this voltage carefully.

Voltage detection

The SCI7631, SCI7632, SCI7638, and SCI7639 series are equipped with a built-in voltage detection function. The detection voltage, V_{DET}, is fixed internally at 1.05 ± 0.05V.

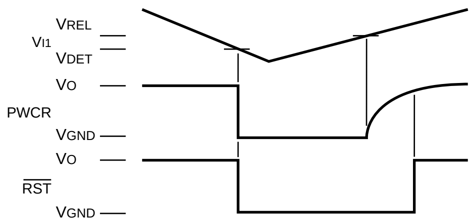
Power-on clear function

The SCI7631 series and SCI7638 series are equipped with a built-in power-on clear function. As shown in the following figure, R1 and C1 are connected to PWCR, and R2 is connected to $\overline{RST}$ to operate the function. If V_{I1} drops below V_{DET}, TR1 and TR2 conduct and PWCR and $\overline{RST}$ are grounded. If V_{I1} recovers and rises higher than V_{REL}, TR1 turns OFF. The detection voltage hysteresis is 5% (Typ.) and V_{REL} is $V_{DET} \times 1.05$ (Typ.).



V_O returns to its normal value when the voltage of PWCR increases and TR2 turns OFF, so that $\overline{RST}$ returns to V_O after a delay specified by the time coefficient of R1 and C1. Thus, after normal output has been obtained, a reset pulse of adjustable width can be obtained which can reset a system connected to $\overline{RST}$.

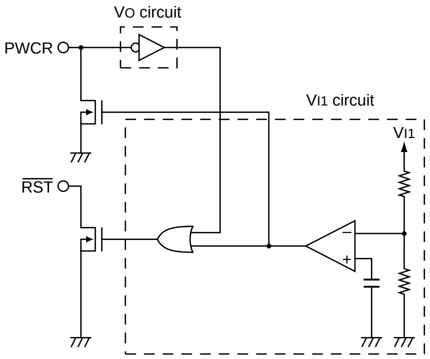
The output from $\overline{RST}$ is an N-channel, open-drain. When V_{I1} exceeds V_{DET}, the drain is opened and, when V_{I1} drops below V_{DET} again, the output transistor conducts and the output is grounded. The characteristic response is shown in the following figure.



Disabling power-on clear

Always connect PWCR to either V_O or GND. If voltage detection only is required, remove the resistor between PWCR and V_O and monitor the level at $\overline{RST}$. If neither function is required, connect PWCR to GND.

Leaving PWCR unconnected results in an undefined inverter gate voltage in the V_O circuit, causing transient currents to flow between V_O and GND.



Output voltage response compensation

The SCI7638 series are provided with a response compensation input. A response compensation capacitor is connected between V_{CONT} and V_O, allowing the ripple voltage generated by the boosted output voltage to be suppressed to a minimum.

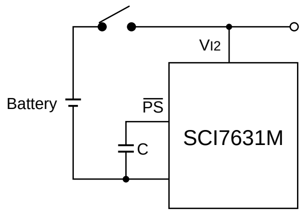
Standby mode and battery backup

The SCI7631 series are equipped with a standby mode, initiated by connecting $\overline{PS}$ to GND.

In standby mode, the booster, including the crystal oscillator, is disabled (the switching transistor used to drive the inductor is turned OFF) and the built-in backup switch is turned ON, so that the input voltage at V_{I2} is output at V_O. This enables the battery backup function. $\overline{PS}$ is pulled-up internally, so when standby mode is not required, the pin should be left open.

Powering up

Ensure that V_0 is at least the minimum operating voltage (0.9V) before switching on the booster circuit.
One way to do this is to attach a battery so that V_0 never drops below the minimum required for backup mode. If no such external power supply is available, connect V_{I2} to V_{I1} and hold $\overline{PS}$ LOW when applying power for the first time.

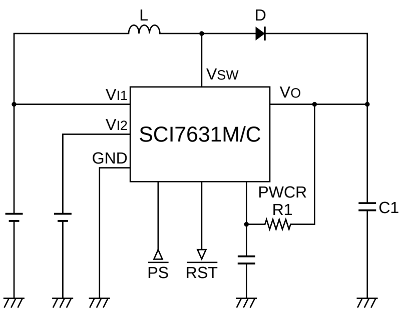


TYPICAL APPLICATIONS

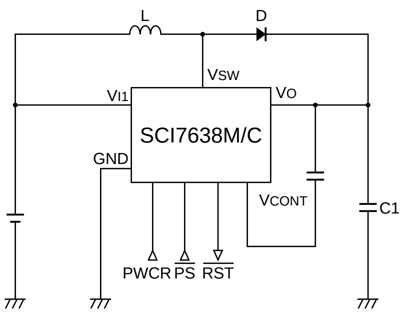
Example Circuits

The output current, I_O, and power conversion efficiency, Peff of a particular device in a series depends on factors such as the switching frequency, type of coil, and the size and type of other external components.

SCI7631 series



SCI7638 series



Notes

- ■ $100\mu H \leq L \leq 1mH$, $C \leq 10\mu F$, D = Schottky diode
- ■ SCI7631MAA
  - Peff = 70% when L = 220μH (leadless inductor), V_{I1} = 1.5V, f_{CLK} = 32kHz, I_O = 4mA
  - Peff = 75% when L = 220μH (drum coil), V_{I1} = 1.5V, f_{CLK} = 32kHz, I_O = 6mA
  - Peff = 80% when L = 300μH (toroidal coil), V_{I1} = 1.5V, f_{CLK} = 32kHz, I_O = 7mA
- ■ SCI7631MBA
  - Peff = 70% when L = 220μH (leadless inductor), V_{I1} = 1.5V, f_{CLK} = 32kHz, I_O = 8mA
  - Peff = 75% when L = 220μH (drum coil), V_{I1} =1.5V, f_{CLK} = 32kHz, I_O = 9mA
  - Peff = 80% when L = 300μH (toroidal coil), V_{I1} = 1.5V, f_{CLK} = 32kHz, I_O = 10mA

External components

The performance characteristics of switching regulators depend greatly on the choice of external components. Observing the following guidelines will ensure high performance and maximum efficiency.

Inductor

Use an inductor with low direct-current resistance and low losses.

Leadless

Pre-wound, leadless inductors using surface-mount technology are the most suitable for portable equipment and other space-critical applications.

Drum coil

Avoid using drum coils because their magnetic field can induce noise.

Toroidal coil

Use a toroidal coil to virtually eliminate magnetic field leakage, reduce losses and improve performance.

Diode

Use a Schottky barrier diode with a high switching speed and low forward voltage drop, V_F.

Capacitor

To minimize ripple voltages, use a capacitor with a small equivalent direct-current resistance for smoothing.

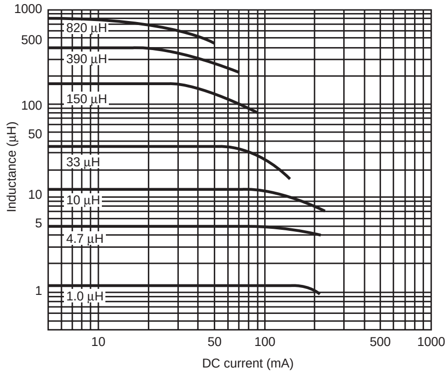
Sample External Components

Leadless Inductors

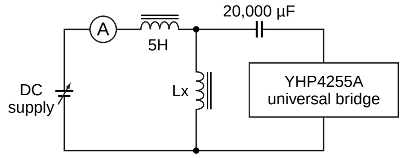
TDK NKF453232 series magnetically shielded leadless inductors

Device	Inductance (µH)	Qmin	LQ frequency (MHz)	Device frequency (MHz-Min.)	DC resistance (Ω-Max.)	Rated current (mA-Max.)
NLF453232-390K	39.0 ±10%	50	2.52	13	1.89	44
NLF453232-470K	47.0 ±10%	50	2.52	12	2.10	41
NLF453232-560K	56.0 ±10%	50	2.52	11	2.34	39
NLF453232-680K	68.0 ±10%	50	2.52	10	2.60	36
NLF453232-820K	82.0 ±10%	50	2.52	10	2.86	34
NLF453232-101K	100.0 ±10%	50	0.796	9	3.25	32
NLF453232-121K	120.0 ±10%	50	0.796	8	3.64	30
NLF453232-151K	150.0 ±10%	50	0.796	7	4.16	28
NLF453232-181K	180.0 ±10%	40	0.796	6	5.72	26
NLF453232-221K	220.0 ±10%	40	0.796	5.5	6.30	24
NLF453232-271K	270.0 ±10%	40	0.796	5	6.90	23
NLF453232-331K	330.0 ±10%	40	0.796	4.5	7.54	23
NLF453232-391K	390.0 ±10%	40	0.796	4	8.20	21
NLF453232-471K	470.0 ±10%	40	0.796	3.8	9.20	19
NLF453232-561K	560.0 ±10%	40	0.796	3.6	10.50	18
NLF453232-681K	680.0 ±10%	40	0.796	3.4	12.00	17
NLF453232-821K	820.0 ±10%	40	0.796	3	13.50	16
NLF453232-102K	1000.0 ±10%	40	0.252	2.5	16.00	15

Characteristic response



Measurement circuit



Switching Regulator

Drum coil inductors

Taiyo Yuuden FL series micro-inductors

Device	Inductance	Direct current (mA)
FL3H	0.22µH to 10µH	280 to 670
FL4H	0.47µH to 12µH	300 to 680
FL5H	10µH to 1mH	50 to 320
FL7H	680µH to 8.2mH	50 to 170
FL9H	330µH to 33mH	50 to 500
FL11H	10mH to 150mH	35 to 110

Toroidal coil inductors

Tohoku Metal Industries HP series toroidal coil inductors

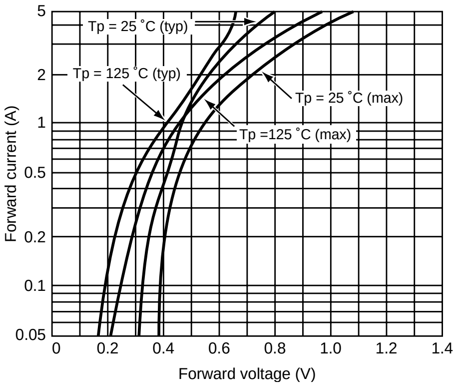
Device	Rated current IDC (A)	Inductance (µH) at 20kHz, 5V		Diameter × height (mm-Max.)	Wire gauge (mm)
		IDC = 0	IDC = rating		
HP011	1	200	160	ϕ 20 × 12	0.5
HP021	2	65	55		0.7
HP031	3	30	23		0.8
HP012	1	600	450	ϕ 22 × 13	0.5
HP022	2	180	135		0.7
HP032	3	120	80		0.8
HP052	5	45	30		1.0
HP013	1	1000	800	ϕ 26 × 14	0.5
HP023	2	500	330		0.7
HP033	3	130	100		0.8
HP055	5	90	55		1.0
HP034S	3	400	250	ϕ 36 × 18	0.8
HP054S	5	350	160		1.0
HP104S	10	50	30		1.6
HP024	2	1500	950	ϕ 36 × 21	0.7
HP034	3	300	230		0.8
HP054	3	210	140		1.0
HP104	10	45	30		1.6
HP035	3	700	500	ϕ 43 × 23	0.5
HP055	5	600	330		1.0
HP105	10	180	95		1.6
HP205	20	20	14		1.8 × 2 P

Diodes

Shindengen DINS4 Schottky barrier diodes

Parameter	Symbol	Condition	Rating			Unit
			Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 1.1A, pulse measurement	—	—	0.55	V
Reverse current	I_R	$V_R = V_{RM}$, pulse measurement	—	—	1	mA
Junction-to-lead thermal resistance	θ_{jl}		—	—	23	˚C/W
Junction-to-ambient thermal resistance	θ_{ja}		—	—	157	˚C/W

Characteristics



Smoothing capacitors

NEC MSV series capacitors

Device	Package type	Rated voltage (V)	Static capacitance (μF)	Tan δ			Leakage current (μA)
				+25, +85 ˚C	+125 ˚C	–55 ˚C	
MSVAOJ475M	A	6.3	4.7	0.08	0.1	0.12	0.5
MSVB2OJ106M	B2	6.3	10	0.08	0.1	0.12	0.6
MSVB2OJ156M	B2	6.3	15	0.08	0.1	0.12	0.9
MSVBOJ156M	B	6.3	15	0.08	0.1	0.12	0.9
MSVCOJ336M	C	6.3	33	0.08	0.1	0.12	2.0
MSVD2OJ686M	D2	6.3	68	0.08	0.1	0.12	4.2
MSVDOJ686M	D	6.3	68	0.08	0.1	0.12	4.2

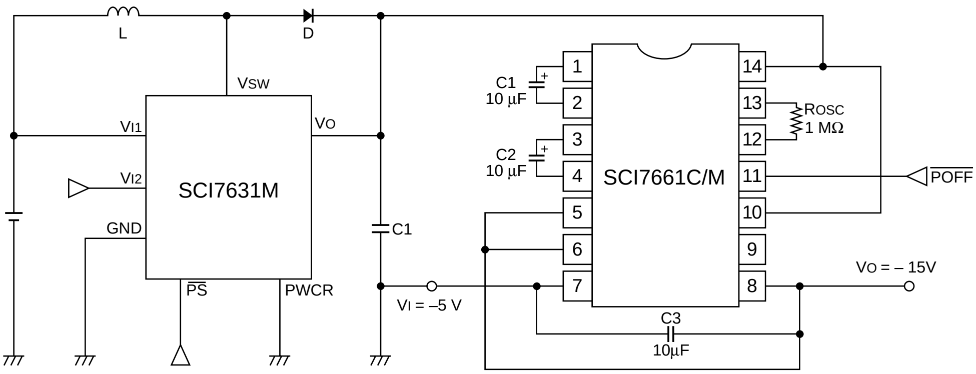
Note

The figures on the previous pages show data from the documents of various manufactures. For further details, please contact the relevant manufacture.

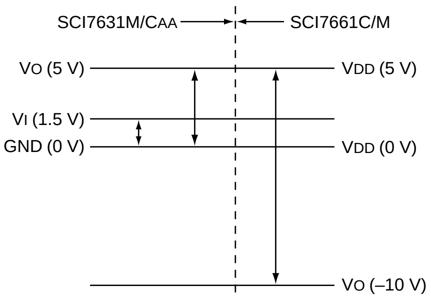
Other Applications

Voltage booster

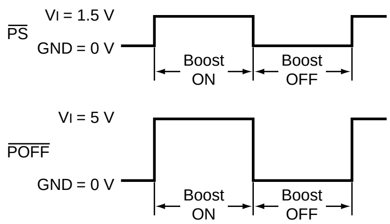
Combining an SCI7631 switching regulator with an SCI7661C/M DC/DC converter and voltage regulator creates the voltage booster circuit shown in the following figure.



Potential levels are shown in the following figure.

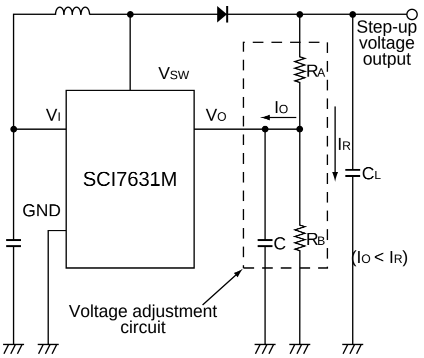


Although the circuit appears to have two ON/OFF control points, PS on the SCI7631CAA/MAA and POFF on the SCI7661C/M, PS only shuts down the SCI7631MAA. The input voltage still reaches the SCI7661C/M through L and D.



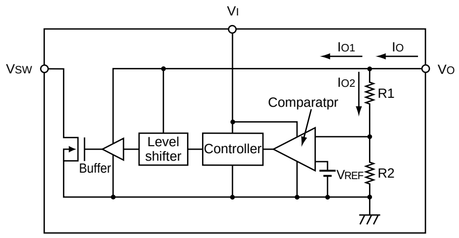
Output voltage adjustment

To ensure stable output, any circuit that adjusts the output voltage must contain C1, R_A and R_B. To stop switching current from affecting V_O, the circuit must also satisfy the condition $I_O < I_R$.



The following figure summarizes the relevant circuits inside an SCI7630 series chip.

V_O is connected to the level shift and buffer circuit, which provide the gate bias for the switching transistor driving the inductor. The current drain, I_{O1}, varies with the load and is typically 10µA. The current, I_{O2}, through the internal resistors R1 and R2, is typically 1µA.



Switching
Regulator

SCI7633 Series CMOS Switching Regulators

DESCRIPTION

The SCI7633 series of CMOS switching regulators provide input voltage step-up and regulation to a specified voltage using an external coil. The devices in these series incorporate precision, low-power reference voltage generators and transistors for driving an internal comparator. They feature low power consumption, low operating voltages and standby operation.

The devices offer a range of fixed output voltages, from 2.35 to 5.00V.

They are available in 8-pin SOP3s.

FEATURES

- 0.9V (Min.) operating voltage
- 8µA (Typ.) maximum current consumption
- Standby operation
- 3µA (Typ.) standby current consumption
- Built-in oscillator circuit for use with external crystal oscillator
- 8-pin SOP3

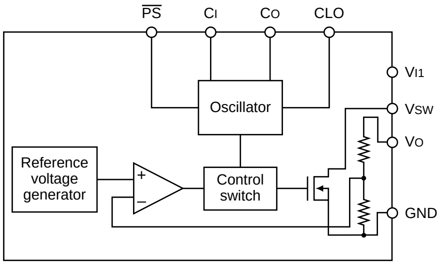
APPLICATIONS

- Fixed-voltage power supplies for battery-operated equipment such as portable video cassette recorders, video cameras and radios
- Power supplies for pages, memory cards, calculators and similar hand-held equipment
- Fixed-voltage power supplies for medical equipment
- Fixed-voltage power for communications equipment
- Power supplies for microcomputers
- Uninterruptable power supplies

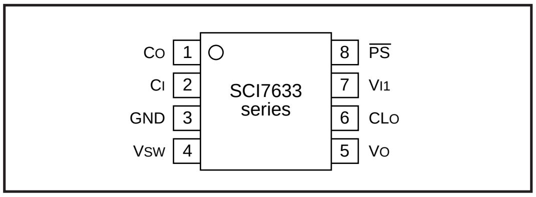
LINE-UP

Device	Voltage (V)		Multiplication frequency source	Voltage detection	Power-on clear	Battery backup	Response compensation	Output voltage temperature characteristic	Package
	Input	Output							
SCI7633MBA	1.5 (0.9 min.)	3.00	Crystal oscillator	No	No	No	No	No	SOP3-8pin

BLOCK DIAGRAMS
SCI7633 series



PIN CONFIGURATIONS
SCI7633 series



PIN DESCRIPTIONS
SCI7633 series

Number	Name	Description
1	CO	Crystal drain
2	CI	Crystal gate
3	GND	Ground
4	VSW	External inductor drive
5	VO	Output voltage
6	CLO	Oscillator output
7	VI	Step-up input voltage
8	$\overline{PS}$	Power save. See note.

Note
See standby mode in the functional description.

SPECIFICATIONS
Absolute Maximum Ratings
SCI7633 series

Parameter	Symbol	Rating	Unit
Input voltage	V_{I1}	7	V
Output current	I_O	100	mA
Output voltage	V_O	7	V
Power dissipation	P_D	200 (SOP) 300 (DIP)	mW
Operating temperature range	Topr	–30 to 85	˚C
Storage temperature range	Tstg	–65 to 150	˚C
Solding temperature (for 10 s. See note.)	Tsol	260	˚C

Note
Temperatures during reflow soldering must remain within the limits set out in LSI Device Precautions. Never use solder dip to mount SCI7000 series power supply devices.

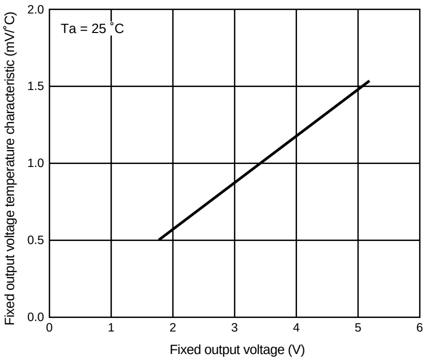
Electrical Characteristics

SCI7633MBA
V_{SS} = 0V, Ta = 25 ˚C unless otherwise noted

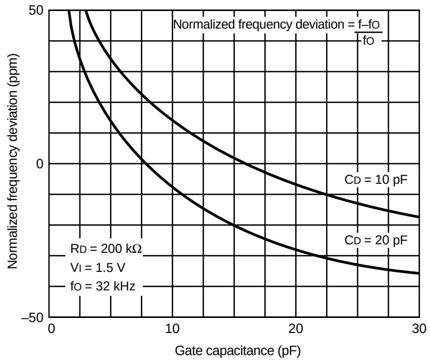
Parameter	Symbol	Conditions	Rating			Unit
			Min.	Typ.	Max.	
Input voltage	V_{I1}	$V_O > V_{I2}$	0.9	—	2.0	V
Output voltage	V_O	V_{I1} = 1.5V	2.90	3.00	3.10	V
Operating current	I_{DDO}	V_{I1} = 1.5V, f_{CLK} = 32kHz, I_O = 1.0mA	—	5	30	µA
Standby current	I_{DDS}	V_{I1} = 1.5V	—	3	10	µA
Switching transistor ON resistance	R_{SWON}	V_{I1} = 1.5V, V_O = 3.0V, V_{SW} = 0.2V	—	6	12	Ω
Switching transistor leakage current	I_{SWQ}	V_{I1} = 1.5V, V_O = 1.5V, V_{SW} = 7.0V	—	—	0.5	µA
CLO LOW-level output current	I_{OL}	V_{I1} = 1.5V, V_O = 3.0V, V_{OL} = 0.2V	0.5	1.0	—	µA
CLO HIGH-level output current	I_{OH}	V_{I1} = 1.5V, V_O = 3.0V, V_{OH} = 0.2V	0.55	1.1	—	µA
$\overline{PS}$ pull-up current	I_{IH}	V_{IH} = 1.5V	—	—	0.5	µA
Oscillator start-up voltage	V_{STA}	C_G = 10pF, C_D = 10pF, R_D = 300kΩ, f_{OSC} = 32kHz	0.9	—	—	V
Oscillator shut-down voltage	V_{STP}		—	—	0.9	V

Typical Performance Characteristics

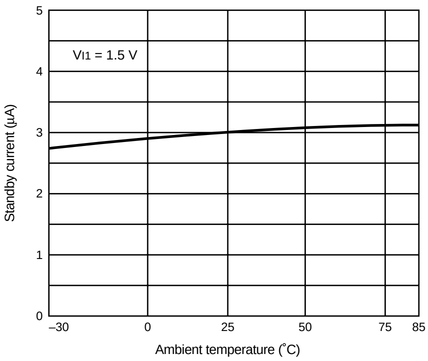
Fixed output voltage temperature characteristic



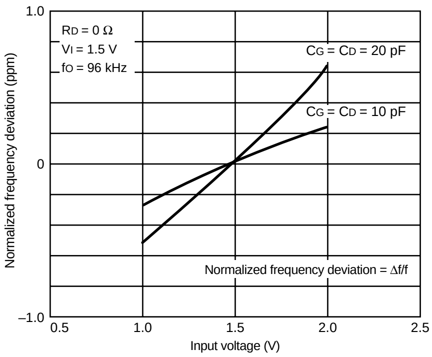
Normalized frequency deviation vs. gate capacitance 1



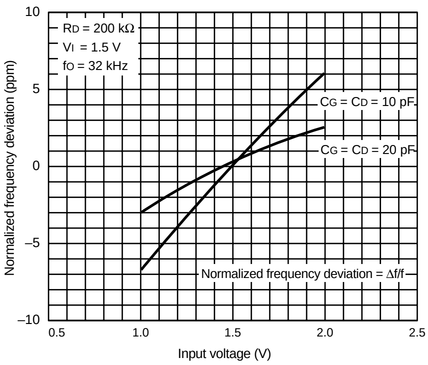
Standby current vs. ambient temperature



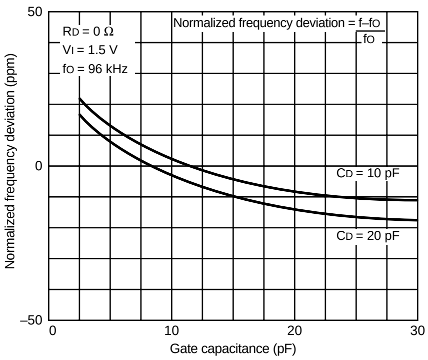
Normalized frequency deviation vs. input voltage 2



Normalized frequency deviation vs. input voltage 1

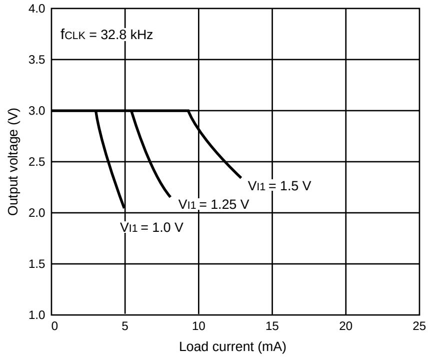


Normalized frequency deviation vs. gate capacitance 2



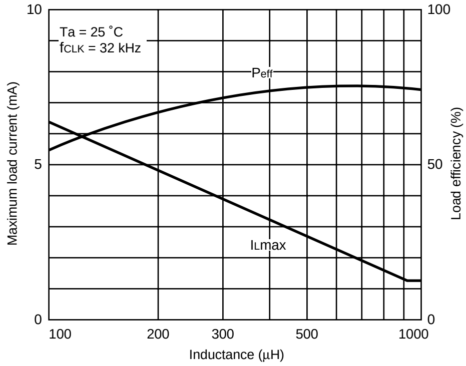
Load characteristics

SCI7633MBA



Notes

Inductor: TDK NLF453232-221k (220μH)
Diode: Shindengen DINS4 Schottky barrier diode
Capacitor: NEC MSUB20J106M (10μF)



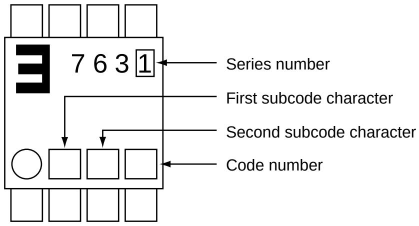
Notes

1. V_{I1} = 1.5V
2. Inductor: TDK NLF453232 series
   Diode: Shindengen DINS4 Schottky barrier diode
   Capacitor: NEC MSUB20J106M (10μF)

Switching Regulator

PACKAGE MARKINGS

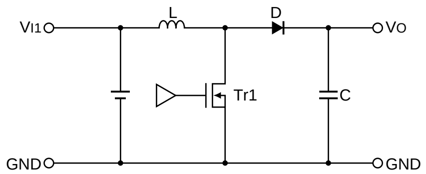
SCI7633 device packages use the following marking.



FUNCTIONAL DESCRIPTION

Basic Voltage Booster Operation

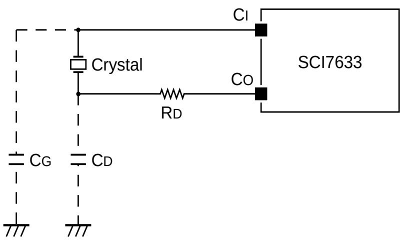
TR1 switches ON and OFF at the frequency of the clock pulses from the crystal oscillator. When the transistor is ON, the circuit stores energy in L. When it is OFF, this energy flows through D to charge C.



Internal Circuits

Crystal oscillator

The SCI7633 series incorporate a crystal oscillator circuit. An external crystal and drain resistor are used to generate the booster circuit clock. The crystal oscillator is connected to C_I and C_O as shown in the following figure.

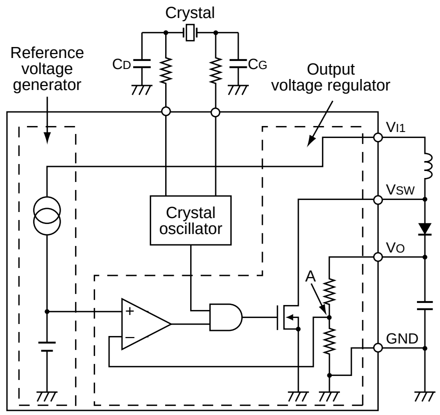


In the SCI7633 series, the crystal oscillator output is sent to CL_O as the V_O system signal. The crystal oscillator circuit is activated by V_I but, because the output level is shifted and the output is connected to CL_O, the oscillator output cannot be obtained without a voltage at V_O. Since the crystal oscillator is activated when an input voltage is applied, oscillation continues even in standby mode.

Reference voltage generator and output voltage regulator

The reference voltage generator regulates V_{I1} to generate a voltage for the voltage regulator circuit.

The output voltage regulator regulates the boosted output voltage. This voltage is determined by the level at point A between the two resistors connecting V_O and GND. These series use an on-chip resistor to set the output at a specified voltage.



Note

In step-up voltage operation, the ripple voltage created by the switching operation is large relative to the output voltage described above. This ripple voltage is affected by external components and load conditions. The user is advised to check this voltage carefully.

Standby mode

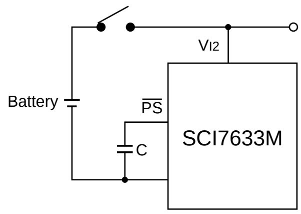
Connecting $\overline{PS}$ to GND places the chip in standby mode. In this mode, the crystal oscillator is disabled, switching off the inductor drive transistor and the voltage booster circuit. Typically, $\overline{PS}$ is connected to $\overline{RST}$. If standby mode is not required, leave $\overline{PS}$ open as it has a pull-up resistor.

Output voltage response compensation

The SCI7634 series incorporates a response compensation input. A response compensation capacitor is connected between V_{CONT} and V_O, allowing the ripple voltage generated by the boosted output voltage to be suppressed to a minimum.

Powering up

Ensure that V_O is at least the minimum operating voltage (0.9V) before switching on the booster circuit. One way to do this is to connect a capacitor between $\overline{PS}$ and GND so that the chip connects V_O to V_I when the power is applied for the first time.

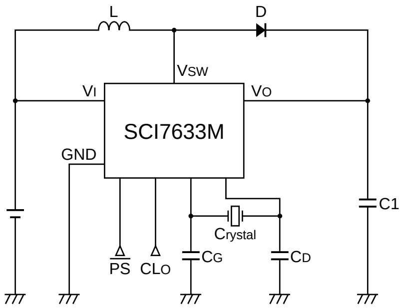


TYPICAL APPLICATIONS

Example Circuits

The output current, I_O, and power conversion efficiency Peff, of a particular device in the series depends on factors such as the switching frequency, type of coil, and the size and type of other external components.

SCI7633 series



Notes

■ 100µH ≤ L ≤ 1mH, C ≤ 10µF, D: Schottky diode

■ SCI7633MBA

- Peff = 70% when L = 220µH (leadless inductor), V_{I1} = 1.5V, f_{CLK} = 32kHz, I_O = 8mA
- Peff = 75% when L = 220µH (drum coil), V_{I1} = 1.5V, f_{CLK} = 32kHz, I_O = 9mA
- Peff = 80% when L = 300µH (toroidal coil), V_{I1} = 1.5V, f_{CLK} = 32kHz, I_O = 10mA

External Components

The performance characteristics of switching regulators depend greatly on the choice of external components. Observing the following guidelines will ensure high performance and maximum efficiency.

Inductor

Use an inductor with low direct-current resistance and low losses.

Leadless

Pre-wound, leadless inductors using surface-mount technology are the most suitable for portable equipment and other space-critical applications.

Drum coil

Avoid drum coils because their magnetic field can induce noise.

Toroidal coil

Use a toroidal coil to virtually eliminate magnetic field leakage, reduce losses and improve performance.

Switching Regulator

Diode

Use a Schottky barrier diode with a high switching speed and low forward voltage drop, V_F.

Capacitor

To minimize ripple voltages, use capacitors with a small equivalent direct-current resistance for smoothing.

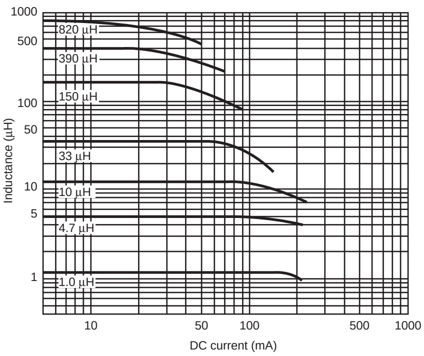
Sample External Components

Leadless inductors

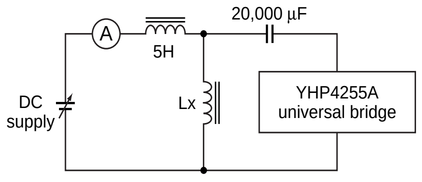
TDK NLF453232 series magnetically-shielded leadless inductors

Device	Inductance (µH)	Qmin	LQ frequency (MHz)	Device freuquency (MHz-Min.)	DC resistance (Ω-Max.)	Rated current (mA-Max.)
NLF453232-390K	39.0 ±10%	50	2.52	13	1.89	44
NLF453232-470K	47.0 ±10%	50	2.52	12	2.10	41
NLF453232-560K	56.0 ±10%	50	2.52	11	2.34	39
NLF453232-680K	68.0 ±10%	50	2.52	10	2.60	36
NLF453232-820K	82.0 ±10%	50	2.52	10	2.86	34
NLF453232-101K	100.0 ±10%	50	0.796	9	3.25	32
NLF453232-121K	120.0 ±10%	50	0.796	8	3.64	30
NLF453232-151K	150.0 ±10%	50	0.796	7	4.16	28
NLF453232-181K	180.0 ±10%	40	0.796	6	5.72	26
NLF453232-221K	220.0 ±10%	40	0.796	5.5	6.30	24
NLF453232-271K	270.0 ±10%	40	0.796	5	6.90	23
NLF453232-331K	330.0 ±10%	40	0.796	4.5	7.54	23
NLF453232-391K	390.0 ±10%	40	0.796	4	8.20	21
NLF453232-471K	470.0 ±10%	40	0.796	3.8	9.20	19
NLF453232-561K	560.0 ±10%	40	0.796	3.6	10.50	18
NLF453232-681K	680.0 ±10%	40	0.796	3.4	12.00	17
NLF453232-821K	820.0 ±10%	40	0.796	3	13.50	16
NLF453232-102K	1000.0 ±10%	40	0.252	2.5	16.00	15

Characteristic response



Measurement circuit



Drum coil inductors

Taiyo Yuuden FL series micro inductors

Device	Inductance	Direct current (mA)
FL3H	0.22µH to 10µH	280 to 670
FL4H	0.47µH to 12µH	300 to 680
FL5H	10µH to 1mH	50 to 320
FL7H	680µH to 8.2mH	50 to 170
FL9H	330µH to 33mH	50 to 500
FL11H	10µH to 150mH	35 to 110

Toroidal coil inductors

Tohoku Metal Industries HP series toroidal coil inductors

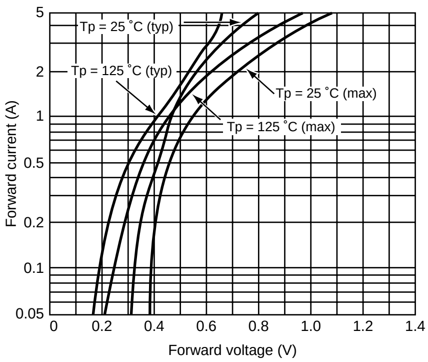
Device	Rated current IDC (A)	Inductance (µH) at 20kHz, 5V		Diameter × height (mm-Max.)	Wire gauge (mm)
		IDC = 0	IDC = rating		
HP011	1	200	160	20 × 12	0.5
HP021	2	65	55		0.7
HP031	3	30	23		0.8
HP012	1	600	450	22 × 13	0.5
HP022	2	180	135		0.7
HP032	3	120	80		0.8
HP052	5	45	30		1.0
HP013	1	1000	800	26 × 14	0.5
HP023	2	500	330		0.7
HP033	3	130	100		0.8
HP055	5	90	55		1.0
HP034S	3	400	250	36 × 14	0.8
HP054S	5	350	160		1.0
HP104S	10	50	30		1.6
HP024	2	1500	950	36 × 21	0.7
HP034	3	300	230		0.8
HP054	5	210	140		1.0
HP104	10	45	30		1.6
HP035	3	700	500	43 × 23	0.8
HP055	5	600	330		1.0
HP105	10	180	95		1.6
HP205	20	20	14		1.8 × 2 P

Diodes

Shindengen DINS4 Schottky barrier diodes

Parameter	Symbol	Conditions	Rating			Unit
			Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 1.1A, pulse measurement	—	—	0.55	V
Reverse current	I_R	$V_R = V_{RM}$, pulse measurement	—	—	1	mA
Junction-to-lead thermal resistance	θ_{jl}		—	—	23	˚C/W
Junction-to-ambient thermal resistance	θ_{ja}		—	—	157	˚C/W

Characteristics



Smoothing capacitors

NEC MSV series capacitors

Device	Package type	Voltage (V)	Static capacitance (μF)	Tan δ			Leakage current (μA)
				+25, +85 ˚C	+125 ˚C	–55 ˚C	
MSVA0J475M	A	6.3	4.7	0.08	0.1	0.12	0.5
MSVB20J106M	B2	6.3	10	0.08	0.1	0.12	0.6
MSVB20J156M	B2	6.3	15	0.08	0.1	0.12	0.9
MSVB0J156M	B	6.3	15	0.08	0.1	0.12	0.9
MSVC0J336M	C	6.3	33	0.08	0.1	0.12	2.0
MSVD20J686M	D2	6.3	68	0.08	0.1	0.12	4.2
MSVD0J686M	D	6.3	68	0.08	0.1	0.12	4.2

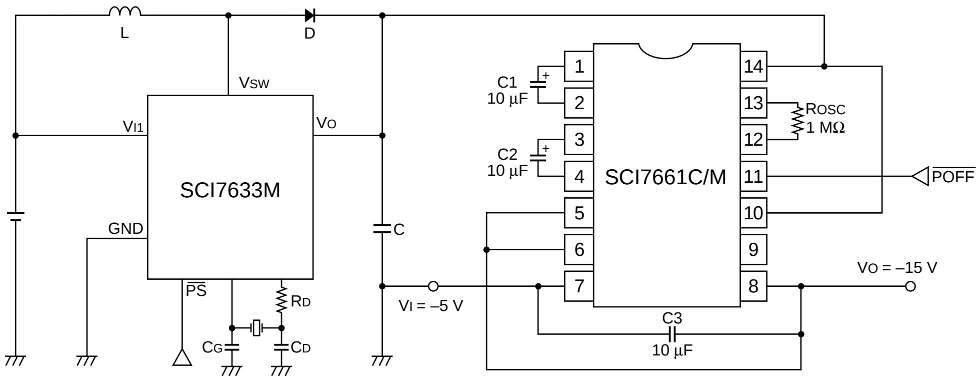
Note

The figures on the previous pages show data from the documents of various manufacturers. For further details, please contact the relevant manufacturer.

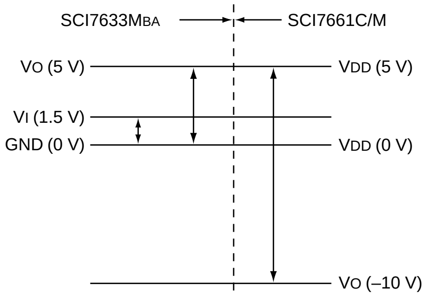
Other Applications

Voltage booster

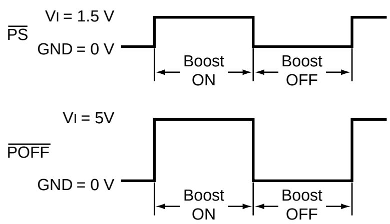
Combining an SCI7633MBA switching regulator with an SCI7661C/M DC/DC converter and voltage regulator creates the voltage booster circuit shown in the following figure.



Potential levels are shown in the following figure.

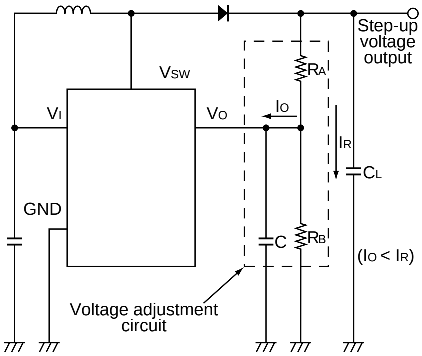


Although the circuit appears to have two ON/OFF control points, $\overline{PS}$ on the SCI7633MBA and $\overline{POFF}$ on the SCI7661C/M, $\overline{PS}$ only shuts down the SCI7633MBA. The input voltage still reaches the SCI7661C/M through L and D.



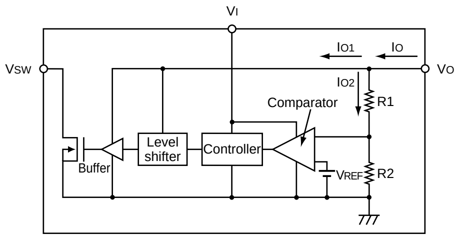
Output voltage adjustment

To ensure stable output, any circuit that adjusts the output voltage must contain C1, R_A and R_B. To stop switching current from affecting V_O, the circuit must also satisfy the condition $I_O < I_R$.



The following figure summarizes the relevant circuits inside an SCI7000 series chip.

V_O is connected to the level shift and buffer circuit, which provide the gate bias for the switching transistor driving the inductor. The current drain I_{O1}, varies with the load and is typically 10µA. The current, I_{O2}, through the internal resistors R1 and R2 is typically 1µA.



SCI7720Y Series

POWER SUPPLY IC

5.

Voltage Detector

DESCRIPTION

The SCI7720Y series products are non-adjusting voltage detectors being developed utilizing he base of the CMOS silicon gate process.

This voltage detector consists of the reference voltage circuit, voltage comparator, hysteresis circuit and output circuit, all operating on smaller current.

A voltage range to be detected is internally set on respective detectors. A wide variety of our standard products are grouped as shown below according to the output format employed for the voltage detector output pin. The SCI7720Y series employs N-channel open drain output approach. And the SCI7721Y series and SCI 7722Y series employ the CMOS output and P-channel output, respectively.

The package used is the SOT89-3 pin plastic package.

Our voltage detectors are used for determining battery life, and also for monitoring supply voltage fed to microcomputers and LSI systems.

FEATURES

- Full lineups: 19 types are prepared for the detection range between 2.0V to 5.0V.
  For the detection range from 0.8V to 2.5V, 7 types are available (products designed for lower voltage detection).
- Low operating current: Typ. 2.0 uA (V_{DD} = 5.0V).
- Low operating voltage: 0.8V at minimum (designed for lower voltage operation).
- Absolute maximum rated voltage: 15V maximum.
- Highly stable built-in reference voltage source: Typ. 1.0V/0.8V (designed for lower voltage operation).
- Better temperature characteristics of output voltage: Typ. -100ppm/°C.

MODEL GROUPS

Table 5-1

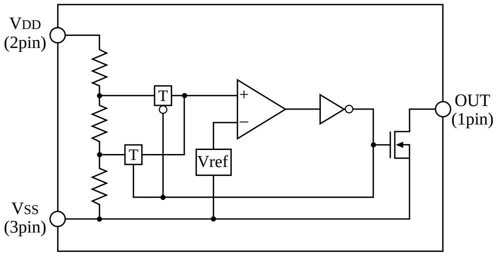
Product name	Voltage detectable			Output format	Output phase	
	Min.	Typ.	Max.		Less than VDET	VDET or above
SCI7721YCA	2.10	2.15	2.20	CMOS	Low level	High level
SCI7721YPA	2.20	2.25	2.30	CMOS	Low level	High level
SCI7721YSA	2.30	2.35	2.40	CMOS	Low level	High level
SCI7721YEA	2.50	2.55	2.60	CMOS	Low level	High level
SCI7721YFA	2.60	2.65	2.70	CMOS	Low level	High level
SCI7721YRA	2.73	2.80	2.87	CMOS	Low level	High level
SCI7721YGA	2.93	3.00	3.07	CMOS	Low level	High level
SCI7721YHA	3.13	3.20	3.27	CMOS	Low level	High level
SCI7721Y3A	3.43	3.50	3.57	CMOS	Low level	High level
SCI7721YTA	3.90	4.00	4.10	CMOS	Low level	High level
SCI7721YMA	4.10	4.20	4.30	CMOS	Low level	High level
SCI7721YJA	4.30	4.40	4.50	CMOS	Low level	High level
SCI7721Y2A	4.50	4.60	4.70	CMOS	Low level	High level
SCI7721YKA	4.70	4.80	4.90	CMOS	Low level	High level
SCI7721YLA	4.90	5.00	5.10	CMOS	Low level	High level
SCI7721YCB	2.10	2.15	2.20	CMOS	High level	Low level
SCI7721YFB	2.60	2.65	2.70	CMOS	High level	Low level

Table 5-2

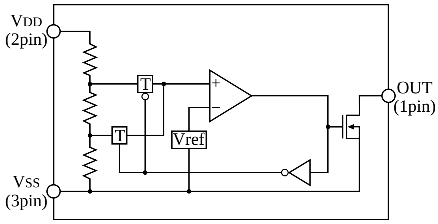
Product name	Voltage detectable			Output format	Output phase	
	Min.	Typ.	Max.		Less than VDET	VDET or above
SCI7720YTA	3.90	4.00	4.10	N ch Open Drain	Low level	Hi–Z
SCI7720YFA	2.60	2.65	2.70	N ch Open Drain	Low level	Hi–Z
SCI7720YCA	2.10	2.15	2.20	N ch Open Drain	Low level	Hi–Z
SCI7720YNA	1.85	1.90	1.95	N ch Open Drain	Low level	Hi–Z
SCI7720YBA	1.10	1.15	1.20	N ch Open Drain	Low level	Hi–Z
SCI7720YYA	1.05	1.10	1.15	N ch Open Drain	Low level	Hi–Z
SCI7720YAA	1.00	1.05	1.10	N ch Open Drain	Low level	Hi–Z
SCI7720YVA	0.90	0.95	1.00	N ch Open Drain	Low level	Hi–Z
SCI7722YDB	1.20	1.25	1.30	P ch Open Drain	High level	Hi–Z

BLOCK DIAGRAM

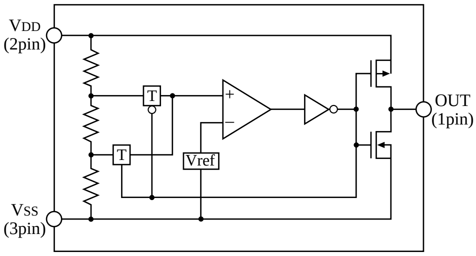
SCI7720Y✱A Type



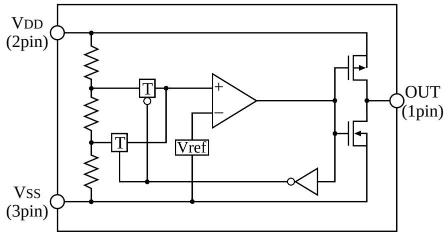
SCI7720Y✱B Type



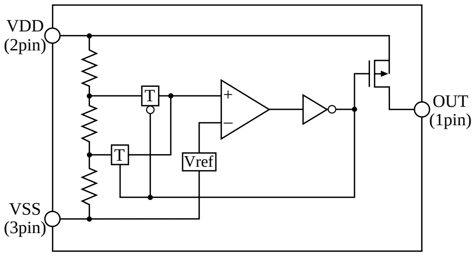
SCI7721Y✱A Type



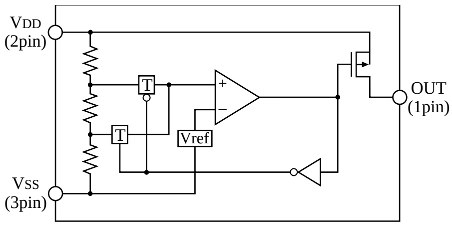
SCI7721Y✱B Type



SCI7722Y✱A Type



SCI7722Y✱B Type



Note: A different code can be employed for the ones preceded by ✱ marking depending on their detecting voltage specification.

Voltage Detector

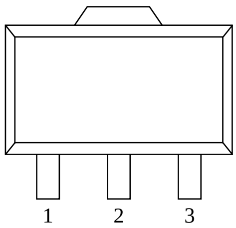
PIN DESCRIPTION

Pin function

Pin No.	Pin name	Pin function
1	OUT	Voltage detection output pin
2	V_{DD}	Input voltage pin (positive side)
3	V_{SS}	Input voltage pin (negative side)

Pin assignment

SOT89-3pin

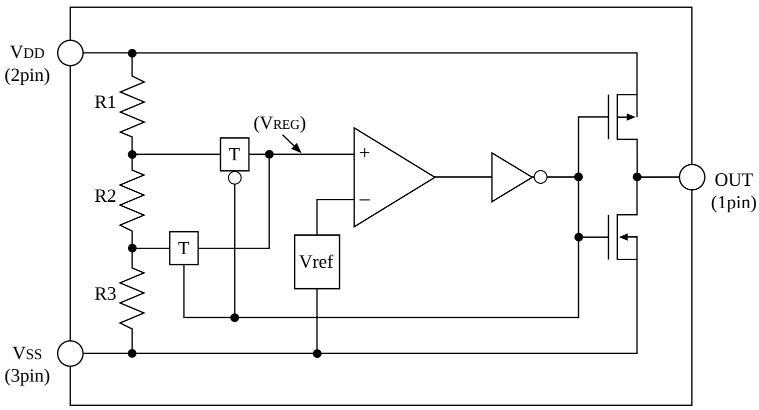


DESCRIPTION OF FUNCTION

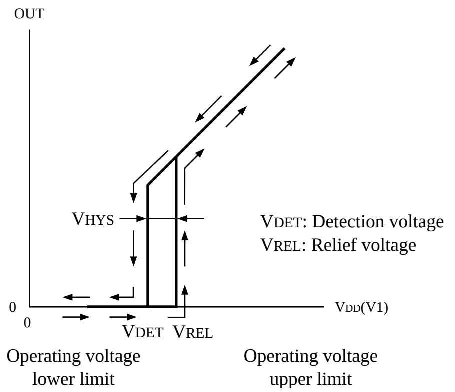
The SCI7720Y series has the circuit configuration as shown in the figure below. For the detection, divided potential (V_{REG}) across the resistors inserted across the power supply and the reference voltage (Vref) generated on the IC are entered to the voltage comparator. Since the voltage comparator is designed to detect a target voltage even when potential difference between V_{REG} and Vref minute, hysteresis is added so that the comparator may not fail due to noise on the power supply and such. In the example shown in the figure below, detection voltage (V_{DET}) for the input voltage drop and relief voltage (V_{REL}) for the increased input voltage are set based the following formula.

Detection voltage: $V_{DET} = \frac{R1+R2+R3}{R2+R3} \cdot Vref$

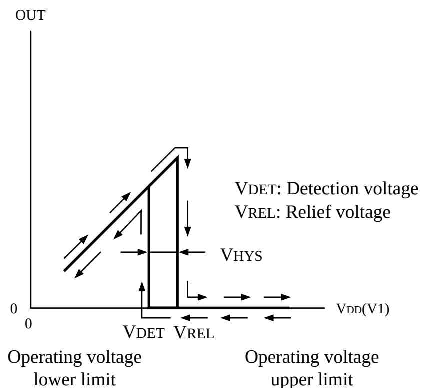
Relief voltage: $V_{REL} = \frac{R1+R2+R3}{R3} \cdot Vref$



The following figures show the input and output characteristics of the SCI7720Y series.



[SCI772*Y*A Type]



SCI772*Y*B Type

Note: The above input/output characteristics assumes that the pull up resistor is connected to the output pin for the SCI7720Y series. For the SCI7722Y series, it assumes that the pull down resistor is connected between the OUT and V_{DD} pins.

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit
Supply voltage range	V_{DD} – V_{SS}	15	V
Output voltage	V_O	V_{DD} + 0.3 to V_{SS} – 0.3 (SCI7721)	V
		15 to V_{SS} – 0.3 (SCI7720)	
		V_{DD} + 0.3 to V_{DD} – 15 (SCI7722)	
Output current	I_O	50	mA
Allowable dissipation	P_D	200	mW
Operating temperature	Topr	–30 to +85	°C
Storage temperature	Tstg	–65 to +150	
Soldering time Soldering temperature	Tsol	260°C 10 seconds (at lead)	—

ELECTRIC CHARACTERISTICS

SCI7721YCA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (V_{SS} = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	V_{DD}	————	1.50	—	12.0	V
Detection voltage	V_{DET}	Ta = 25°C	2.10	2.15	2.20	V
Hysteresis width	V_{HYS}	$V_{HYS} = V_{REL} - V_{DET}$	0.05	0.10	0.15	V
Operating current	I_{DD}	V_{DD} = 3.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	$\frac{\Delta V_{DET}}{V_{DET}}$	————	–300	–100	+100	ppm/°C
High level output current	I_{OH}	V_{DD} = 3.0V OUT = 2.7V	—	–1.00	–0.25	mA
Low level output current	I_{OL}	V_{DD} = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	T_{PHL}	V_{DD} = 3V→2V Ta = 25°C	—	8	40	µS
		V_{DD} = 3V→2V Ta = –30°C to 85°C	—	—	200	µS

SCI7721YPA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (V_{SS} = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	V_{DD}	————	1.50	—	12.0	V
Detection voltage	V_{DET}	Ta = 25°C	2.20	2.25	2.30	V
Hysteresis width	V_{HYS}	$V_{HYS} = V_{REL} - V_{DET}$	0.05	0.10	0.15	V
Operating current	I_{DD}	V_{DD} = 3.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	$\frac{\Delta V_{DET}}{V_{DET}}$	————	–300	–100	+100	ppm/°C
High level output current	I_{OH}	V_{DD} = 3.0V OUT = 2.7V	—	–1.00	–0.25	mA
Low level output current	I_{OL}	V_{DD} = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	T_{PHL}	V_{DD} = 3V→2V Ta = 25°C	—	8	40	µS
		V_{DD} = 3V→2V Ta = –30°C to 85°C	—	—	200	µS

SCI7721YSA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (VSS = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	VDD	————————	1.50	—	12.0	V
Detection voltage	VDET	Ta = 25°C	2.30	2.35	2.40	V
Hysteresis width	VHYS	VHYS = VREL – VDET	0.05	0.10	0.15	V
Operating current	IDD	VDD = 3.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	ΔVDET / VDET	————————	–300	–100	+100	ppm/°C
High level output current	IOH	VDD = 3.0V OUT = 2.7V	—	–1.00	–0.25	mA
Low level output current	IOL	VDD = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	TPHL	VDD = 3V→2V Ta = 25°C	—	8	40	µS
		VDD = 3V→2V Ta = –30°C to 85°C	—	—	200	µS

SCI7721YEA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (VSS = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	VDD	————————	1.50	—	12.0	V
Detection voltage	VDET	Ta = 25°C	2.50	2.55	2.60	V
Hysteresis width	VHYS	VHYS = VREL – VDET	0.05	0.10	0.15	V
Operating current	IDD	VDD = 3.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	ΔVDET / VDET	————————	–300	–100	+100	ppm/°C
High level output current	IOH	VDD = 3.0V OUT = 2.7V	—	–1.00	–0.25	mA
Low level output current	IOL	VDD = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	TPHL	VDD = 3V→2V Ta = 25°C	—	8	40	µS
		VDD = 3V→2V Ta = –30°C to 85°C	—	—	200	µS

SCI7721YFA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (V_{SS} = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	V_{DD}	———	1.50	—	12.0	V
Detection voltage	V_{DET}	Ta = 25°C	2.60	2.65	2.70	V
Hysteresis width	V_{HYS}	$V_{HYS} = V_{REL} - V_{DET}$	0.05	0.10	0.15	V
Operating current	I_{DD}	V_{DD} = 3.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	$\frac{\Delta V_{DET}}{V_{DET}}$	———	–300	–100	+100	ppm/°C
High level output current	I_{OH}	V_{DD} = 3.0V OUT = 2.7V	—	–1.00	–0.25	mA
Low level output current	I_{OL}	V_{DD} = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	T_{PHL}	V_{DD} = 3V→2V Ta = 25°C	—	8	40	µS
		V_{DD} = 3V→2V Ta = –30°C to 85°C	—	—	200	µS

SCI7721YRA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (V_{SS} = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	V_{DD}	———	1.50	—	12.0	V
Detection voltage	V_{DET}	Ta = 25°C	2.73	2.80	2.87	V
Hysteresis width	V_{HYS}	$V_{HYS} = V_{REL} - V_{DET}$	0.05	0.10	0.15	V
Operating current	I_{DD}	V_{DD} = 3.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	$\frac{\Delta V_{DET}}{V_{DET}}$	———	–300	–100	+100	ppm/°C
High level output current	I_{OH}	V_{DD} = 3.0V OUT = 2.7V	—	–1.00	–0.25	mA
Low level output current	I_{OL}	V_{DD} = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	T_{PHL}	V_{DD} = 3V→2V Ta = 25°C	—	8	40	µS
		V_{DD} = 3V→2V Ta = –30°C to 85°C	—	—	200	µS

SCI7721YGA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (V_{SS} = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	V_{DD}	———	1.50	—	12.0	V
Detection voltage	V_{DET}	Ta = 25°C	2.93	3.00	3.07	V
Hysteresis width	V_{HYS}	$V_{HYS} = V_{REL} - V_{DET}$	0.09	0.15	0.21	V
Operating current	I_{DD}	V_{DD} = 4.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	$\frac{\Delta V_{DET}}{V_{DET}}$	———	–300	–100	+100	ppm/°C
High level output current	I_{OH}	V_{DD} = 4.0V OUT = 3.6V	—	–1.60	–0.40	mA
Low level output current	I_{OL}	V_{DD} = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	T_{PHL}	V_{DD} = 4V→3V Ta = 25°C	—	8	40	µS
		V_{DD} = 4V→3V Ta = –30°C to 85°C	—	—	200	µS

SCI7721YHA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (V_{SS} = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	V_{DD}	———	1.50	—	12.0	V
Detection voltage	V_{DET}	Ta = 25°C	3.13	3.20	3.27	V
Hysteresis width	V_{HYS}	$V_{HYS} = V_{REL} - V_{DET}$	0.09	0.15	0.21	V
Operating current	I_{DD}	V_{DD} = 4.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	$\frac{\Delta V_{DET}}{V_{DET}}$	———	–300	–100	+100	ppm/°C
High level output current	I_{OH}	V_{DD} = 4.0V OUT = 3.6V	—	–1.60	–0.40	mA
Low level output current	I_{OL}	V_{DD} = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	T_{PHL}	V_{DD} = 4V→3V Ta = 25°C	—	8	40	µS
		V_{DD} = 4V→3V Ta = –30°C to 85°C	—	—	200	µS

SCI7721Y3A

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (VSS = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	VDD	————————	1.50	—	12.0	V
Detection voltage	VDET	Ta = 25°C	3.43	3.50	3.57	V
Hysteresis width	VHYS	VHYS = VREL – VDET	0.09	0.15	0.21	V
Operating current	IDD	VDD = 4.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	ΔVDET / VDET	————————	–300	–100	+100	ppm/°C
High level output current	IOH	VDD = 4.0V OUT = 3.6V	—	–1.60	–0.40	mA
Low level output current	IOL	VDD = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	TPHL	VDD = 4V→3V Ta = 25°C	—	8	40	µS
		VDD = 4V→3V Ta = –30°C to 85°C	—	—	200	µS

SCI7721YTA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (VSS = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	VDD	————————	1.50	—	12.0	V
Detection voltage	VDET	Ta = 25°C	3.90	4.00	4.10	V
Hysteresis width	VHYS	VHYS = VREL – VDET	0.13	0.20	0.27	V
Operating current	IDD	VDD = 5.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	ΔVDET / VDET	————————	–300	–100	+100	ppm/°C
High level output current	IOH	VDD = 5.0V OUT = 4.5V	—	–2.00	–0.50	mA
Low level output current	IOL	VDD = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	TPHL	VDD = 5V→4V Ta = 25°C	—	8	40	µS
		VDD = 5V→4V Ta = –30°C to 85°C	—	—	200	µS

SCI7721YMA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (VSS = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	VDD	————————	1.50	—	12.0	V
Detection voltage	VDET	Ta = 25°C	4.10	4.20	4.30	V
Hysteresis width	VHYS	VHYS = VREL – VDET	0.13	0.20	0.27	V
Operating current	IDD	VDD = 5.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	ΔVDET / VDET	————————	–300	–100	+100	ppm/°C
High level output current	IOH	VDD = 5.0V OUT = 4.5V	—	–2.00	–0.50	mA
Low level output current	IOL	VDD = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	TPHL	VDD = 5V→4V Ta = 25°C	—	8	40	µS
		VDD = 5V→4V Ta = –30°C to 85°C	—	—	200	µS

SCI7721YJA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (VSS = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	VDD	————————	1.50	—	12.0	V
Detection voltage	VDET	Ta = 25°C	4.30	4.40	4.50	V
Hysteresis width	VHYS	VHYS = VREL – VDET	0.13	0.20	0.27	V
Operating current	IDD	VDD = 5.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	ΔVDET / VDET	————————	–300	–100	+100	ppm/°C
High level output current	IOH	VDD = 5.0V OUT = 4.5V	—	–2.00	–0.50	mA
Low level output current	IOL	VDD = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	TPHL	VDD = 5V→4V Ta = 25°C	—	8	40	µS
		VDD = 5V→4V Ta = –30°C to 85°C	—	—	200	µS

SCI7721Y2A

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (V_{SS} = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	V_{DD}	———	1.50	—	12.0	V
Detection voltage	V_{DET}	Ta = 25°C	4.50	4.60	4.70	V
Hysteresis width	V_{HYS}	$V_{HYS} = V_{REL} - V_{DET}$	0.08	0.15	0.22	V
Operating current	I_{DD}	V_{DD} = 5.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	$\frac{\Delta V_{DET}}{V_{DET}}$	———	–300	–100	+100	ppm/°C
High level output current	I_{OH}	V_{DD} = 5.0V OUT = 4.5V	—	–2.00	–0.50	mA
Low level output current	I_{OL}	V_{DD} = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	T_{PHL}	V_{DD} = 5V→4V Ta = 25°C	—	8	40	µS
		V_{DD} = 5V→4V Ta = –30°C to 85°C	—	—	200	µS

SCI7721YKA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (V_{SS} = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	V_{DD}	———	1.50	—	12.0	V
Detection voltage	V_{DET}	Ta = 25°C	4.70	4.80	4.90	V
Hysteresis width	V_{HYS}	$V_{HYS} = V_{REL} - V_{DET}$	0.13	0.20	0.27	V
Operating current	I_{DD}	V_{DD} = 5.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	$\frac{\Delta V_{DET}}{V_{DET}}$	———	–300	–100	+100	ppm/°C
High level output current	I_{OH}	V_{DD} = 5.0V OUT = 4.5V	—	–2.00	–0.50	mA
Low level output current	I_{OL}	V_{DD} = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	T_{PHL}	V_{DD} = 5V→4V Ta = 25°C	—	8	40	µS
		V_{DD} = 5V→4V Ta = –30°C to 85°C	—	—	200	µS

SCI7721YLA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (VSS = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	VDD	————————	1.50	—	12.0	V
Detection voltage	VDET	Ta = 25°C	4.90	5.00	5.10	V
Hysteresis width	VHYS	VHYS = VREL – VDET	0.13	0.20	0.27	V
Operating current	IDD	VDD = 6.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	ΔVDET / VDET	————————	–300	–100	+100	ppm/°C
High level output current	IOH	VDD = 6.0V OUT = 5.4V	—	–2.40	–0.60	mA
Low level output current	IOL	VDD = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	TPHL	VDD = 6V→4V Ta = 25°C	—	8	40	µS
		VDD = 6V→4V Ta = –30°C to 85°C	—	—	200	µS

SCI7721YCB

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (VSS = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	VDD	————————	1.50	—	12.0	V
Detection voltage	VDET	Ta = 25°C	2.10	2.15	2.20	V
Hysteresis width	VHYS	VHYS = VREL – VDET	0.05	0.10	0.15	V
Operating current	IDD	VDD = 3.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	ΔVDET / VDET	————————	–300	–100	+100	ppm/°C
High level output current	IOH	VDD = 2.0V OUT = 1.8V	—	–0.40	–0.10	mA
Low level output current	IOL	VDD = 3.0V OUT = 0.3V	0.50	2.00	—	mA
Detection voltage response time	TPHL	VDD = 3V→2V Ta = 25°C	—	8	40	µS
		VDD = 3V→2V Ta = –30°C to 85°C	—	—	200	µS

SCI7721YFB

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (V_{SS} = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	V_{DD}	————	1.50	—	12.0	V
Detection voltage	V_{DET}	Ta = 25°C	2.60	2.65	2.70	V
Hysteresis width	V_{HYS}	$V_{HYS} = V_{REL} – V_{DET}$	0.05	0.10	0.15	V
Operating current	I_{DD}	V_{DD} = 3.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	$\frac{\Delta V_{DET}}{V_{DET}}$	————	–300	–100	+100	ppm/°C
High level output current	I_{OH}	V_{DD} = 2.0V OUT = 1.8V	—	–0.40	–0.10	mA
Low level output current	I_{OL}	V_{DD} = 3.0V OUT = 0.3V	0.50	2.00	—	mA
Detection voltage response time	T_{PHL}	V_{DD} = 3V→2V Ta = 25°C	—	8	40	µS
		V_{DD} = 3V→2V Ta = –30°C to 85°C	—	—	200	µS

SCI7720YTA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (V_{SS} = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	V_{DD}	————	1.50	—	12.0	V
Detection voltage	V_{DET}	Ta = 25°C	3.90	4.00	4.10	V
Hysteresis width	V_{HYS}	$V_{HYS} = V_{REL} – V_{DET}$	0.13	0.20	0.27	V
Operating current	I_{DD}	V_{DD} = 5.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	$\frac{\Delta V_{DET}}{V_{DET}}$	————	–300	–100	+100	ppm/°C
Low level output current	I_{OL}	V_{DD} = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	T_{PHL}	V_{DD} = 5V→4V Ta = 25°C	—	8	40	µS
		V_{DD} = 5V→4V Ta = –30°C to 85°C	—	—	200	µS

SCI7720YFA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (V_{SS} = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	V_{DD}	————	1.50	—	12.0	V
Detection voltage	V_{DET}	Ta = 25°C	2.60	2.65	2.70	V
Hysteresis width	V_{HYS}	$V_{HYS} = V_{REL} - V_{DET}$	0.05	0.10	0.15	V
Operating current	I_{DD}	V_{DD} = 3.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	$\frac{\Delta V_{DET}}{V_{DET}}$	————	–300	–100	+100	ppm/°C
Low level output current	I_{OL}	V_{DD} = 2.0V OUT = 0.2V	0.20	1.00	—	mA
Detection voltage response time	T_{PHL}	V_{DD} = 3V→2V Ta = 25°C	—	8	40	µS
		V_{DD} = 3V→2V Ta = –30°C to 85°C	—	—	200	µS

SCI7720YCA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (V_{SS} = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	V_{DD}	————	0.80	—	10.0	V
Detection voltage	V_{DET}	Ta = 25°C	2.10	2.15	2.20	V
Hysteresis width	V_{HYS}	$V_{HYS} = V_{REL} - V_{DET}$	0.05	0.10	0.15	V
Operating current	I_{DD}	V_{DD} = 3.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	$\frac{\Delta V_{DET}}{V_{DET}}$	————	–300	–100	+100	ppm/°C
Low level output current	I_{OL}	V_{DD} = 1.5V OUT = 0.15V	0.15	0.75	—	mA
Detection voltage response time	T_{PHL}	V_{DD} = 3V→2V Ta = 25°C	—	8	40	µS
		V_{DD} = 3V→2V Ta = –30°C to 85°C	—	—	200	µS

SCI7720YNA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (VSS = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	VDD	———	0.80	—	10.0	V
Detection voltage	VDET	Ta = 25°C	1.85	1.90	1.95	V
Hysteresis width	VHYS	VHYS = VREL – VDET	0.03	0.05	0.08	V
Operating current	IDD	VDD = 3.0V	—	2.00	5.00	µA
Detection voltage temperature characteristics	ΔVDET / VDET	———	–300	–100	+100	ppm/°C
Low level output current	IOL	VDD = 1.5V OUT = 0.15V	0.15	0.75	—	mA
Detection voltage response time	TPHL	VDD = 2V→1V Ta = 25°C	—	8	40	µS
		VDD = 2V→1V Ta = –30°C to 85°C	—	—	200	µS

SCI7720YBA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (VSS = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	VDD	———	0.80	—	10.0	V
Detection voltage	VDET	Ta = 25°C	1.10	1.15	1.20	V
Hysteresis width	VHYS	VHYS = VREL – VDET	0.03	0.05	0.08	V
Operating current	IDD	VDD = 1.5V	—	1.50	4.00	µA
Detection voltage temperature characteristics	ΔVDET / VDET	———	–300	–100	+100	ppm/°C
Low level output current	IOL	VDD = 0.8V OUT = 0.16V	0.05	0.40	—	mA
Detection voltage response time	TPHL	VDD = 1.5V→0.8V Ta = 25°C	—	8	40	µS
		VDD = 1.5V→0.8V Ta = –30°C to 85°C	—	—	200	µS

SCI7720YYA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (V_{SS} = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	V_{DD}	———	0.80	—	10.0	V
Detection voltage	V_{DET}	Ta = 25°C	1.05	1.10	1.15	V
Hysteresis width	V_{HYS}	$V_{HYS} = V_{REL} - V_{DET}$	0.03	0.05	0.08	V
Operating current	I_{DD}	V_{DD} = 1.5V	—	1.50	4.00	µA
Detection voltage temperature characteristics	$\frac{\Delta V_{DET}}{V_{DET}}$	———	–300	–100	+100	ppm/°C
Low level output current	I_{OL}	V_{DD} = 0.8V OUT = 0.16V	0.05	0.40	—	mA
Detection voltage response time	T_{PHL}	V_{DD} = 1.5V→0.8V Ta = 25°C	—	8	40	µS
		V_{DD} = 1.5V→0.8V Ta = –30°C to 85°C	—	—	200	µS

SCI7720YAA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (V_{SS} = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	V_{DD}	———	0.80	—	10.0	V
Detection voltage	V_{DET}	Ta = 25°C	1.00	1.05	1.10	V
Hysteresis width	V_{HYS}	$V_{HYS} = V_{REL} - V_{DET}$	0.03	0.05	0.08	V
Operating current	I_{DD}	V_{DD} = 1.5V	—	1.50	4.00	µA
Detection voltage temperature characteristics	$\frac{\Delta V_{DET}}{V_{DET}}$	———	–300	–100	+100	ppm/°C
Low level output current	I_{OL}	V_{DD} = 0.8V OUT = 0.16V	0.05	0.40	—	mA
Detection voltage response time	T_{PHL}	V_{DD} = 1.5V→0.8V Ta = 25°C	—	8	40	µS
		V_{DD} = 1.5V→0.8V Ta = –30°C to 85°C	—	—	200	µS

SCI7720YVA

(Ta = –30°C to +85°C is assumed except where otherwise specified.)

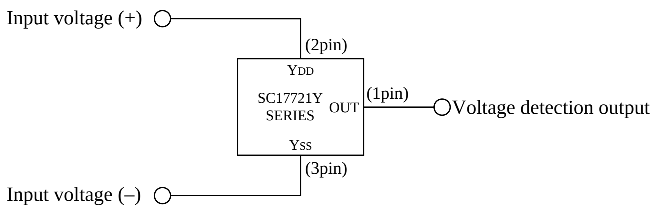
Parameter	Symbol	Condition (V_{SS} = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	V_{DD}	———	0.80	—	10.0	V
Detection voltage	V_{DET}	Ta = 25°C	0.90	0.95	1.00	V
Hysteresis width	V_{HYS}	$V_{HYS} = V_{REL} - V_{DET}$	0.03	0.05	0.08	V
Operating current	I_{DD}	V_{DD} = 1.5V	—	1.50	4.00	µA
Detection voltage temperature characteristics	$\frac{\Delta V_{DET}}{V_{DET}}$	———	–300	–100	+100	ppm/°C
Low level output current	I_{OL}	V_{DD} = 0.8V OUT = 0.16V	0.05	0.40	—	mA
Detection voltage response time	T_{PHL}	V_{DD} = 1.5V→0.8V Ta = 25°C	—	8	40	µS
		V_{DD} = 1.5V→0.8V Ta = –30°C to 85°C	—	—	200	µS

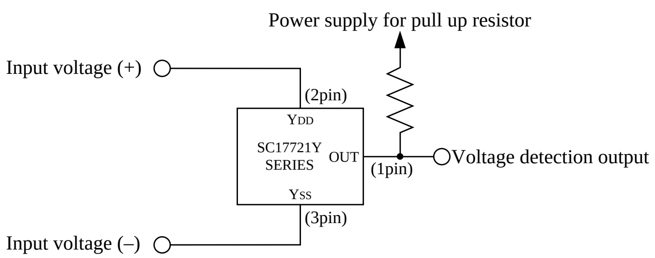
SCI7722YDB

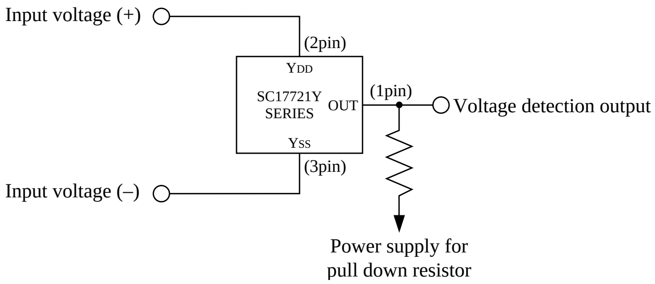
(Ta = –30°C to +85°C is assumed except where otherwise specified.)

Parameter	Symbol	Condition (V_{SS} = 0.0V)	Min.	Typ.	Max.	Unit
Operating voltage	V_{DD}	———	0.80	—	10.0	V
Detection voltage	V_{DET}	Ta = 25°C	1.20	1.25	1.30	V
Hysteresis width	V_{HYS}	$V_{HYS} = V_{REL} - V_{DET}$	0.03	0.05	0.08	V
Operating current	I_{DD}	V_{DD} = 1.5V	—	1.50	4.00	µA
Detection voltage temperature characteristics	$\frac{\Delta V_{DET}}{V_{DET}}$	———	–300	–100	+100	ppm/°C
Low level output current	I_{OL}	V_{DD} = 0.8V OUT = 0.64V	—	–0.08	–0.01	mA
Detection voltage response time	T_{PHL}	V_{DD} = 1.5V→0.8V Ta = 25°C	—	8	40	µS
		V_{DD} = 1.5V→0.8V Ta = –30°C to 85°C	—	—	200	µS

EXAMPLES OF EXTERNAL CONNECTION







SAMPLE CIRCUITS (SCI7721Y SERIES)

CR timer circuit

When the SCI7721Y circuit configured as shown in Figure 5-14, it can be used as a CR timer circuit.

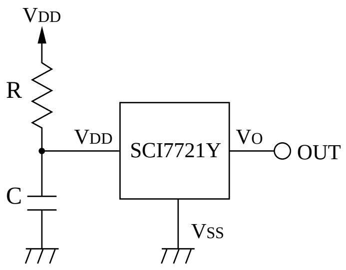


Figure 5-14 CR timer circuit

Battery backup circuit

The following is an example of the supply voltage switching circuit for the battery backup supply configured featuring the SCI7721Y series.

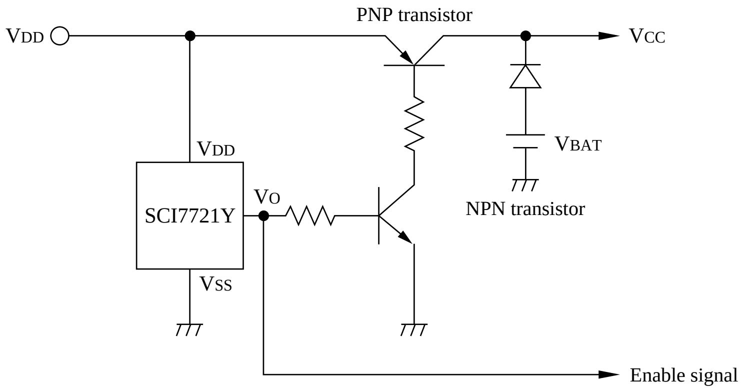


Figure 5-15 Battery backup circuit

SAMPLE CIRCUITS (SCI7720Y SERIES)

CR timer circuit

When the SCI77210 circuit is configured as shown in Figure 5-16, it can be used as a CR timer circuit.

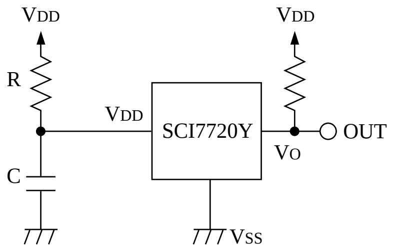


Figure 5-16 CR timer circuit

Battery backup circuit

The following is an example of the supply voltage switching circuit for the battery backup configured featuring the SCI7720Y series.

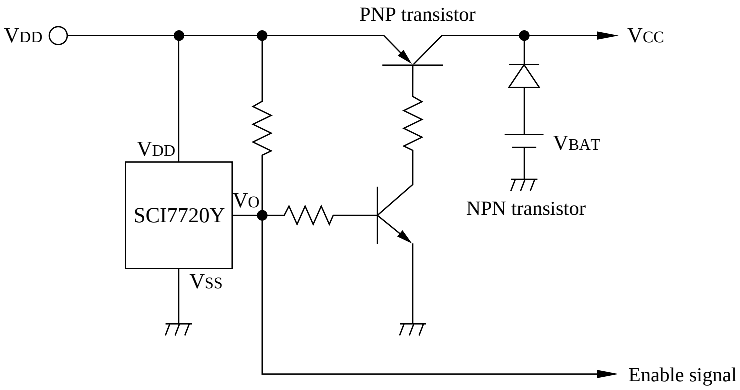


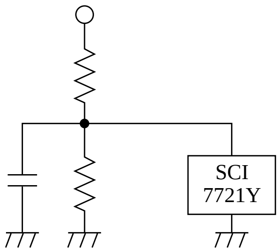
Figure 5-17 Battery backup circuit

PRECAUTIONS

Short cut current on the SCI 7721 (CMOS output voltage detector)

Since the SCI772Y series employs CMOS output, as an input voltage nears the detection voltage range, short cut current is flown between V_{DD} and V_{SS}. The short cut current is voltage sensitive, and approximately 2 mA flows at 5V level or so (our products are not check for short cut current after volume production has been started).
Although duration of the short cut current depends on operating conditions (such as type the circuit used and supply impedance), normally it is assumed to continue several usec to several dozens of usec.
If a load with high impedance is inserted across the power supply, oscillation can be introduced by the short cut current. In order to reject this trouble, the following measures should be considered:

(1) Reduce the resistance value.
(2) Insert a capacitor.
(3) Replace with the SCI7720Y series (it employs N-channel open drain approach).

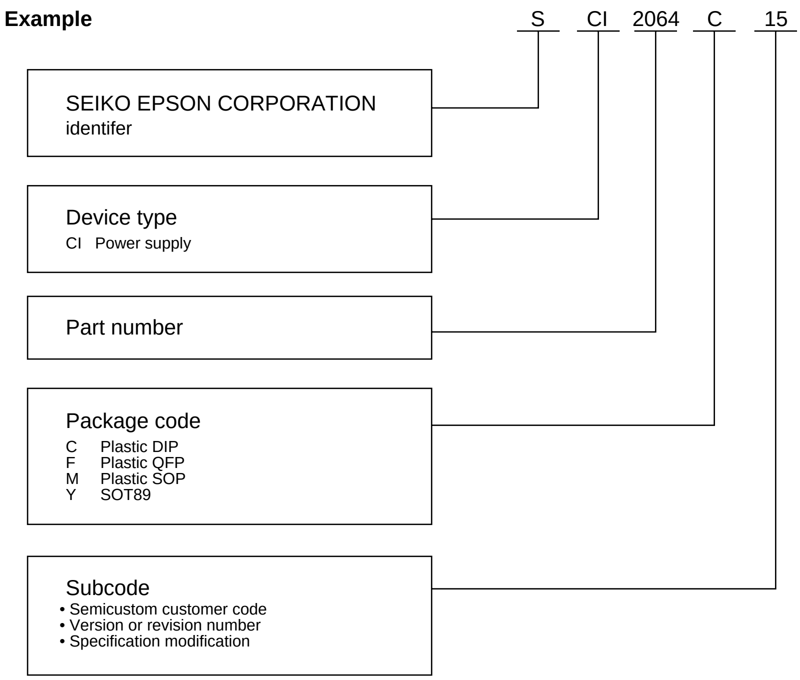


SCI7000 Series POWER SUPPLY IC

6. Appendix

ORDERING INFORMATION

SEIKO EPSON IC products are ordered by part number.



CMOS LSI LINEUP

Product Type	Device	Series
ASICs (application-specific ICs)	Gate arrays	SLA
	Standard cells	SSC
ASMICs (application-specific microcomputer ICs)	4-bit microcomputers	E0C
	Peripherals	E0C
ASSPs (application-specific standard products)	Graphic ICs	SPC
	LCD controllers	SED
	LCD drivers	SED
	Disk storage management ICs	SED/SPC/E0C
	Font processor ICs	SPC

Product Type	Device	Series
ASSPs (application-specific standard products)	Telecom ICs	STC/SVM
	Melody ICs	SVM
	Power supply ICs	SCI
	Analog switch ICs	SED
	Timepiece ICs	SRM
Memories	Static RAMs	SRM
	Mask ROMs	SMM
	EEPROMs	SPM

ABSOLUTE MAXIMUM RATINGS

Absolute maximum ratings are the maximum physical and electrical ratings of a device beyond which performance degradation or damage will occur. Always check circuit conditions before using a device to avoid exceeding these ratings. Typically, absolute maximum ratings include the following parameters.

1. Power supply voltage

   Steady state applied voltages, noise, reverse voltage transients and power-on-transients can degrade or damage the integrated circuit if they exceed the maximum power supply voltage rating.

2. Input signal voltage

   Input signals exceeding this rate can damage input protection circuits

3. Output current

   Generally, specifications are not set for CMOS devices with small output currents. Devices that provide large drive currents will have output current specifications.

4. Power dissipation

   The maximum power dissipation of a device is limited by its construction and package type. Maximum output current limits are set to prevent thermal damage.

5. Operating temperature range

   The temperature range for normal device operation with no change in performance characteristics.

6. Storage temperature range

   The temperature range for device storage with no degradation or damage. This specification is particularly important when ICs are being transported by air.

7. Soldering temperature and the duration

   The maximum soldering temperature and the time for which the leads can be at this temperature.

RECOMMENDED OPERATING CONDITIONS

Recommended operating conditions are the conditions under which a device functions correctly. These include power supply voltage, input conditions and output current. These conditions are sometimes listed as part of the electrical characteristics.

ELECTRICAL CHARACTERISTICS

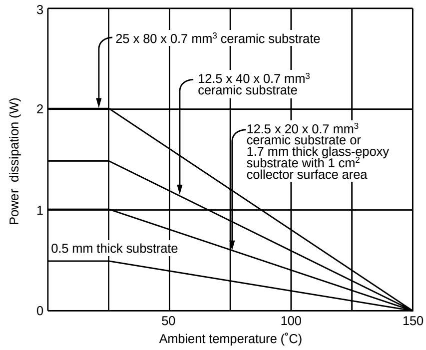
Electrical characteristics specify the DC and AC characteristics of a device under the worst measurement conditions.

POWER DISSIPATION CONDITIONS

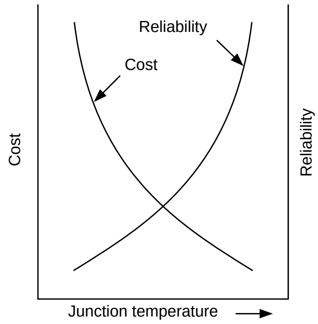
To prevent damage always consider the following points when designing with power regulation ICs.

1. A precise thermal design is necessary to ensure adequate heat dissipation.

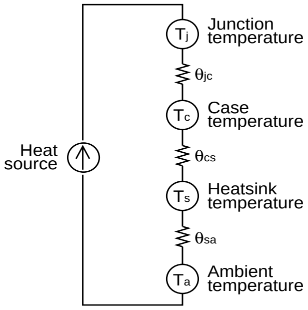
   The following figure shows the power dissipation capacity in relation to ambient temperature.



The following figure shows the cost and reliability of a product and is significant when designing a system.



The following figure shows a thermal design model which can be used to determine heatsink capacity.



2. Ensure that the regulator common pin is a single-point ground to prevent earth loops. Make ground lines as thick and short as possible. Use the specified bypass capacitors for inputs and outputs. If there is a switching load, use a tantalum or ceramic capacitor, as these devices have a high frequency response between the power supply and ground.

PARAMETER SUMMARY

Symbol	Parameter
C_D	Drain capacitance
C_{F8}	Field slew capacitance
C_G	Gate capacitance
C_I	Input capacitance
C_n	Capacitance
CT	Crosstalk
C_{Tn}	Temperature gradient
f_{CLK}	Clock frequency
f_{max}	Maximum clock frequency
f_{OSC}	Oscillator frequency
FT	Field through (channel OFF)
I_{BSQ}	Backup switching leakage current
I_{DDO}	Operating current
I_{DDS}	Standby current
I_{DD}	Power supply current
I_{IH}	HIGH-level input current
I_{IL}	LOW-level input current
I_{LK1}	input leakage current
I_{MAX}	Maximum current
I_O	Output current
I_{OH}	HIGH-level output current
I_{OL}	LOW-level output current
I_{opr1}	Multiplier circuit power dissipation

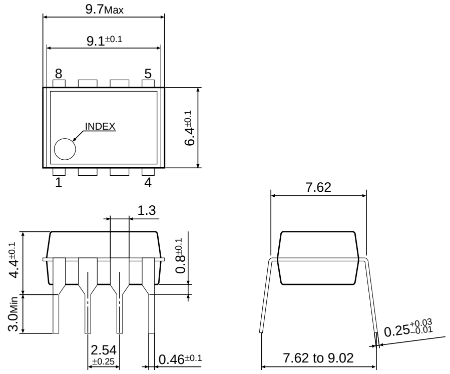
Symbol	Parameter
I_{opr2}	Stabilization circuit power dissipation
I_Q	Quiescent current
I_R	Reverse current
I_{SWQ}	Switching transistor leakage current
K_I	Output voltage temperature gradient
P_D	Power dissipation
P_{eff}	Voltage multiplication efficiency
R_{BSON}	Backup switch ON resistance
R_L	Load resistance
R_O	Output impedance
R_{ON}	ON resistance
R_{OSC}	Oscillator network resistor
R_{RV}	Stabilization voltage sensing resistor
R_{RVn}	Reference voltage
R_{SAT}	Stabilization output saturation resistance
R_{SWON}	Switching transistor ON resistance
T_a	Ambient temperature
t_{AE}	Minimum pulsewidth
t_{HA}	Address hold time
t_{HD}	Data hold time
THD	Total harmonic distortion
θ_{jn}	Thermal resistance
t_{MRR}	Memory reset recovery time

Symbol	Parameter
t_{MR}	Memory reset
T_{opr}	Operating temperature
t_{PAE}	Propagation delay
t_{PHL}	LOW-level transition time
t_{PLH}	HIGH-level transition time
t_{PLS}	Propagation delay
t_{POP}	Propagation delay
t_{PS}	Propagation delay
t_{SA}	Address setup time
t_{SD}	Data setup time
T_{sol}	Soldering temperature and time
T_{stg}	Storage temperature
V_{DD}	Power supply voltage
V_{DET}	Detection voltage
V_F	Forward voltage

Symbol	Parameter
V_I	Input voltage
V_{IH}	HIGH-level input voltage
V_{IL}	LOW-level input voltage
V_I	Input voltage
V_O	Output voltage
V_{off}	Input offset voltage
V_{op+}	Input voltage range
V_{OPMAX}	Maximum output voltage
V_{OPMIN}	Minimum output voltage
V_{REF}	Reference voltage
V_{REG}	Output voltage (regulated)
V_{SS}	Power supply voltage
V_{SSn}	Power supply voltage
V_{STA}	Oscillator start-up voltage
V_{STP}	Oscillator shut-down voltage

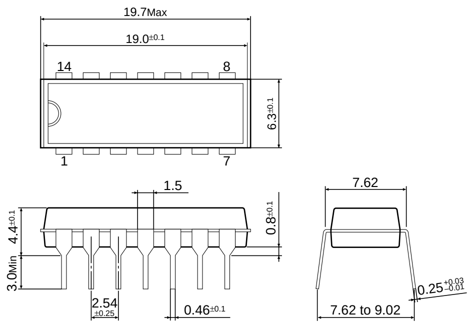
DIMENSIONS

Plastic DIP–8pin



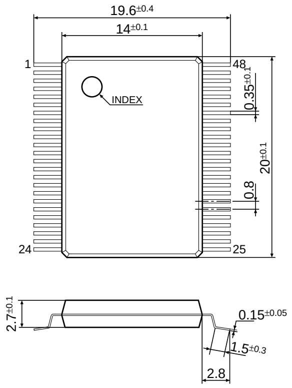
Unit: mm

Plastic DIP–14pin



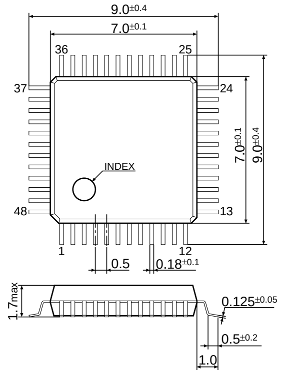
Unit: mm

Plastic QFP5–48pin



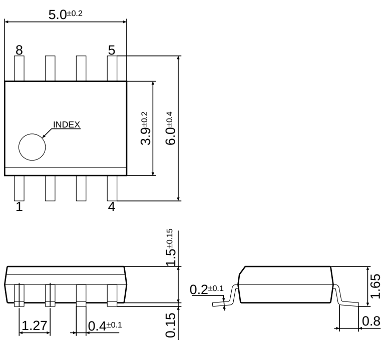
Unit: mm

Plastic QFP12-48pin



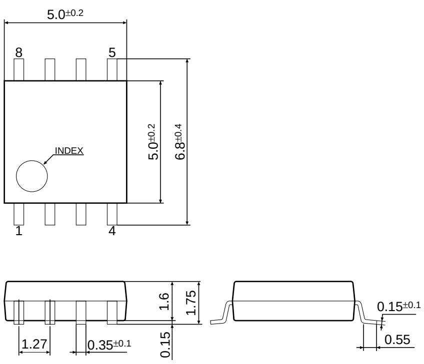
Unit: mm

Plastic SOP3–8pin



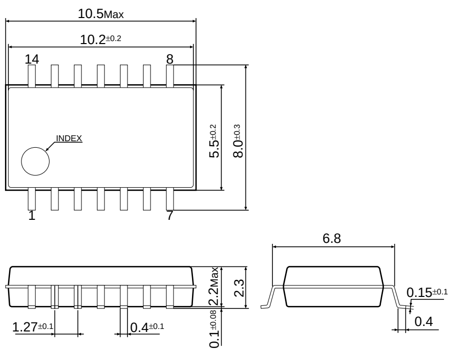
Unit: mm

Plastic SOP4–8pin



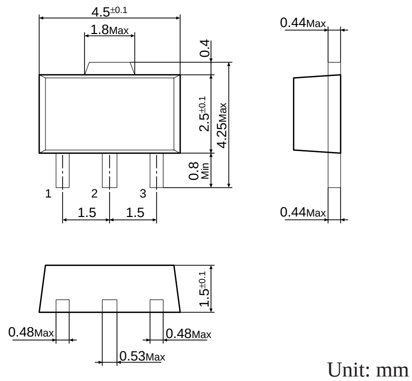
Unit: mm

Plastic SOP5–14pin



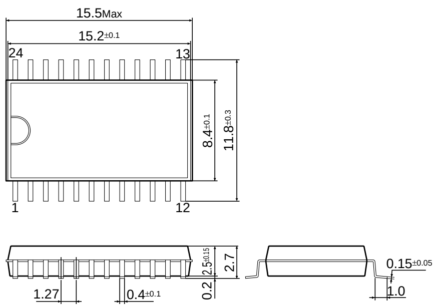
Unit: mm

SOT 89–3pin



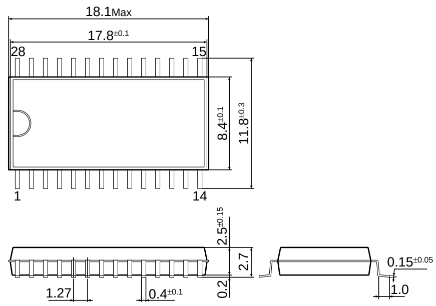
Unit: mm

Plastic SOP2-24pin



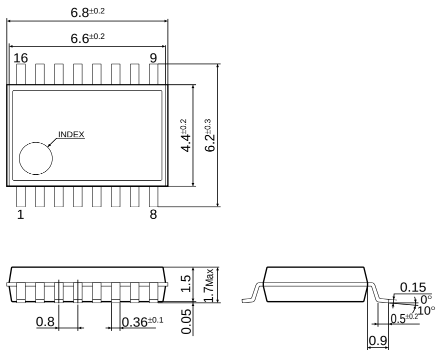
Unit: mm

Plastic SOP2–28pin



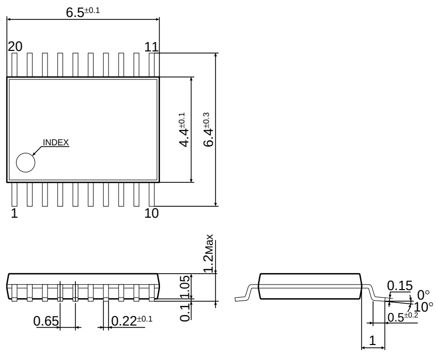
Unit: mm

Plastic SSOP2–16pin



Unit: mm

Plastic SSOP1–20pin



Unit: mm

EMBOSS CARRIER TAPING STANDARD (3-PIN SOT89)

TAPING INFORMATION

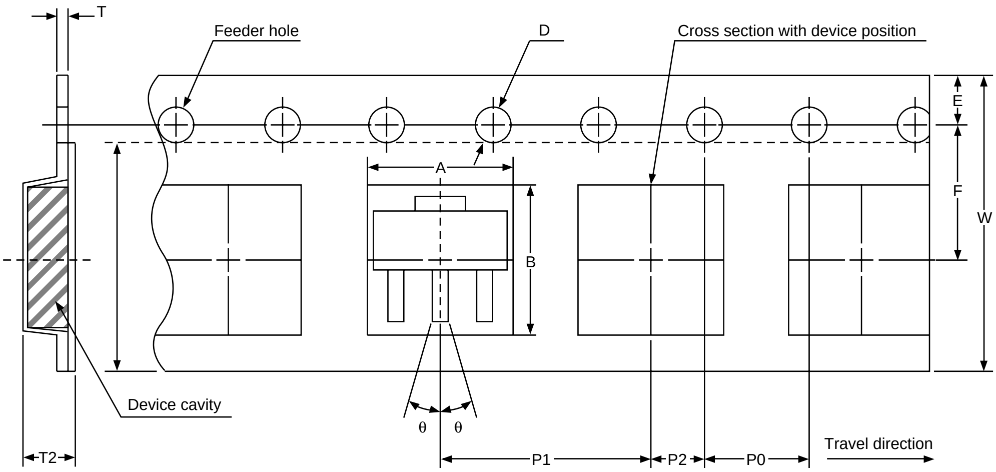
The emboss carrier taping standard is shown in the following table and figure. This standard conforms to the EIAJ RCI00B electronic parts taping specification. Each tape holds 1,000 devices.

Dimension code	Dimensions/angles (mm/°)
A	5.0
B	4.6
D	1.5 +0.1, –0.05
E	1.50 ±0.1
F	5.65 ±0.05
P1	8.0 ±0.1
P0	4.0 ±0.1

Dimension code	Dimensions/angles (mm/°)
P2	2.0 ±0.05
T	0.3
T2	2.3
W	12.0 ±0.2
W1	9.5
θ	30°max

Note

The tape thickness is 0.1 mm max.



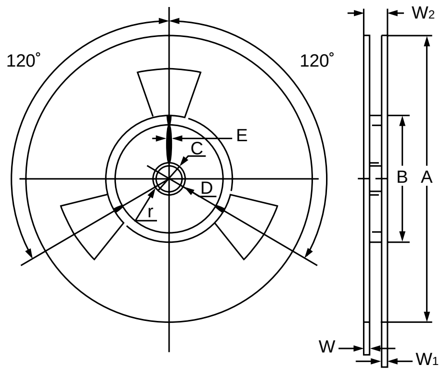
There are no joints in either the cover or carrier tapes. Less than 0.2% of the total device count is comprised of non-sequential blanks. There are no sequential blanks. This does not apply to the tape leader and trailer.

REEL SPECIFICATIONS

The reel specifications are shown in the following table and figure. The reel is made of paperboard.

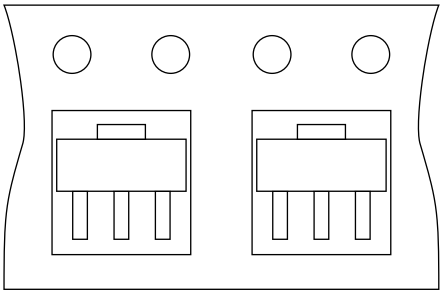
Dimension code	Dimensions (mm)
A	178 ±2.0
B	80 ±1.0
C	13.0 ±0.5
D	21.0 ±1.0
E	2.0 ±0.5
W	14.0 (See note.)
W1	1.5 ±0.1
W2	17 (See note.)
r	1.0

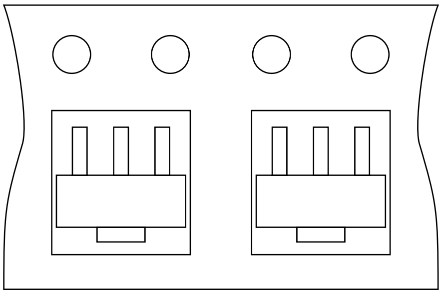
Note
W and W2 are measured at the reel core.



DEVICE POSITIONING

Small molded power IC devices are positioned as shown in the following figure.


T1


T2

EMBOSS CARRIER TAPING STANDARD (8-PIN SOP3)

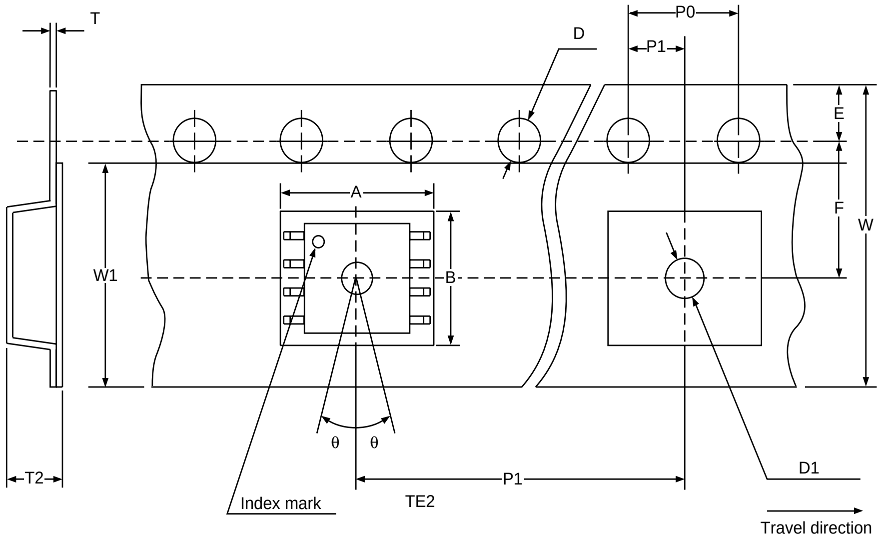
TAPING INFORMATION

The emboss carrier taping standard is shown in the following table and figure. This standard conforms to the EIAJ RCI009B electronic parts taping specification. Each tape holds 2,000 devices.

Dimension code	Dimensions/angles (mm/°)
A	6.7
B	5.4
D	1.55 +0.05, –0
D1	1.55 ±0.05
E	1.75 ±0.1
F	5.5 ±0.1
P1	8.0 ±0.1
P0	4.0 ±0.1

Dimension code	Dimensions/angles (mm/°)
P2	2.0 ±0.05
T	0.3 ±0.05
T2	2.5
W	12.0 ±0.3
W1	9.5
θ	15°max

Note
The tape thickness is 0.1 mm max.



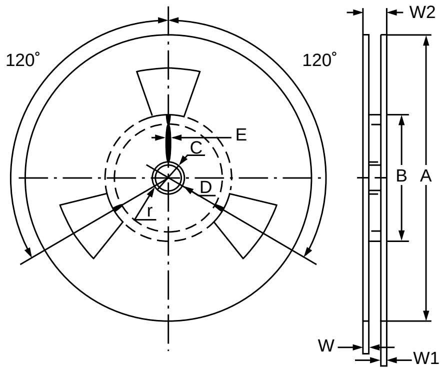
There are no joints in either the cover or carrier tapes. Less than 0.2% of the total device count is comprised of non-sequential blanks. There are no sequential blanks. This does not apply to the tape leader and trailer.

REEL SPECIFICATIONS

The reel specifications are shown in the following table and figure. The reel is made of paperboard.

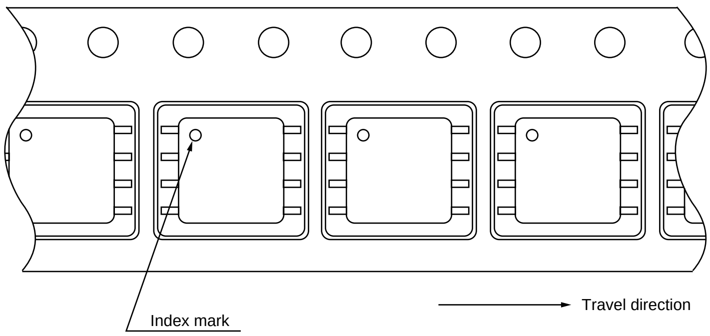
Dimension code	Dimensions (mm)
A	330 ±2.0
B	80 ±1.0
C	13.0 ±0.5
D	21.0 ±0.5
E	2.0 ±0.5
W	15.4 ±1.0 (See note.)
W1	2.0 ±0.5
W2	23.4 (See note.)
r	1.0

Note
W and W2 are measured at the reel core.

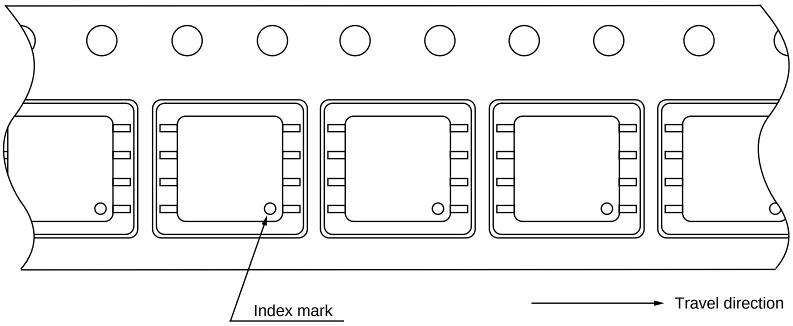


DEVICE POSITIONING

Type B products are positioned so that the index mark is on the sprocket hole side of the tape, as shown in the following figure.



Type F product are positioned so that the index mark is on the opposite side to the sprocket holes, as shown in the following figure.



EMBOSS CARRIER TAPING STANDARD (14-PIN SOP5)

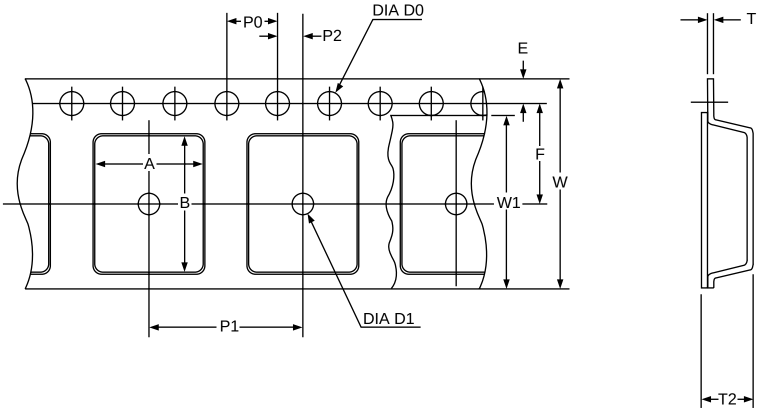
TAPING INFORMATION

The emboss carrier taping standard is shown in the following table and figure. This standard conforms to the EIAJ RCI009B electronic parts taping specification. Each tape holds 2,000 devices.

Dimension code	Dimensions (mm/°)
A	8.4
B	10.6
D0	1.55 ±0.05
D1	1.55 ±0.05
E	1.75 ±0.1
F	7.5 ±0.1
P1	12 ±0.1
P0	4.0 ±0.1

Dimension code	Dimensions (mm/°)
P2	2.0 ±0.1
T	0.3 ±0.05
T2	3.0
W	16.0 ±0.3
W1	13.5

Note
The tape thickness is 0.1 mm max.



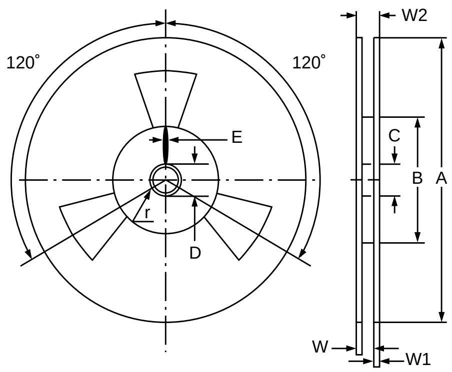
There are no joints in either the cover or carrier tapes. Less than 0.1% of the total device count is comprised of non-sequential blanks. There are no sequential blanks. This does not apply to the tape leader and trailer.

REEL SPECIFICATIONS

The reel specifications are shown in the following table and figure. The reel is made of paperboard.

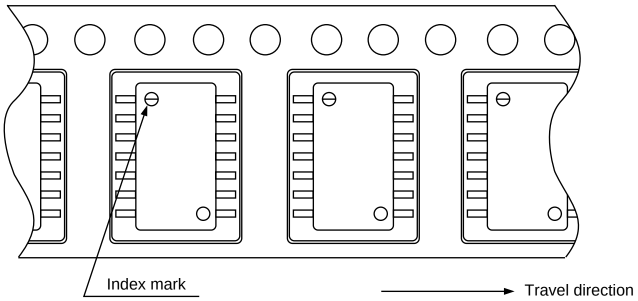
Dimension code	Dimensions (mm)
A	330 ±2.0
B	80 ±1.0
C	13.0 ±0.5
D	21.0 ±1.0
E	2.0 ±0.5
W	14.0 ±1.5 (See note.)
W1	2.0 ±0.5
W2	20.5 max (See note.)
r	1.0

Note
W and W2 are measured at the reel core.

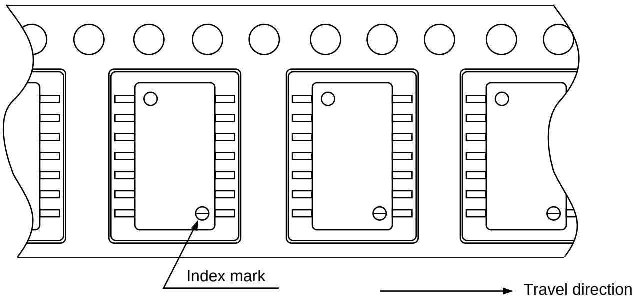


DEVICE POSITIONING

Type B products are positioned so that the index mark is on the sprocket hole side of the tape, as shown in the following figure.



Type F products are positioned so that the index mark is on the opposite side to the sprocket holes, as shown in the following figure.



EMBOSS CARRIER TAPING STANDARD (24-PIN SOP2)

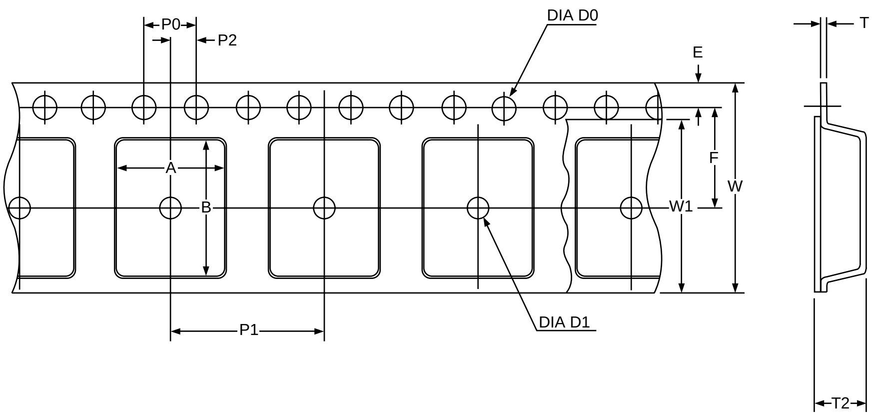
TAPING INFORMATION

The emboss carrier taping standard is shown in the following table and figure. This standard conforms to the EIAJ RCI009B electronic parts taping specification. Each tape holds 1,000 devices.

Dimension code	Dimensions (mm)
A	12.4
B	15.6
D0	1.55 +0.1, –0
D1	2.0 +0.1, –0
E	1.75 ±0.1
F	11.5 ±0.1
P1	16 ±0.1

Dimension code	Dimensions (mm)
P0	4.0 ±0.1
P2	2.0 ±0.1
T	0.3 ±0.05
T2	3.0 ±0.1
W	24 ±0.2
W1	21.5 typ

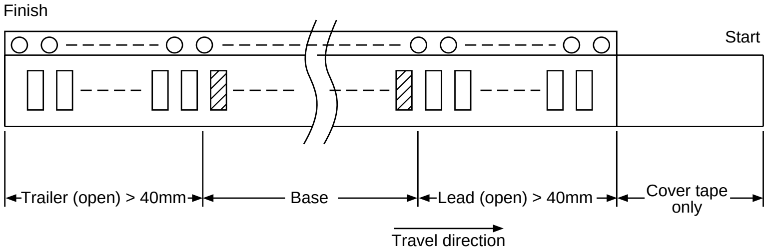
Note
The tape thickness is 0.1 mm max.

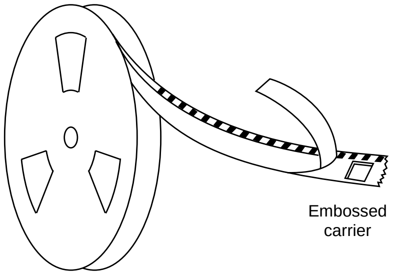


There are no joints in either the cover or carrier tapes. Less than 0.2% of the total device count is comprised of non-sequential blanks. There are no sequential blanks. This does not apply to the tape leader and trailer. The tape tension should be approximately 10 N (1 kgf). A label indicates the part name, quantity and lot number.

Tape configuration

The tape configuration is shown in the following figure. Blank sections are provided as a leader and trailer, with 1,000 SOP2 packages fitted into the component mounting section between them. At the beginning of the leader section there is an extra section of tape which contains the cover tape only.



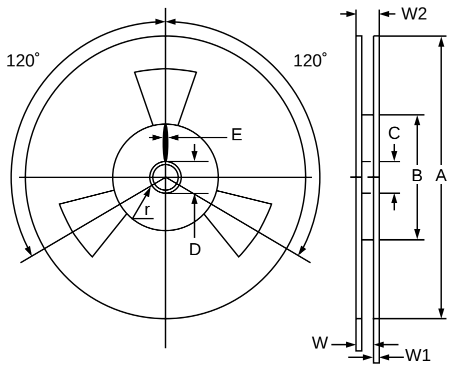


REEL SPECIFICATIONS

The reel specifications are shown in the following table and figure. The reel is made of conductive PVC.

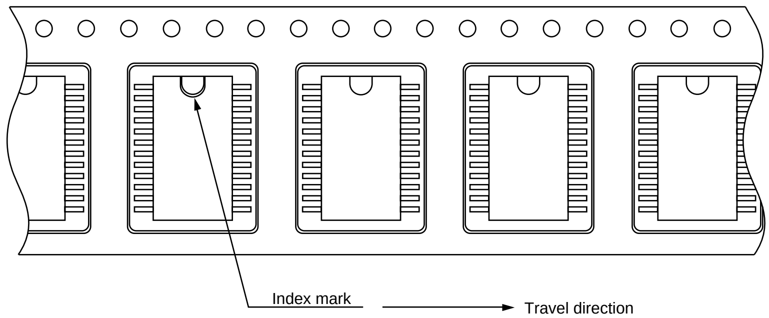
Dimension code	Dimensions (mm)
A	330 ±2.0
B	80 ±1.0
C	13.0 ±0.5
D	21.0 ±1.0
E	2.0 ±0.5
W	24.4 +2, –0 (See note.)
W1	2.0 ±0.5
W2	31.4 max (See note.)
r	1.0

Note
W and W2 are measured at the reel core.

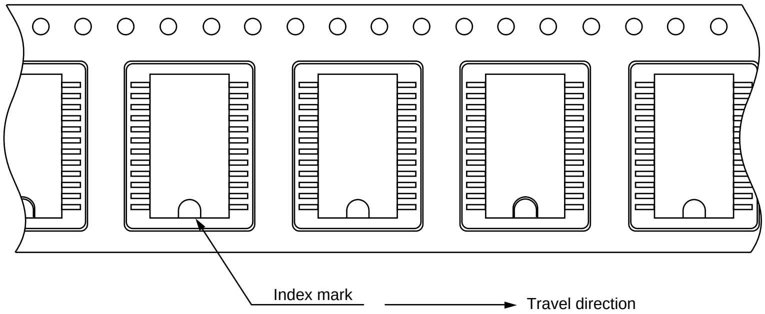


DEVICE POSITIONING

Type B products are positioned so that the index mark is on the sprocket hole side of the tape, as shown in the following figure.



Type F products are positioned so that the index mark is on the opposite side to the sprocket holes, as shown in the following figure.



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