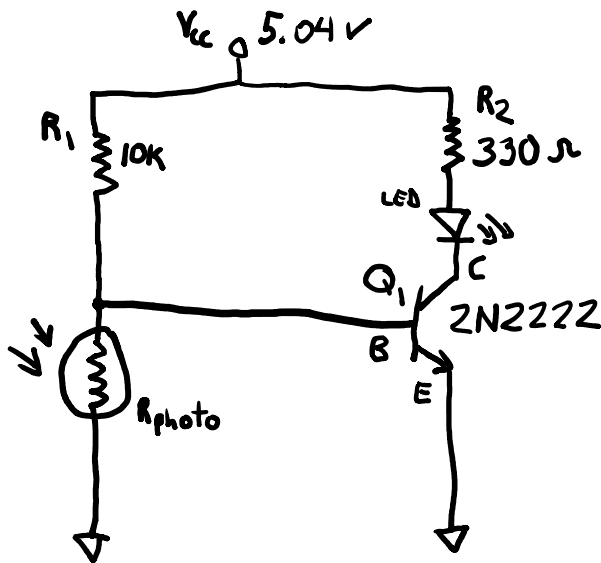


Build a Night-Light Circuit



$$V_B = V_{CC} \times \frac{R_{photo}}{R_1 + R_{photo}}$$

Daylight LED OFF

$$V_B = 5.04 \times \frac{1K}{(10K + 1K)}$$

$$V_B = 5.04 \times \frac{1}{11}$$

$$V_B = 0.46V$$

Dark LED ON

$$V_B = 5.04 \times \frac{100K}{(10K + 100K)}$$

$$V_B = 5.04 \times \frac{100}{110}$$

$$V_B = 4.58V \text{ (unloaded)}$$

$$\text{measured } V_B = 0.70V$$

calculated R_2

$$R_2 = \frac{V_{CC} - V_{LED} - V_{CE(sat)}}{I_{LED}} = \frac{V_{R2}}{I_{LED}}$$

$$R_2 = \frac{5.04 - 2.0 - 0.2}{0.010} = 284 \text{ ohms}$$

(The closest Value I had was 330 ohms.)

KVL:

$$V_{CC} - V_{R2} - V_{LED} - V_{CE(sat)} = 0$$

$$V_{R2} = V_{CC} - V_{LED} - V_{CE(sat)}$$

$$V_{LED} = 1.98V - 0.02V = 1.96V$$

$$V_{R2} = 5.04V - 1.98V = 3.06V$$

$$I = \frac{3.06V}{330} = 0.00927 = 9.27mA$$

$$I_B = 10mA$$

$$V_{CC} = 5.04V$$

$$V_{LED} = 2.0V$$

$$V_{CE} = 0.2V$$

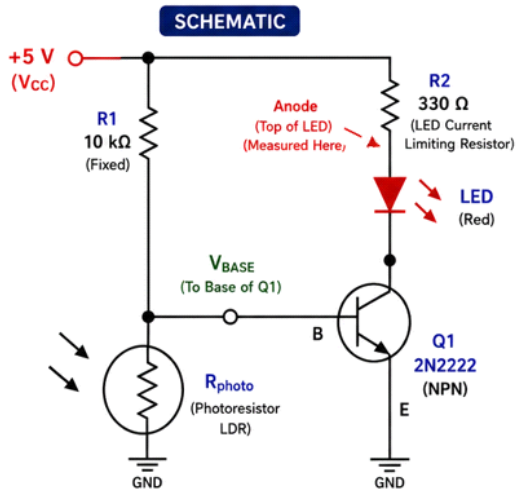
$$V_{CC} = 5.04V$$

$$V = IR$$

$$I = \frac{V}{R}$$

NIGHT-LIGHT CIRCUIT

SCHEMATIC & MEASURED DATA (LED ON in DARK, LED OFF in BRIGHT)



COMPONENT VALUES

R1	=	10 kΩ	(Fixed Resistor)
Rphoto	=	Photoresistor (LDR)	
		Bright Light ~ 1 kΩ	
		Dark (Covered) ~ 100 kΩ	
R2	=	330 Ω	(LED Resistor)
LED	=	Red LED ($V_F \approx 2.0$ V)	
Q1	=	2N2222 NPN Transistor	
Vcc	=	+5 V DC	(Measured ≈ 5.04 V)

HOW IT WORKS



- In **DARK**: LDR resistance is high (~100 kΩ)
 - Base voltage rises (~0.7 V)
 - Transistor turns ON (saturates)
 - Current flows through R2 and LED → LED ON
- In **BRIGHT**: LDR resistance is low (~1 kΩ)
 - Base voltage drops (~0.43 V)
 - Transistor stays OFF (cutoff)
 - No current through LED → LED OFF



DARK (Covered)
LED ON

MEASURED DATA - DARK CONDITION

Point / Quantity	Symbol	Measured Value	Notes
Supply Voltage	V_{CC}	5.04 V	At +5 V rail
Base Voltage	V_B	0.70 V	At base of Q1
Collector Voltage	V_C	0.02 V	At collector (LED cathode)
LED Anode Voltage	$V_{LED} \text{ (anode)}$	1.98 V	Top of LED (above LED)
LED Forward Voltage	$V_F \text{ (LED)}$	1.96 V	$\approx 1.98 \text{ V} - 0.02 \text{ V}$
Collector Current	I_C	9.36 mA	Measured

CALCULATIONS (DARK CONDITION)

Voltage across R2:

$$\begin{aligned} V_{R2} &= V_{CC} - V_{LED(\text{anode})} \\ &= 5.04 \text{ V} - 1.98 \text{ V} \\ &= 3.06 \text{ V} \end{aligned}$$

Collector (LED) current (through R2):

$$I = \frac{V_{R2}}{R_2} = \frac{3.06}{330} = 9.27 \text{ mA}$$

Measured $I_C = 9.36 \text{ mA}$ (very close to calculated 9.27 mA)



BRIGHT (Daylight)
LED OFF

MEASURED DATA - BRIGHT CONDITION

Point / Quantity	Symbol	Measured Value	Notes
Supply Voltage	V_{CC}	5.04 V	At +5 V rail
Base Voltage	V_B	0.43 V	At base of Q1
Collector Voltage	V_C	3.52 V	At collector (LED cathode)
LED Anode Voltage	$V_{LED} \text{ (anode)}$	5.05 V	Top of LED (above LED)
LED Voltage (Anode-Cathode)	V_{LED}	1.31 V	Measured across LED
Collector Current	I_C	0 mA	Measured

CALCULATIONS (BRIGHT CONDITION)

LED voltage (measured):

$$V_{LED} = 1.31 \text{ V}$$

This is below the typical red LED forward voltage (~1.9 – 2.0 V), so the LED remains OFF.

Collector current:

$$I_C \approx 0 \text{ mA}$$

The transistor is OFF (cutoff). Only tiny leakage current flows, not enough to light the LED.

SUMMARY

DARK (LED ON)

- ✓ $V_B = 0.70 \text{ V}$
- ✓ $V_C = 0.02 \text{ V}$
- ✓ $V_{LED} = 1.96 \text{ V}$
- ✓ $I_C = 9.36 \text{ mA}$
- ✓ LED = ON

BRIGHT (LED OFF)

- ✓ $V_B = 0.43 \text{ V}$
- ✓ $V_C = 3.52 \text{ V}$
- ✓ $V_{LED} = 1.31 \text{ V}$
- ✓ $I_C = 0 \text{ mA}$
- ✓ LED = OFF

KEY TAKEAWAY



This simple circuit automatically turns an LED ON at night and OFF during the day by using an LDR to sense light and a transistor as a switch.