## STEP-UP CONVERTER WHITE LED CONSTANT CURRENT DRIVER + OP Pin

### GENERAL DESCRIPTION

The BSC74K1937O is a step-up DC/DC converter specifically designed to drive white LEDs with a constant pre-set current.

The device can drive up to 27 LEDs from a 5V supply.

BSC74K1937O also offers an Overvoltage Protection pin to protect the device in case the load LED are not connected.

The BSC74K1937O is offered in an industry standard SOT-26 package.

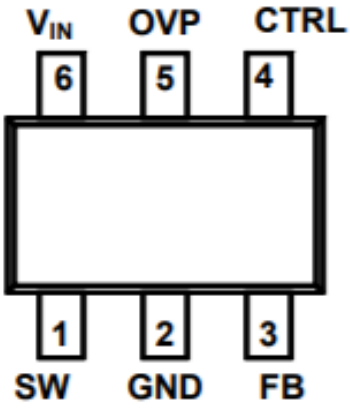
### FEATURES

- **High Efficiency: 84% Typical**
- **36V internal Bipolar Switch**
- **Fast 1.2MHz Switching Frequency**
- **Can drive upto 126 LEDs (9S14P) from a 12V supply**
- **External Matched LED Current**
- **Overvoltage protection at 36V**
- **Low profile TSOT package**

### APPLICATIONS

LED Flashlight
Digital Cameras, MP3 Players
Handheld Electronics

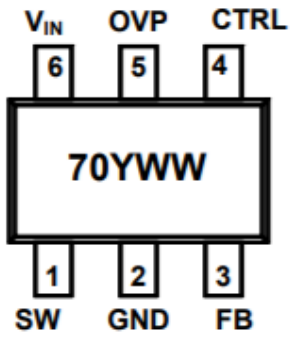
### PIN CONFIGURATION

| Package Designator | Pin Configuration (Top view) |
|---|---|
| SOT-26 |  |

**PIN DESCRIPTION**

| No. | Pin | Description |
|---|---|---|
| 1 | SW | Switch Pin. This is the collector of the internal NPN power switch. Connect to inductor and diode (Minimize trace area at this pin to reduce EMI.) |
| 2 | GND | Ground connection for the IC. |
| 3 | FB | Feedback Pin. Reference voltage is 95 mV. LED current is determined by the $R_{FB}$ resistance and CTRL voltage. (Calculate resistor value according to the formula $R_{FB}$=95 mV / $I_{LED}$ .) |
| 4 | CTRL | This Pin could be used as either shut down or dimming functions: When $V_{CTRL}$ > 1.8V, generates maximum set LED current. When $V_{CTRL}$ < 0.4V, chip is OFF, When 0.4V ≤ $V_{CTRL}$ ≤ 1.8V, PWM duty cycle controls the LED current |
| 5 | OVP | Over Voltage Protection, 30V |
| 6 | $V_{IN}$ | The input supply pin, bypass this pin with a capacitor as close to the device as possible |

**DEVICE MARKING**




**70**: Device Code, Green Product
**Y**: Year
**W**: Week code
**A**: Assembly/testing site

## ABSOLUTE MAXIMUM RATINGS

| Parameter | Symbol | Ratings | Unit |
|---|---|---|---|
| Maximum Supply Voltage | $V_{IN}$ | 20 | V |
| Maximum Voltage at pin SW | $V_{SW}$ | 36 | V |
| Maximum Voltage at pin FB | $V_{FB}$ | 10 | V |
| Maximum Voltage at pin CTRL | $V_{CTRL}$ | 10 | V |
| Continuous Total Power Dissipation – SOT-25 | $P_D$ | 300 | W |
| Junction Temperature | $T_J$ | -40…+125 | °C |
| Storage Temperature | $T_{STG}$ | -65…+150 | °C |
| Lead Temperature (Soldering, 10 sec) | | 260 | °C |

**Note 1:** Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## RECOMMENDED OPERATING CONDITIONS

| Parameter | Symbol | Ratings | Unit |
|---|---|---|---|
| Supply Voltage | $V_{IN}$ | 2.5 …18 | V |
| Output Voltage | $V_{OUT}$ | <28 | V |
| Operating Temperature | $T_{OPR}$ | 0…+70 | °C |

## ELECTRICAL CHARACTERISTICS

$T_A$ = 25°C, VIN = 5V, $V_{CTRL}$ = 5V, unless otherwise noted

| Parameter | Symbol | Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| Operating Voltage Range | $V_{IN}$ | | 2.5 | | 18 | V |
| Feedback Voltage | $V_{FB}$ | $I_{LOAD}$ = 180mA | 80 | 95 | 107 | mV |
| FB Pin Bias Current | $I_{FB}$ | $V_{IN}$ = $V_{OUT}$ + 1V to 16V | 10 | 45 | 100 | nA |
| Supply Current | $I_{CC}$ | | | 2.1 | 3 | mA |
| Standby Current | $I_{STBY}$ | $V_{CTRL}$ = 0V | | 0.1 | 1 | μA |
| Switching Frequency | $f_{OSC}$ | | 1.1 | 1.3 | 1.6 | MHz |
| Maximum Duty Cycle | $D_{MAX}$ | | 85 | 90 | | % |
| Switch Current Limit | $I_{CL}$ | | | 650 | | mA |
| Switch $V_{CESAT}$ | $V_{SAT}$ | $I_{SW}$ = 250mA | | 350 | | mV |
| Switch Leakage Current | $I_{LEAK}$ | $V_{SW}$ = 5V | | 0.01 | 5 | μA |
| CTRL Voltage High | $V_{TH}$ | | 1.5 | | | V |
| CTRL Voltage Low | $V_{TH}$ | | | | 0.4 | V |
| CTRL Pin Bias Current | $I_{CTRL}$ | | | 65 | | μA |
| OVP Threshold | | | | 29 | | V |

**FUNCTIONAL BLOCK DIARGAM**

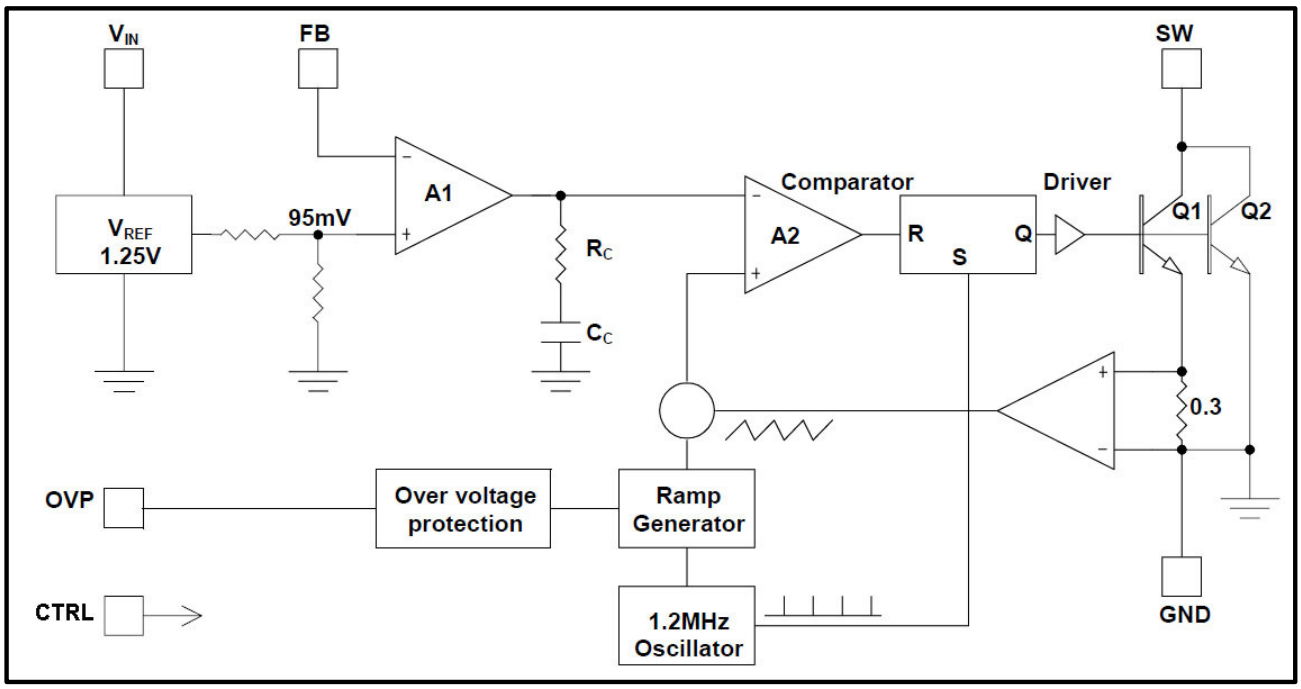



**Figure 1** BSC74K1937O Functional Block Diagram

## APPLICATION INFORMATION

BSC74K1937O uses a constant frequency, current mode control scheme to provide excellent line and load regulations. See Figure 1 for BSC74K1937O device operation and Figure 5 for a typical application circuit. At the start of each oscillator cycle, the RS latch is set, which turns on the power switch Q1. A voltage proportional to the switch current is added to a stabilizing ramp and the resulting sum is fed into the positive terminal of the PWM comparator A2. When this voltage exceeds the level at the negative input of A2, the RS latch is reset turning off the power switch. The voltage level at the negative input of A2 is set by the error amplifier A1, and is simply an amplified version of the difference between the feedback voltage and the reference voltage of 95mV. With this implementation, the error amplifier sets the correct peak current level to regulate the output current. If the error amplifier's output increases, more current is delivered to the output; if it decreases, less current is delivered.

## OVER VOLTAGE AND OPEN CIRCUIT PROTECTION

In case of output open circuit, while the LED strings are disconnected from the circuit or the LEDs fail open, the feedback voltage, $V_{FB}$, will be zero. The BSC74K1937O will then switch at a high duty cycle condition, resulting in a high output voltage, which may cause the SW pin voltage to exceed its maximum voltage rating. In order to prevent occurrence of this condition, the BSC74K1937O integrates a latch-mode open-circuit protection circuit. Based on the reading from the sensing pin, OVP pin, the chip can detect the output open condition when the OVP voltage is higher than 30V. The device will shutdown until $V_{IN}$ is reset.

## INDUCTOR SELECTION

A 10uH inductor is recommended for most BSC74K1937O applications. Although small size and high efficiency are major concerns, the selected inductor should have low core losses at 1.2MHz and low DCR (copper wire resistance).

## CAPACITOR SELECTION

The small size of ceramic capacitors makes them ideal for BSC74K1937O applications. X5R and X7R types are recommended because they retain their capacitance over wider voltage and temperature ranges than other types such as Y5V or Z5U. A 4.7uF input capacitor and a 4.7uF output capacitor are sufficient for most BSC74K1937O applications.

## DIODE SELECTION

Schottky diodes, with their low forward voltage drop and fast reverse recovery, are the ideal choices for BSC74K1937O applications. The forward voltage drop of a Schottky diode represents the conduction losses in the diode while the diode capacitance (CT or CD) represents the switching losses. For diode selection, both forward voltage drop and diode capacitance need to be considered. Schottky diodes with higher current ratings usually have lower forward voltage drop and larger diode capacitance, which can cause significant switching losses at the 1.2MHz switching frequency of the BSC74K1937O. A Schottky diode rated at 1000mA is sufficient for most BSC74K1937O applications.

## SOFT START AND CURRENT LIMIT

The internal soft start circuit minimizes the inrush current during turning on BSC74K1937O. The Typical switch current is limited to about 650mA by the device circuit design.

## LED CURRENT CONTROL

The LED current is controlled by the feedback resistor ($R_{SET}$, in Figure 5). The feedback reference is 95mV. The LED current is 95mV/$R_{SET}$. The formula and Table 1 for $R_{SET}$ selection are shown below. $R_{SET}$=95mV/$I_{LED}$

**Table 1** Resistor Value Selection

| $I_{LED}$ (mA) | $R_{SET}$ (Ω) |
|---|---|
| 5 | 19.1 |
| 10 | 9.53 |
| 12 | 7.87 |
| 15 | 6.34 |
| 20 | 4.75 |
| 60 | 1.56 |
| 375 | 0.22 |

## DIMMING CONTROL

There are four different types of dimming control:

**1. Using a PWM Signal to CTRL Pin**
With the PWM signal applied to the CTRL pin, the BSC74K1937O is turned on or off by the PWM signal. The LED operate at either zero or full current. The average LED current increases proportionally with the duty cycle of the PWM signal. A 0% duty cycle will turn off the BSC74K1937O and corresponds to zero LED current. A 100% duty cycle corresponds to full current. The typical frequency range of the PWM signal is 100Hz to 1KHz. The magnitude of the PWM signal should be higher than the minimum $V_{CTRL}$ = high.

**2. Using a DC Voltage**
For some applications, the preferred method of brightness control is a variable DC voltage to adjust the LED current. The dimming control using a DC voltage is shown in below Figure 2. As the DC voltage increases, the voltage drop on R3 increases and the voltage drop on $R_{SET}$ decreases. Thus, the LED current decreases. The selection of R2 and R3 should make the current from the variable DC source much smaller than the LED current and much larger than the FB pin bias current. For $V_{DC}$ range from 0V to 2V, the

selection of resistors in below figure gives dimming control of LED current from 0mA to 15mA.

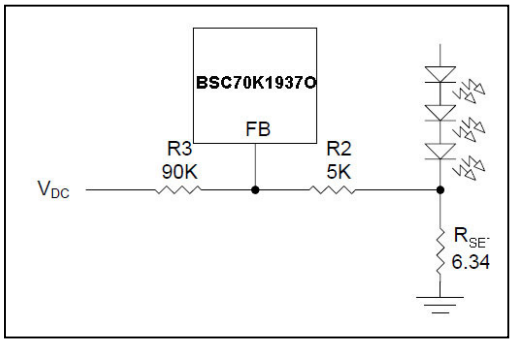



**Figure 2** Dimming Control Using a DC Voltage

**3. Using a Filtered PWM Signal**

The filtered PWM signal can be considered as an adjustable DC voltage. It can be used to replace the variable DC voltage source in dimming control. The circuit is shown in Figure 3.

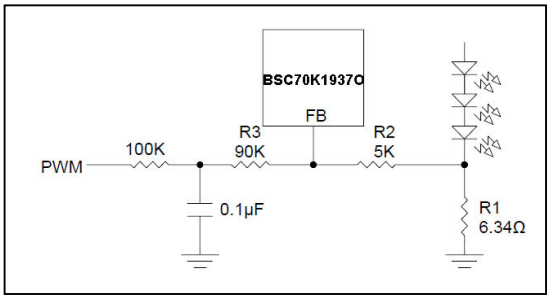



**Figure 3** Dimming Control Using a Filtered PWM Signal

**4. Using a Logic Signal**

For applications that need to adjust the LED current is discrete steps, a logic signal can be used as shown in Figure 4. $R_{SET}$ sets the minimum LED current (when the NMOS is OFF). $R_{INC}$ sets how much the LED current increases when the NMOS is turned on. The selection of $R_{SET}$ can be found in Table 1.

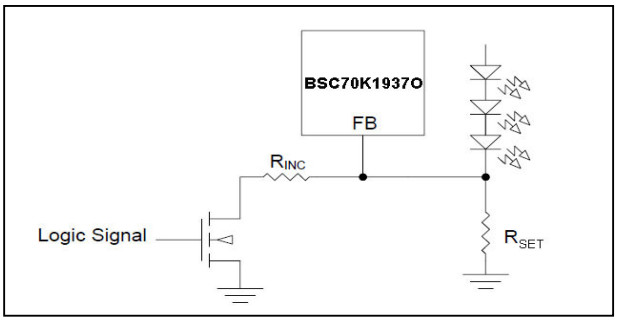



**Figure 4** Dimming Control Using a Logic Signal

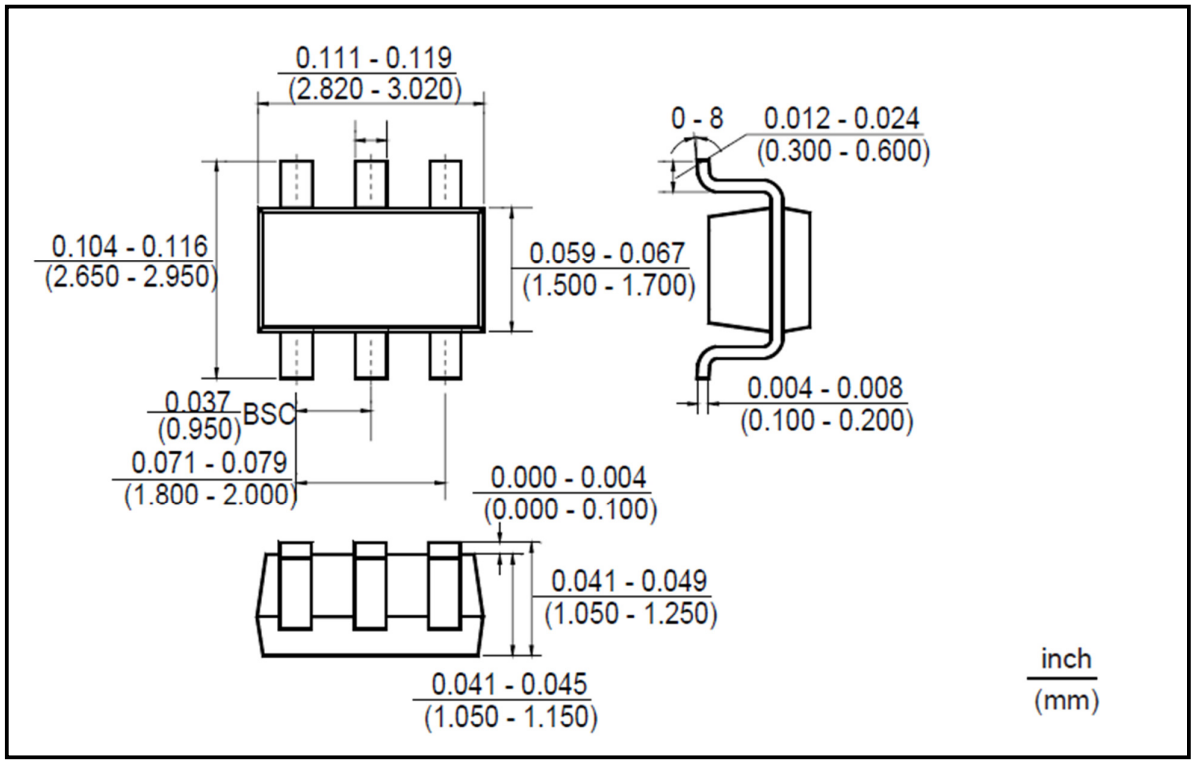
**BOARD LAYOUT CONSIDERATIONS**

As with all switching regulators, careful attention must be paid to the PCB board layout and component placement. To maximize efficiency, the rising and falling times of the switch are made as short as possible.

To prevent electromagnetic interference (EMI) problems, proper layout of the high frequency switching path is essential. The voltage signal of the SW pin has sharp rising and falling edges. Minimize the length and area of all traces connected to the SW pin and always use a ground plane under the switching regulator to minimize inter-plane coupling. In addition, the ground connection for the feedback resistor $R_{SET}$ should be tied directly to the GND pin and not shared with any other component, ensuring a clean, noise-free connection.

## PACKAGE INFORMATION

### PACKAGE OUTLINE DIMENSIONS
**SOT-26**



## TYPICAL APPLICATION CIRCUIT

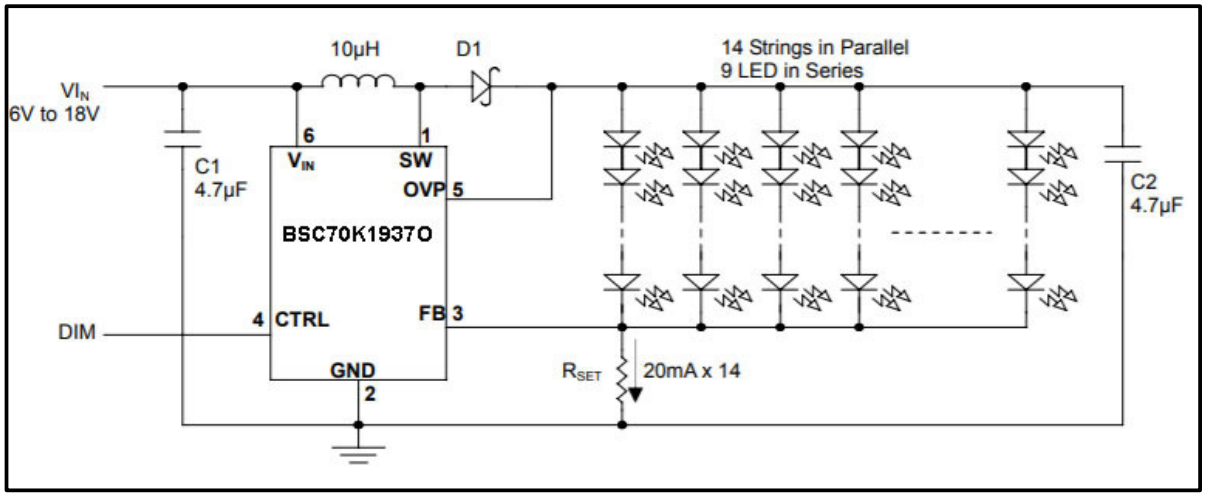



**Figure 5** BSC74K1937O Typical Application Circuit

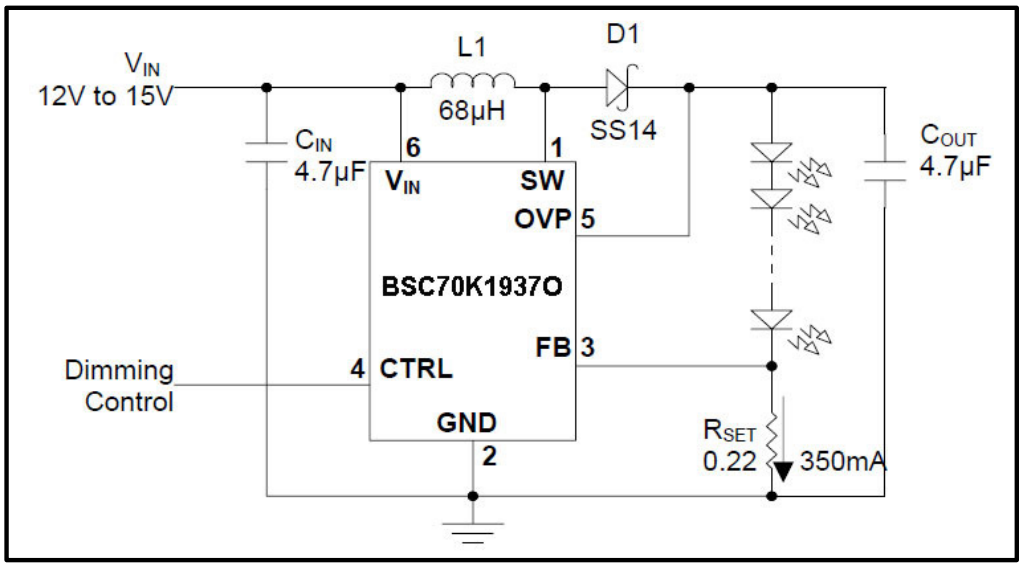



**Figure 6** BSC74K1937O Typical Application Circuit - application for 1W LED x 6

**ORDERING INFORMATION**

| BSC | 70K | 1937O | ST26 | R | G |
|---|---|---|---|---|---|
| BRAVE Semiconductor Corporation | LED Driver Product Family | Circuit Type | Device Package ST26: SOT 26 | Shipping Type R: Tape & Reel | Blank:Pb-free G:Green |

Note:

**Pb-free products:**

- RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.
- Suitable for use in SnPb or Pb-free soldering processes with 100% matte tin (Sn) plating.

**Green products:**

- Lead-free (RoHS compliant)
- Halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight)

**Operating Temperature Range: 0°C To +70°C**

| Order Part No. | Package | QTY/Reel |
|---|---|---|
| BSC74K1937OST26RG | SOT-26, Lead-free | 3000 Units Per Tape / Reel |

**REVISION HISTORY**

| Revision | Detail Information | Date |
|---|---|---|
| A | Initial Release | 2021.03.08 |