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

Power Supply

AC-DC

- DC-DC
- DC-DC
- DC-DC
- DC-DC

- 18V: Power Amp.
- 5V: Logic Circuit, CPU, Motor Driver
- 3.3V: Graphic Processor, Analog IC
- 1.8V: Memory
- 1.2V: CPU (Core)
- 1.2V: Graphic Processor (Core)

Main Processing

Key Switches (Bet/Start/Stop)

Status LED

Photo Interrupter

Buffer

Main CPU

Solenoid Driver

Relay

Stepping Motor Driver

Hall Computer

Data Latch

Compalator

Medal Processing

DC Motor Driver

Medal Feed Motor

Sub Processing

Isolation

Sub CPU

ROM (Control)

ROM (Sound)

Photo Interrupter

Detection Switch

Buffer

Solenoid Driver

Relay

Stepping Motor Driver

Hall Computer

Data Latch

Compalator

Medal Processing

Graphics Processing

Graphics Processor

Main LCD

Sub LCD

ROM (Graphics)

Main Processing

Buffer

Solenoid Driver

Relay

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Graphics Processing

Graphics Processor

Main LCD

Sub LCD

ROM (Graphics)

ROM (Control)

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Relay

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Hall Computer

Data Latch

Compalator

Medal Processing

Graphics Processing

Graphics Processor

Main LCD

Sub LCD

ROM (Graphics)
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**
  CMOS logic IC: Buffer, Flip-flop
- **AGC enables step-out prevention and efficient control**
  Stepping motor driver built-in AGC
- **High efficient motor control**
  Bipolar type stepping motor driver
- **Suitability for amusement and easy to use**
  Unipolar type stepping motor driver
- **Reduced mounting area and number of parts**
  Transistor array
- **BOM cost reduction by replacement of SiP component**
  Solenoid driver

*Click on the numbers in the circuit diagram to jump to the detailed descriptions page*
Amusement Device  Detail of medal processing circuit

**Medal processing circuit**

- **Medal Sensor** → **Comparator** → **Logic Circuit** → **DC Motor Driver** → **Medal Feed Motor** → **Main CPU**

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

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**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**
  CMOS logic IC: Gate function
- **Highly accurate voltage comparator**
  General purpose comparator
- **Low power drive using BiCD process**
  DC brushed motor driver
Amusement Device  Detail of sub processing circuit

Sub processing circuit

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
- **AGC enables step-out prevention and efficient control**
  Stepping motor driver
- **High efficient motor control**
  Bipolar type stepping motor driver
- **Suitability for amusement and easy to use**
  Unipolar type stepping motor driver
- **Industry proven 9-ch and 24-ch, 2-wire input**
  Constant current LED driver
- **Turn on 4-digit, 7 segments with one device**
  7-segment LED driver

* Click on the numbers in the circuit diagram to jump to the detailed descriptions page
Amusement Device  Detail of graphics processing circuit

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

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

<table>
<thead>
<tr>
<th></th>
<th>Device Type</th>
<th>Withstand voltage</th>
<th>High Efficiency</th>
<th>Small packaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CMOS logic: Buffer</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>2</td>
<td>CMOS logic: Flip-flop</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>3</td>
<td>CMOS logic: Gate function</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>4</td>
<td>General purpose comparator</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>5</td>
<td>Stepping motor driver built-in AGC</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>6</td>
<td>Bipolar type stepping motor driver</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>7</td>
<td>Unipolar type stepping motor driver</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>8</td>
<td>DC brushed motor driver</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>9</td>
<td>Transistor array</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>10</td>
<td>Solenoid driver</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>11</td>
<td>Constant current LED driver</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>12</td>
<td>7-segment LED driver</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>
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.

The TC74VHC9541P has hysteresis at its input, making it suitable for shaping slow-changing signal waveforms as well as having strong immunity against noise.
Ultra high-speed logic using silicon gate CMOS technology to achieve miniaturization

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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.
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.

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   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.

**Line up**

<table>
<thead>
<tr>
<th>Part number</th>
<th>74VHC132FT</th>
<th>74VHC14FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>TSSOP14B</td>
<td>TSSOP14B</td>
</tr>
<tr>
<td>$V_{CC}$ [V]</td>
<td>2.0 to 5.5</td>
<td>2.0 to 5.5</td>
</tr>
<tr>
<td>$I_{CC}$ [μA]</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>$I_{O(HL)}$ [mA] @ $V_{CC}$=4.5 V</td>
<td>±8.0</td>
<td>±8.0</td>
</tr>
<tr>
<td>$t_{PLH/L}$ [ns] @ $V_{CC}$=5.0 V</td>
<td>4.9</td>
<td>5.5</td>
</tr>
</tbody>
</table>
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**
   - $I_{CC} \ (\text{Typ.}) = 0.8 \ [mA]$
   - 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**

<table>
<thead>
<tr>
<th>Part number</th>
<th>TA75W393FU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>SM8</td>
</tr>
<tr>
<td>$V_{CC,\text{EE}} \ (\text{Max}) \ [V]$</td>
<td>2 to 36 / ±1 to ±18.0</td>
</tr>
<tr>
<td>$I_{CC} \ (\text{Max}) \ [mA]$</td>
<td>2</td>
</tr>
<tr>
<td>$CMV_{IN} \ [V]$</td>
<td>0 to $V_{CC} - 1.5$</td>
</tr>
</tbody>
</table>

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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.

### Line up

<table>
<thead>
<tr>
<th>Feature</th>
<th>TB67S285FTG</th>
<th>TB67S289FTG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part number</td>
<td>TB67S285FTG</td>
<td>TB67S289FTG</td>
</tr>
<tr>
<td>Output withstand voltage (Abs. Max)</td>
<td>50 V</td>
<td>50 V</td>
</tr>
<tr>
<td>Output current (Abs. Max)</td>
<td>3.0 A</td>
<td>3.0 A</td>
</tr>
<tr>
<td>Output ON-resistance (H+L)</td>
<td>0.4 Ω</td>
<td>0.4 Ω</td>
</tr>
<tr>
<td>Control impedance</td>
<td>3-wire serial</td>
<td>Clock input</td>
</tr>
<tr>
<td>Step</td>
<td>1/1, 1/2</td>
<td>1/1, 1/2, 1/4, 1/8, 1/16, 1/32</td>
</tr>
<tr>
<td>Features</td>
<td>AGC (step-out prevention), ADMD (high efficiency control), ACDS (detection resistor-less)</td>
<td></td>
</tr>
<tr>
<td>Error detection</td>
<td>overheating, overcurrent, low voltage, open load</td>
<td></td>
</tr>
<tr>
<td>Package</td>
<td>QFN48</td>
<td>QFN48</td>
</tr>
</tbody>
</table>
Bipolar type stepping motor driver
TB67S101A / TB67S105 / TB67S109A

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.

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

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.
Unipolar type stepping motor driver
TB67S141A / TB67S145 / TB67S149A

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
TB67S14x

Bipolar
TB67S10x

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.

High efficiency

Line up

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

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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

<table>
<thead>
<tr>
<th>Line up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part number</td>
</tr>
<tr>
<td>Motor type</td>
</tr>
<tr>
<td>Output withstand voltage</td>
</tr>
<tr>
<td>Output current</td>
</tr>
<tr>
<td>Output On resistance</td>
</tr>
<tr>
<td>Output circuit</td>
</tr>
<tr>
<td>Control impedance</td>
</tr>
<tr>
<td>Step resolution/excitation mode</td>
</tr>
<tr>
<td>Error detection</td>
</tr>
<tr>
<td>Package</td>
</tr>
</tbody>
</table>

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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, IOUT = 200 mA)

D-FF integrated type

<table>
<thead>
<tr>
<th>Line up</th>
<th>Part number</th>
<th>Function</th>
<th>Outputs</th>
<th>Inputs</th>
<th>Output ratings</th>
<th>Output on-resistance</th>
<th>Clamp diode</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TBD62089APG</td>
<td>Sink output TR array +D-FF</td>
<td>8 circuits</td>
<td>CMOS input compatible</td>
<td>50 V</td>
<td>1.6 Ω (Typ.)</td>
<td>no</td>
<td>DIP20</td>
</tr>
<tr>
<td></td>
<td>TBD62789APG</td>
<td>Source output TR array +D-FF</td>
<td>8 circuits</td>
<td>CMOS input compatible</td>
<td>50 V</td>
<td>1.4 Ω (Typ.)</td>
<td>yes</td>
<td>DIP20</td>
</tr>
</tbody>
</table>

Return to Block Diagram TOP
**Solenoid driver**

**TB67S111PG / TB67S112PG**

---

**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**

<table>
<thead>
<tr>
<th></th>
<th>TB67S111PG</th>
<th>TB67S112PG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part number</td>
<td>TB67S111PG</td>
<td>TB67S112PG</td>
</tr>
<tr>
<td>Category</td>
<td>Solenoid driver</td>
<td>Solenoid driver</td>
</tr>
<tr>
<td>Number of output</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Output voltage rating</td>
<td>84 V</td>
<td>50 V</td>
</tr>
<tr>
<td>Output on-resistance</td>
<td>1500 mA</td>
<td>1500 mA</td>
</tr>
<tr>
<td>Clamp diode</td>
<td>Available</td>
<td>Available</td>
</tr>
<tr>
<td>Abnormality detection</td>
<td>Over-temperature</td>
<td>Over-temperature</td>
</tr>
<tr>
<td>Package</td>
<td>DIP16</td>
<td>DIP16</td>
</tr>
</tbody>
</table>

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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.

---

**Line up**

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

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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.

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**Line up**

<table>
<thead>
<tr>
<th>Part number</th>
<th>TB62785NG</th>
<th>TB62785FTG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>SDIP24</td>
<td>VQFN24</td>
</tr>
<tr>
<td>Outputs</td>
<td>4 columns x 7 outputs</td>
<td></td>
</tr>
<tr>
<td>Operating voltage</td>
<td>4 to 5.5 V</td>
<td></td>
</tr>
<tr>
<td>Internal power supply</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>LED power supply (Max)</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Output current (Max)</td>
<td>50 mA</td>
<td></td>
</tr>
<tr>
<td>Cascade connection</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>PWM control</td>
<td>○ 16-step light control possible (total)</td>
<td></td>
</tr>
</tbody>
</table>

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