SGM4593
Low Voltage 16-Bit I^{2}C and SMBus Low-Power I/O Expander

GENERAL DESCRIPTION

The SGM4593 is a general-purpose parallel input and output (I/O) expander device, which consists of two lanes and 8 bits parallel I/O expansion. The device communicates with processor through two-line bidirectional I^{2}C bus (or SMBus), supporting I^{2}C standard mode (100kHz) and I^{2}C fast mode (400kHz) clock frequency. The SGM4593 provides a simple solution for the devices that need additional I/Os, such as LEDs, buttons, sensors, etc.

The SGM4593 can select device address by the A0, A1 and A2 pins. The SGM4593 features an interrupt generated on the nINT pin whenever the state of input port changes. An output anomaly may also be indicated by the nINT pin when the corresponding Output Anomaly Indication port register is set to 1 and the device is in push-pull output mode. The SGM4593 can cycle the power supply and cause a power-on reset to reset itself to the default state.

The SGM4593 is available in Green TSSOP-24 and TQFN-4×4-24FL packages and supports -40℃ to +125℃ temperature range.

FEATURES

- 1.65V to 5.5V Input Voltage Range
- Parallel I^{2}C I/O Expander
- 5V Tolerant Input and Output Ports
- Active Low Interrupt Output
- Support 400kHz I^{2}C Fast Mode
- Internal Power-on Reset
- No Glitch on Power-up
- Polarity Inversion Register
- Compatible with Most Processors
- Select Device Address by Three Pins (up to Eight Devices)
- Latched Outputs Drive LEDs Directly
- Latch-up Performance (> 100mA) to Meet JESD 78, Class II Standard
- -40℃ to +125℃ Operating Temperature Range
- Available in Green TSSOP-24 and TQFN-4×4 -24FL Packages

APPLICATIONS

I^{2}C GPIO Expansion
Industrial, Factory, Building, Test and Measurement
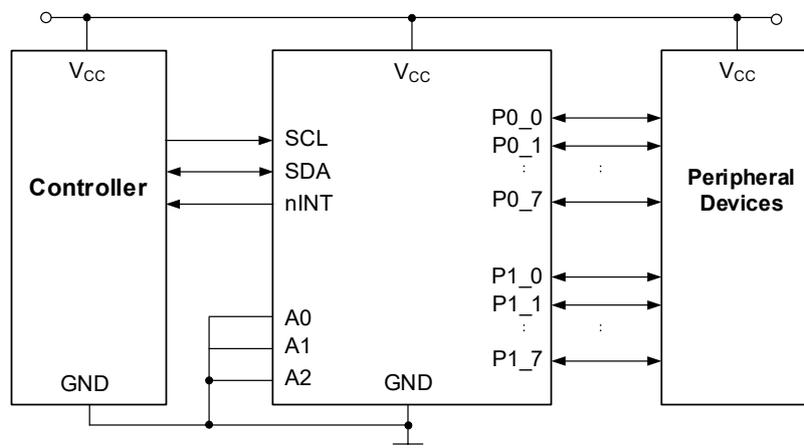
TYPICAL APPLICATION

Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM4593	TSSOP-24	-40℃ to +125℃	SGM4593XTS24G/TR	SGM4593 XTS24 XXXXX	Tape and Reel, 4000
	TQFN-4×4-24FL	-40℃ to +125℃	SGM4593XTXD24G/TR	SGM4593 XTXD24 XXXXX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XXXXX = Date Code, Trace Code and Vendor Code.

X X X X X
- Vendor Code
- Trace Code
- Date Code - Year

Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage Range, V_{CC} .... -0.5V to 6V
Input Voltage Range [(1)], V_I .... -0.5V to 6V
Output Voltage Range [(1)], V_O .... -0.5V to 6V
Input Clamp Current, I_{IK} (V_I < 0V) .... -20mA
Output Clamp Current, I_{OK} (V_O < 0V) .... -20mA
Input-Output Clamp Current, I_{IOK} (V_O < 0V or V_O > V_{CC})
.... ±20mA
Continuous Output Low Current, I_{OL} (V_O = 0V to V_{CC}) .. 50mA
Continuous Output High Current, I_{OH} (V_O = 0V to V_{CC}) -50mA
Continuous Current through GND .... -250mA
Continuous Current through V_{CC} 160mA
Package Thermal Resistance
    TSSOP-24, θ_{JA} .... 84℃/W
    TSSOP-24, θ_{JB} .... 52.8℃/W
    TSSOP-24, θ_{JC} .... 33.2℃/W
    TQFN-4×4-24FL, θ_{JA} .... 45.4℃/W
    TQFN-4×4-24FL, θ_{JB} .... 23.2℃/W
    TQFN-4×4-24FL, $\theta_{JC (TOP)}$ .... 35.6℃/W
    TQFN-4×4-24FL, $\theta_{JC (BOT)}$ .... 12.1℃/W
Junction Temperature ....+150℃
Storage Temperature Range .... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ....+260℃
ESD Susceptibility [(2) (3)]
HBM ....±4000V
CDM ....±1000V

NOTES:

1. When the input and output current ratings are observed, the input and I/O negative voltage ratings may be exceeded.

2. For human body model (HBM), all pins comply with ANSI/ESDA/JEDEC JS-001 specifications.

3. For charged device model (CDM), all pins comply with ANSI/ESDA/JEDEC JS-002 specifications.

RECOMMENDED OPERATING CONDITIONS

Supply Voltage Range, V_{CC}............................. 1.65V to 5.5V
I/O Ports Voltage Range, $V_{I/O}$
    SCL, SDA, A0, A1, A2, nINT .... -0.5V to 5.5V
    For P0_7-0, P1_7-0 Configured as Outputs .... -0.5V to 5.5V
    For P0_7-0, P1_7-0 Configured as Inputs .... -0.5V to 5.5V
High-Level Input Voltage Range, V_{IH}
    SCL, SDA, A0, A1, A2, P0_7-0, P1_7-0 .... 0.65 × V_{CC} (MIN)
Low-Level Input Voltage, V_{IL}
    SCL, SDA, A0, A1, A2, P0_7-0, P1_7-0 ... 0.35 × V_{CC} (MAX)
High-Level Output Current, I_{OH} (P0_7-0, P1_7-0)
    .... -10mA (MAX)
Low-Level Output Current, I_{OL} (P0_7-0, P1_7-0)
    T_J ≤ +65℃ ....25mA (MAX)
    T_J = +85℃ ....18mA (MAX)
    T_J = +105℃ ....9mA (MAX)
    T_J = +125℃ ....4.5mA (MAX)
    T_J = +135℃ ....3.5mA (MAX)
Low-Level Output Current, I_{OL} (nINT, SDA)
    T_J ≤ +85℃ ....6mA (MAX)
    T_J = +105℃ ....3mA (MAX)
    T_J = +125℃ ....1.8mA (MAX)
    T_J = +135℃ ....1.5mA (MAX)
Operating Ambient Temperature Range ..... -40℃ to +125℃

ESD SENSITIVITY CAUTION

This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

PIN CONFIGURATIONS

(TOP VIEW)

TSSOP-24

(TOP VIEW)

TQFN-4×4-24FL
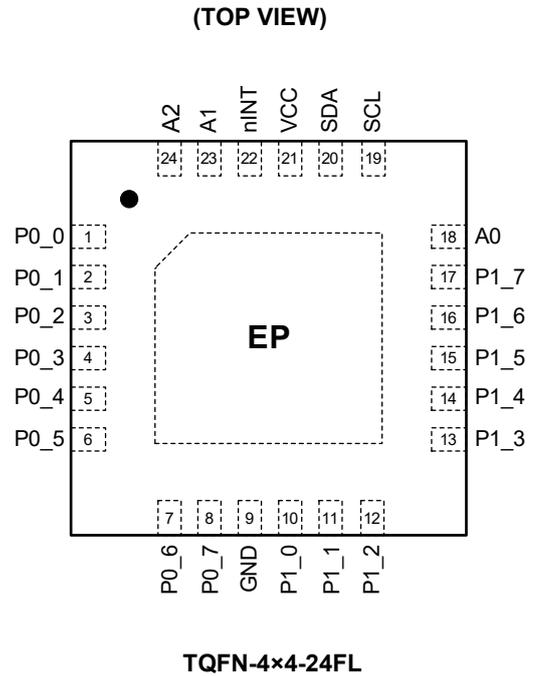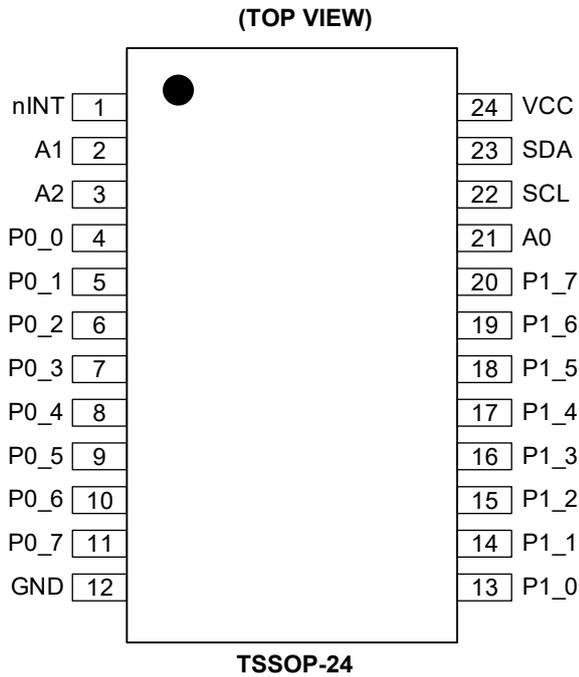
PIN DESCRIPTION

PIN		NAME	TYPE	DESCRIPTION
TSSOP-24	TQFN-4×4-24 FL			
1	22	nINT	O	Open-Drain Output Pin. A pull-up resistor is used to connect to V_{CC}.
2	23	A1	I	Analog Input A1. Connected to V_{CC} or GND.
3	24	A2	I	Analog Input A2. Connected to V_{CC} or GND.
4-11	1-8	P0_0-7	I/O	P0_0 to P0_7 of Port 0 Input/Output. Default as an input at power-on.
12	9	GND	G	Ground.
13-20	10-17	P1_0-7	I/O	P1_0 to P1_7 of Port 1 Input/Output. Default as an input at power-on.
21	18	A0	I	Analog Input A0. Connected to V_{CC} or GND.
22	19	SCL	I	Clock Signal.
23	20	SDA	I/O	Data Signal.
24	21	VCC	P	Supply Voltage.
—	Exposed Pad	EP	—	Thermal Pad. It can be connected to GND or be left floating. This pad is not an electrical connection point.

NOTE: I = input, O = output, I/O = input/output, P = power, G = ground.

TEST CIRCUIT
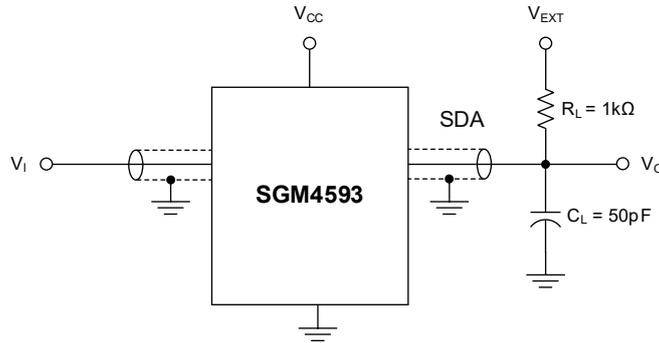
Figure 2. I^{2}C Interface Load Circuit

NOTES:

1. R_L refers to load resistance. C_L refers to load capacitance (includes jig and probe).

2. All inputs are supplied by generators featured by: PRR ≤ 10MHz, Z_O = 50Ω, t_R/t_F ≤ 30ns.
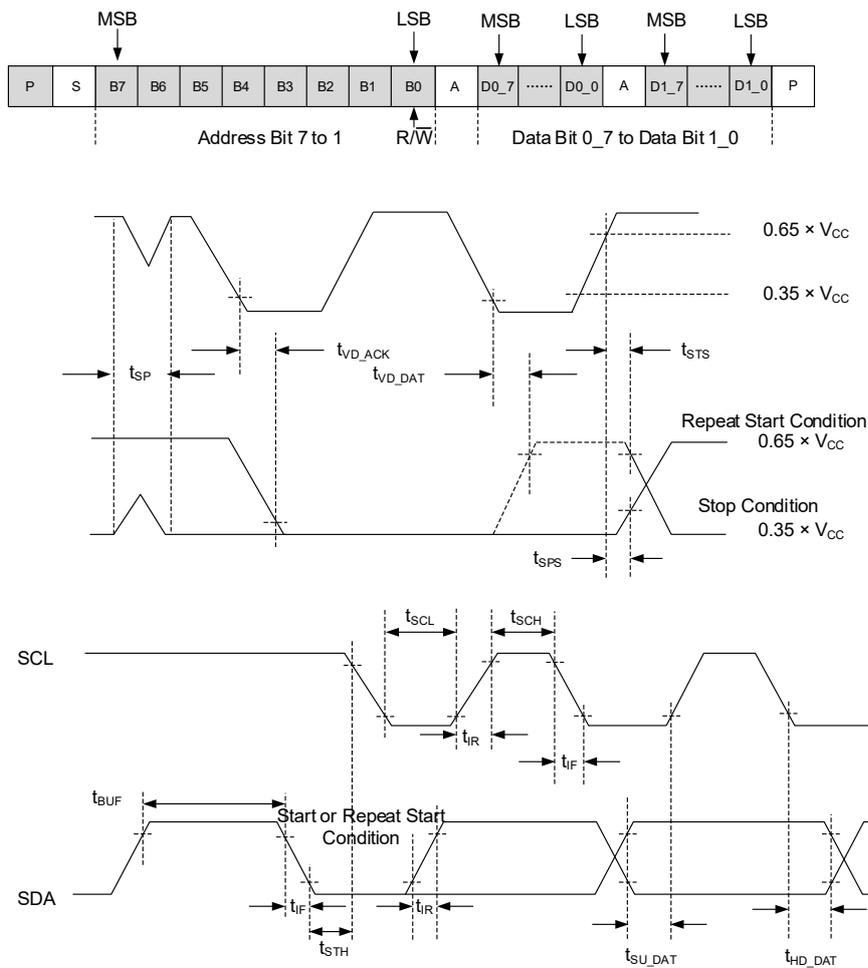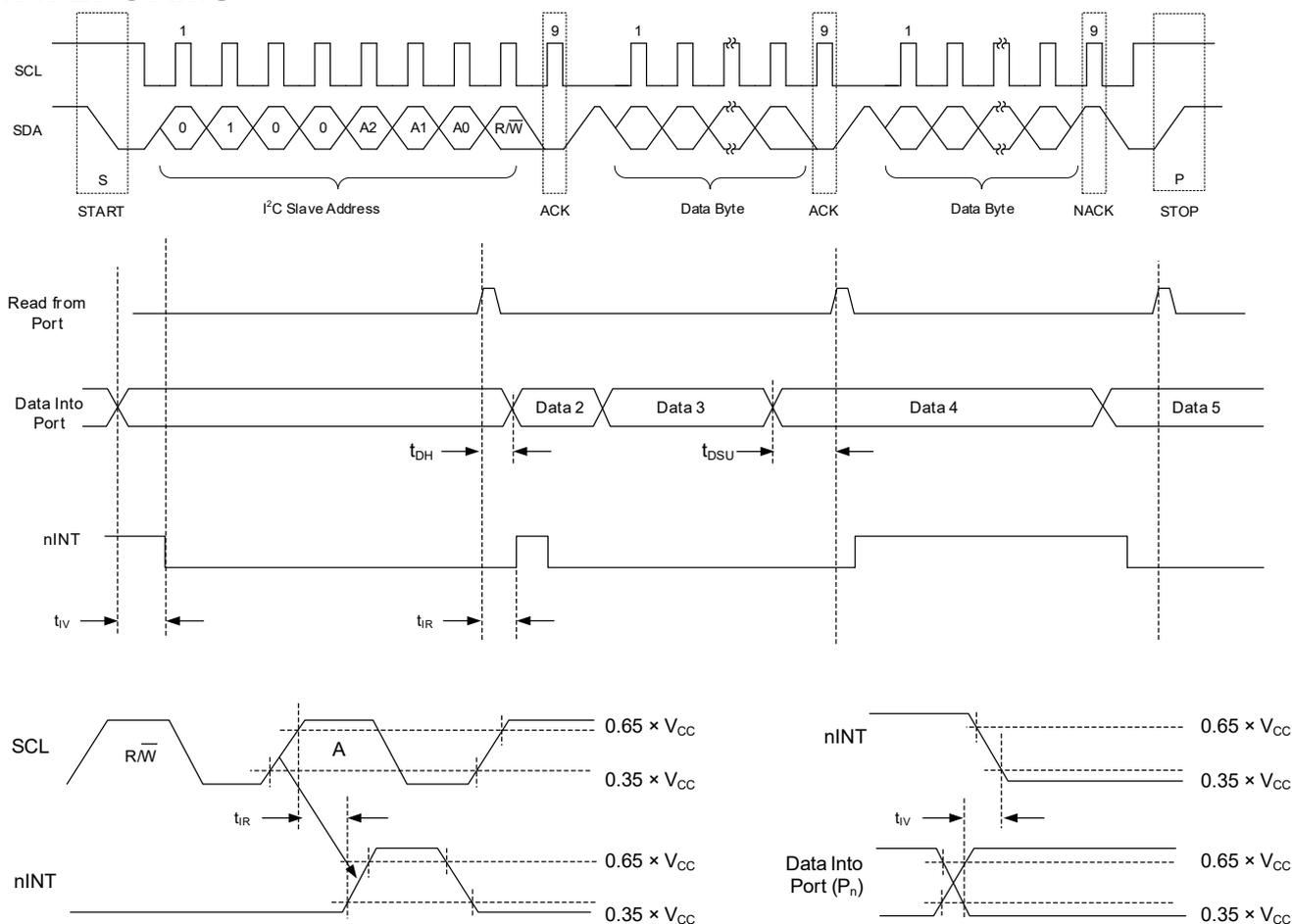
WAVEFORMS

Byte	Description
1	I^{2}C Address
2, 3	P-Port Data

Figure 3. I^{2}C Interface Voltage Waveforms

TEST CIRCUIT (continued)
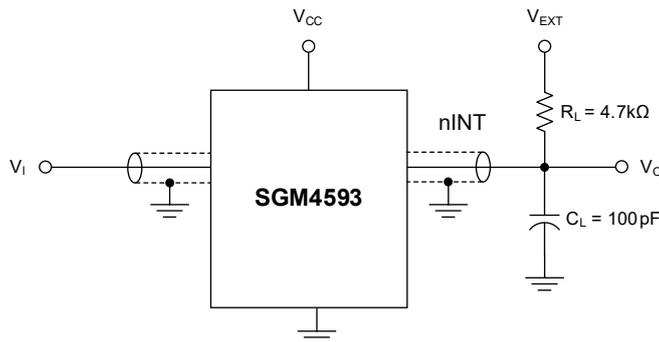
Figure 4. Interrupt Load Circuit

NOTES:

1. R_L refers to load resistance. C_L refers to load capacitance (includes jig and probe).

2. All inputs are supplied by generators featured by: PRR ≤ 10MHz, Z_O = 50Ω, t_R/t_F ≤ 30ns.

WAVEFORMS

Figure 5. Interrupt Voltage Waveforms

TEST CIRCUIT (continued)
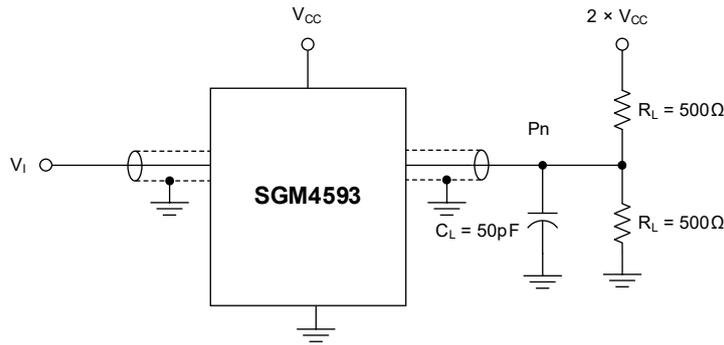
Figure 6. P-Port Load Circuit

NOTES:

1. R_L refers to load resistance. C_L refers to load capacitance (includes jig and probe).

2. All inputs are supplied by generators featured by: PRR ≤ 10MHz, Z_O = 50Ω, t_R/t_F ≤ 30ns.

3. t_{VD} is measured from 0.65 × V_{CC} on SCL to 50% I/O (P_n) output.

4. The outputs are measured one by one with a transition every measurement.

WAVEFORMS
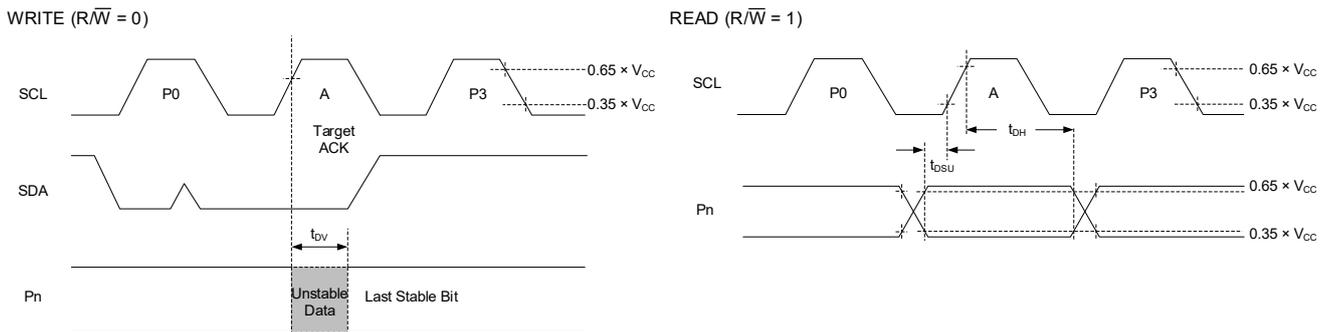
Figure 7. P-Port Voltage Waveforms

FUNCTIONAL BLOCK DIAGRAM
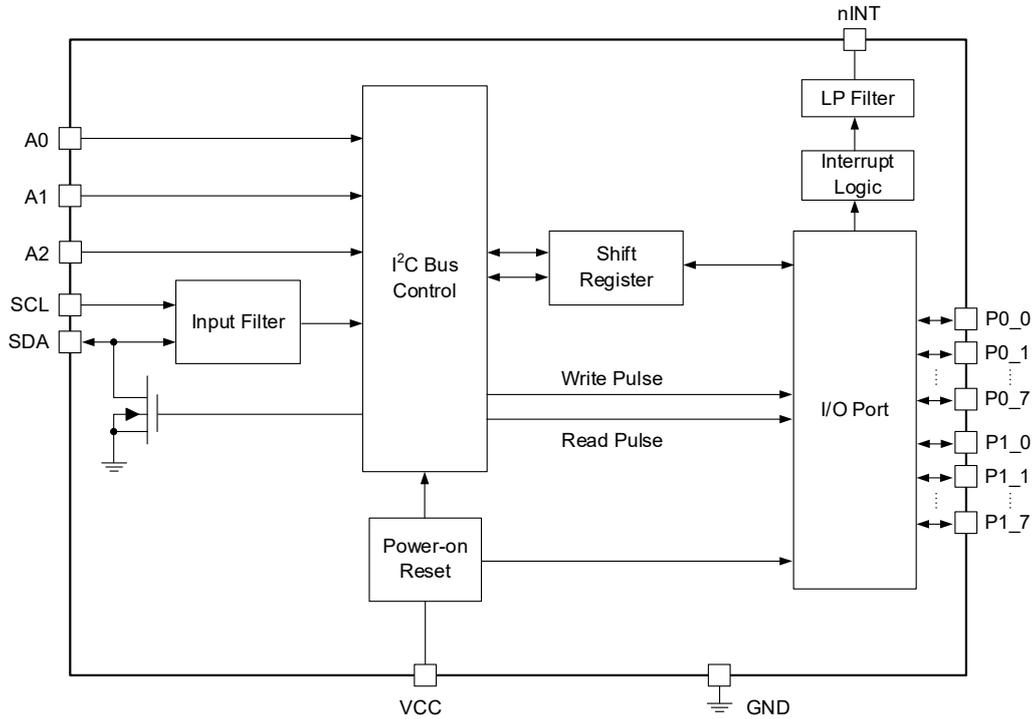
NOTE: All I/Os are set as inputs when reset.

Figure 8. Block Diagram (Positive Logic)
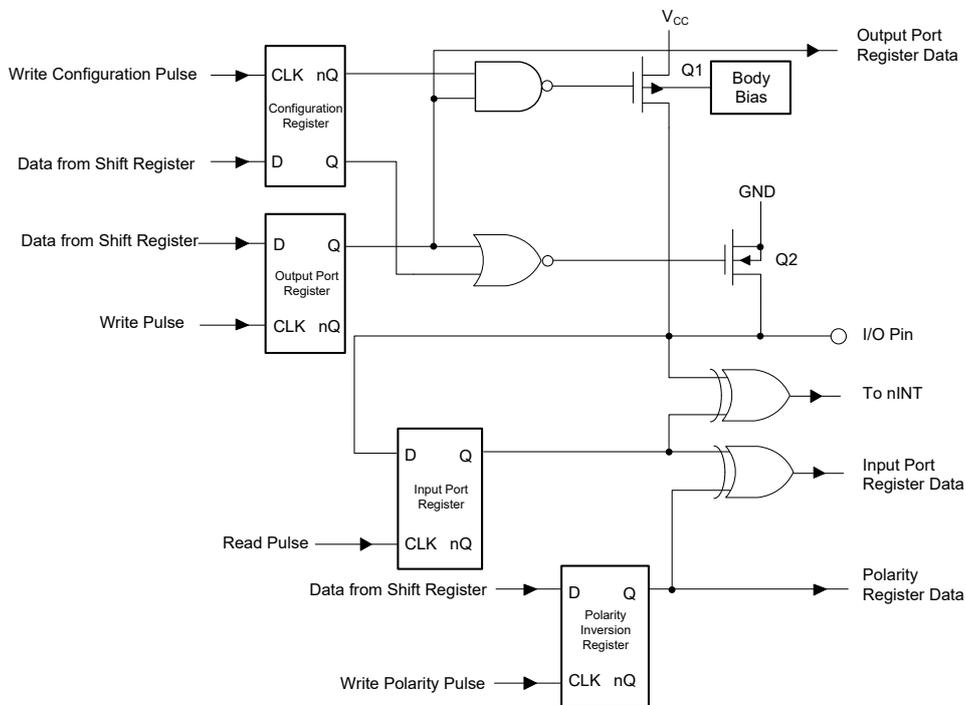
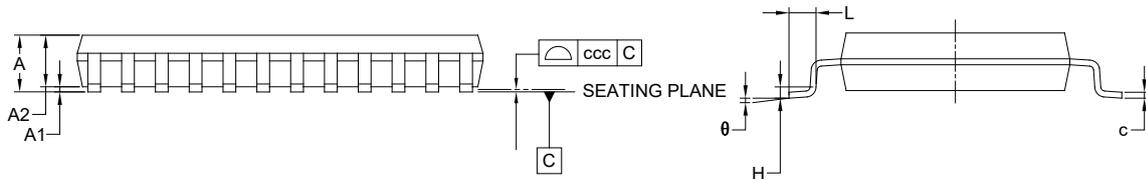NOTE: At power-on reset, all registers return to default values.

Figure 9. Simplified Schematic of P-Port Inputs or Outputs

PACKAGE OUTLINE DIMENSIONS
TSSOP-24

5.94

1.78

0.42

0.65

RECOMMENDED LAND PATTERN (Unit: mm)

SEATING PLANE

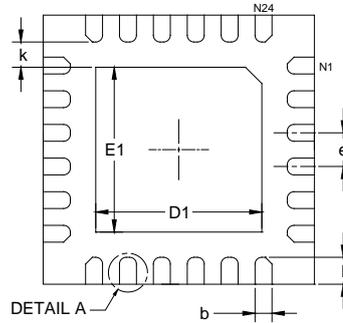| Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	-	-	1.200
A1	0.050	-	0.150
A2	0.800	-	1.050
b	0.190	-	0.300
c	0.090	-	0.200
D	7.700	-	7.900
E	4.300	-	4.500
E1	6.200	-	6.600
e	0.650 BSC		
L	0.450	-	0.750
H	0.250 TYP		
θ	0°	-	8°
ccc	0.100		

NOTES:
1. This drawing is subject to change without notice.
2. The dimensions do not include mold flashes, protrusions or gate burrs.
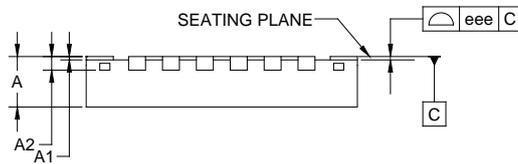3. Reference JEDEC MO-153.
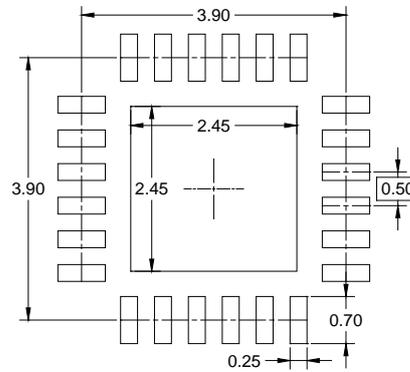
PACKAGE OUTLINE DIMENSIONS

TQFN-4×4-24FL
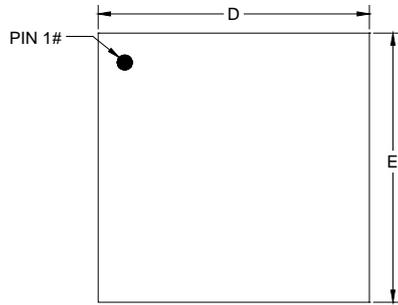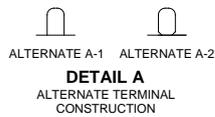

TOP VIEW

BOTTOM VIEW

SIDE VIEW

ALTERNATE A-1   ALTERNATE A-2

DETAIL A
ALTERNATE TERMINAL
CONSTRUCTION

RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	0.700	-	0.800
A1	0.000	-	0.050
A2	0.203 REF		
b	0.180	-	0.300
D	3.900	-	4.100
D1	2.350	-	2.550
E	3.900	-	4.100
E1	2.350	-	2.550
e	0.500 BSC		
k	0.375 REF		
L	0.300	-	0.500
eee	0.080		

NOTE: This drawing is subject to change without notice.

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TAPE AND REEL INFORMATION

REEL DIMENSIONS

TAPE DIMENSIONS
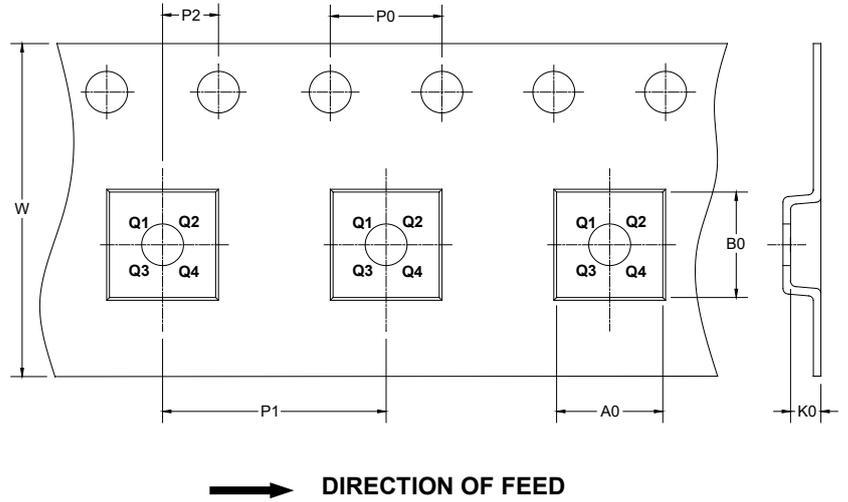
DIRECTION OF FEED

NOTE: The picture is only for reference. Please make the object as the standard.
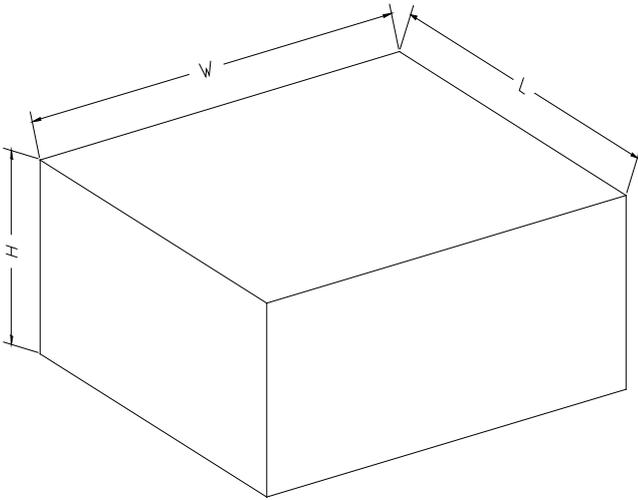
KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
TSSOP-24	13"	16.4	6.80	8.30	1.60	4.0	8.0	2.0	16.0	Q1
TQFN-4×4-24FL	13"	12.4	4.30	4.30	1.10	4.0	8.0	2.0	12.0	Q2

DD0001

CARTON BOX DIMENSIONS

NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
13″	386	280	370	5

DD0002

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