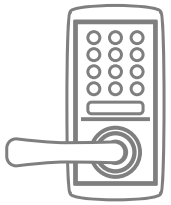
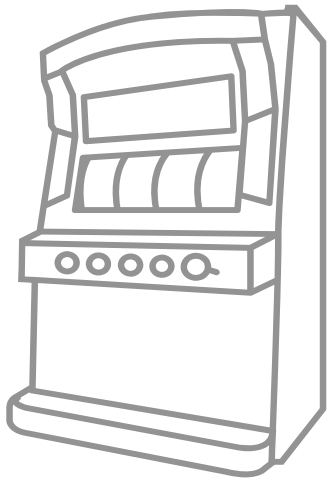
TOSHIBA

R17

Amusement Device

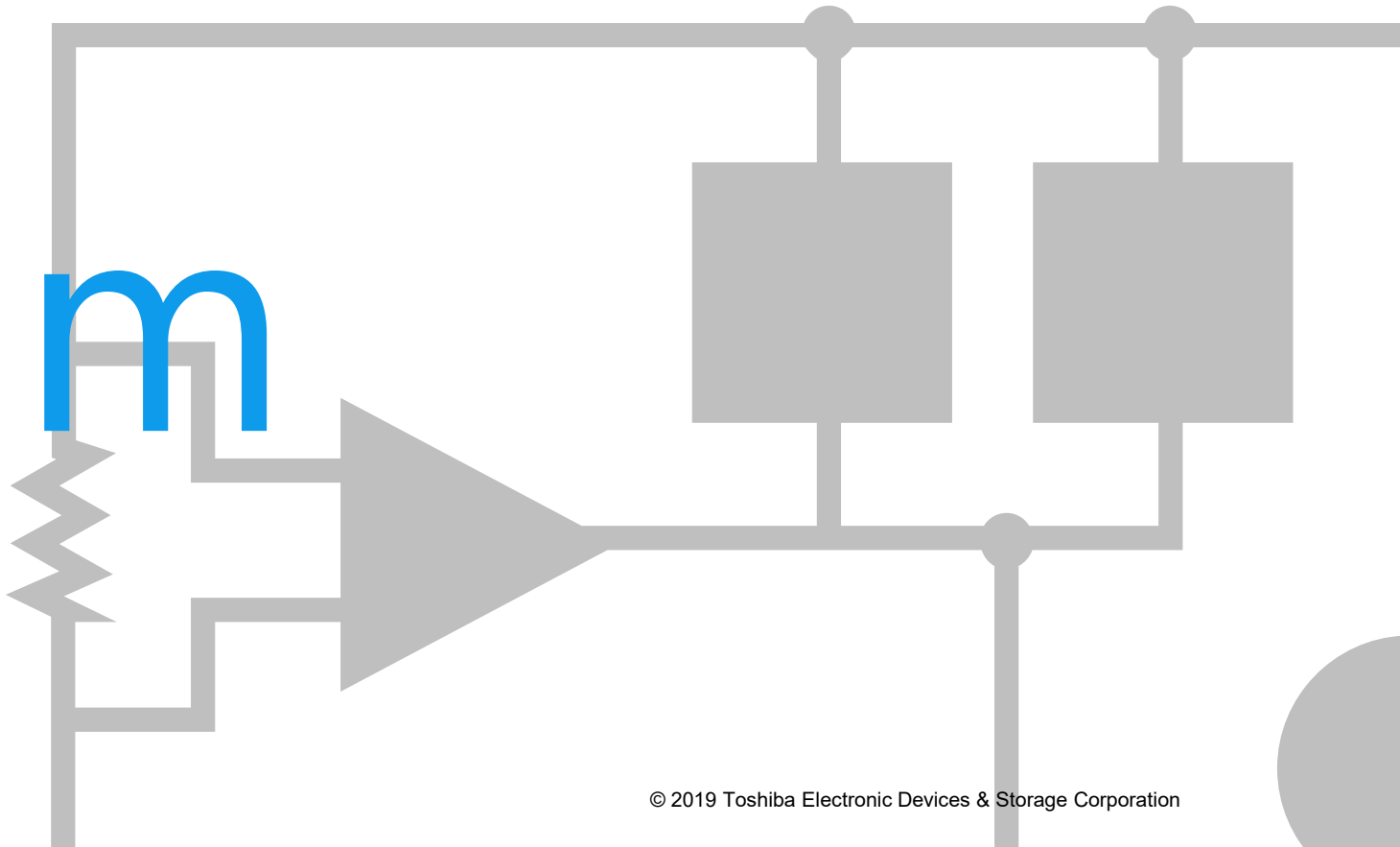
Solution Proposal by Toshiba



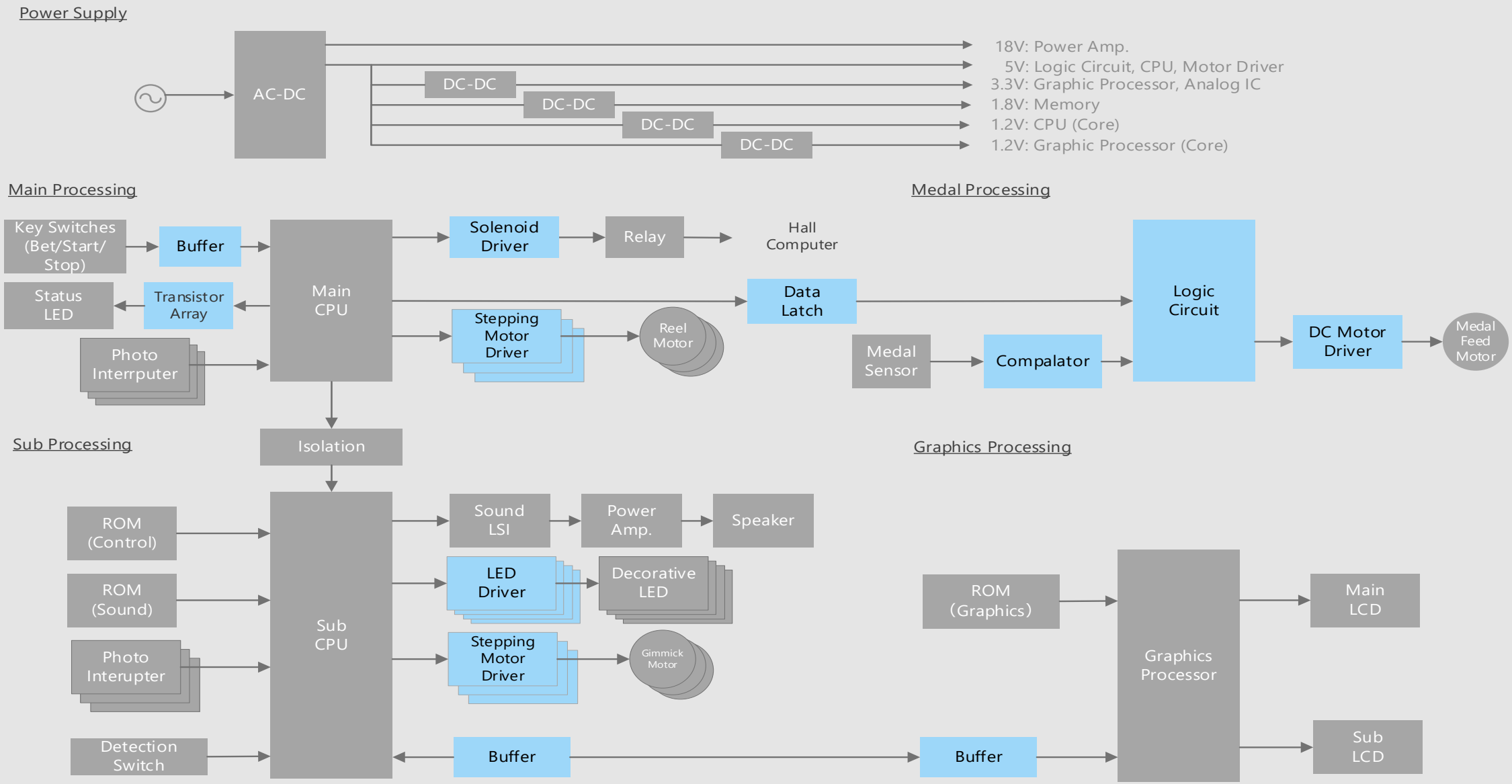


Toshiba Electronic Devices & Storage Corporation provides comprehensive device solutions to customers developing new products by applying its thorough understanding of the systems acquired through the analysis of basic product designs.

Block Diagram

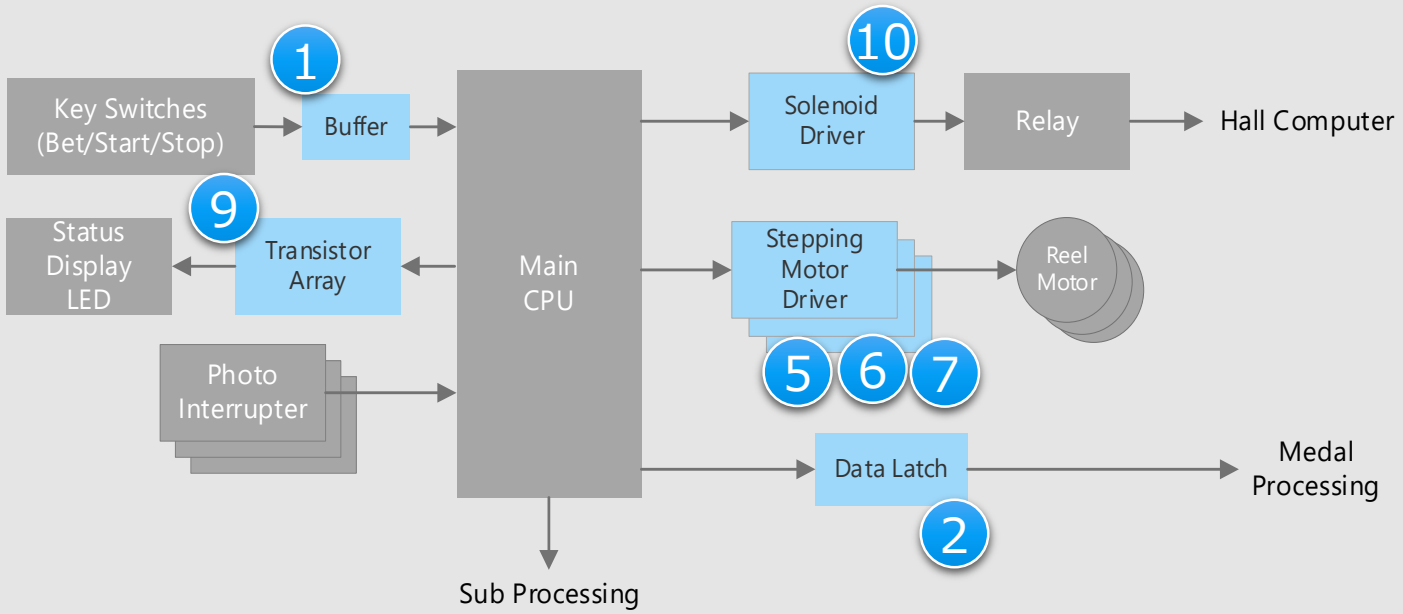


Amusement Device　Overall block diagram



Amusement Device　Detail of main processing circuit

Main processing circuit



* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

Criteria for device selection

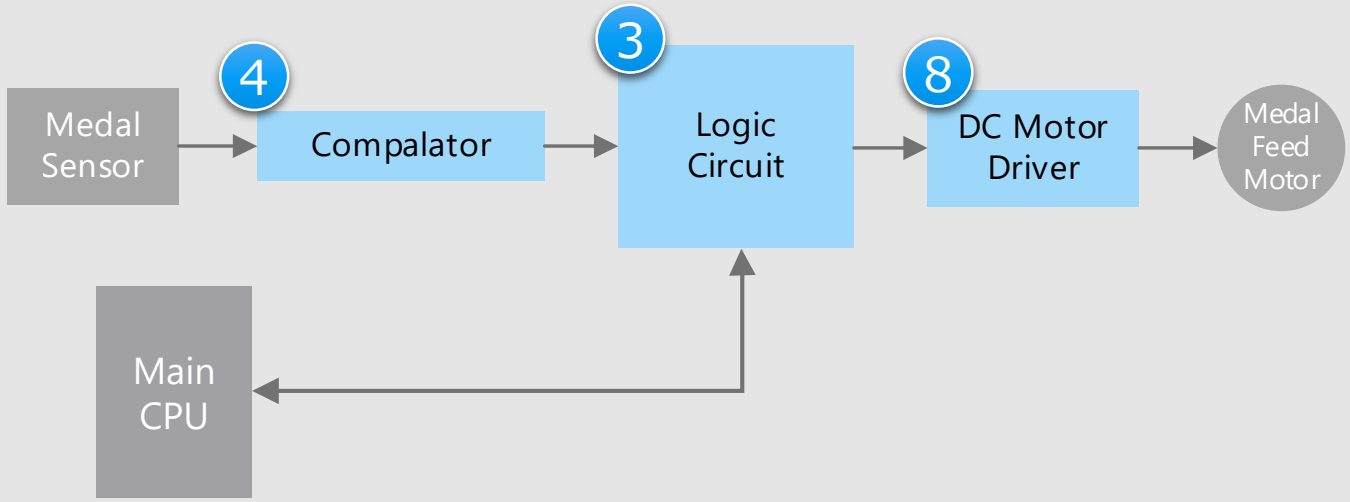
- Buffer ICs are used to reduce noise from switches and signal lines coming from outside the board
- Schmitt trigger circuits can prevent malfunctions caused by ripple noise from power supplies and GND lines
- The use of logic ICs such as buffers can restore waveforms degraded by wiring capacitance

Proposal from Toshiba

- **Achieves both high speed and low noise performance** 1 2
  CMOS logic IC: Buffer, Flip-flop
- **AGC enables step-out prevention and efficient control** 5
  Stepping motor driver built-in AGC
- **High efficient motor control** 6
  Bipolar type stepping motor driver
- **Suitability for amusement and easy to use** 7
  Unipolar type stepping motor driver
- **Reduced mounting area and number of parts** 9
  Transistor array
- **BOM cost reduction by replacement of SiP component** 10
  Solenoid driver

Amusement Device　Detail of medal processing circuit

Medal processing circuit



* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

Criteria for device selection

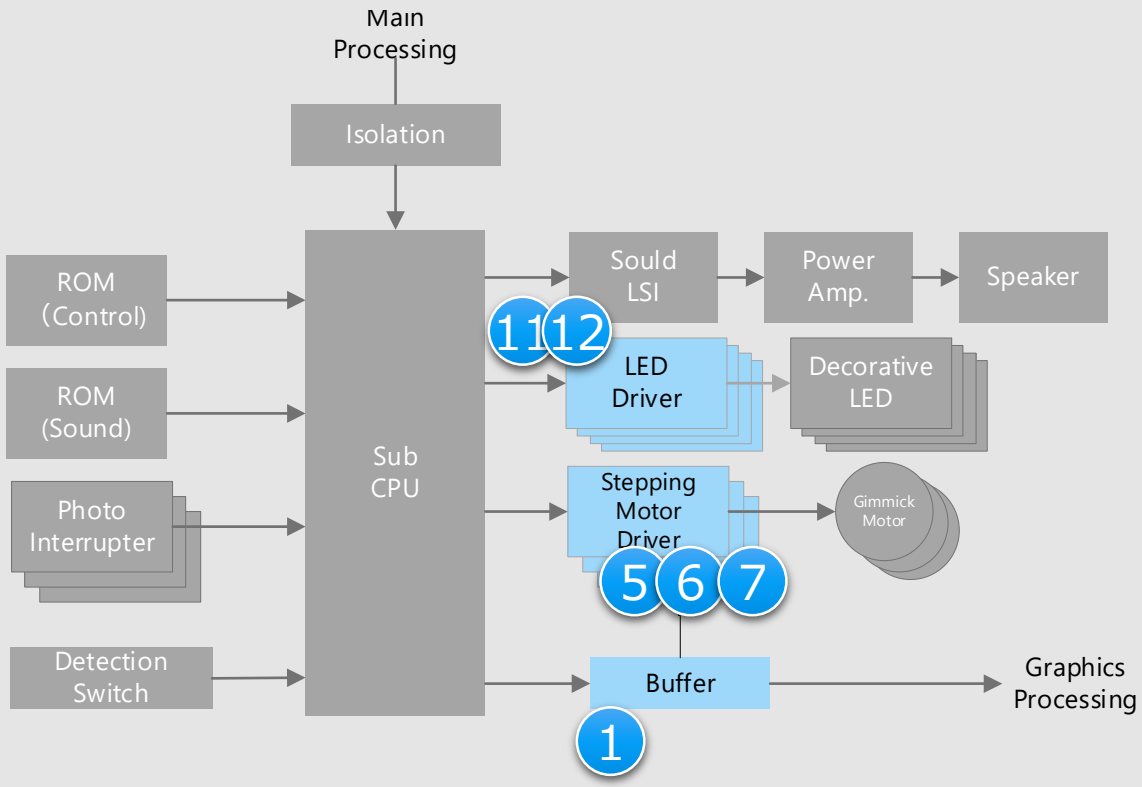
- Buffer ICs are used to reduce noise from switches and signal lines coming from outside the board
- Schmitt trigger circuits can prevent malfunctions caused by ripple noise from power supplies and GND lines
- The use of logic ICs such as buffers can restore waveforms degraded by wiring capacitance

Proposal from Toshiba

- **High speed and low noise performance** 3
  CMOS logic IC: Gate function
- **Highly accurate voltage comparator** 4
  General purpose comparator
- **Low power drive using BiCD process** 8
  DC brushed motor driver

Amusement Device　Detail of sub processing circuit

Sub processing circuit



* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

Criteria for device selection

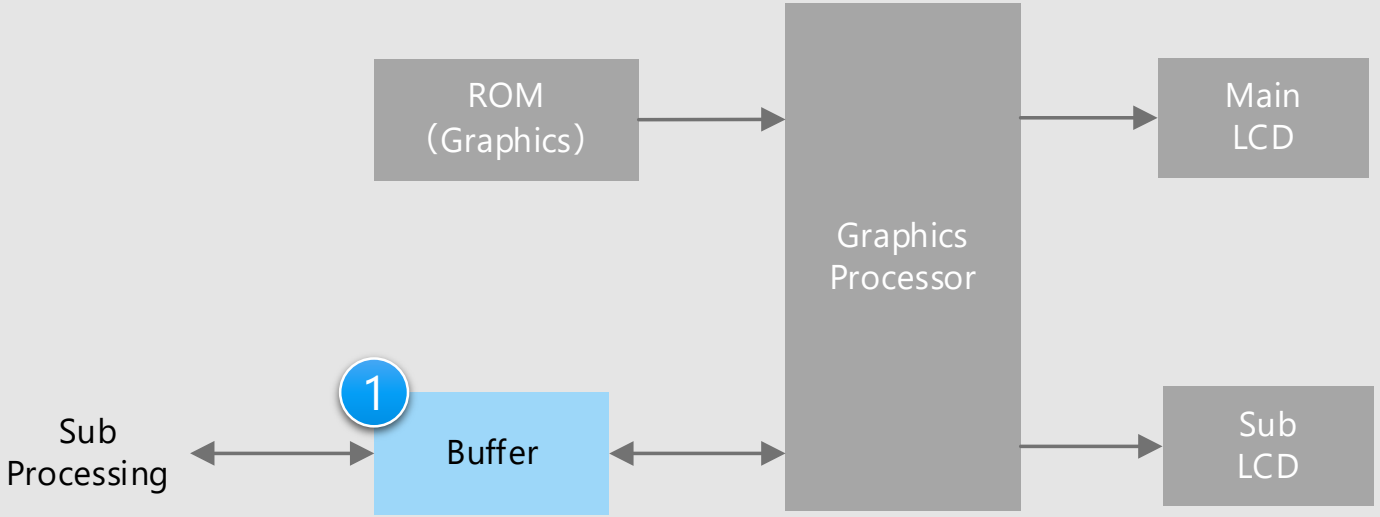
- Buffer ICs are used to reduce noise from switches and signal lines coming from outside the board
- Schmitt trigger circuits can prevent malfunctions caused by ripple noise from power supplies and GND lines
- The use of logic ICs such as buffers can restore signal waveforms that are degraded due to wiring capacitance

Proposal from Toshiba

- **High speed and low noise performance** 1
  CMOS logic IC: Buffer
- **AGC enables step-out prevention and efficient control** 5
  Stepping motor driver
- **High efficient motor control** 6
  Bipolar type stepping motor driver
- **Suitability for amusement and easy to use** 7
  Unipolar type stepping motor driver
- **Industry proven 9-ch and 24-ch, 2-wire input** 11
  Constant current LED driver
- **Turn on 4-digit, 7 segments with one device** 12
  7-segment LED driver

Amusement Device　Detail of graphics processing circuit

Graphics processing circuit



* Click on the numbers in the circuit diagram to jump to the detailed descriptions page

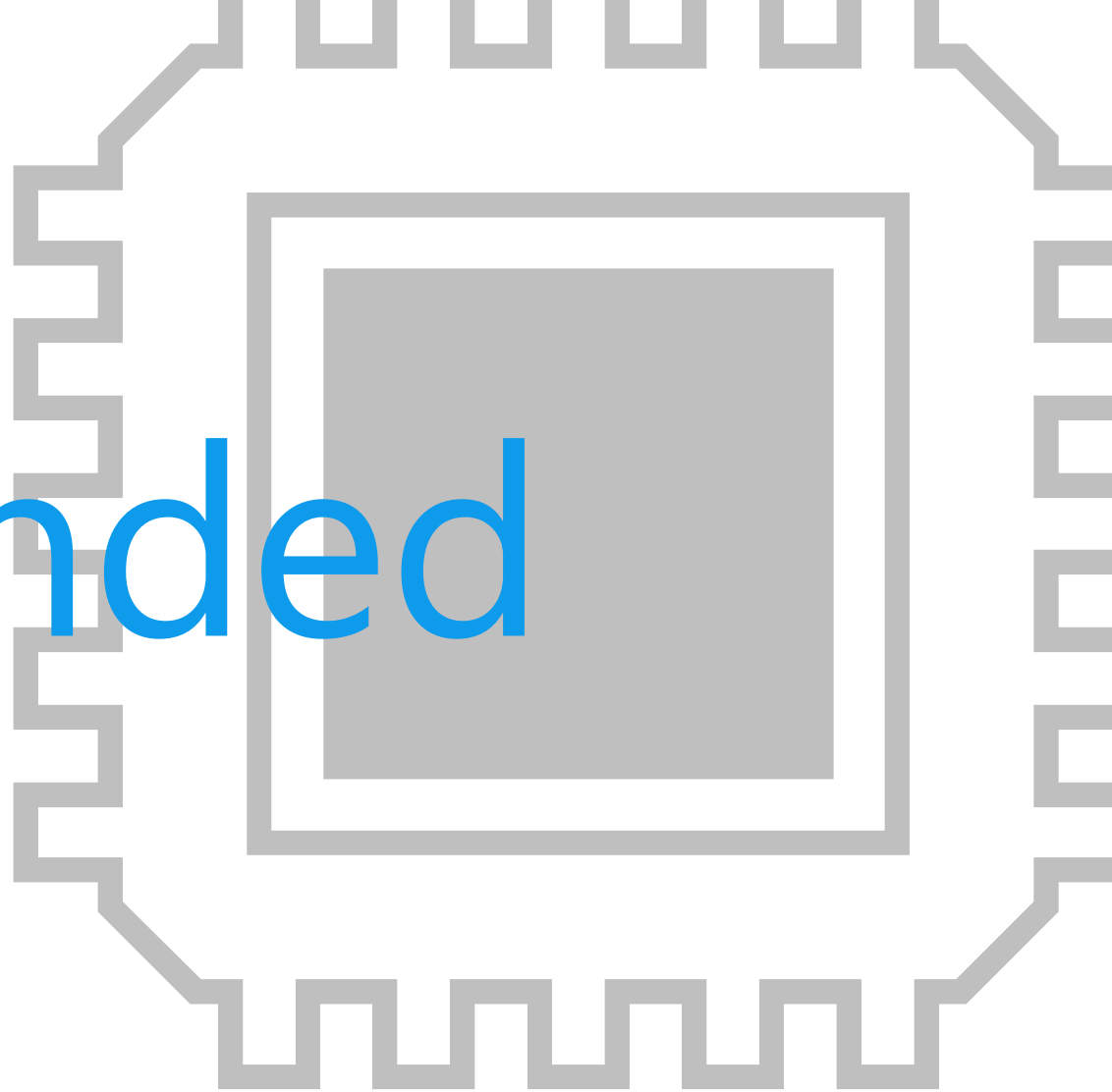
Criteria for device selection

- Buffer ICs are used to reduce noise from switches and signal lines coming from outside the board
- Schmitt trigger circuits can prevent malfunctions caused by ripple noise from power supplies and GND lines
- The use of logic ICs such as buffers can restore signal waveforms that are degraded due to wiring capacitance

Proposal from Toshiba

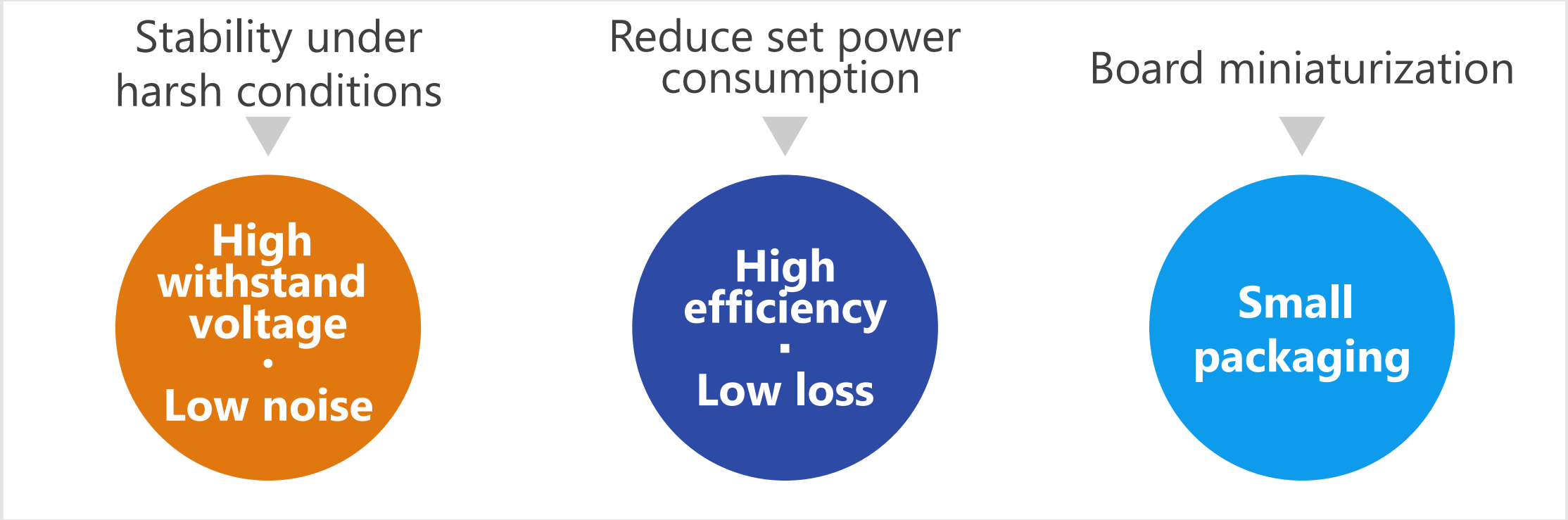
- **High speed and low noise performance**
  CMOS logic IC: Buffer 1

Recommended Devices



Device solutions to address customer needs

As described above, in order to design Amusement Device, “Stability under harsh conditions”, “Reduce set power consumption” and “Board miniaturization” are important factors. Toshiba’s proposals are based on these three solution perspectives.



Device solutions to address customer needs

	Withstand voltage • Low noise	High Efficiency • Low loss	Small packaging
1 CMOS logic: Buffer	●	●	●
2 CMOS logic: Flip-flop	●	●	●
3 CMOS logic: Gate function	●	●	●
4 General purpose comparator	●		●
5 Stepping motor driver built-in AGC	●	●	●
6 Bipolar type stepping motor driver	●	●	●
7 Unipolar type stepping motor driver	●	●	●
8 DC brushed motor driver	●	●	●
9 Transistor array	●	●	
10 Solenoid driver	●	●	
11 Constant current LED driver	●	●	●
12 7-segment LED driver	●	●	●

1 CMOS logic IC : Buffer

74VHC541FT / TC74VHC9541P

Withstand voltage Low noise | Efficiency Low loss | Small packaging

Value provided

Ultra high-speed logic using silicon gate CMOS technology to achieve miniaturization

1 Low power and high speed

High-speed operation comparable to Schottky TTL achieved using low power CMOS circuitry.

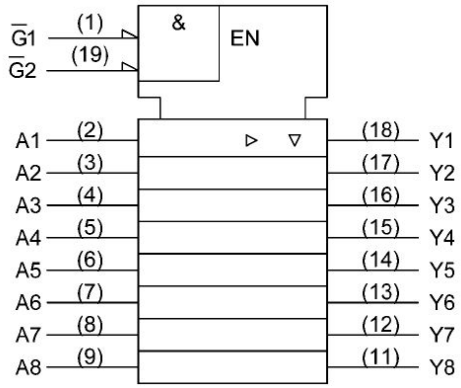
2 High speed and low noise

0.6 µm CMOS technology was adopted to achieve higher speed than conventional series. The switching noise generated is also significantly reduced.

3 Optimized gate switching speed

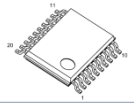
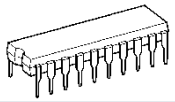
A newly developed diode-less input protection circuit is adopted.

74VHC541FT logic diagram



The TC74VHC9541P has hysteresis at its input, making it suitable for shaping slow-changing signal waveforms as well as having strong immunity against noise.

Line up

Part number	74VHC541FT	TC74VHC9541P
Package	TSSOP20B 	DIP20 
V_{CC} [V]	2.0 to 5.5	2.0 to 5.5
I_{CC} [µA]	4.0	4.0
$I_{OH/L}$ [mA] @ V_{CC}=4.5 V	±8.0	±8.0
$t_{PLH/HL}$ [ns] @ V_{CC}=5.0 V	3.5	5.0

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2 CMOS logic IC : Flip-Flop

74VHC273FT / TC74VHC9273P

Withstand voltage Low noise | Efficiency Low loss | Small packaging

Value provided

Ultra high-speed logic using silicon gate CMOS technology to achieve miniaturization

1 Low power and high speed

High-speed operation comparable to Schottky TTL achieved using low power CMOS circuitry.

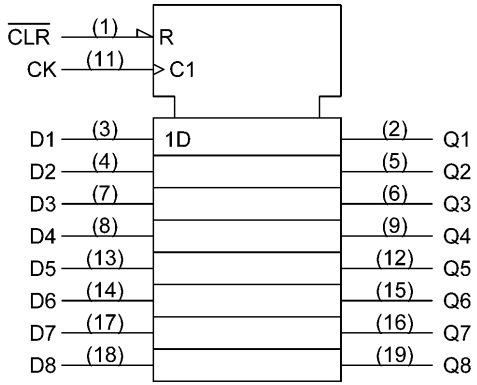
2 High speed and low noise

0.6 µm CMOS technology was adopted to achieve higher speed than conventional series. The switching noise generated is also significantly reduced.

3 Optimized gate switching speed

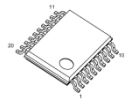
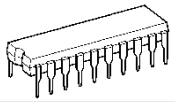
A newly developed diode-less input protection circuit is adopted.

74VHC273FT logic diagram



The TC74VHC9273P has hysteresis on the clear input and clock input, making it suitable for shaping slow-changing signal waveforms as well as having strong immunity against noise.

Line up

Part number	74VHC273FT	TC74VHC9273P
Package	TSSOP20B 	DIP20 
V_{CC} [V]	2.0 to 5.5	2.0 to 5.5
I_{CC} [µA]	4.0	4.0
$I_{OH/L}$ [mA] @ V_{CC}=4.5 V	±8.0	±8.0
$t_{PLH/HL}$ [ns] @ V_{CC}=5.0 V	5.8	4.2

◆Return to Block Diagram TOP

Value provided

Ultra high-speed logic using silicon gate CMOS technology to achieve miniaturization

1 Low power and high speed

High-speed operation comparable to Schottky TTL achieved using low power CMOS circuitry.

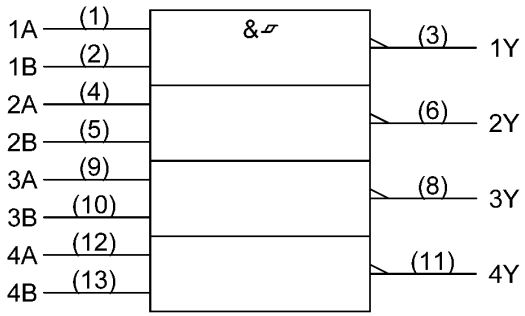
2 High speed and low noise

0.6 µm CMOS technology was adopted to achieve higher speed than conventional series. The switching noise generated is also significantly reduced.

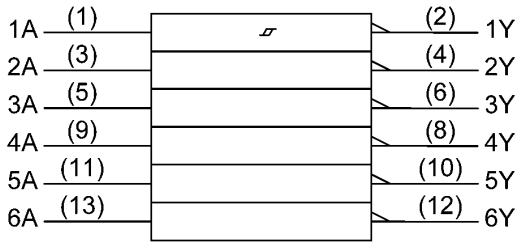
3 Optimized gate switching speed

A newly developed diode-less input protection circuit is adopted.

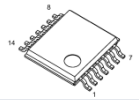
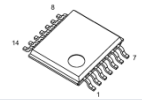
74VHC132FT
logic diagram



74VHC14FT
logic diagram



Line up

Part number	74VHC132FT	74VHC14FT
Package	TSSOP14B 	TSSOP14B 
V_{CC} [V]	2.0 to 5.5	2.0 to 5.5
I_{CC} [µA]	2.0	2.0
$I_{OH/L}$ [mA] @ V_{CC}=4.5 V	±8.0	±8.0
$t_{PLH/HL}$ [ns] @ V_{CC}=5.0 V	4.9	5.5

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4 General purpose comparator

TA75W393FU

Withstand voltage Low noise | Efficiency Low loss | Small packaging

Value provided

General purpose comparator having two circuits, capable of operating with two supplies if the supply voltage is between ±1 and ±18 V.

1 Wide range of single or dual supply operation possible

Can be used with a wide range of voltages.
- For single supply: 2 to 36 V
- For dual power supply: ±1 to ±18 V

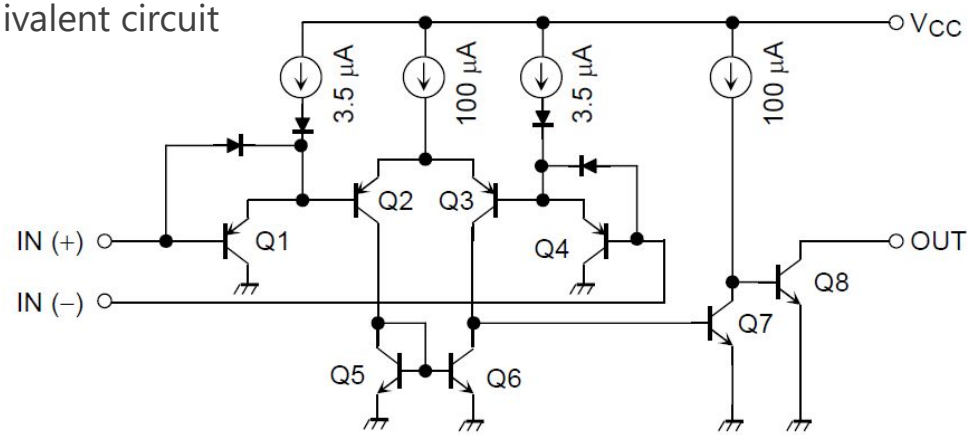
2 Low current consumption I_{CC} (Typ.) =0.8 [mA]

Low current consumption broadens the range of possible applications.

3 Low input offset voltage V_{IO} (Typ.)=±2.0 [mV]

Since the input offset voltage is small, the accuracy of the comparison results is improved.

Equivalent circuit



Line up

Part number	TA75W393FU
Package	SM8 
$V_{CC,EE}$ (Max) [V]	2 to 36 / ±1 to ±18.0
I_{CC} (Max) [mA]	2
CMV_{IN} [V]	0 to V_{CC} -1.5

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5 Stepping motor driver built-in AGC

TB67S279FTG / TB67S285FTG / TB67S289FTG / TB67S249FTG / TB67S128FTG

Withstand voltage Low noise | Efficiency Low loss | Small packaging

Value provided

Motor current optimization by using built-in AGC technology in real time

1 High withstand voltage (50 V)

Raising the maximum voltage rating to 50 V (withstand voltage, breakdown tolerance) allows usage in amusement environments, which require a supply of 12 V ~ 36 V, with sufficient margin.

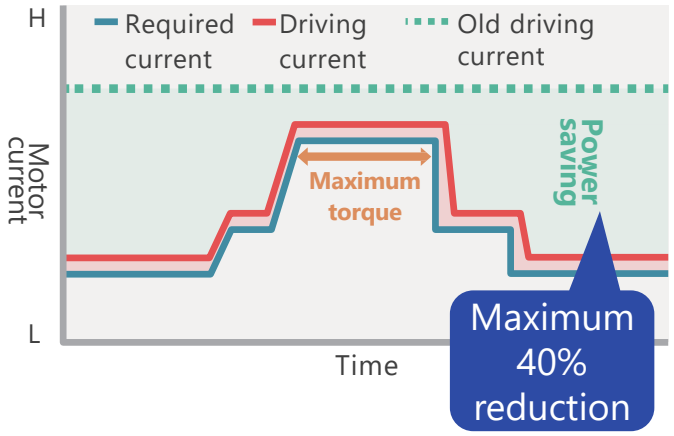
2 Step-out prevention and high efficiency control using AGC (Active Gain Control)

By detecting the motor load torque with just the driver IC and automatically optimizing the current according to the drive condition, step-out avoidance and highly efficient motor control are possible.

3 High precision current without external resistor using ADCD (Advanced Current Detect System)

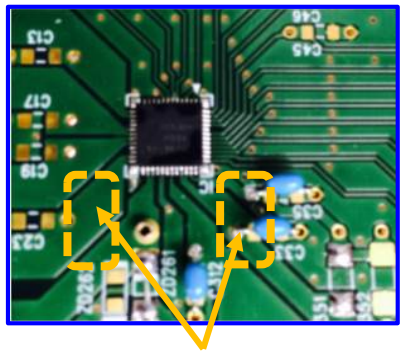
Precision constant-current motor drive is possible without using an external detection resistor. Eliminating this reduces the number of components and helps reduce board area and cost.

■ Active Gain Control



Advanced Current Detect System

Built-in register sensing motor current



Reduction of register sensing current

Line up

Part number	TB67S285FTG	TB67S289FTG
Output withstand voltage (Abs. Max)	50 V	
Output current (Abs. Max)	3.0 A	3.0 A
Output ON-resistance (H+L)	0.4 Ω	0.4 Ω
Control impedance	3-wire serial	Clock input
Step	1/1, 1/2	1/1, 1/2, 1/4, 1/8, 1/16, 1/32
Features	AGC (step-out prevention), ADMD (high efficiency control), ACDS (detection resistor-less)	
Error detection	overheating, overcurrent, low voltage, open load	
Package	QFN48	

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6 Bipolar type stepping motor driver

TB67S101A / TB67S105 / TB67S109A

Withstand voltage Low noise | Efficiency Low loss | Small packaging

Value provided

Bipolar type motor driver dedicated for amusement application

1 High withstand voltage (50 V)

Maximum voltage rating 50 V satisfies fully amusement operation requirement (voltage surge proof) which used usually in the amusement application 12 V~36 V.

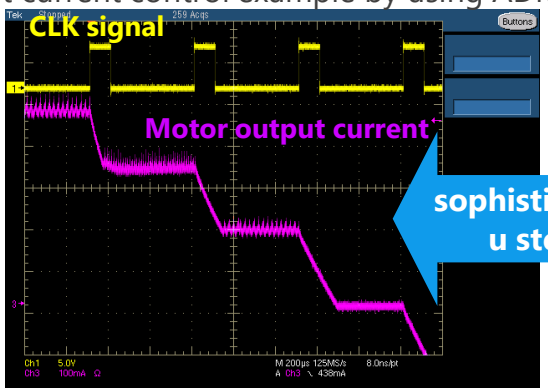
2 Low on-resistance contributed to power consumption reduction

Low on-resistance contributes low heat of driver IC and high efficient motor driver system.

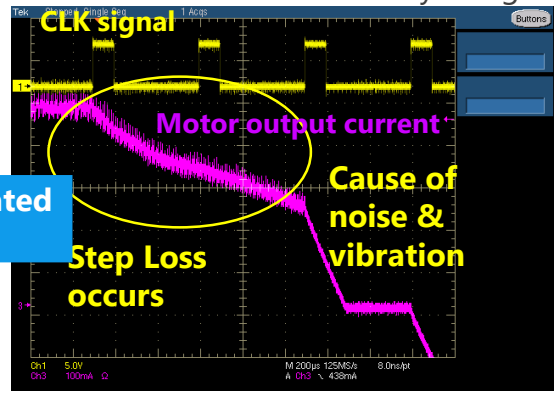
3 3 types of input interface support various main controller

There are 3 types IC line up such as 3-wire serial, phase input and clock input. User can select the adequate type matching to MCU.

Constant current control example by using ADMD



Previous control method by using Decay technology



TB67S109AFTG improves stepping motor tracking accuracy and 1/32 step high resolution by adopting ADMD(Advanced Dynamic Mixed Decay). It results in silent and smooth motor control.

Line up

Part number	TB67S101AFTG	TB67S105FTG	TB67S109AFTG
Output voltage (Max) [V]	50		
Output current (Max) [A]	4.0	3.0	4.0
On-resistance(H+L) [Ω]	0.49	0.6	0.49
Control interface	Phase interface	3-wire serial	Clock input
Control step	1/1, 1/2, 1/4	1/1, 1/2	1/1, 1/2, 1/4, 1/8, 1/16, 1/32
Other feature	DIP type available	Torch control(4b)	ADMD available
Abnormality detection	Over heat, over current, open load		
Package except QFN48	HTSSOP48/SDIP24	Only QFN48	HSSOP48

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7 Unipolar type stepping motor driver

TB67S141A / TB67S145 / TB67S149A

Withstand voltage Low noise | Efficiency Low loss | Small packaging

Value provided

Much adopting experience in amusement application based on bipolar type products technology

1 High withstand voltage (84 V)

Maximum voltage rating 84 V satisfies fully amusement operation requirement (voltage surge proof) which used usually in the amusement application 12 V ~ 36 V.

2 Low on-resistance contributed to power consumption

Low on-resistance contributes low heat of driver IC and high efficient motor driver system.

3 3 types of input interface support various main controller

There are 3 types IC line up such as 3-wire serial, phase input and clock input. User can select the adequate type matching to MCU.

Adopting experience and easy to use

Unipolar
TB67S**14x**

⟷

High efficiency

Bipolar
TB67S**10x**

Toshiba supports both unipolar and bipolar types

If 3 end number of the part number, above both series has pin compatibility about the principal pins and software setting parameter.

Line up

Part number	TB67S141FTG	TB67S145FTG	TB67S149FTG
Output voltage (Max) [V]	84		
Output current (Max) [A]	3.0		
On-resistance(H+L) [Ω]	0.25		
Control interface	Phase input	3-wire serial	Clock input
Control step	1/1, 1/2,, 1/4	1/1, 1/2	1/1, 1/2, 1/4, 1/8, 1/16, 1/32
Other feature	DIP/ZIP available	Small package	High resolution u step
Abnormality detection	Over heat, over current, under low voltage		
Package except QFN48	HZIP25/SDIP24	QFN48	HZIP25/HSSOP48

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8 DC brushed motor driver

TB67H400A / TB67H410

Withstand voltage Low noise | Efficiency Low loss | Small packaging

Value provided

Adoption of BiCD process enables high withstand voltage, large current and low power consumption drive.

1 High withstand voltage (50 V) / High current

In order to allow margin for air discharge test etc., the withstand voltage of the output is increased from 40 V to 50 V. The TB67H400A can handle an absolute output maximum current of 8 A.

2 DIP package available

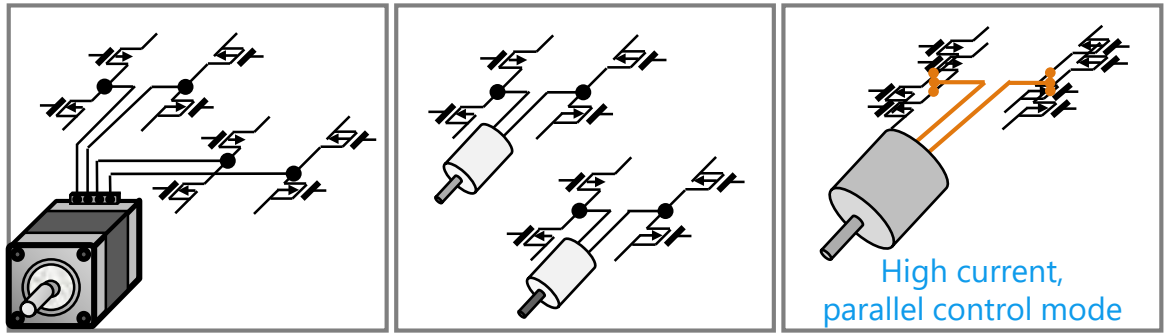
A lineup of products compatible with self-insertion DIP packages, required for basic amusement systems, are available to meet all needs.

3 3-in-1 function

The H-bridge combination can be tailored according to the type of motor and the required current capacity as: (1) single stepper drive, (2) dual brush drive, and (3) high current, single-brush drive.

■ 3-in-1 function

① Single stepper ② Dual brush ③ High current, single brush



Line up

Part number	TB67H400A	TB67H410
Motor type	Brushed DC motor	
Output withstand voltage	50 V	
Output current	8.0 A (Large mode)	5.0 A (Large mode)
Output On resistance	0.25 Ω	0.4 Ω
Output circuit	1 circuit (large current drive mode)	
Control impedance	4 modes	
Step resolution/excitation mode	1/1, ½ step (2-phase,1-2 phase excitation)	
Error detection	overheating, overcurrent, low voltage monitoring	
Package	QFN48/HTSSOP48/HZIP25/SDIP24	QFN48/SDIP24

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9 Transistor array

TBD62089APG / TBD62789APG

Withstand voltage Low noise | Efficiency Low loss | Small packaging

Value provided

A comprehensive lineup of products with DMOS output including DIP packages and built-in logic circuit (D-FF)

1 High withstand voltage / High current

The BiCD process (a high-voltage monolithic process) has an FET, with an absolute maximum voltage rating of 50 V. The current can be selected from three available types: 0.3, 0.5 A and 1.5 A.

2 Wide line-up

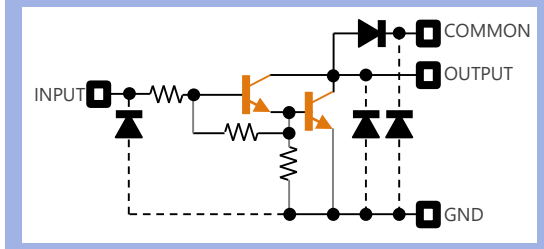
Lineup offers selectable input type (buffer, inverter), output type (sink, source), and number of channels (4 to 8). A total of 55 products are available, with DIP packages and D-FF built-in products newly added.

3 Low loss

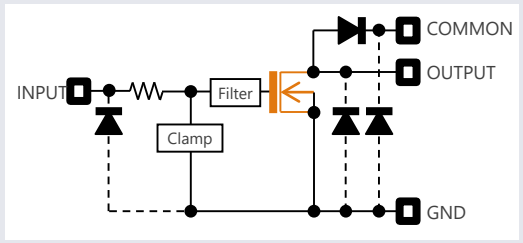
Low loss is realized by the low Ron of the output circuit. Power loss has been reduced by approximately 40 % compared to our conventional products. (Conditions: Ta = 25 °C, I_{OUT} = 200 mA)

TBD62xxx**A** series

Before Output stage: **Bipolar transistor**



After Output stage: **DMOS FET**



DMOS FET : Double-diffused MOSFET

D-FF integrated type

Line up

Part number	TBD62089APG	TBD62789APG
Function	Sink output TR array +D-FF	Source output TR array +D-FF
Outputs	8 circuits	8 circuits
Inputs	CMOS input compatible	CMOS input compatible
Output ratings	50 V	50 V
	500 mA	-500 mA
Output on-resistance	1.6 Ω (Typ.)	1.4 Ω (Typ.)
Clamp diode	no	yes
Package	DIP20	DIP20

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10 Solenoid driver

TB67S111PG / TB67S112PG

Withstand voltage Low noise | Efficiency Low loss | Small packaging

Value provided

System cost reduction by replacing DMOS single SIP product to 2in1 or 4in1

1 High withstand voltage Large output current

Monoclinic BiCD process based FET output stage results in high withstand voltage and large output current

2 DIP package and cost optimization

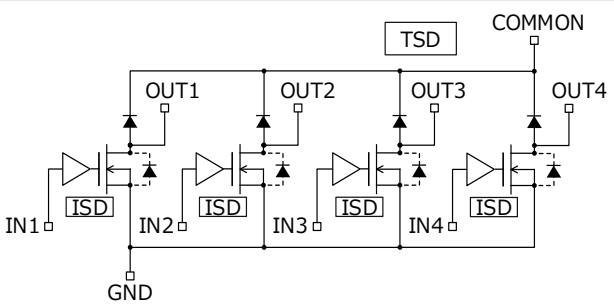
DIP package satisfies amusement particular requirement about verification. 4in1 and 2in1 contribute system cost optimization.

3 Safety system design

Built-in over-temperature and over-current detection function contribute safety solenoid drive.

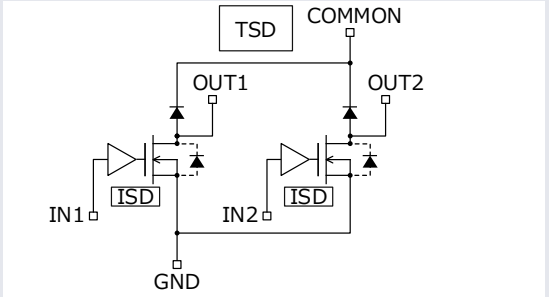
TB67S111PG

Output：**DMOS FET**



TB67S112PG

Output：**DMOS FET**



Line up

Part number	TB67S111PG	TB67S112PG
Category	Solenoid driver	Solenoid driver
Number of output	4	2
Output voltage rating	84 V	50 V
	1500 mA	1500 mA
Output on-resistance	0.35 Ω (Typ.)	0.40 Ω (Typ.)
Clamp diode	Available	Available
Abnormality detection	Over-temperature Over-current	Over-temperature Over-current
Package	DIP16	DIP16

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11 Constant current LED driver

2-wire SPI TB62781FNG / TB62D612FTG, 1-wire I/F TB62D786FTG / TB62D787FTG

Withstand voltage Low noise | Efficiency Low loss | Small packaging

Value provided

A lineup of industry-proven 9-ch and 24-ch, two-wire input types and the first single-wire input model

1 Suitable for 3 or 8 LEDs

Controls three (TB62781FNG) or eight (TB62D612FTG) full-color LEDs with dual-wire input control. In addition, a 10 MHz high-speed data communication link is possible.

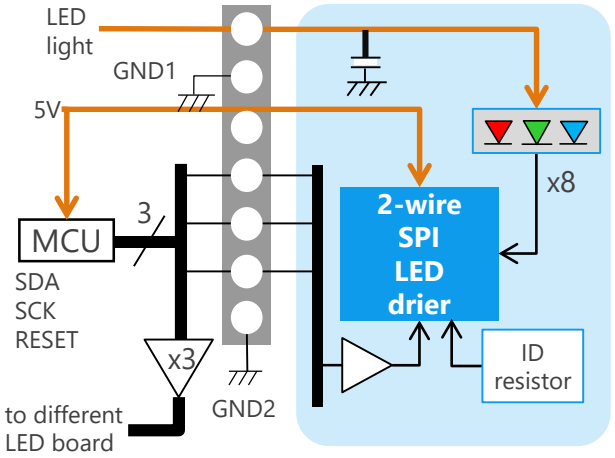
2 High withstand voltage, high performance LED with constant current output

The LED output supports up to 28 V and 80 mA. The LED current can be set by resistors for each RGB. The current accuracy is ± 3% (within each RGB group) and high performance LED driver.

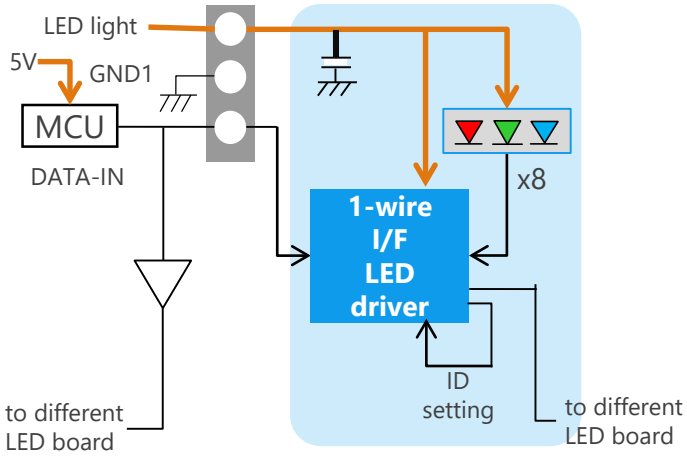
3 Simple control inputs

The PWM data is reduced to 7 bits, reducing the load on the controller. Up to 64 IDs can be set with three ID pins. The latest one-wire system has also been added to the line-up.

2-wire SPI
TB62D612FTG



1-wire I/F
TB62D787FTG



Line up

	2-wire SPI		1-wire I/F	
Part number	TB62781FNG	TB62D612FTG	TB62D786FTG	TB62D787FTG
Package	SSOP20	WQFN36	VQFN24	VQFN40
Outputs	9	24	9	24
Operating voltage	3 to 5.5 V		7 to 26 V	
LED power (Max)	26 V			
Output current (Max)	Constant current range 5 to 40 mA, 80 mA (Max)			
PWM control	Each output 128-step PWM controllable			

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12 7-segment LED driver

TB62785NG / FTG

Withstand voltage Low noise | Efficiency Low loss | Small packaging

Value provided

LED driver which can light a 4-digit, 7-segment LED using one device

1 Suitable for 7-segment LED displays

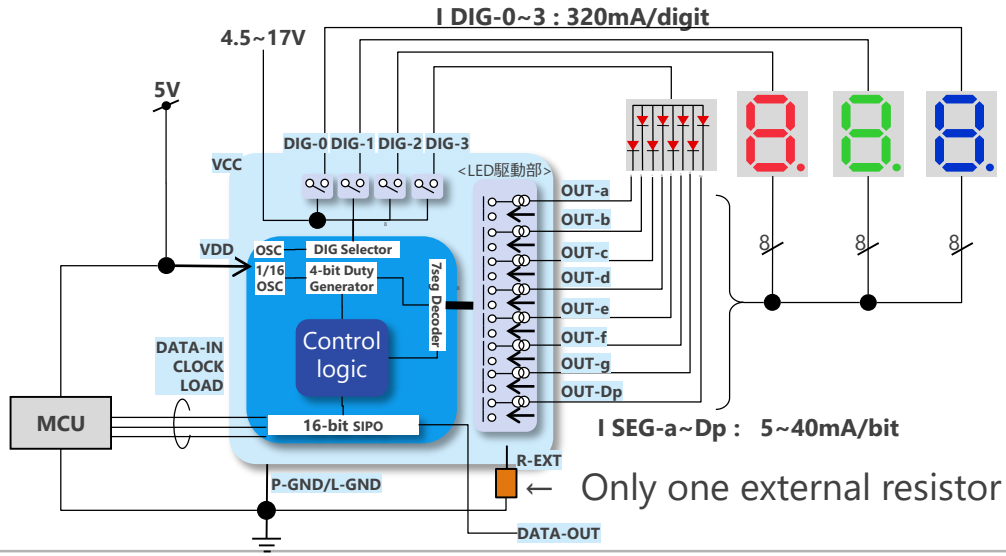
This driver can serially control a 4-digit 7-segment LED. Matrix drive is performed by scanning the digits at 480 Hz. The 3-wire control can also be cascaded, reducing the number of harnesses.

2 Current control possible with one external resistor

The LED current can be set with an external resistor. No other components are needed.

3 Lead insertion type package

We have a line-up of free-standing lead insertion packages (SDIP24) and small packages (QFN24) that can be used for the main board.



← Only one external resistor required

Line up

Part number	TB62785NG	TB62785FTG
Package	SDIP24	VQFN24
Outputs	4 columns ×7 outputs	
Operating voltage	4 to 5.5 V	
Internal power supply	17	
LED power supply (Max)	17	
Output current (Max)	50 mA	
Cascade connection	○	
PWM control	○ 16-step light control possible (total)	

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