8:1, 1-Channal, 4:1, 2-Channal CMOS ANALOG SIGNAL MULTIPLEXERS/DEMULTIPLEXERS

General Description

The QM4051 is a CMOS analog IC configured as an 8:1,1-channel multiplexer which with the low-power consumption. The QM4052 is an 4:1, 2-channel multiplexer. The QM405X can operate from 2.5V to 5.5V single supplies. And each switch can handle rail-to-rail analog signals. It is also guaranteed On-Resistance 48Ω(TYP) with 5V supply.

The QM405X features a low On-Resistance flatness (15Ω TYP) and low On-Resistance matching between channels (1.5Ω TYP). The off-leakage current is less then 1nA (TYP) at +25°C.

It is capable of operating over an ambient temperature range of -40°C to +125°C.The QM405X is available in Green SOP16 and TSSOP16 packages.

Features and Benefits

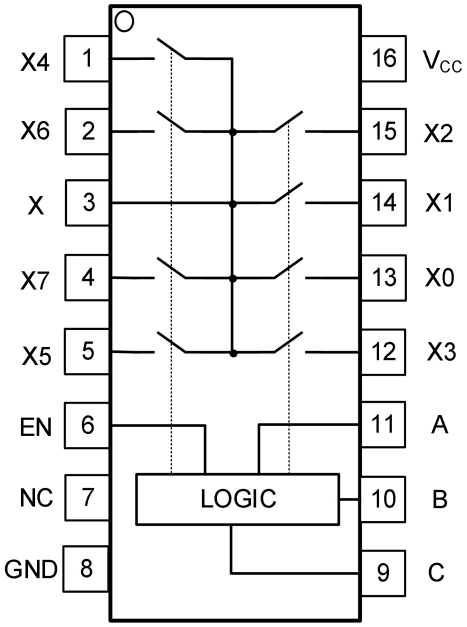
- Fast Switching and Propagation Speeds
- Low On-Resistance：48Ω (TYP)
- Low On-Resistance Match Between Channels
- 2.5V to 5.5V Single Supply Operation
- Low power consumption
- TTL/CMOS-Logic Compatible
- Rail-to-Rail Signal Handling
- Break-Before-Make Switching
- High Channel Off Feedthrough: - 90dB
- Operating Temperature Range: - 40˚C to +125˚C
- Enhanced ESD Protection on All Inputs/Outputs
- These are Pb-Free Devices

Applications

- Automotive
- Sensor
- Communications Circuits
- Audio and Video Signal Routing
- Low-Voltage Data-Acquisition Systems
- Battery-Operated Equipment
- Appliances
- Signal Gating
- Factory Automation

Function Diagram

QM4051

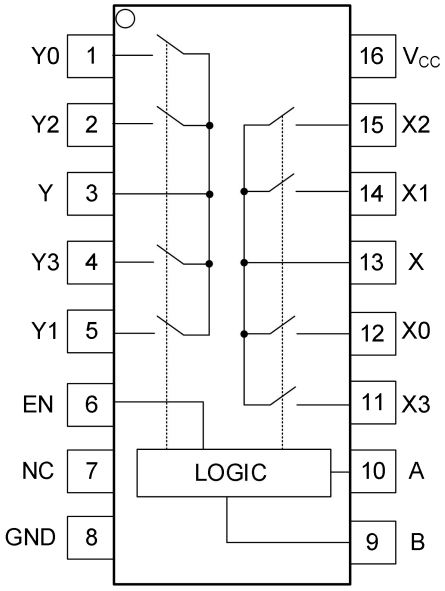


SOP16/TSSOP16

Function Description

QM4051 Control Inputs				ON Channels
EN	Select			
	C	B	A	
L	L	L	L	X0
L	L	L	H	X1
L	L	H	.L	X2
L	L	H	H	X3
L	H	L	L	X4
L	H	L	H	X5
L	H	H	L	X6
L	H	H	H	X7
H	X	X	X	NONE

QM4052



SOP16/TSSOP16

QM4052 Control Inputs			ON Channels
EN	Select		
	B	A	
L	L	L	X0/Y0
L	L	H	X1/Y1
L	H	L	X2/Y2
L	H	H	X3/Y3
H	X	X	NONE

X = Don't Care

Recommended Operating Conditions

Parameter	Min	Max	Unit
Supply Voltage Range	2.5	5.5	V
Operating Temperature Range	-40	125	℃

Ordering Information

Model	Part Number	Package	Container, Pack Qty
QM4051	QM4051D	SOP16	Reel, 4000
QM4051	QM4051PW	TSSOP16	Reel, 4000
QM4052	QM4052D	SOP16	Reel, 4000
QM4052	QM4052PW	TSSOP16	Reel, 4000

Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) (1)

Parameter	Min	Max	Unit
V_{CC} to GND	-0.3	6	V
Voltage into Any Terminal	-0.3	V_{CC} + 0.3	V
Junction Temperature		150	℃
Storage Temperature Range	-65	150	℃
Lead Temperature (Soldering, 10s)		260	℃
ESD Susceptibility HBM		±6000	V
ESD Susceptibility CDM		±2000	V
Continuous Current into Any Terminal	-20	+20	mA
Peak Current, X_ (Pulsed at 1ms, 10% Duty Cycle)	-40	+40	mA

(1) Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ESD CAUTION

ESD (electrostatic discharge) sensitive device

Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjects to high energy ESD. Therefore, proper ESD precautions should be taken to avoid

Electrical Characteristics: V_S = +2.5V to +5.5V

Boldface limits apply over the specified temperature range, **T_A = −40℃ to +125℃**.

At T_A = +25℃, V_{CC} = 5.0V (unless otherwise noted)

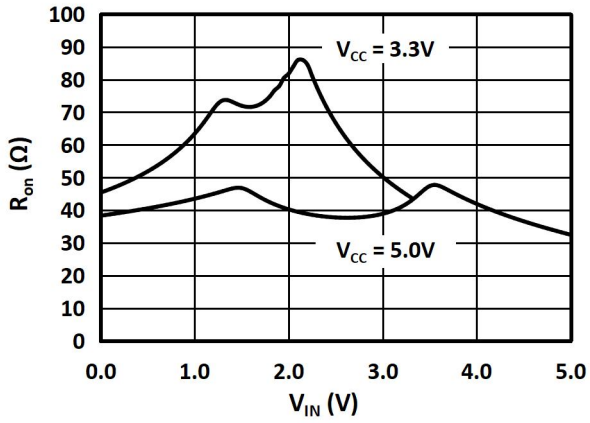
Parameter		Test Conditions	Min	Typ	Max	Unit
Power Supply						
V_{CC}	Power Supply Range	**T_A = −40℃ to +125℃**	**2.5**		**5.5**	**V**
I_{CC}	Power Supply Current	V_{CC} = 5.0V, V_A, V_B, V_C, V_{EN} = V_{CC} or 0V		0.001	6	μA
		V_{CC} = 3.3V, V_A, V_B, V_C, V_{EN} = V_{CC} or 0V			4	μA
Analog Switch						
V_X, $V_{X\_}$	Analog Signal Range		GND		V_{CC}	V
R_{ON}	On-Resistance	V_{CC} = 5.0V, I_X = 1mA		48	60	Ω
		T_A = −40℃ to +125℃			**70**	**Ω**
		V_{CC} = 3.3V, I_X = 1mA		85	110	Ω
		T_A = −40℃ to +125℃			**125**	**Ω**
$\triangle R_{ON}$	On-Resistance Match Between Channels	I_X = 1mA		0.5	4	Ω
		T_A = −40℃ to +125℃			**5**	**Ω**
$R_{FLAT(ON)}$	On-Resistance Flatness	I_X = 1mA		15	22	Ω
		T_A = −40℃ to +125℃			**28**	**Ω**
$I_{X\_(OFF)}$	X_ Off Leakage Current	$V_{X\_}$ = 4.5V or 0V, V_X = 4.5V or 0V		±0.001	±1	μA
$I_{X(OFF)}$	X Off Leakage Current	$V_{X\_}$ = 4.5V or 0V, V_X = 4.5V or 0V		±0.001	±1	μA
$I_{X(ON)}$	X On Leakage Current	V_X = 4.5V or 0V		±0.001	±1	μA
Digital I/O						
V_{IH}	High-level input voltage		1.7			V
V_{IL}	Low-level input voltage				0.5	V
I_{AH}, I_{BH}, I_{CH}, I_{EN}	Input-Current High	V_A, V_B, V_C, V_{EN} = V_{CC}		1	1000	nA
I_{AL}, I_{BL}, I_{CL}, I_{EN}	Input-Current Low	V_A, V_B, V_C, V_{EN} = 0V		1	1000	nA
Dynamic Characteristics						
t_{TRANS}	Address Transition Time	$V_{X\_}$ = V_{CC} or 0V, R_L = 300Ω, C_L = 35pF		55		ns
t_{ON}	EN Turn-On Time	$V_{X\_}$ = V_{CC} or 0V, R_L = 300Ω, C_L = 35pF		30		ns
t_{OFF}	EN Turn-Off Time	$V_{X\_}$ = V_{CC} or 0V, R_L = 300Ω, C_L = 35pF		40		ns
t_{pd}	Analog channel signal delay	R_L = 300Ω, C_L = 35pF		2		ns
t_D	Break-Before-Make Time Delay	$V_{X\_}$ = V_{CC}, R_L = 300Ω, C_L = 35pF, Test Circuit 4		50		ns
Q	Charge Injection	C_L = 1nF, Test Circuit 3		5		pC
	Channel Off Feedthrough	R_L = 50Ω, C_L = 10pF, f = 1MHz, Test Circuit 6		-90		dB
$C_{X\_(OFF)}$	X_ Off-Capacitance (QM4051)	$V_{X\_}$ = 0V, f = 1MHz, Test Circuit 1		3		pF
	X_ Off-Capacitance (QM4052)	$V_{X\_}$ = 0V, f = 1MHz, Test Circuit 1		3		pF
$C_{X(OFF)}$	X Off-Capacitance (QM4051)	$V_{X\_}$ = 0V, f = 1MHz, Test Circuit 1		8		pF
	X Off-Capacitance (QM4052)	$V_{X\_}$ = 0V, f = 1MHz, Test Circuit 1		5		pF
$C_{X(ON)}$	X On-Capacitance (QM4051)	V_{X_Other} = 0V, f = 1MHz, Test Circuit 1		13		pF
	X On-Capacitance (QM4052)	V_{X_Other} = 0V, f = 1MHz, Test Circuit 1		10		pF

BW	-3dB Bandwidth (QM4051)	R_L = 50Ω		180		MHz
	-3dB Bandwidth (QM4052)	R_L = 50Ω		200		MHz
	Feedthrough Noise	R_L = 600Ω, C_L = 50pF, Test Circuit 2		140		mV
		R_L = 10kΩ, C_L = 10pF, Test Circuit 2		160		mV
THD	Total Harmonic Distortion	R_L= 600Ω, $5V_{P-P}$,1kHz, sine, Test Circuit 5		0.1		%

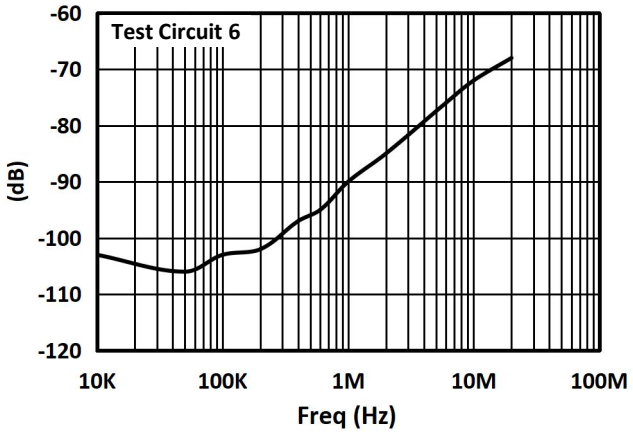
Typical Characteristics:

At T_A = 25°C, V_{CC} = 5.0V (unless otherwise noted)

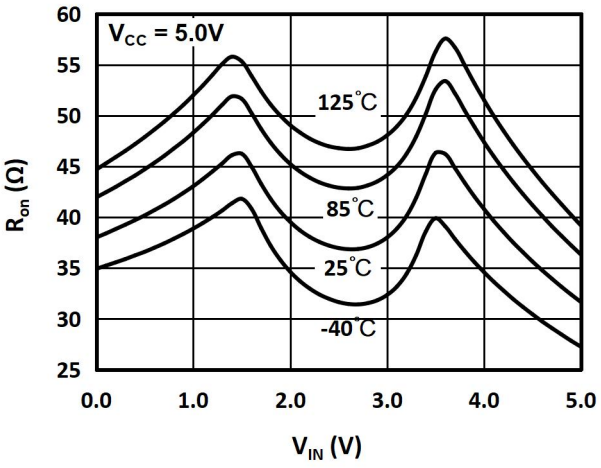
On-Resistence vs Input Voltage



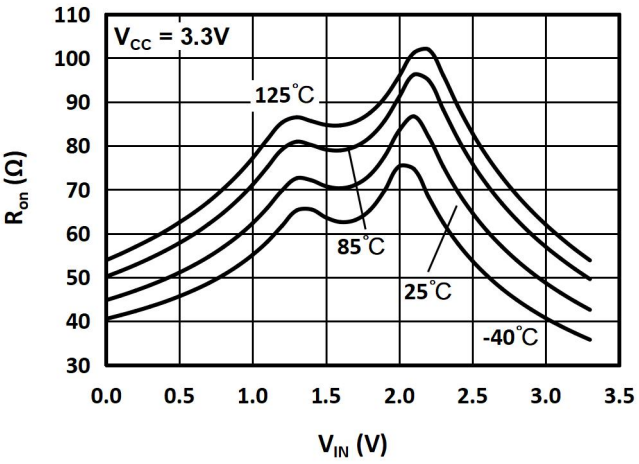
Channel OFF Feedthrough



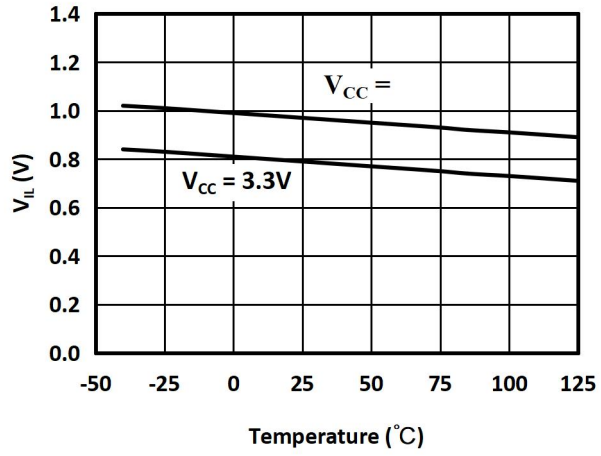
On-Resistence vs Input Voltage



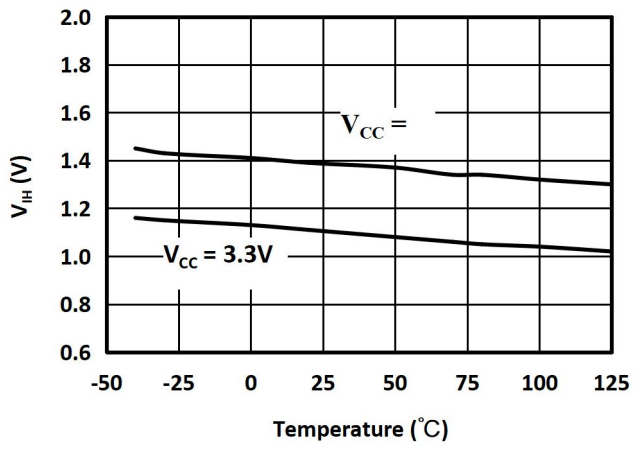
On-Resistence vs Input Voltage



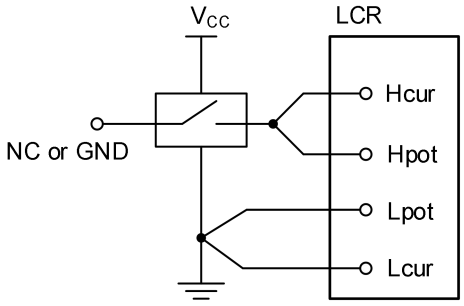
Low-Level Input Voltage vs Temperature



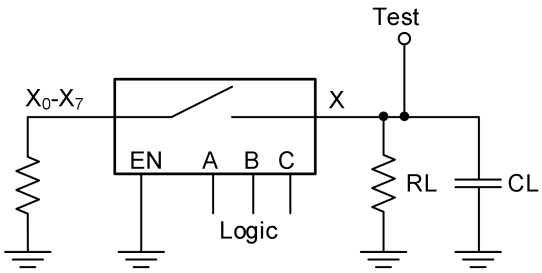
High-Level Input Voltage vs Temperature



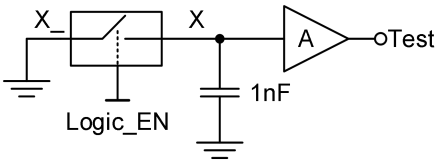
Test Circuit

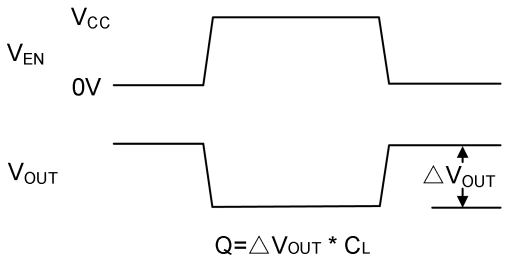


Test Circuit 1. Capacitance

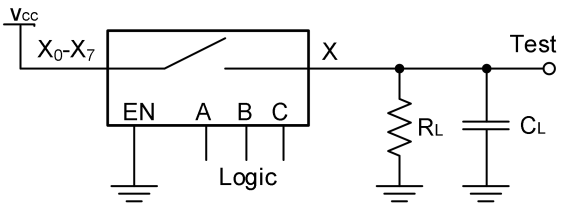


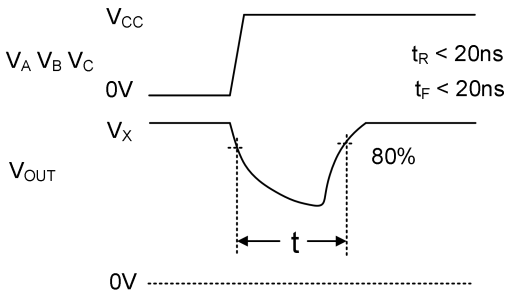
Test Circuit 2. Feedthrough Noise



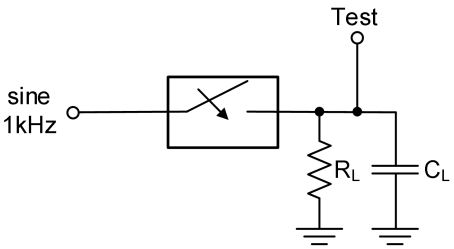


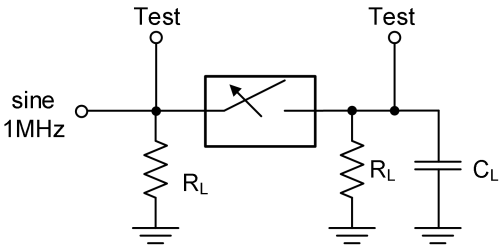
Test Circuit 3. Charge Injection





Test Circuit 4. Break-Before-Make time delay





Test Circuit 5. THD

Test Circuit 6. Channel Off Feedthrough

Application Notes & Additional Details

On-Resistance

The block diagram of a unit inside the device is shown in Figure 1. The device uses PMOS and NMOS in parallel to reduce the on-resistance and improve the flatness index of the on-resistance. When a single PMOS or NMOS is used as a switch, its on-resistance varies when the signal voltage changes. The variation of on-resistance can be reduced by parallel connection. Figure 2 is a plot of the on-resistance change vs. the signal voltage when two devices are used separately as a switch and in parallel connection.

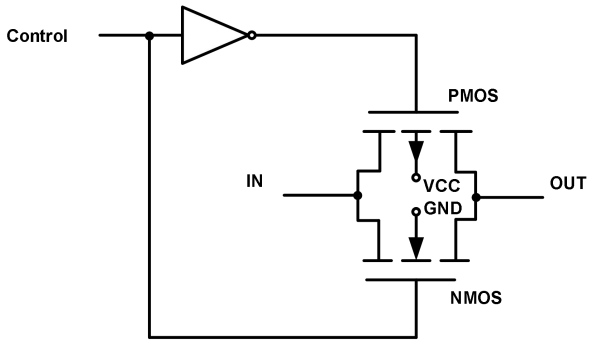


Figure 1. Schematic Diagram of Single Unit of Analog Switch

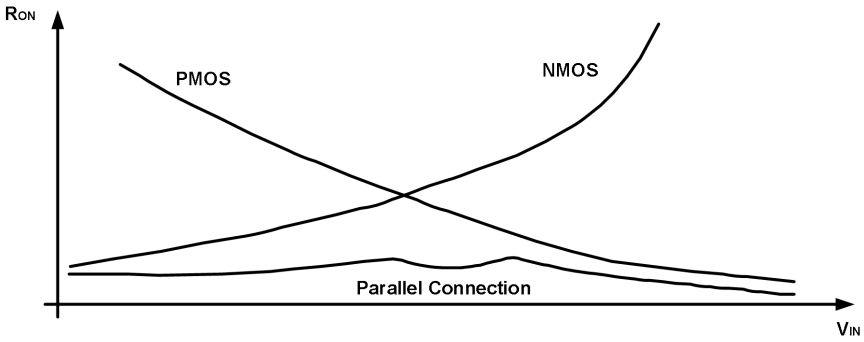


Figure 2. Relationship between On-Resistance and Signal Voltage

Break-Before-Make Time Delay

The function of "Break-Before-Make Time Delay" is to ensure that the two channels will never be in the state of on at the same time when the multiplexer switches from one channel to another. This is a safety function. When channels switch, the current channel turns off first, then another channel turns on after certain delay to prevent short circuit. When connect the input of both channel to V_X and pull down the output of the channel to GND, the behavior shown in figure 3 happens when one channel switches to another.

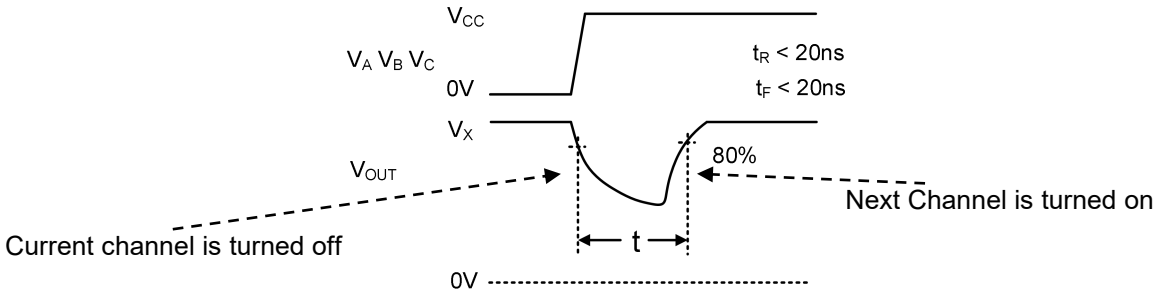


Figure 3. Break-Before-Make Time Delay

Application Notes & Additional Details (Continue)

Typical Application of Polling Keyboard

Figure 4 shows the simplified block diagram of the polling keyboard based on QM4051 and the microcontroller. The microcontroller selects different channel through channel selection pin, reads the key state of each channel and judges whether any key is pressed. Multiple keys can be pressed simultaneously in this configuration. It has the advantages of low power consumption. The disadvantage is that the microcontroller needs to scan the input and output ports frequently.

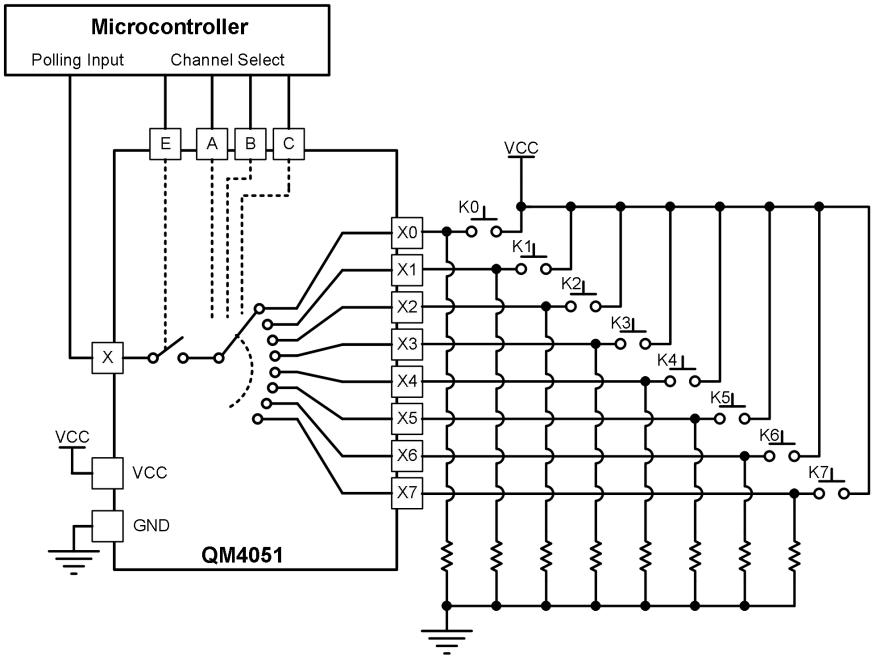


Figure 4. Typical Application of Polling Keyboard

Typical Application of Signal Acquisition System

The device is used for the multiplexing function in the signal acquisition system to achieve multi-channel signal acquisition and can transmit DC voltage signals or AC signals. It can reduce the number of acquisition channel in analog-to-digital converters or signal processing circuits.

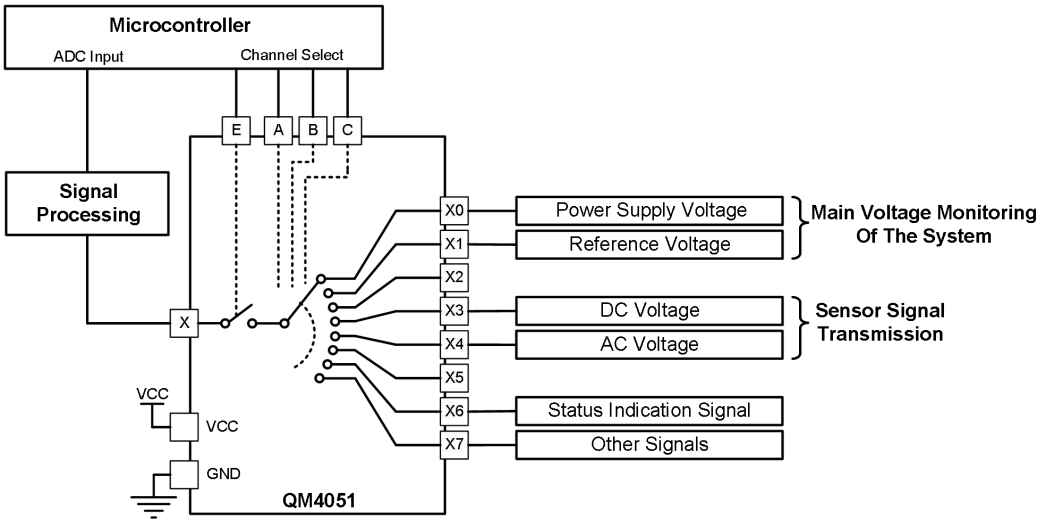
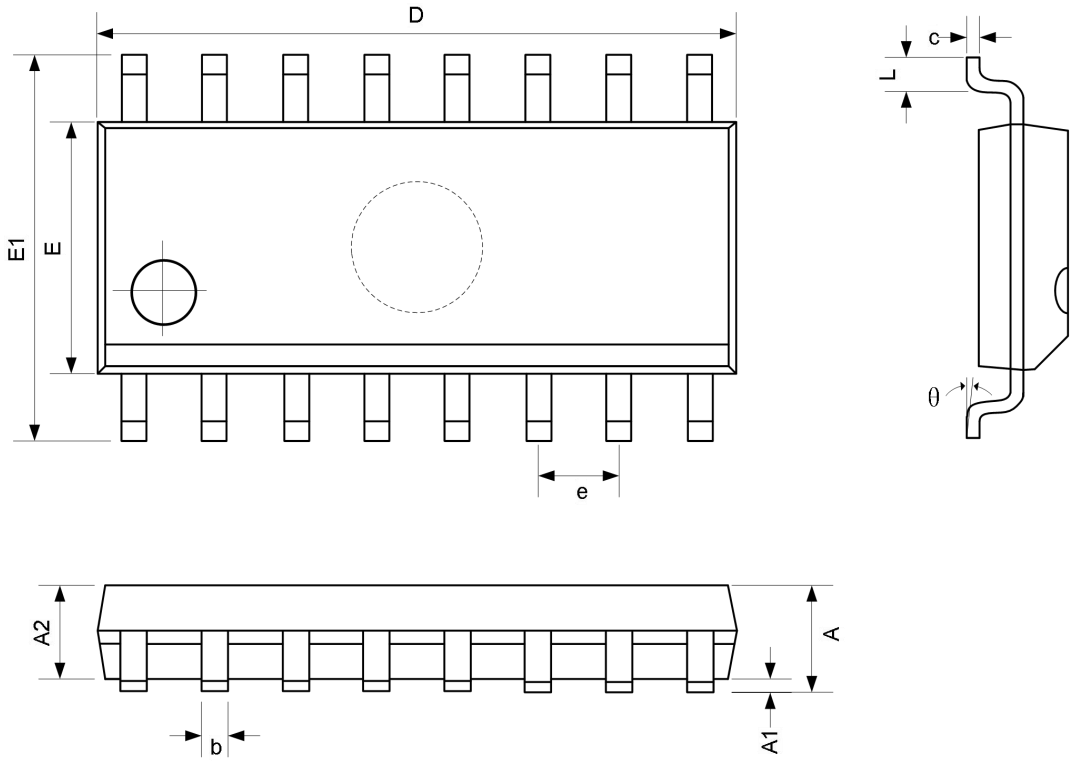


Figure 5. Typical Application of Signal Acquisition System

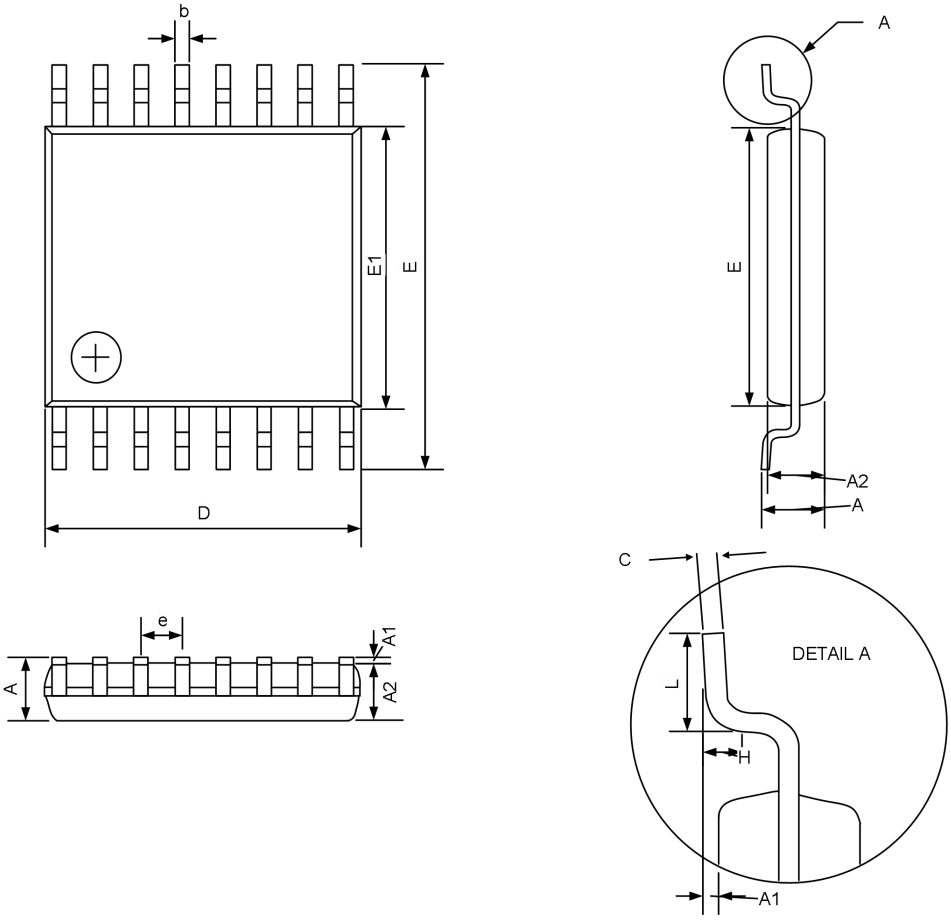
Package Outline

SOP16 PACKAGE



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.150	0.250	0.006	0.010
A2	1.400	1.500	0.055	0.059
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	9.800	10.000	0.386	0.394
E	3.800	4.000	0.150	0.157
E1	5.900	6.100	0.232	0.240
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

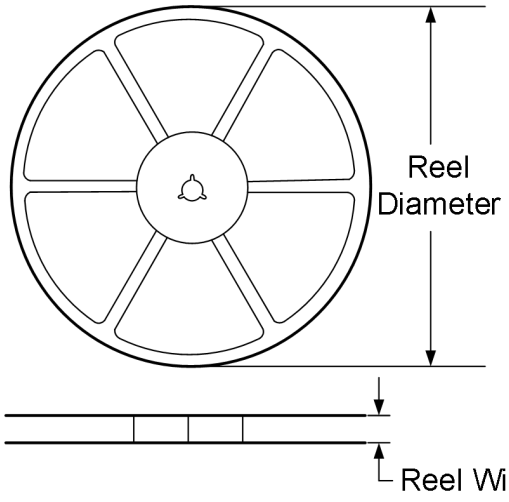
TSSOP16 PACKAGE



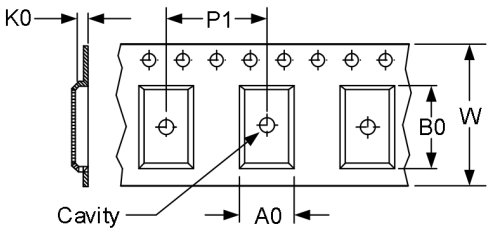
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.000	0.031	0.039
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.900	5.100	0.193	0.201
E	6.250	6.550	0.246	0.258
E1	4.300	4.500	0.169	0.177
e	0.650(BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
H	0.250(TYP)		0.010(TYP)	
θ	1°	7°	1°	7°

Tape and Reel Information

REEL DIMENSIONS

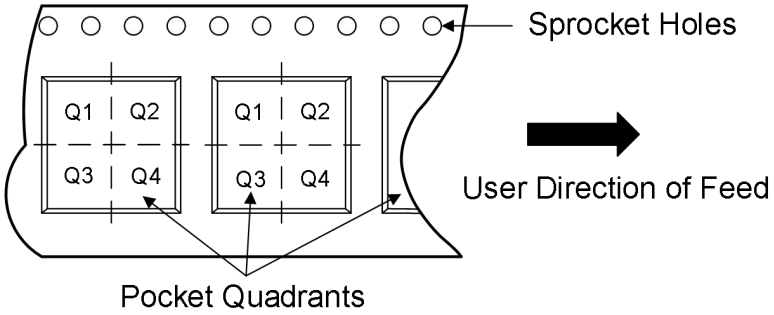


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component width thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



Device	Package Type	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
QM4051D	SOP16	16	4000	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
QM4051PW	TSSOP16	16	4000	330.0	15.4	6.8	5.4	1.3	8.0	12.0	Q1
QM4052D	SOP16	16	4000	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
QM4052PW	TSSOP16	16	4000	330.0	15.4	6.8	5.4	1.3	8.0	12.0	Q1

Revision History

Revision	Date	Description
0.5	2024.05	初版
1.0	2025.02	