For optical synchronous detection under high background light condition

FEATURES

- Superior allowable background light level
  S6986, S4282-51: 10000 lx Typ.
  S6846, S7136: 4000 lx Typ.
- Photodiode, LED driver circuit, signal processing circuit, etc. are integrated in one chip.
- Minimum detectable level
  S6986, S4282-51: 1 µW/mm² Typ.
  S6846, S7136: 0.3 µW/mm² Typ.
- Digital output
- Miniature size epoxy-molded package

APPLICATIONS

- Detection for copiers, printers, etc.
- Optical switches, etc.

The light modulation photo ICs contain an oscillator, LED driver, photodiode, pre-amplifier, comparator, and signal processing circuit all integrated in a single chip. By connecting an infrared LED externally, photorefractors and photointerrupters which perform optical synchronous detection can be easily configured. Using our own original circuit design, the S6986 and S4282-51 achieve superior allowable background light level (10000 lx typical 2856 K), and S6846 and S7136 feature a minimum detectable level of 0.3 µW/mm² typical (λ=940 nm).

### ABSOLUTE MAXIMUM RATINGS (Ta=25 °C)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>S6986, S4282-51</th>
<th>S6846, S7136</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>Vcc</td>
<td>-0.5 to +16</td>
<td>-0.5 to +16</td>
<td>V</td>
</tr>
<tr>
<td>Output Voltage</td>
<td>Vo</td>
<td>-0.5 to +16</td>
<td>-0.5 to +16</td>
<td>V</td>
</tr>
<tr>
<td>Output Current</td>
<td>Io</td>
<td>50</td>
<td>50</td>
<td>mA</td>
</tr>
<tr>
<td>Cathode Output Voltage</td>
<td>Vcath</td>
<td>-0.5 to +16</td>
<td>-0.5 to +16</td>
<td>V</td>
</tr>
<tr>
<td>Cathode Pulsed Output Current</td>
<td>Icath</td>
<td>70</td>
<td>70</td>
<td>mA</td>
</tr>
<tr>
<td>Power Dissipation *1</td>
<td>P</td>
<td>250</td>
<td>250</td>
<td>mW</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>Topr</td>
<td>-25 to +60</td>
<td>-25 to +60</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>Tstg</td>
<td>-40 to +100</td>
<td>-40 to +100</td>
<td>°C</td>
</tr>
</tbody>
</table>

*1: The derating is -3.3 mW/°C above Ta=25 °C.
## Electrical and Optical Characteristics (Vcc=5 V, Ta=25 °C)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>S6986, S4282-51 *1</th>
<th>S6846, S7136 *2</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Consumption</td>
<td>Icc</td>
<td>Vo, LED terminal is open</td>
<td>4.5</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>Low Level Output Voltage</td>
<td>VOL</td>
<td>IOL=16 mA</td>
<td>-</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>High Level Output Voltage</td>
<td>VOH</td>
<td></td>
<td>4.9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Output Short Circuit Current</td>
<td>Ios</td>
<td></td>
<td>-</td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>Low Level Output Voltage</td>
<td>Vcath</td>
<td>Icath=40 mA</td>
<td>15</td>
<td>35</td>
<td>60</td>
</tr>
<tr>
<td>Low Level Output Current</td>
<td>Icath</td>
<td>Vcath=1.2 V</td>
<td>65</td>
<td>130</td>
<td>220</td>
</tr>
<tr>
<td>Pulse Period</td>
<td>Tp</td>
<td></td>
<td>4</td>
<td>8</td>
<td>13.7</td>
</tr>
<tr>
<td>Pulse Width</td>
<td>Tw</td>
<td></td>
<td>4</td>
<td>8</td>
<td>13.7</td>
</tr>
<tr>
<td>H→L Threshold Illuminance</td>
<td>Eep</td>
<td>λ=940 nm No background light</td>
<td>0.45</td>
<td>0.65</td>
<td>0.95</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>f</td>
<td></td>
<td>0.5</td>
<td>1.25</td>
<td>0.5</td>
</tr>
<tr>
<td>Allowable Background Light</td>
<td>Ex</td>
<td>Signal light: 5 μW/mm² λp=940 nm Background light: A lamp</td>
<td>5000</td>
<td>10000</td>
<td>-</td>
</tr>
</tbody>
</table>

*1:

- Cathode
- Output

*2:

- Cathode
- Output

*3:

- Cathode
- Output
Figure 1: Special Response

The optical signal of the signal processing circuit is displayed and processed through this circuit.

(7) Diode Circuit

The diode circuit is used in the next stage.

(6) Signal Processing Circuit

The signal processing circuit is configured as a gain circuit and a diode integrator circuit. The signal is amplified and passed through the diode circuit. The output is then used as the input for the next stage.

(5) Comparator Circuit

A comparator circuit is used to compare the reference signal with the signal processed in the signal processing circuit. The output of the comparator is used to control the gain of the signal processing circuit.

(4) Pre-amplifier Circuit

A pre-amplifier circuit is used to amplify the signal further. The amplified signal is then used as the input for the signal processing circuit.

(3) Photodiode/Pre-amplifier Circuit

A photodiode/pre-amplifier circuit is used to amplify the amplified signal further. The amplified signal is then used as the input for the signal processing circuit.

(2) LED Driver Circuit

The LED driver circuit is used to control the LED. The output is used as the input for the signal processing circuit.

(1) Oscillation Timing Generator Circuit

An oscillator circuit is used to generate the timing signal for the signal processing circuit. The output is used as the input for the signal processing circuit.
The simple circuit shown in Figure 1 always provides the supply plus of the S428-1 to give some measure of protection. This is particularly important on high-voltage supplies as they are frequently mounted on high-leads away from the main}

**Figure 1**

4 CND (short lead)
3 Y0UT
2 VCC
1 CATHODE (LED)

**Connection Details**

If it is a good idea to physically test that the circuit is connected to GND to check your connection.

The S428-1 operates from supply voltages between ±4.5 and ±12V.

The S428-1 forms a simple diode with a high turn-off time. The supply voltage is applied to the diode and a current flows through it. The turn-off time is around 10 to 15 nanoseconds. The device is designed to protect circuits from transient voltage spikes.

**Description**

The S428-1 is a simple LED-activated high-speed diode. It is designed to provide protection against high-speed, high-energy surges. The LED is used to indicate that the circuit is active.

**Background**

Using Hamamatsu's S428-51.
The best place to do this is in a darkened room where you can clearly see where the light is hitting from. Alternatively, wet type-ex is not

effective shielding of the light from the sides of the LED.

I use two main techniques for evaluating the problem. The first one is a multiple angle of viewing over the LED to give very

Although the LEDs themselves are insulated, they do emit a lot of light on the sides and back.

unexposed circuits.

You may have a problem with the sensor not lining up. This can be caused by any light from the LED crossing the sensor by

Controlling the light

Problems caused by optical effects:

The most tricky problems are caused by a single bad device that can mislead the circuits and miss many connections but these are rare.

The one I'm going to explain is the effect of reflection. Because of this effect, there is a chance of false readings on these sensors.

To begin with, placing the sensor at a high enough viewing angle will clear some of the confusion. During the calibration it will be

always as accurate as the actual sensor. During the calibration, you will find that the LED

When the sensor to check the condition and also when it's directly on top of the sensor to check the condition.

When you build your first sensor it is worth mounting the LED on an extended lead, this will allow you to complete the shield the LED

$428-2$ is the one to check. It is a good compromise between the LED and its power supply. I do not recommend using the

I always use an indicator LED so that I can tell when the sensor is on or off. This is a matter of convenience in connecting LED and external.

The red LED can be an infrared type for the best match to the sensor characteristics. I don't use these as I want to see where the light is

唐朝·郑之行·元和集"
The circuit in Figure 4 uses 4 LEDs. The LED output can be adjusted to suit the individual distances from the sensor.

**Figure 4**

- **LEDs**
- **Digital Output**
- **Green LED**
- **Area Coverage Sensor**

The solution was to use several LEDs driven from one 4428. Each LED produces a small spot of light on the top of the well.

We could have used several separate circuits, each with a different LED. But to keep this design simple, we needed several sensors working on the top of the well to give this kind of discrimination.

In some circumstances, you need a sensor that will detect a well over a range of positions. On DASH-2, I need to detect whether a light is present at the bottom of the well.

Leds so in one case, I added a hole through the bottom and mounted the LED through the board. This saved me some millimeters.

In the sensor circuit, you will need to be careful to follow the sequence and phase the output from the sensor. This is done with a small power amplifier.
You should ensure the LED is not more than 5mm lower than the sensor.

You should ensure the LED is not more than 5mm lower than the sensor.

The requirements for the school's competition are somewhat different. You need to observe the difference between the amount of light reflected from the measuring tape and from the background. This parameter is low but it is sufficient if you take care to position the light source at the floor.

With two HM4010 LEDs, this circuit gives a range of about 10m on DASH. You will get longer range by adding more LEDs, but the effect is not as all-around.

The 47µF electrolytic capacitor is especially necessary; the larger LED currents will cause a large voltage drop on the leads back to the battery. The full LED circuit drives the sensor diode base of a npn power transistor. The transistor provides peak currents of the order of 0.5 Amps.
Another method is to adjust the LED current. Figure 6 shows how to do this on DASH FREE. The SKO trimer can reduce the LED current to a level suitable for the conditions.

You will need to set the threshold accurately and the SKO trimmer has hysteresis. Typically the light level must fall by 65% of the switch-on threshold to turn off; this takes up a lot of the available contrast ratio.

Sensor positioning

Once you have experimented with making sensors you will need to think about the number of sensors needed and where they should be placed.

DASH-1 uses 6 sensors. There are three horizontal long-range sensors to detect if a wall is present at each side of the front and three short-range vertical sensors to detect that the mouse is at the correct distance from that wall.

DASH-2 uses 10 sensors. There are three vertical sensors on each side corresponding to too far, just right, and too close for that wall.

This is a simplified description of the long-range sensors are also wide area sensors.

There are two vertical sensors at the front to detect that DASH-2 is the correct distance from a wall. There is one large horizontal sensor to detect that there is a wall in front of the mouse.

DASH-2 had more sensor inputs. You would have wired several more sensors. When designing your electronic's you should always allow for more sensors than you can possibly imagine you will need, as shortage of sensors is a performance killer for both DASH-1 and DASH FREE.

Our school's competition kit has two sensors mounted at the front. The particular problem with school's Micromouse is that the spacing between the sensor and the wall is critical. With our two-wheel micromouse there is a rocking action as it accelerates or decelerates and this can cause a lot of problems.

These notes are not a comprehensive treatment of the subject but they do outline how I tackle the problem. If you have any questions or comments, please contact me via e-mail: salko@allison.co.uk