# LOW VOLTAGE LOW POWER I/O TYPE MCU WITH BUILT-IN HIGH PRECISION RC OSCILLATOR

DESCRIPTION

SC51P03E02 is a SC51 core based 3V I/O type low power consumption 8-bit MCU with 2K-byte OTP and 128-byte RAM. It features 1.8V~3.6V supply voltage range, ultra-low Stop current, and low operating current under low frequency, which is designed for the battery-powered systems. And rich timer resources and carrier generator equivalent to 8-bit PWM make the SC51P03E02 suitable for various small home appliances control and swich control and intelligent lighting.

SOP-8-225-1.27
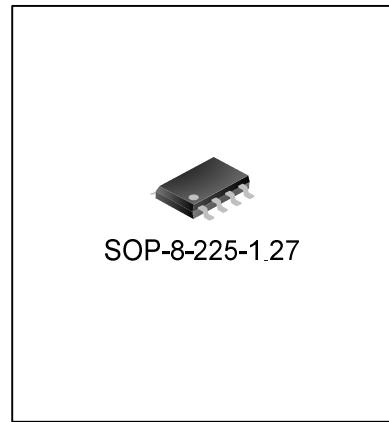
APPLICATION

- ◆ Intelligent lighting
- ◆ Switch dimming and toning
- ◆ Remote control
- ◆ Small home appliances control
- ◆ Power management

FEATURES

- ◆ 8 bit SC51 CPU
  - • Compatible with MCS51 instruction set, dual DPTR; support software trap instruction.
  - • Improved instruction structure, the execution time of 90% instructions is two to four clock cycles.
- ◆ On-Chip Memory
  - • 2K-byte OTP, data retention time > 10 years.
  - • 128-byte RAM.
  - • 128-byte E^{2}PROM
  - • Support In-System-Programming (ISP), only 5-pins are needed (including VDD/VSS).
  - • Support muti-time-programming (MTP): 4 times, 0.5K byte for each programming.
  - • Support OTP page encryption, page size: 0.5K.
- ◆ Power supply and Reset
  - • Built-In Power-On-Reset (POR).
  - • Built-In Low-Voltage-Reset (LVR) with 2 levels selectable:1.63V, 1.9V.
  - • Built-In Low-Voltage-Detect (LVD) with 8 levels selectable:2.0V, 2.1V, 2.2V, 2.3V, 2.4V, 2.5V, 2.7V, 3.0V.
- ◆ System clock
  - • Built-In 20KHz low frequency Oscillator .
  - • Built-In 4MHz high precision Oscillator (RCH): ±1% @-10~50°C.
  - • Frequency of CPU selectable between 1MHz and 4MHz.
  - • Carrier generator: 4MHz.
- ◆ I/O

- Up to 14 I/O Ports.
- Built-in high current output transistor, and drive strength is selectable: I_{OL}=200/250mA@V_{OL}=0.3V, V_{DD}=3V.
- Polarity configurable Keyboard-Interrupt wakeup interrupt at P1 (8 pins)
- 2-channel external interrupt input
- Peripherals
  - Two 16-bit standard Timer (T0,T1).
  - Internal carrier generator (CRG), carrier modulation available.
  - Built-in watchdog (WDT).
- Operation Modes
  - Normal mode.
  - IDLE mode.
 - STOP mode.
- Package
  - 16-pin SOP.
  - 8-pin SOP.

ORDERING INFORMATION:

Part No.	Package	Marking	Hazardous Substance Control	Packing
SC51P03E02SA1G	SOP-8-225-1.27	03E02SA1	Halogen free	Tube
SC51P03E02SA1GTR				Tape & reel

RESOURCE INFORMATION:

Resource	SC51P03E02SA1G
Package	SOP-8
OTP	2K Byte
RAM	128 Byte
E^2PROM	128 Byte
I/O	6
EINT	1
T0	Yes
T1	Yes
CRG	Yes
KBI	3

BLOCK DIAGRAM
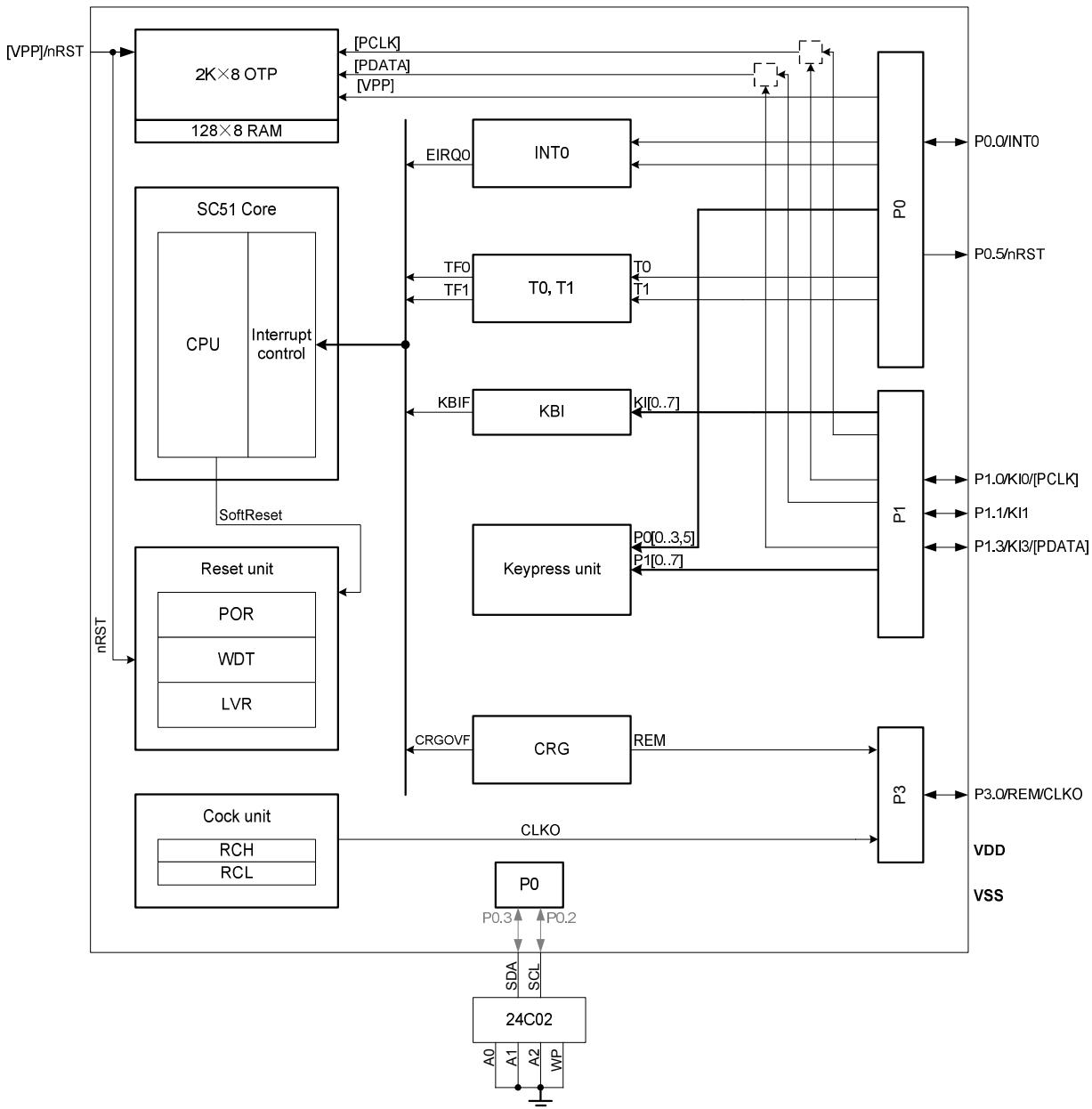
PIN CONFIGURATION
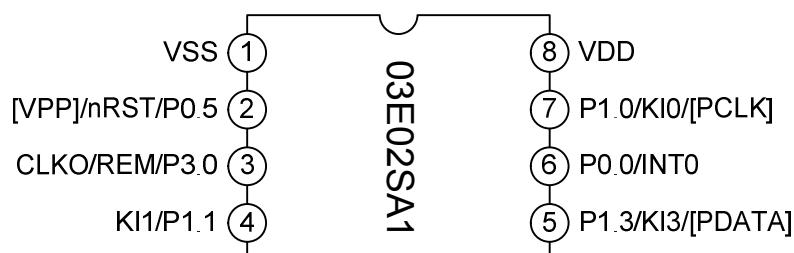
Note 1: The pin with the name in [ ] means it is used for programming.

PIN MULTIPLEX:

I/O	PIN STRUCTURE	PIN NUM. -SC1	PIN NUM. -SA1	SYSTEM	EXTERNAL INT	TIMER	KBI	PROGRAM
P0.0	B	10	5	--	INT0	--	--	--
P0.2	B	12	--	--	--	T1	--	--
P0.3	B	13	--	--	--	T0	--	--
P0.5	A	14	6	nRST	--	--	--	[VPP]
P1.0	B	2	2	--	--	--	KI0	[PCLK]
P1.1	B	3	3	--	--	--	KI1	--
P1.3	B	5	4	--	--	--	KI3	[PDATA]
P3.0	C	15	7	CLKO	--	REM	--	--
VDD	P1	16	8	--	--	--	--	--
VSS	P0	1	1	--	--	--	--	--

PIN DESCRIPTION:

I/O	Pin type	Pin Description
PORT		
P0.0	I/O	1-bit bidirectional I/O, bit operation available
P0.5	I/O	1-bit bidirectional I/O, bit operation available
P1.0	I/O	1-bit bidirectional I/O, bit operation available
P1.1	I/O	1-bit bidirectional I/O, bit operation available
P1.3	I/O	1-bit bidirectional I/O, bit operation available
P3.0	I/O	1-bit bidirectional I/O, bit operation available
PROGRAM		
[PCLK]	I	Program clock input
[PDATA]	I/O	Program data input/output
[VPP]	I	High-voltage input
SYSTEM		
nRST	I	External reset input, active low level
CLKO	O	Clock output
INT0	I/O	External interrupt input 0/1
TIMER		
REM	O	Carrier generator output
KBI		
KI0	I	1-bit Keyboard interrupt wakeup input
KI1	I	1-bit Keyboard interrupt wakeup input
KI3	I	1-bit Keyboard interrupt wakeup input
POWER		
VDD	P	Power supply
VSS	P	Ground

Note: In column "pin type" of above table, P denotes the power supply pin; I/O denotes common input/output pins; I denotes the input pins; O denotes the output pins.

PIN STRUCTURE

Pin structure P1

Pin structure P0

Pin structure A

Pin structure B

Pin structure C
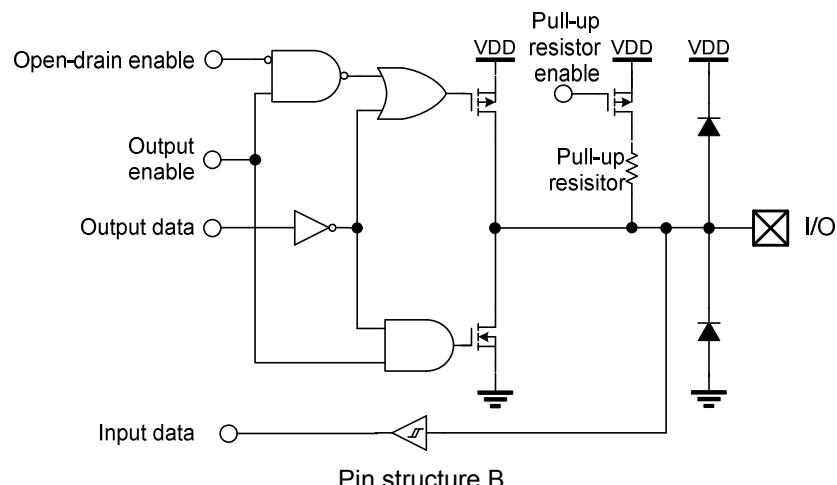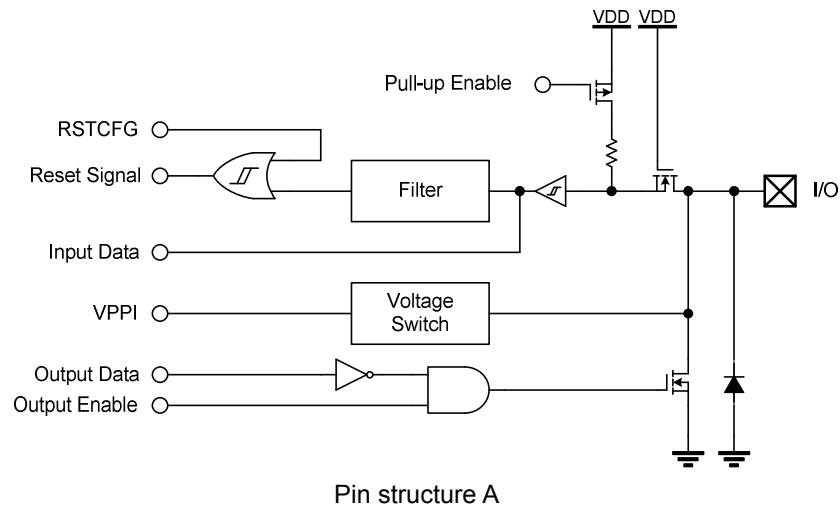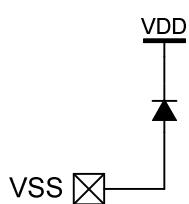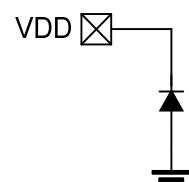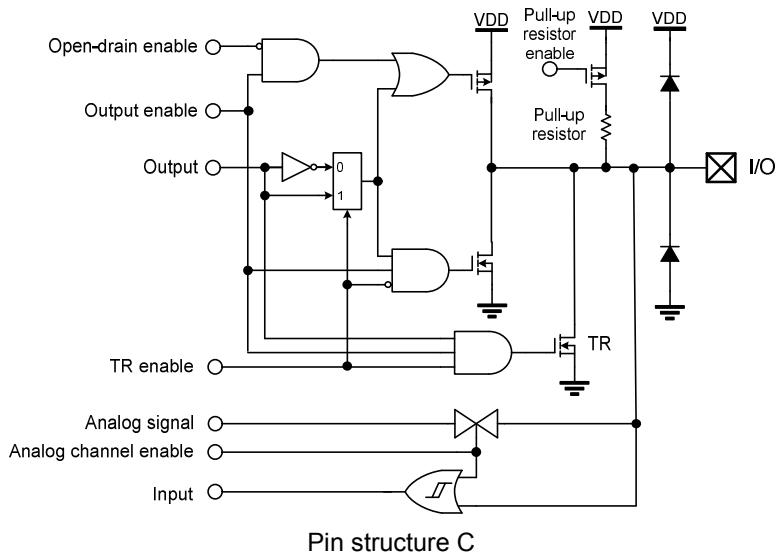
ABSOLUTE MAXIMUM RATING

Stresses above those listed as "absolute maximum rating" may cause permanent damage to the device. This is a stress rating only and functional operation of the device under these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

1. Voltage characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply voltage	V_{DD}	--	-0.3	--	5.5	
Input voltage	V_{IN}	P0.5	-0.3	--	6.75	V
		IO except for P0.5	-0.3	--	V_{DD}+0.3	

Note: unless otherwise specified, all voltages are referenced to V_{SS}.

2. Current characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Total current into V_{DD} power lines	I_{VDD}	--	--	--	80	
Total current out of V_{SS} ground lines	I_{VSS}	Built-in TR not included	--	--	80	
Injected current	I_{INJ}	$V_{IN} > V_{DD}$ or $V_{IN} < V_{SS}$	-4	--	4	mA
		$V_O > V_{DD}$ or $V_O < V_{SS}$	-4	--	4	
Total injected current	ΣI_{INJ}	--	-20	--	20	

3. Thermal characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Ambient temperature	T_A	--	-40	--	85	°C
Storage temperature	T_{STG}	--	-55	--	125	

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Junction temperature	T_J	--	--	--	150	
Thermal resistance	θ_{JA}	SOP16	--	125	--	°C /W
		SOP8	--	184	--	
Power dissipation	P_D	--	--	--	500	mW

Note: thermal resistance is related with package form, PCB, working environment and power dissipation.

4. ESD Protection and static Latch-up Immunity

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
HBM	V_{HBM}	MIL-STD-883H	±2000	--	--	V
MM	V_{MM}	JESD22-A115	±200	--	--	
CDM	V_{CDM}	JESD22-C101E	±1000	--	--	
Latch-up trigger current	I_{LAT}	JEDEC standard NO.78D 2011.11	±100	--	--	mA
V_{DD} overstress	V_{LAT}		5.4	--	--	V

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Operating voltage	V_{DD}	--	1.8	3.3	3.6	V
CPU clock frequency	F_{CPU}	--	--	1 or 4	--	MHz
POR re-arm voltage	V_{PORR}	--	--	0.2	--	V
POR release delay	t_{PWRT}	--	1	--	--	ms
V_{DD} rise time rate	S_{VDD}	Ensure POR is active	0.1	--	--	V/ms
RAM retention voltage	V_{DR}	T_A=-40~85°C	0.8	--	--	V

DC ELECTRICAL CHARACTERISTICS(unless otherwise specified, V_{DD}=3V, T_{AMB}=25°C)

1. Current characteristics

The MCU is placed under the following conditions:

- ♦ All IO pins in input mode with a static value at V_{DD} or V_{SS}, or in output 0 mode(no load);
- ♦ All peripherals are disabled (clock is off through peripheral clock gating registers) except if explicitly mentioned.

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Supply current in run mode	I_{DD}	MClk=1MHz	V_{DD}=3.0	--	365	500	µA
Supply current in Idle mode	I_{IDLE}	MClk=1MHz	V_{DD}=3.0	--	170	180	µA
Supply current in Stop mode	I_{STOP}	Enable RCL	V_{DD}=3.0	--	1.0	2.0	µA
		Disable RCL	V_{DD}=3.0	--	0.7	1.7	

Note: the typical value is based on characteristic results, not tested in production.

2. IO port pin characteristics

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Input high level voltage	V_{IH}	--		$0.7V_{DD}$	--	V_{DD}	V
Input low level voltage	V_{IL}	IO except for P0.5		0	--	$0.3V_{DD}$	V
		P0.5		0	--	$0.2V_{DD}$	V
Input hysteresis	$V_{HYS（IO）}$	IO except for P0.5		--	50	--	mV
		P0.5		--	100	--	mV
Input leakage current	I_{IL}	$V_{SS}＜V_{PIN}＜V_{DD}$ $T_A=85°C$	IO except for P0.5	--	--	±100	nA
			P0.5	--	--	±100	
Pull-up resistor	R_{PU}	$V_{IN}=0V$	IO except for P0.5 and P3.0	100	160	210	KΩ
			P0.5 and P3.0	100	155	210	
Output high level voltage	V_{OH}	I_{OH}=10mA, P3.0		V_{DD}-0.5V	--	--	V
		I_{OH}=4mA, IO except for P0.5 and P3.0		V_{DD}-0.5V	--	--	
Output low level voltage	V_{OL}	I_{OL}=8mA, P0.5		--	--	0.8	V
		I_{OL}=8mA, IO except for P0.5		--	--	0.5	
Output low level voltage of TR	V_{OL}	I_{OL}=200mA, TR low level		--	--	0.5	V
		I_{OL}=250mA, TR high level		--	--	0.4	
nRST filter width	$T_{PW}(IO)$	P0.5		--	2	4	μs

Note: the typical value is based on characteristic results, not tested in production.

3. Power management characteristics

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
LVR on voltage	V_{LVR}	LVRS=0		1.55	1.63	1.7	V
		LVRS=1		1.8	1.9	2.0	
LVR hysteresis	$V_{HYS（LVR）}$	LVRS=0		--	15	--	mV
		LVRS=1		--	20	--	
LVR module current	I_{LVR}	STOP mode, enable LVR		--	40	--	μA
LVD on voltage	V_{LVD}	LVDS=000	VDD falling	1.95	2.0	2.05	V
			VDD rising	2.05	2.1	2.18	
		LVDS=001	VDD falling	2.05	2.1	2.15	
			VDD rising	2.2	2.25	2.28	
		LVDS=010	VDD falling	2.15	2.2	2.25	
			VDD rising	2.25	2.35	2.4	
		LVDS=011	VDD falling	2.22	2.3	2.4	
			VDD rising	2.35	2.45	2.5	

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
		LVDS=100	VDD falling	2.35	2.4	2.45	
			VDD rising	2.45	2.55	2.6	
		LVDS=101	VDD falling	2.45	2.5	2.55	
			VDD rising	2.55	2.65	2.7	
		LVDS=110	VDD falling	2.65	2.7	2.75	
			VDD rising	2.8	2.85	2.94	
			VDD falling	2.95	3.0	3.05	
		LVDS=111	VDD rising	3.1	3.15	3.2	
LVD module current	I_{LVD}	IDLE mode, enable LVD		--	45	--	µA

Note: the typical value is based on characteristic results, not tested in production.

4. Oscillator characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Trimmed RCH frequency	F_{RCH}	V_{DD}=1.8~3.6V, T_A=-10～50°C	3.96	4.0	4.04	MHz
		V_{DD}=1.8~3.6V, T_A=-20～70°C	3.94	4.0	4.06	
		V_{DD}=1.8~3.6V, T_A=-40～85°C	3.86	4.0	4.1	
RCH start-up time	T_{RCHSTR}	--	--	10	--	µs
RCH stable delay cycle	T_{DRCH}	--	--	1024	--	Cycles
RCH current*	I_{RCH}	Enable RCH	--	120	--	µA
RCL frequency	F_{RCL}	1.8~3.6V, -40～85°C	6	20	40	KHz
RCL current	I_{RCL}	Enable RCL	--	0.2	1.0	µA

Note: the typical value is based on characteristic results, not tested in production.

**DC and AC characteristics figure**
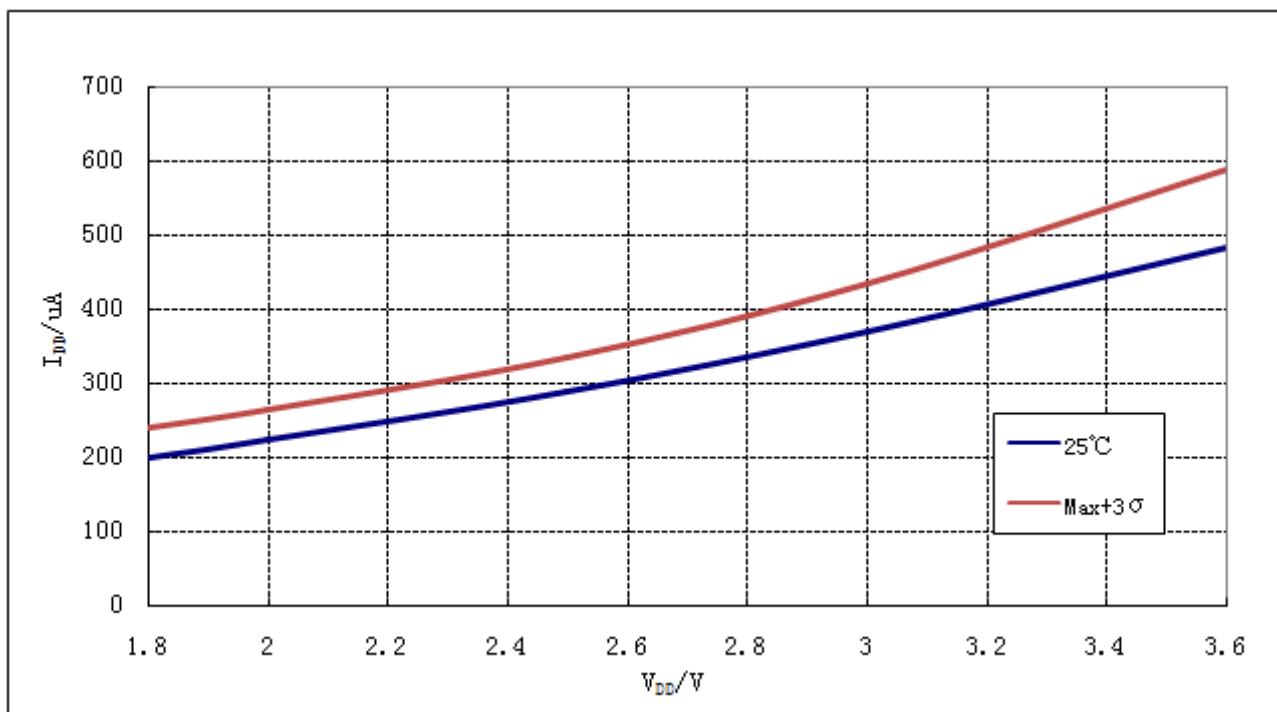
Supply current in run mode @MCLK=1MHz
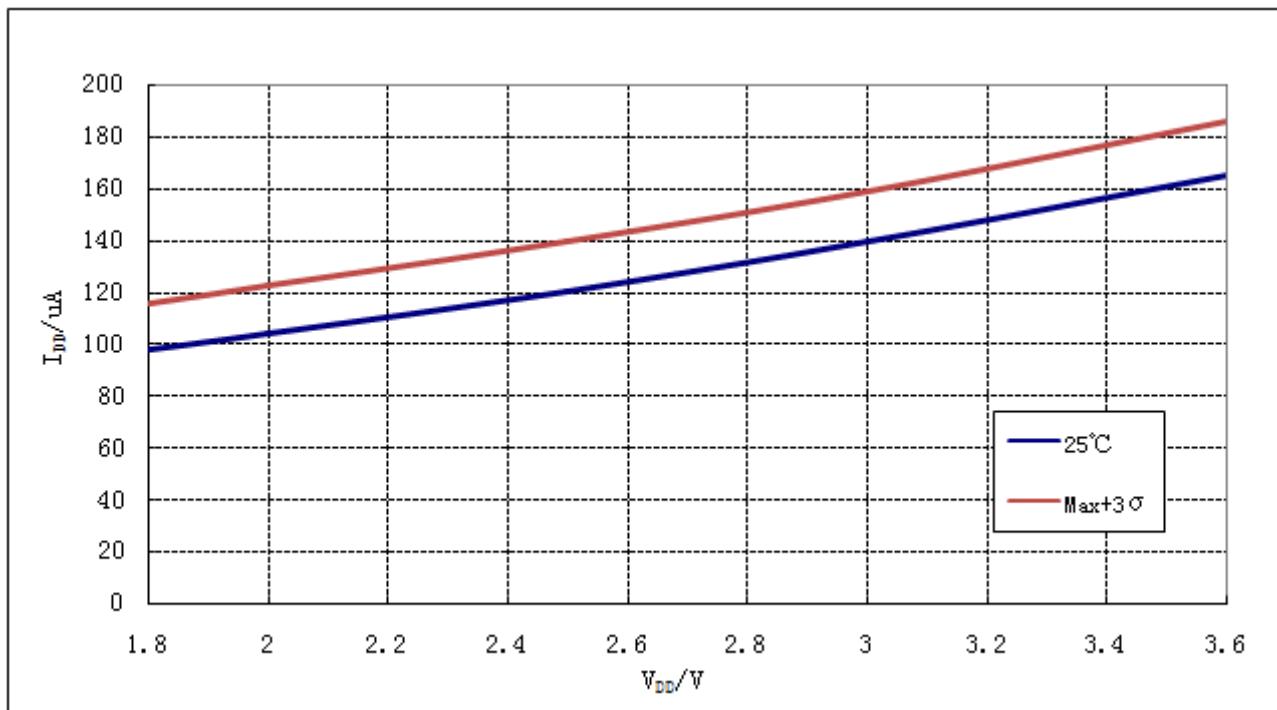
Supply current in IDLE mode @FCLK=1MHz
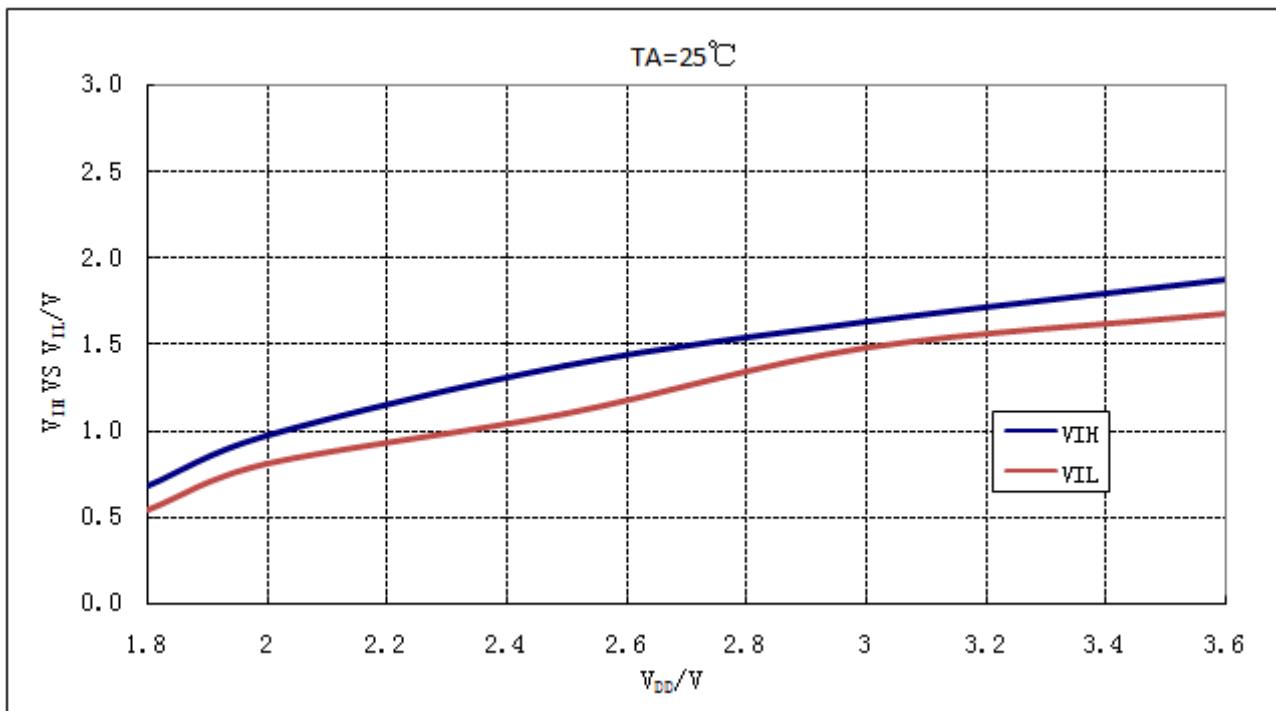
V_{IH} and V_{IL} of P0.5 vs V_{DD} @T_A = 25℃
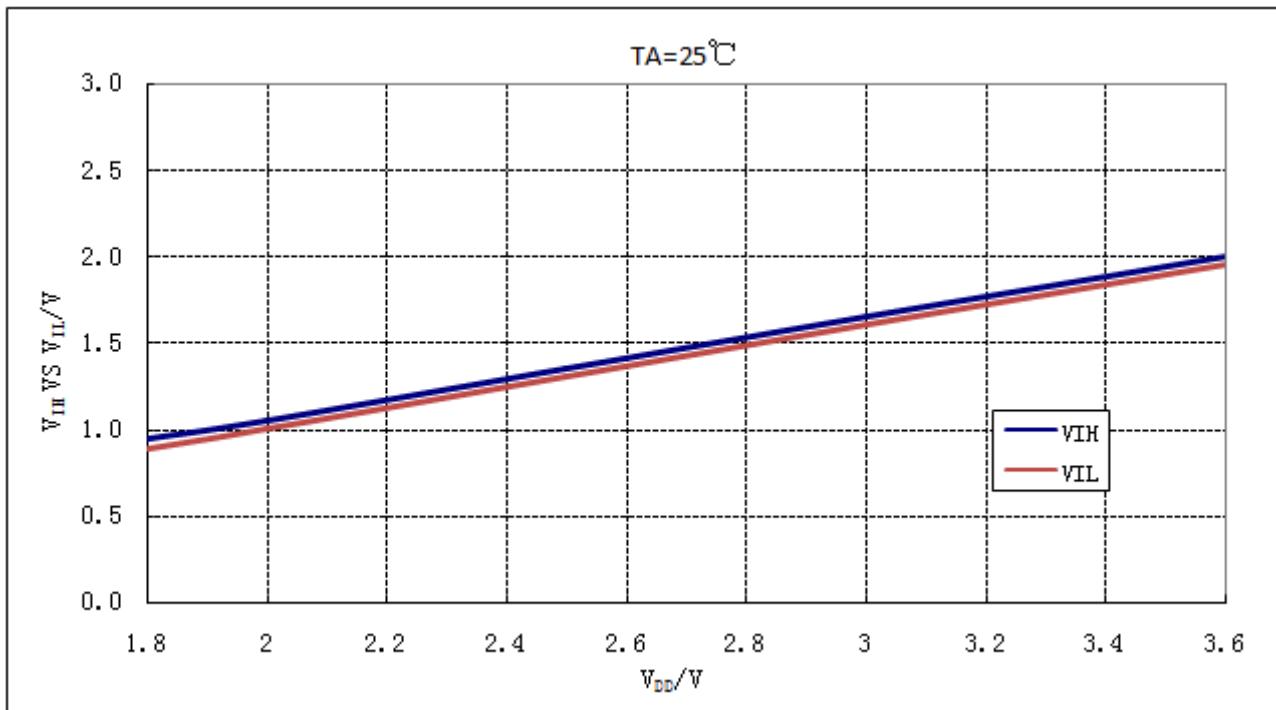
V_{IH} and V_{IL} of IO except for P0.5 vs V_{DD} @T_A = 25℃
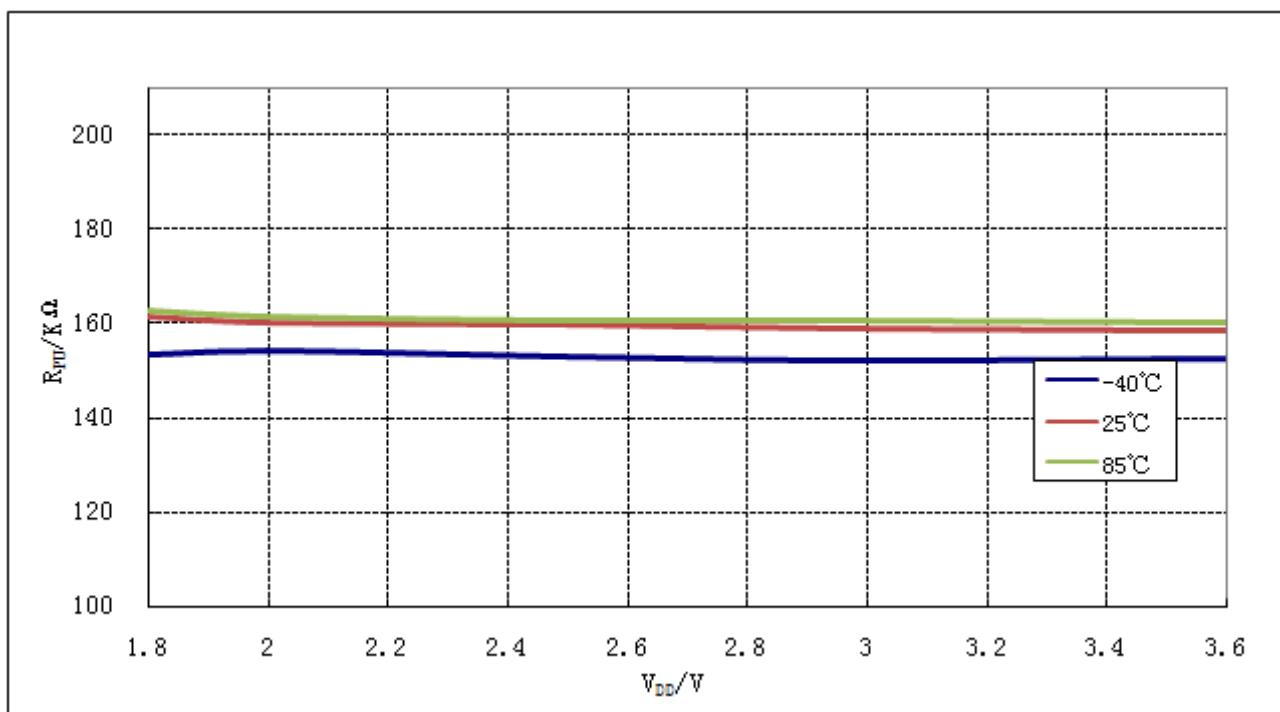
Pull-up resistance of P0.5 and P3.0
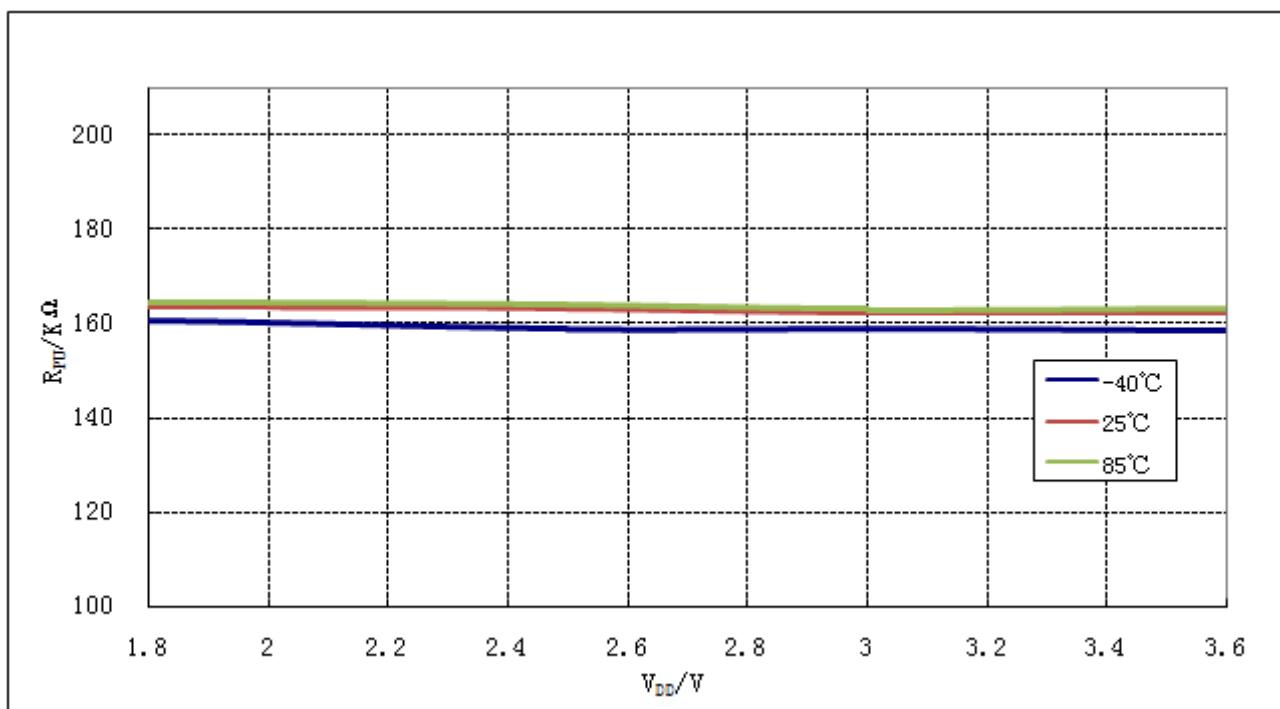
Pull-up resistance of IO except for P0.5 and P3.0
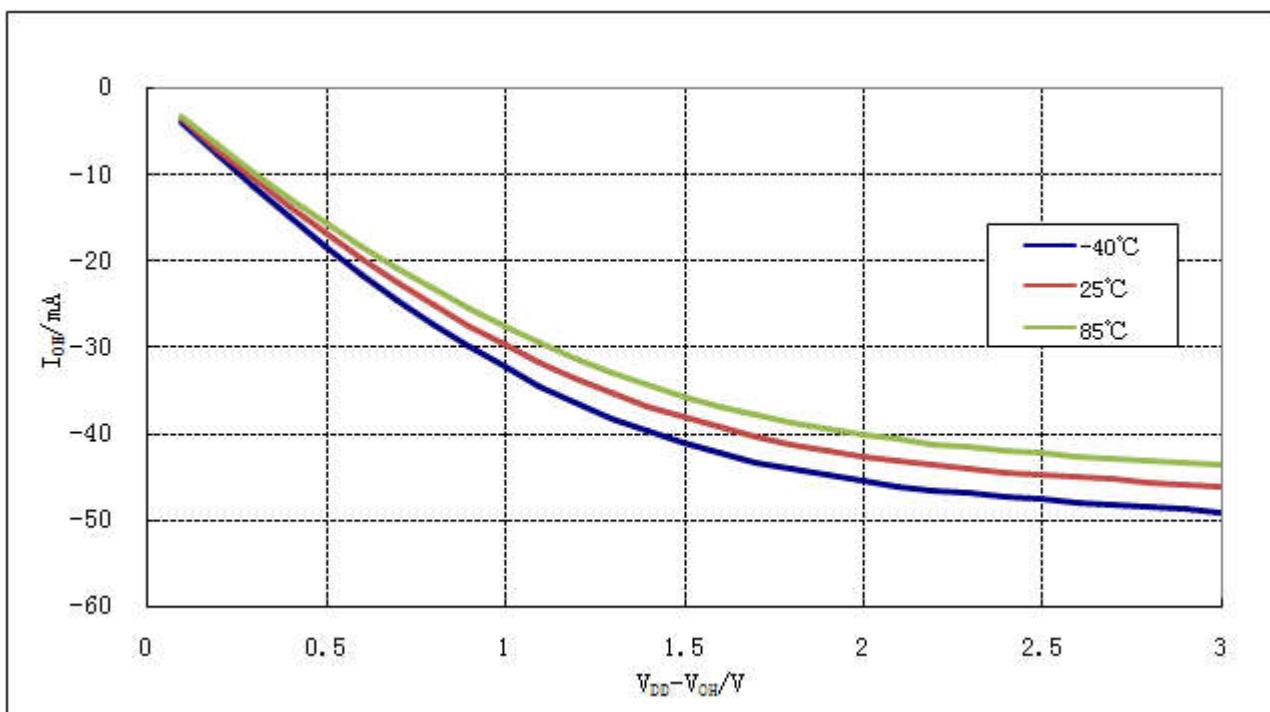
Source current of P3.0 @V_{DD}=3.0V
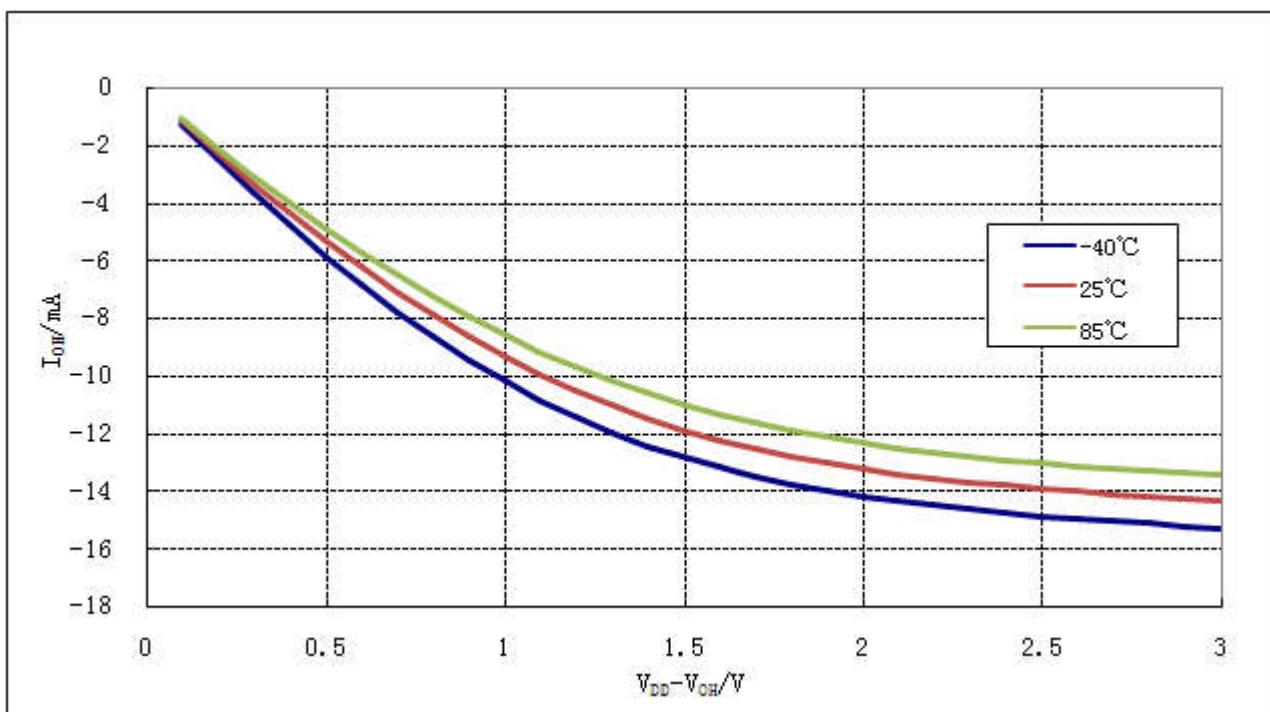


Source current of IO except for P3.0 @V_{DD}=3.0V
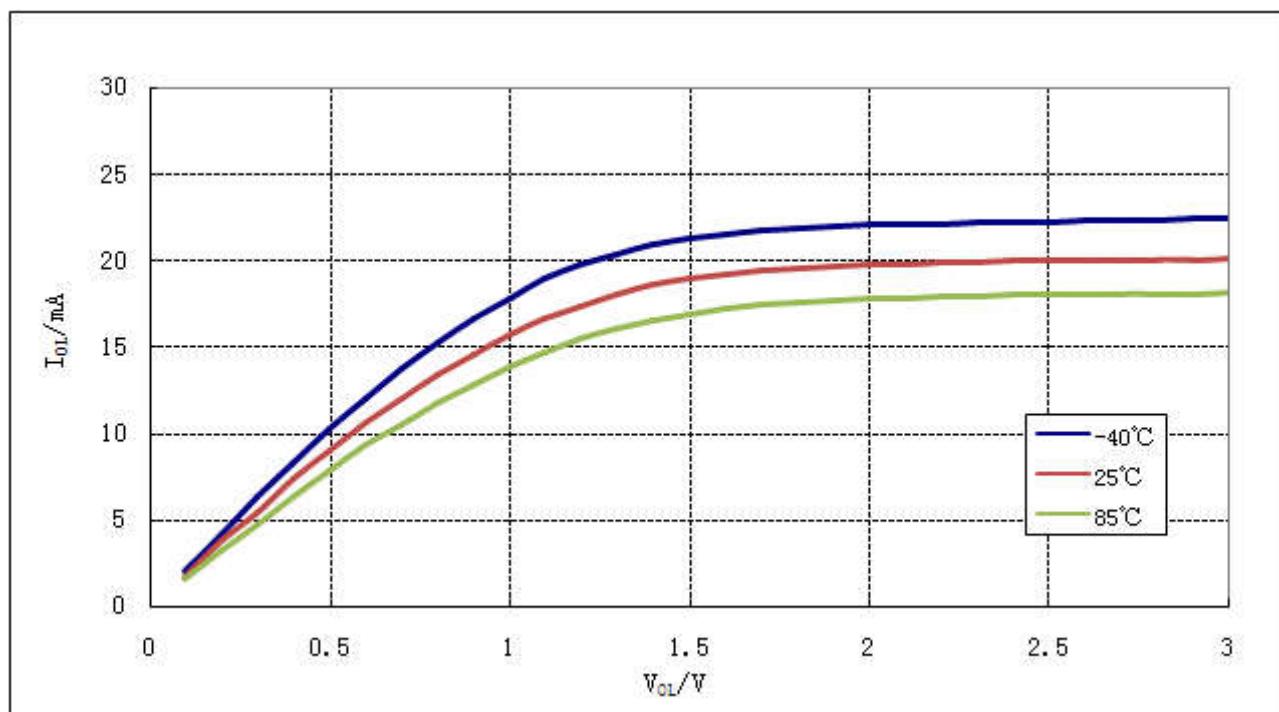
Sink current of P0.5 @V_{DD}=3.0V
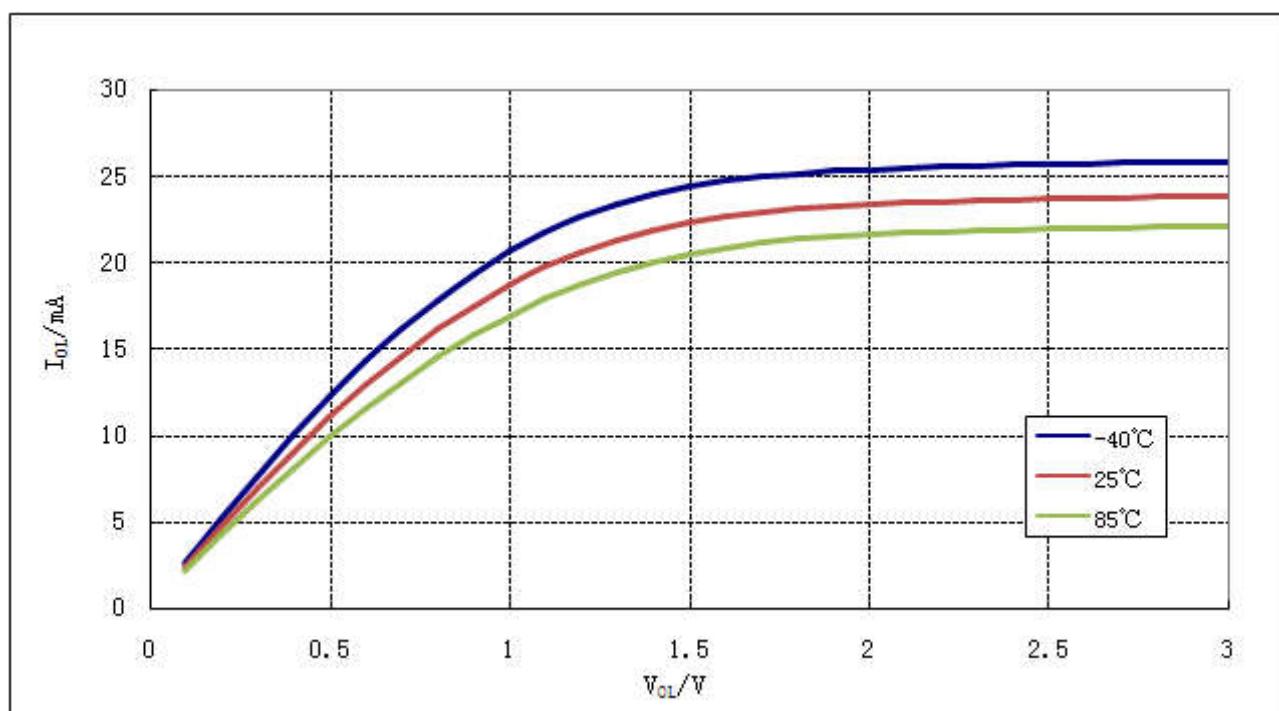
Sink current of IO except P0.5 @V_{DD}=3.0V
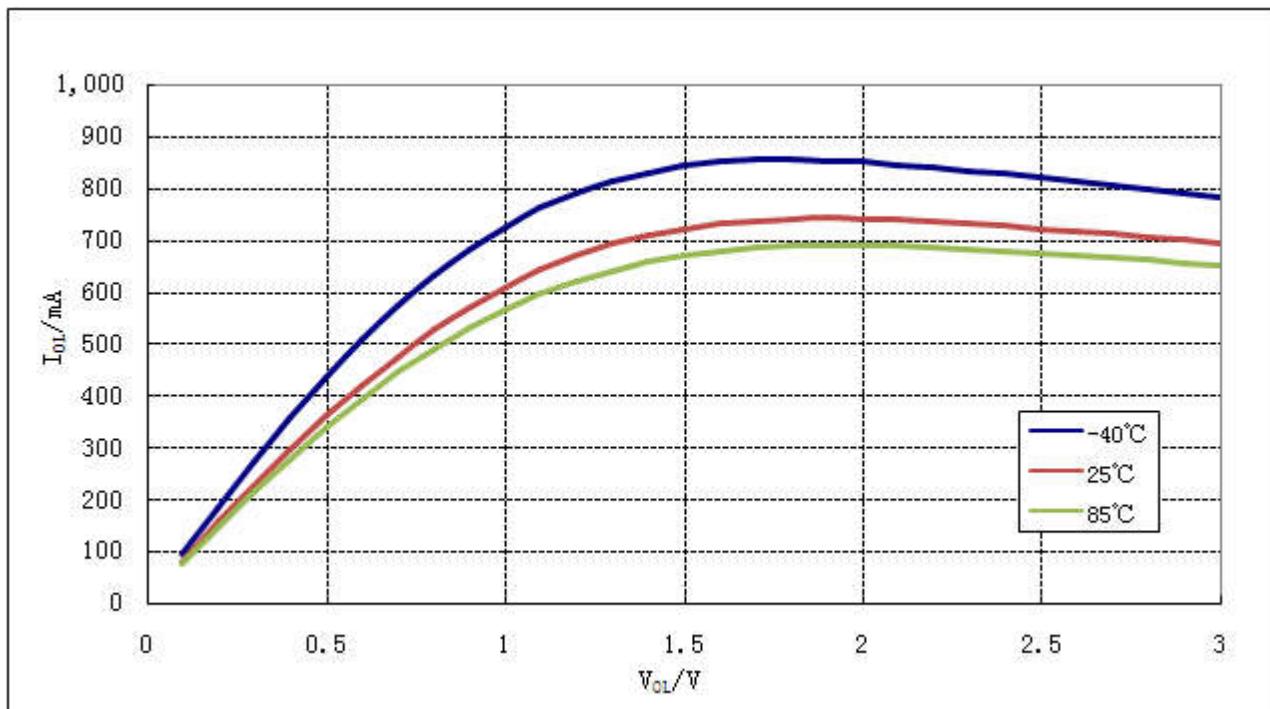
Sink current of TR low level @V_{DD}=3.0V
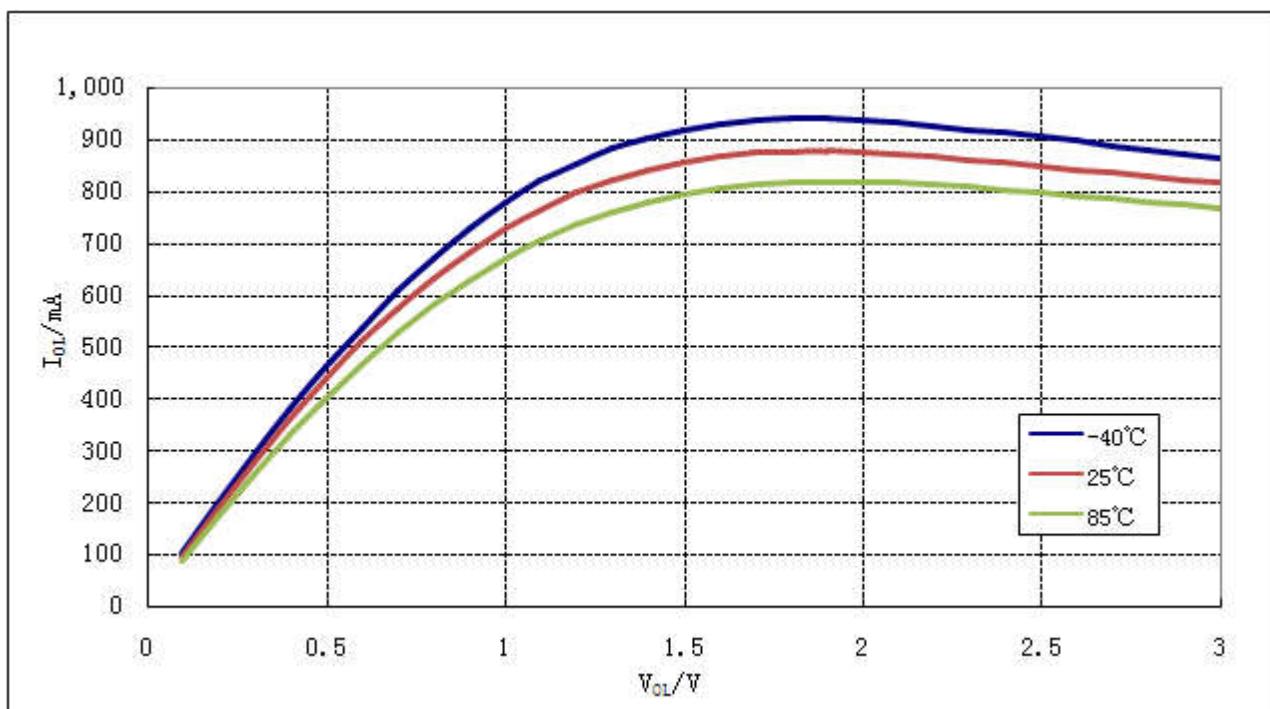
Sink current of TR high level @V_{DD}=3.0V

PACKAGE OUTLINE

SOP-8-225-1.27			UNIT: mm
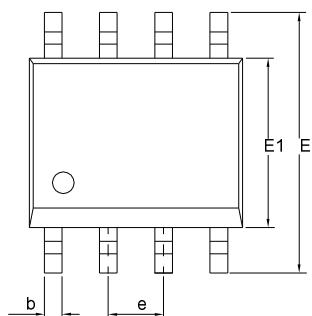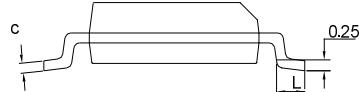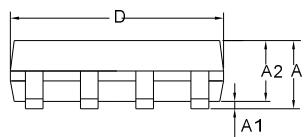
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	1.35	1.55	1.75
A1	0.05	0.15	0.25
A2	1.25	--	1.65
b	0.32	0.42	0.52
c	0.15	0.2	0.26
D	4.70	4.90	5.30
E	5.60	6.00	6.40
E1	3.60	3.90	4.20
e	1.27BSC		
L	0.30	—	1.27

CAUTION
ELECTROSTATIC
SENSITIVE DEVICE
DO NOT OPEN OR HANDLE
EXPECT AT A STATIC-FREE
WORKSTATION

MOS DEVICES OPERATE NOTES:

Electrostatic charges may exist in many things. Please take following preventive measures to prevent effectively the MOS electric circuit as a result of the damage which is caused by discharge:

● The operator must put on wrist strap which should be earthed to against electrostatic.

● Equipment cases should be earthed.

● All tools used during assembly, including soldering tools and solder baths, must be earthed.

● MOS devices should be packed in antistatic/conductive containers for transportation.

Disclaimer :

• **Silan reserves the right to make changes to the information herein for the improvement of the design and performance without prior notice! Customers should obtain the latest relevant information before placing orders and should verify that such information is complete and current.**

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• **Silan will supply the best possible product for customers!**

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Rev.:   1.0

Revision History:

1.   First release