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

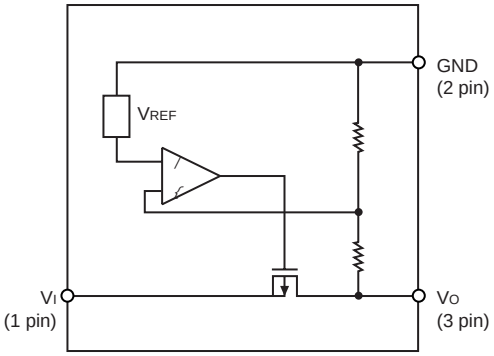
FEATURES

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

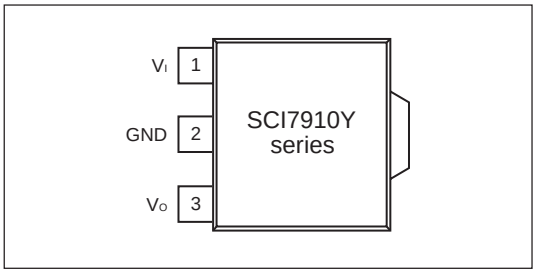
LINE-UP

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	$\lvert V_I - V_O \rvert$	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	$\lvert V_I - V_O \rvert$	V_I = –1.8V, I_O = 10mA	—	0.35	0.70	V
Input voltage stabilization ratio	$\frac{\lvert \Delta V_O \rvert}{\lvert \Delta V_I \bullet V_O \rvert}$	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	$\lvert V_I - V_O \rvert$	V_I = –3.0V, I_O = 10mA	—	0.23	0.46	V
Input voltage stabilization ratio	$\frac{\lvert \Delta V_O \rvert}{\lvert \Delta V_I \bullet V_O \rvert}$	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)

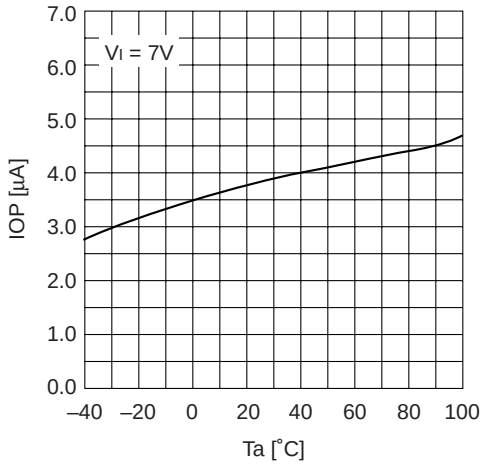
Parameter	Symbol	Conditions	Rating			Unit
			Min.	Typ.	Max.	
Input voltage	V_I	—	–15.0	—	—	V
Output voltage	V_O	V_I = –6.0V, I_O = 10mA Ta = 25°C	–4.10	–4.00	–3.90	V
Operating current	I_{DDO}	V_I = –4.0V to –15.0V	—	4.0	18.0	µA
Input/output voltage differential	$\lvert V_I - V_O \rvert$	V_I = –4.0V, I_O = 10mA	—	0.19	0.38	V
Input voltage stabilization ratio	$\frac{\lvert \Delta V_O \rvert}{\lvert \Delta V_I \bullet V_O \rvert}$	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

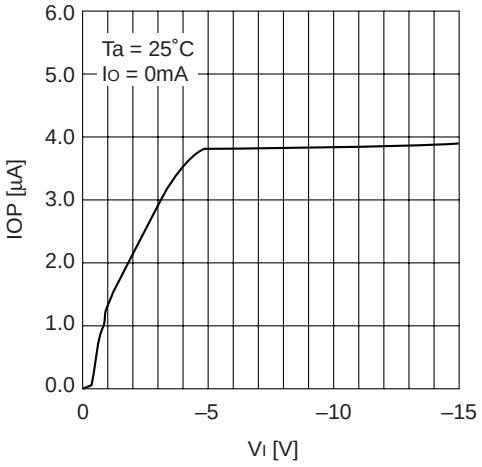
(V_{DD} = 0V, Ta = –40°C to 85°C unless otherwise noted)

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	$\lvert V_I - V_O \rvert$	V_I = –5.0V, I_O = 10mA	—	0.17	0.34	V
Input voltage stabilization ratio	$\frac{\lvert \Delta V_O \rvert}{\lvert \Delta V_I \bullet V_O \rvert}$	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

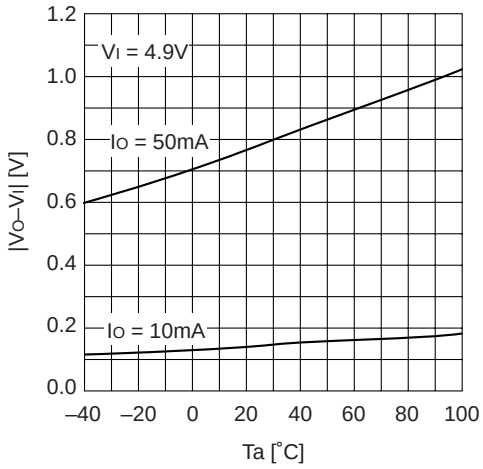
Typical Performance Characteristics
SCI7910YBA



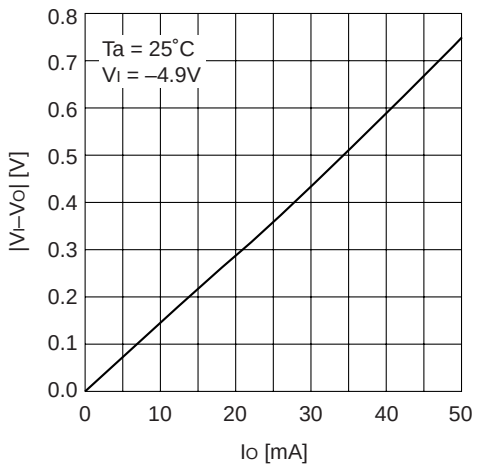
IOP – Ta



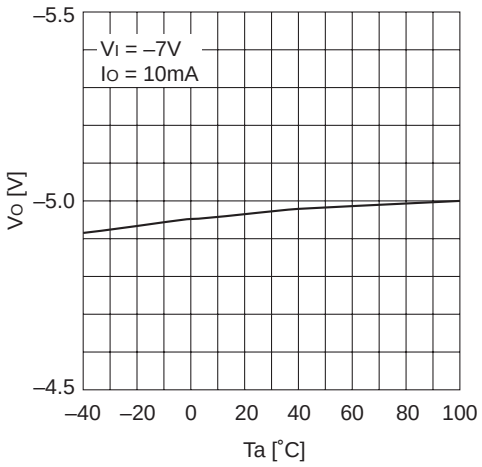
IOP – VI



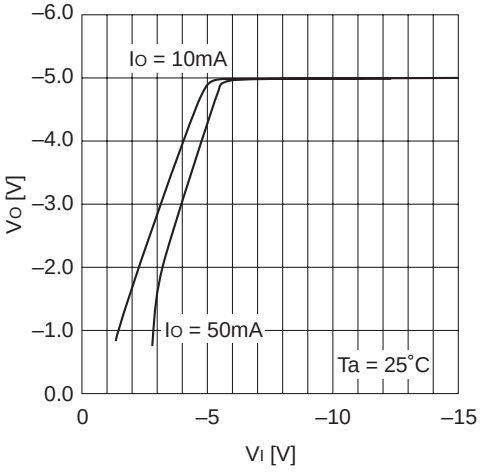
|VO – VI| – Ta



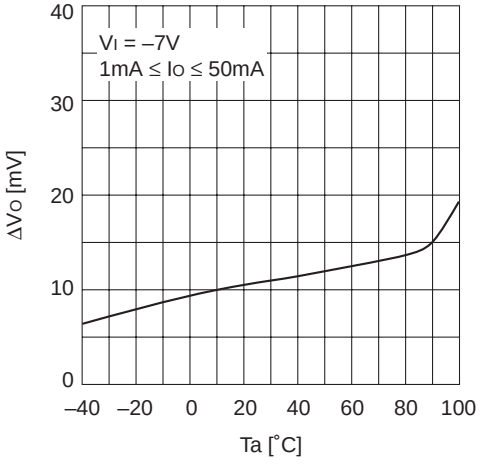
|VI – VO| – IO



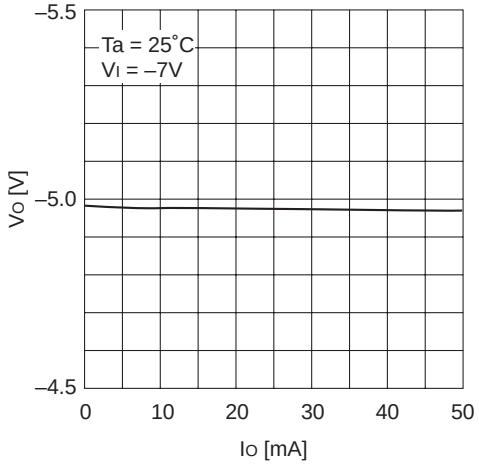
Vo – Ta



Vo – VI

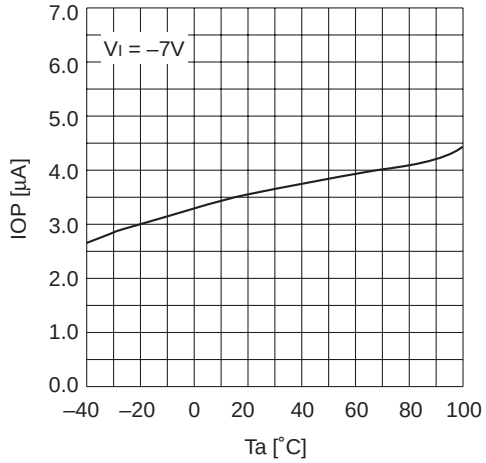


ΔVo – Ta

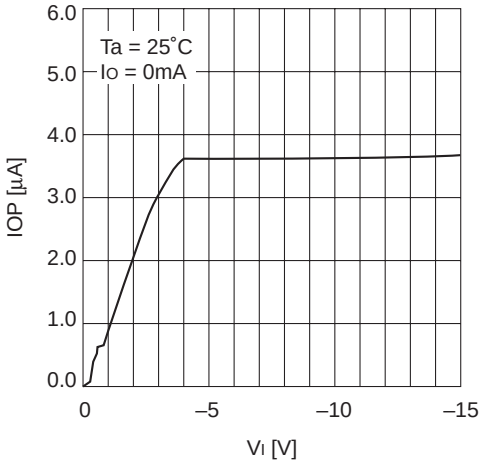


Vo – Io

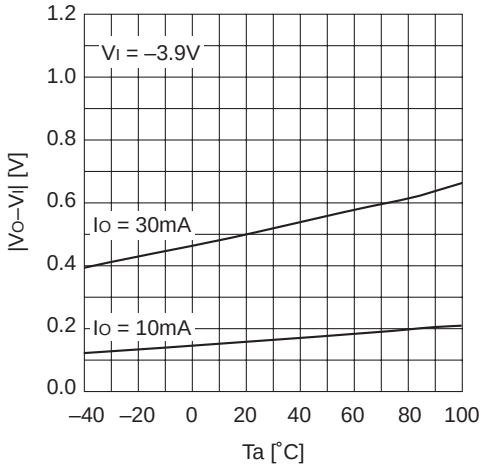
SCI7910YPA



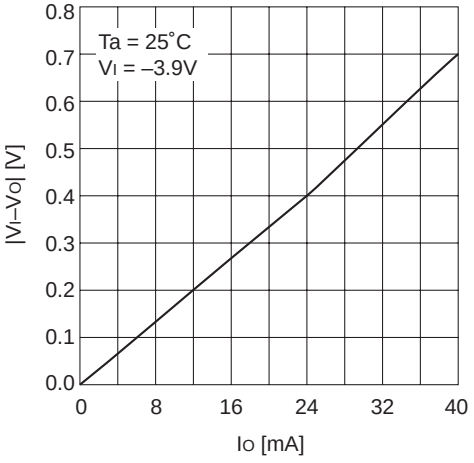
IOP – Ta



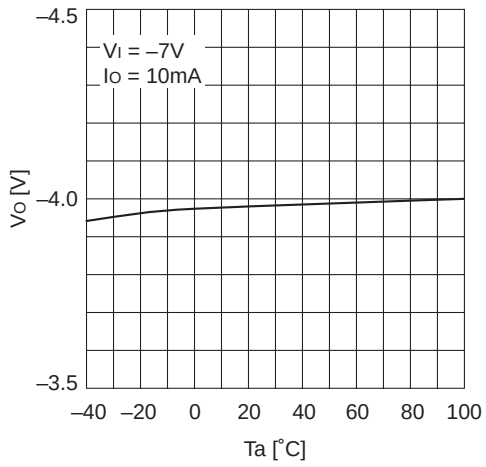
IOP – VI



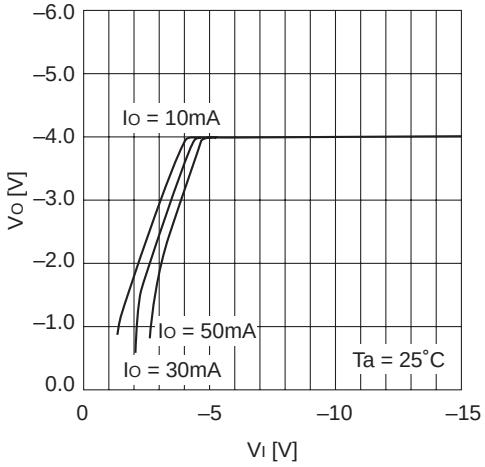
|VO – VI| – Ta



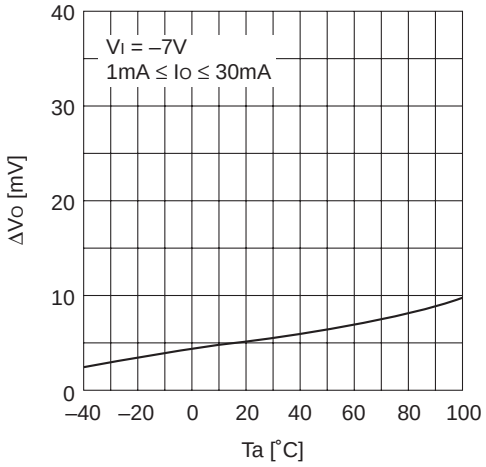
|VI – VO| – IO



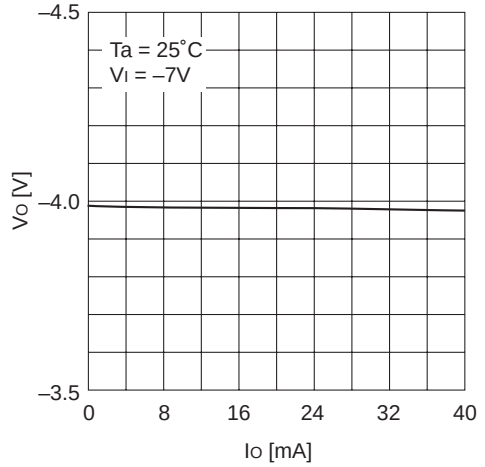
Vo – Ta



Vo – VI

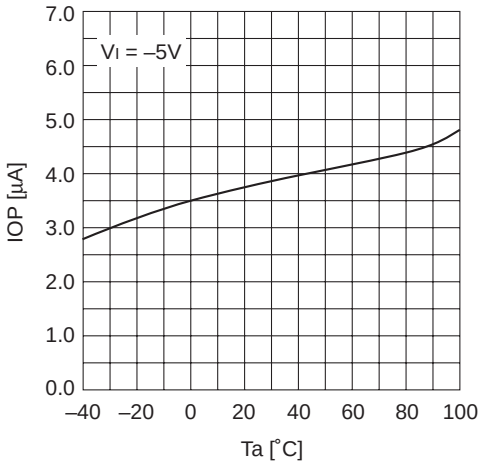


ΔVo – Ta

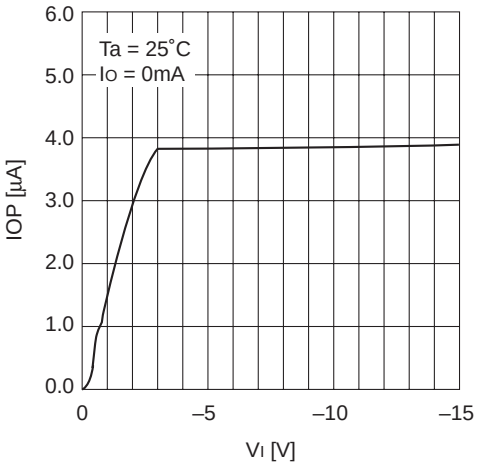


Vo – Io

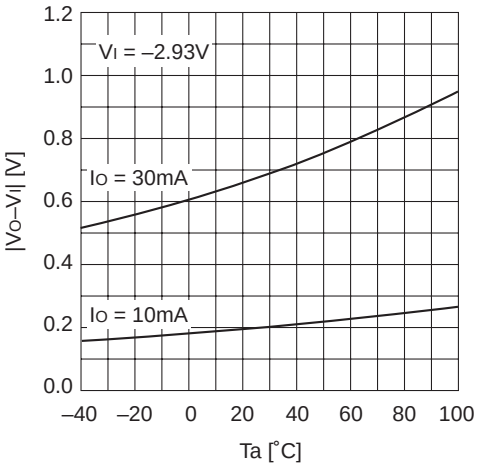
SCI7910YDA



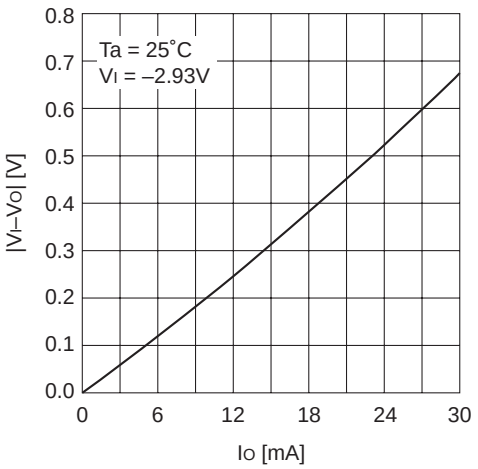
IOP – Ta



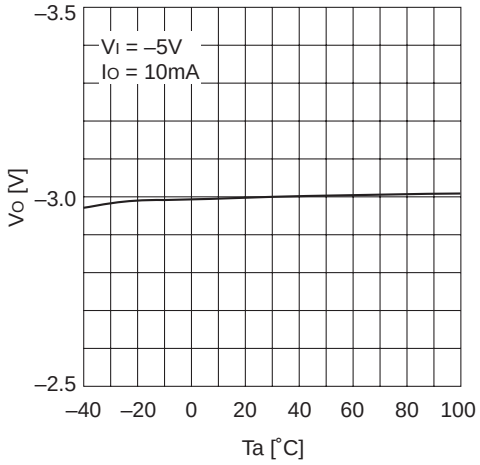
IOP – VI



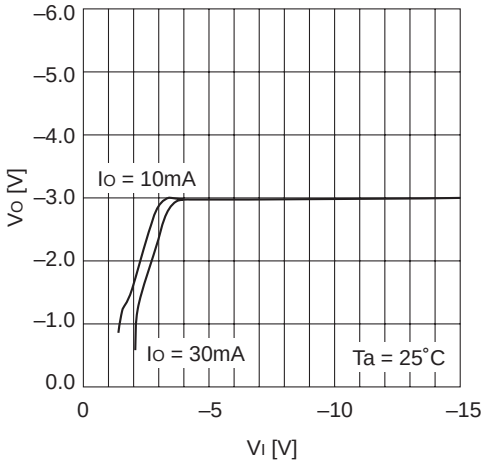
|VO – VI| – Ta



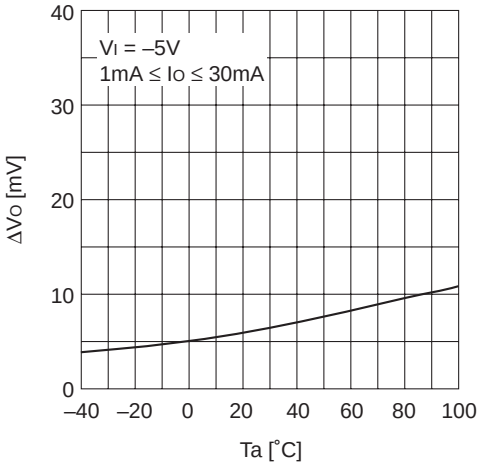
|VI – VO| – IO



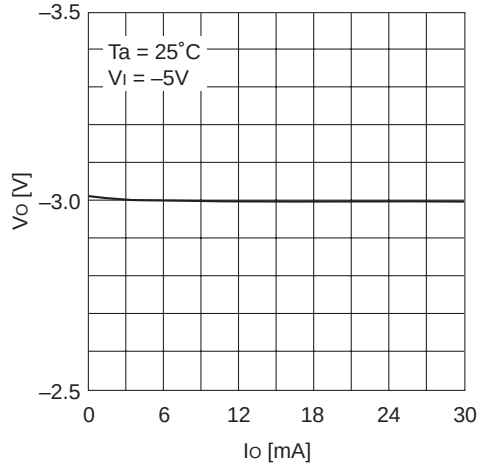
Vo – Ta



Vo – VI



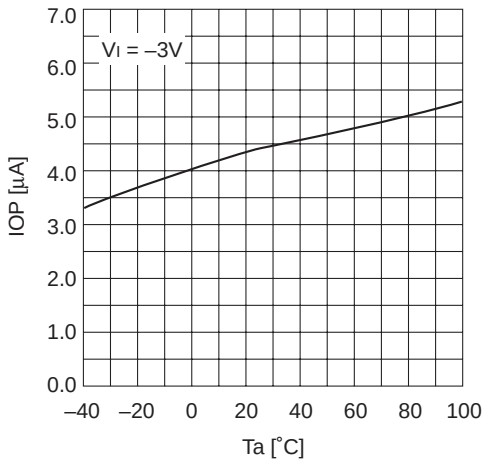
ΔVo – Ta



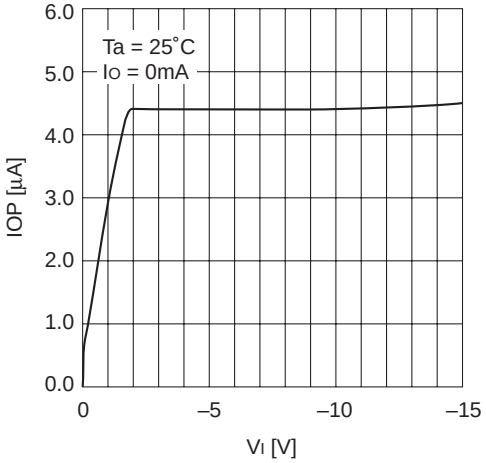
Vo – Io

Voltage Regulator

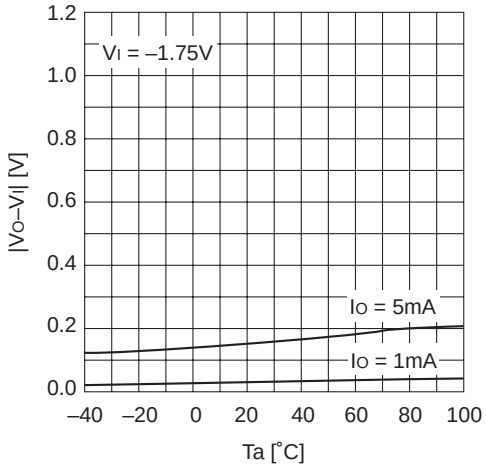
SCI7910YGA



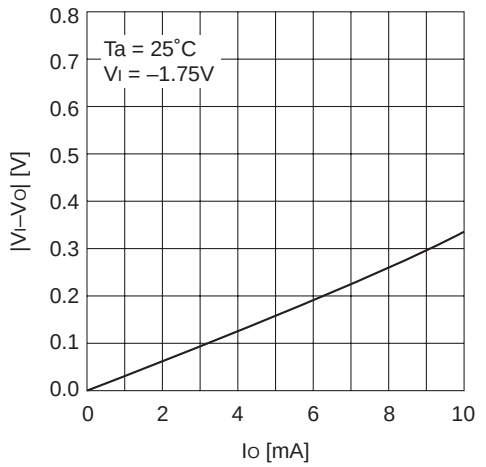
IOP – Ta



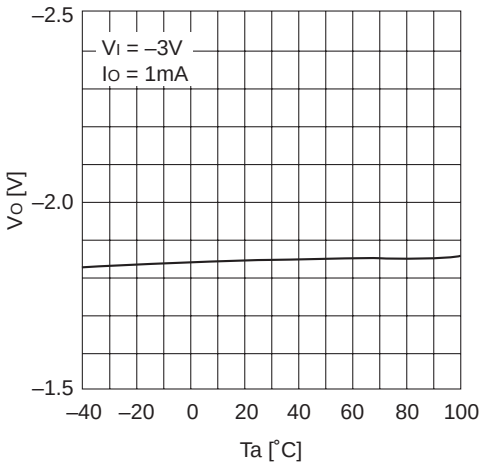
IOP – VI



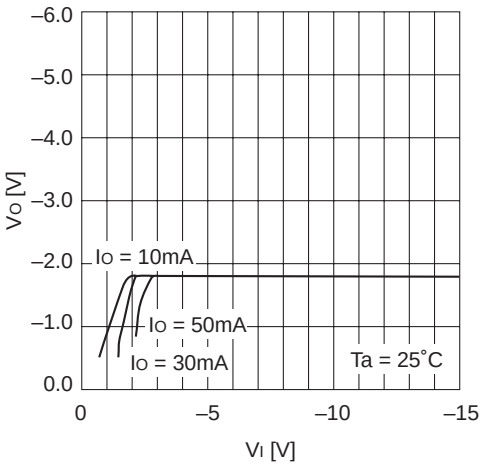
|VO – VI| – Ta



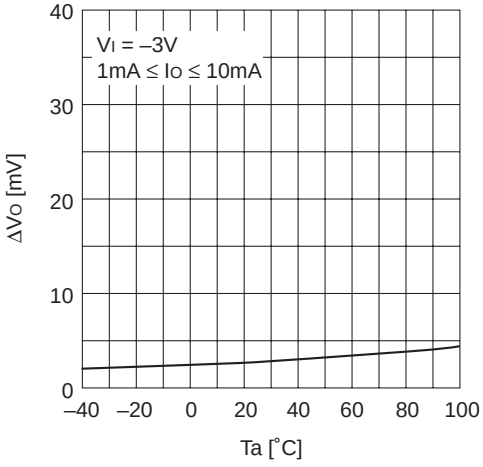
|VI – VO| – IO



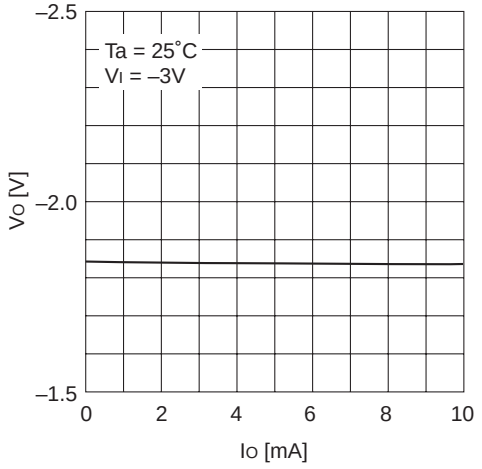
Vo – Ta



Vo – VI

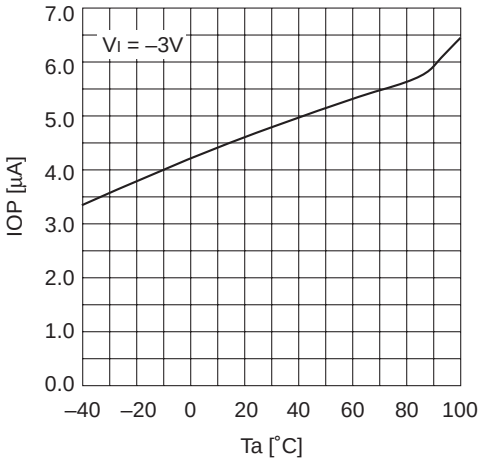


ΔVo – Ta

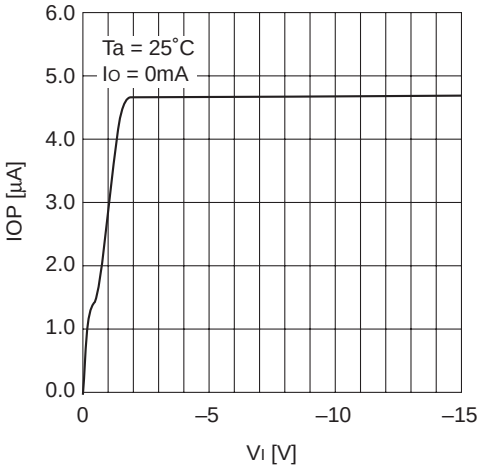


Vo – Io

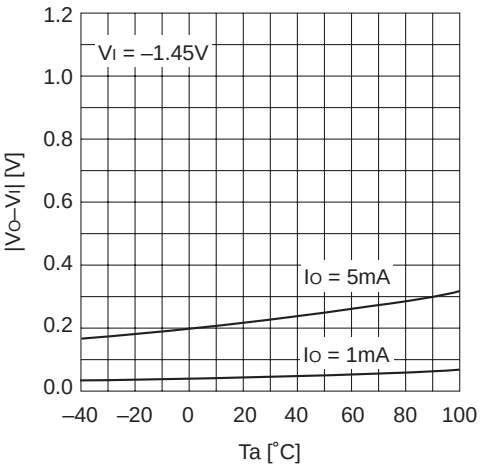
SCI7910YHA



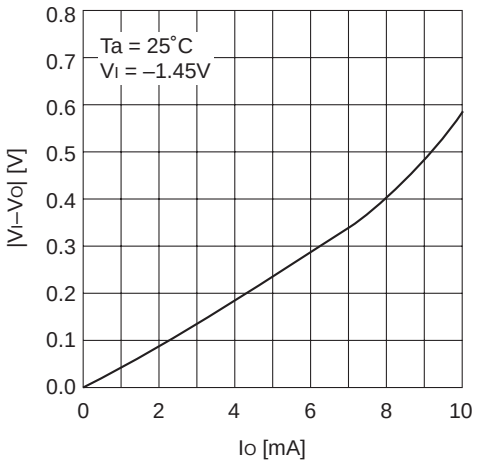
IOP – Ta



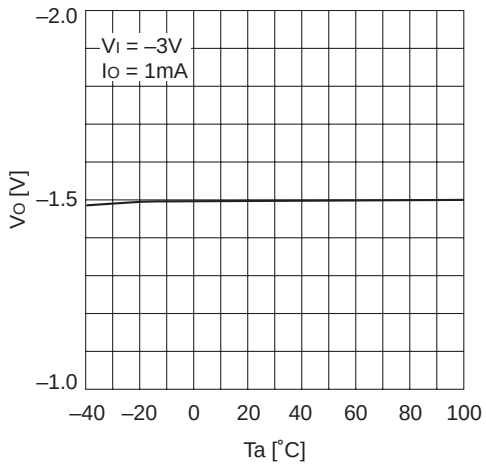
IOP – VI



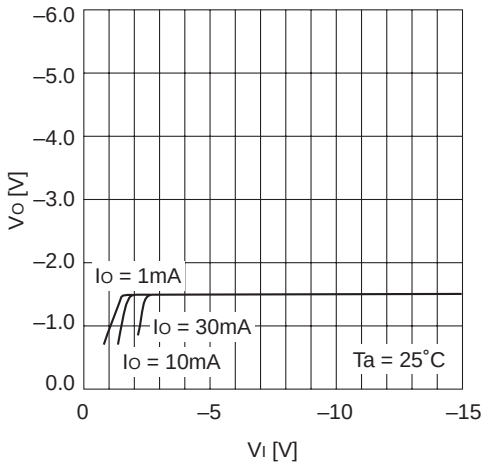
|VO – VI| – Ta



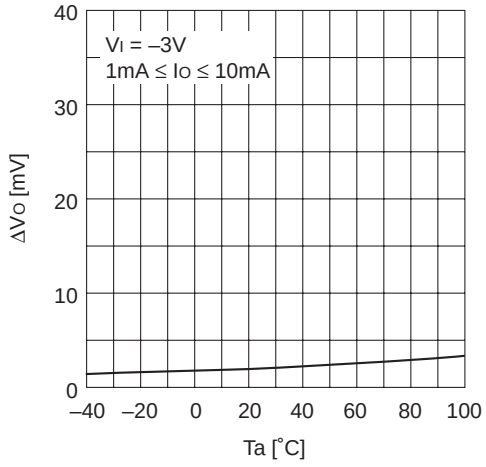
|VI – VO| – IO



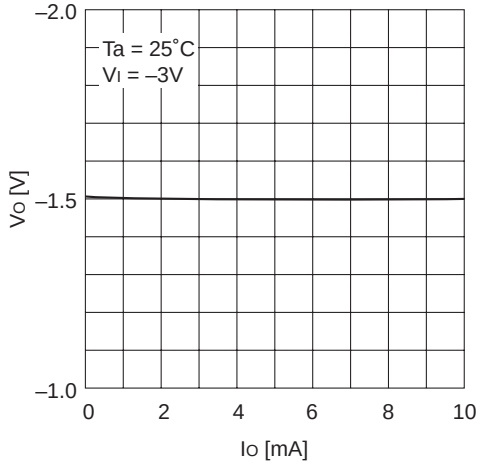
Vo – Ta



Vo – VI



ΔVo – Ta



Vo – Io

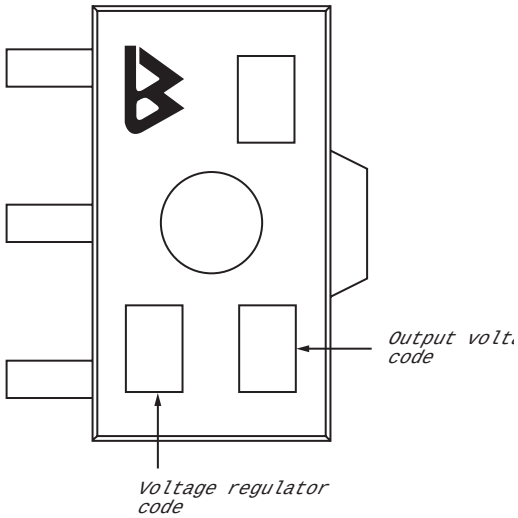
PACKAGE MARKINGS

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.

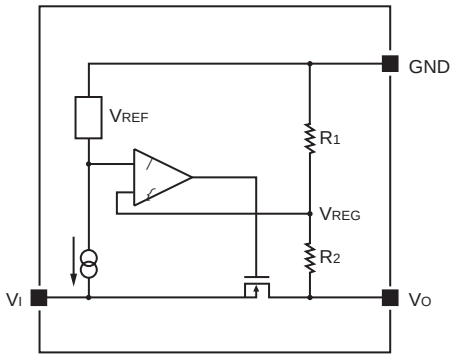
Marking locations



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.



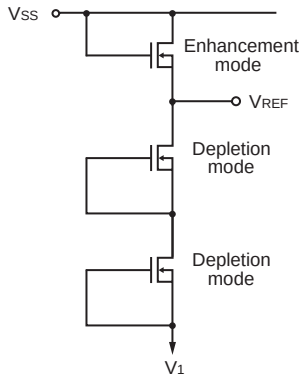
The following equation shows the relationship between V_O and V_{REF}.

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

Internal Circuits

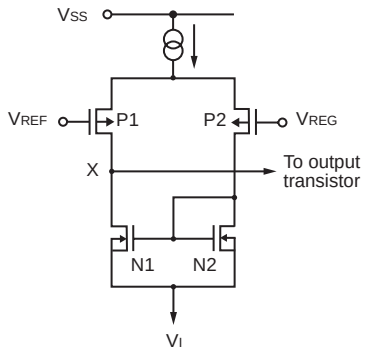
Reference voltage generator

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.



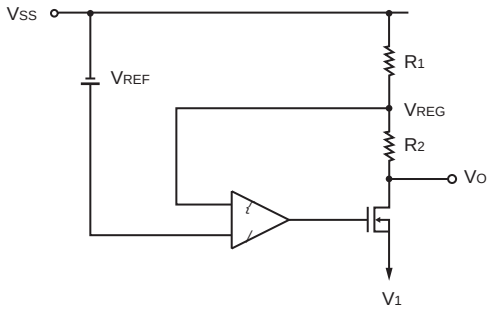
Differential amplifier

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 VREF and VREG.



Output transistor

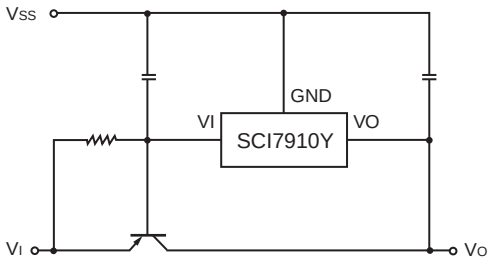
The output side of the p-channel MOS transistors in the output transistor circuit is connected to the voltage divider resistors in the feedback loop.



TYPICAL APPLICATIONS

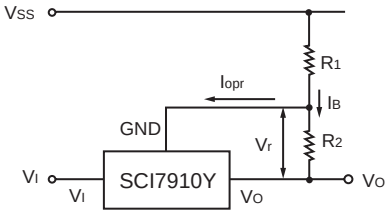
Current Booster

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.

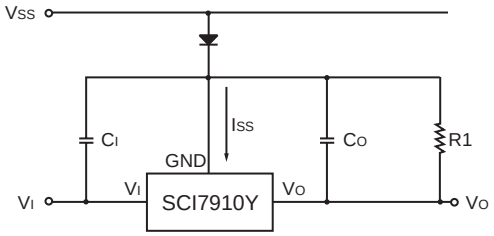


The following equation shows the relationship between the old and new voltages.

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

Note that the application must supply a bias current, IB, high enough to offset the increase in voltage across R1 due to Iopr.

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



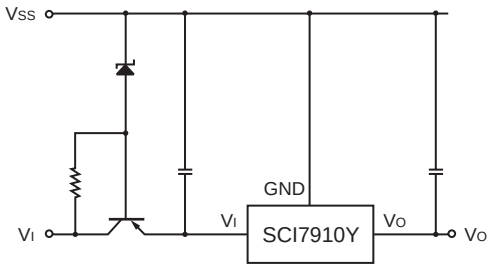
This configuration, however, introduces two design problems.

1. It reduces the output voltage by VF, the forward voltage drop across the diode.
2. It is sensitive to fluctuations in VF due to differences in diodes, operating temperatures and ISS.

R_1 helps reduce the affect of I_{SS} on V_F. It is also required when I_{SS} is lower than the diode bias current. For certain input voltages, a Zener diode with the reverse polarity can be used.

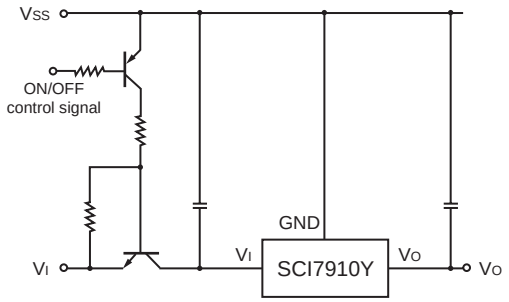
High Input Voltages

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