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LABORATORY

Microcontroller

5

EXPERIMENT:

Seven Segment Counter

1 Seven Segment Display

A Seven-segment displays is a cheap method to display numbers 0-9 using only 7 LEDs (or light bulbs). The segments are named A to G and DP for “decimal point”. See Figure 1.

For displaying a zero the segments must to be set to:

A=1, B=1, C=1, D=1, E=1, F=1, G=0

1.1 The "breadboard"

Today you will use a so called ”breadboard” for plugging the circuits, see Figure 2.

A breadboard is often used for prototyping small circuits. The bread board is broken up into positive (+) and negative (-) ”power rails” which span the height of the board. The positive rails are colored in Red, while the negative rails are colored in Blue. These rails are internally connected vertically. In the middle of the bread board are multiple groups of holes organized in vertical columns and numbered every 5 (for reference). Each group consists of 5 pin sockets wired together horizontally. These groups are not connected over the middle horizontal break of the board, nor do they connect vertically.

1.2 Kingbright Sx39-11

The display, we are going to use is a Kingbright Sx39. A snippet from the datasheet is in Figure 3 and Figure 4.

Please note: We have the SA39 and the SC39 in the lab. Check what you get, this two devices are different!

Read the datasheet! We want to operate the LEDs at a maximum of 6 mA. Since you attended the analog electronics lab, you should know how to limit the current through an LED. Calculate with an LED forward voltage from 2V. The datasheet is appended to this document at page 5. The resisors in the boxes are good to limit the current for the LED’s.

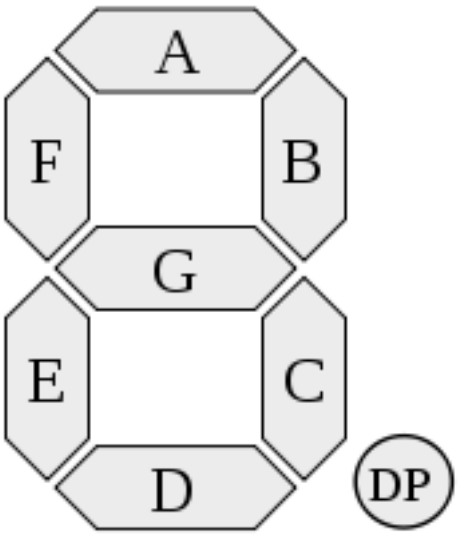


Figure 1: Seven Segment Display

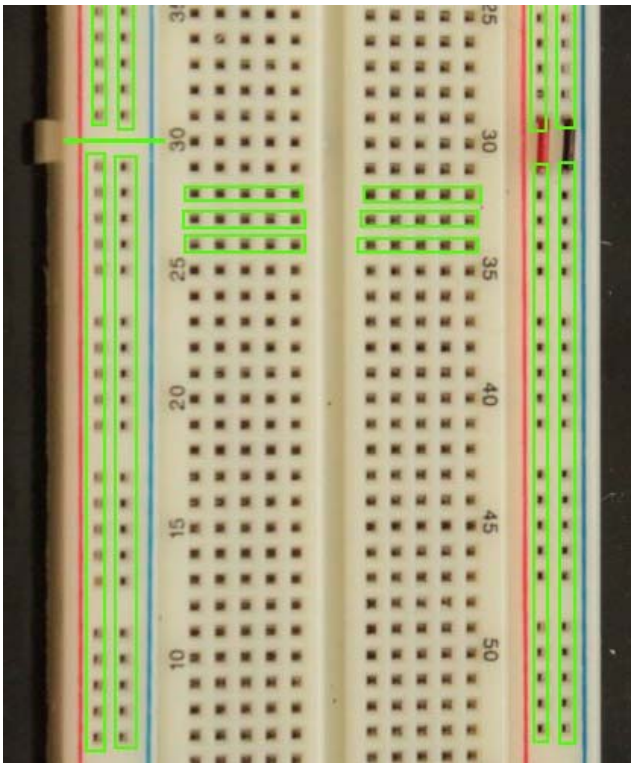


Figure 2: "Breadboard"

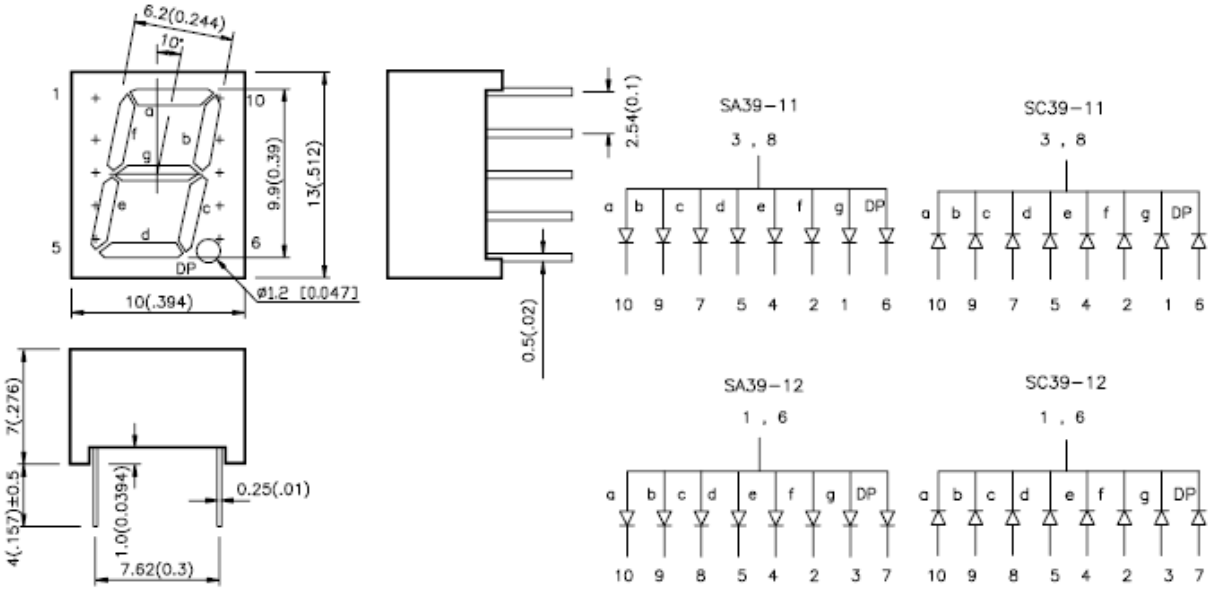


Figure 3: SC39-11

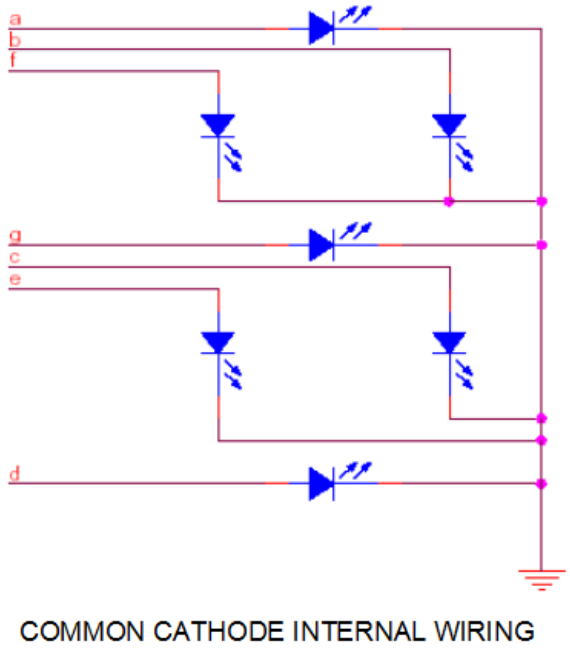


Figure 4: SC39-11

2 Seven Segment Counter

Task 1:
What we want at the end of this task is a working “counter”, see Figure 5.

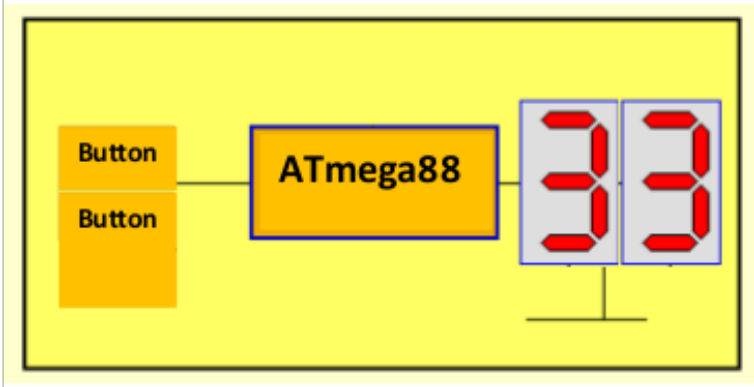


Figure 5: Counter with seven segment display

There should be a button as input and a seven segment display showing the number (0 to 99) of switch operations. This looks very simple, but you will get a few typical problems like:

- contact bouncing
- signal edge evaluation
- bit manipulations
- counting / limits

The displays will be mounted on a breadboard. You can find a short explanation of a breadboard in 1.1. Please try to become familiar with this device. If the provided information is not sufficient, use additional material from the Internet.

If the counter with one button works fine, add a second button for counting up and down. If both buttons are pressed the counter should reset to zero.

There is a template, read this program first, understand and complete it.

You have to write/complete a function to set the outputs. Please use for the input:

- **Key 1 (up):** PC2
- **Key 2 (down):** PC3

and for the output (see Figure 6):

	MyAVR	Sx39-11 Pin
A	PD7	10
B	PD6	9
C	PD5	7
D	PB4	5
E	PB5	4
F	PC0	2
G	PC1	1
A	PD4	10
B	PD3	9
C	PD2	7
D	PB0	5
E	PB1	4
F	PB2	2
G	PB3	1
	Hi/Lo	3,8

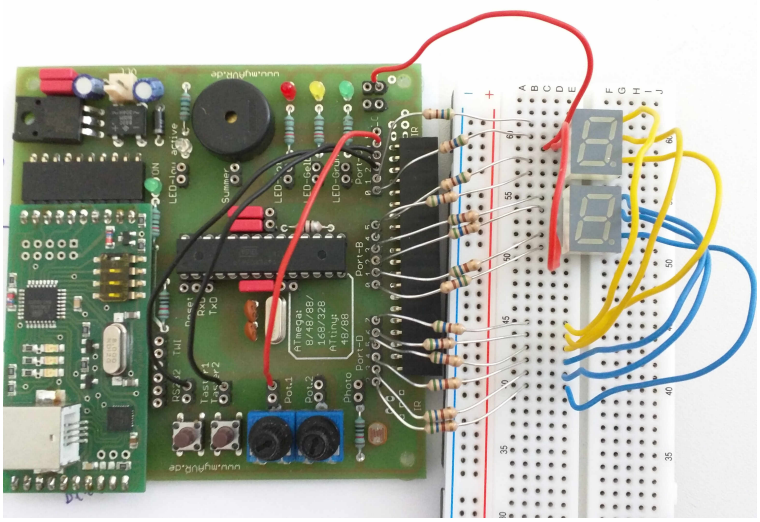


Figure 6: Dual sevensegment counter

Task 2 (Optional):
Use one analog to digital converter to create a simple voltmeter. Measure the voltage from a potentiometer. The output over the seven segment can only show two digits, so only display a rounded value ($0.1V$ steps).

Please use for the input:

- **Analog:** PC4

3 Appendix

Datasheet: Kingbright® Sx39

Kingbright®

9.9mm (0.39INCH) SINGLE DIGIT NUMERIC DISPLAYS

SA39-11 SC39-11

SA39-12 SC39-12

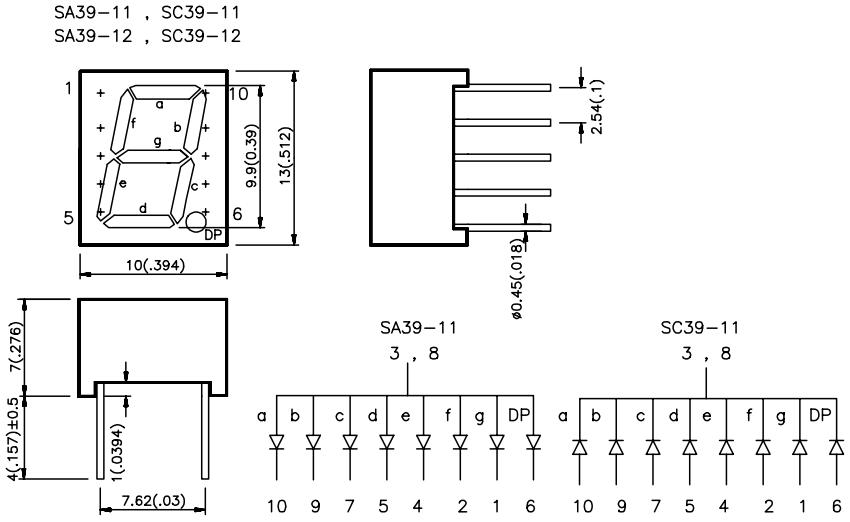
Features

- ●0.39 INCH DIGIT HEIGHT.
- ●LOW CURRENT OPERATION.
- ●EXCELLENT CHARACTER APPEARANCE.
- ●EASY MOUNTING ON P.C. BOARDS OR SOCKETS.
- ●I.C. COMPATIBLE.
- ●CATEGORIZED FOR LUMINOUS INTENSITY,
- ●YELLOW AND GREEN CATEGORIZED FOR COLOR.
- ●MECHANICALLY RUGGED.
- ●STANDARD : GRAY FACE, WHITE SEGMENT.

Description

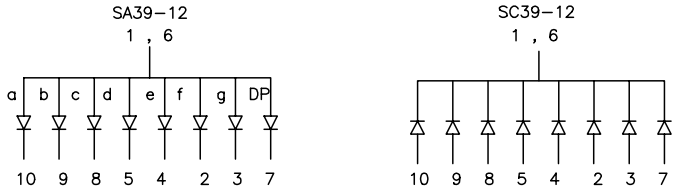
The Bright Red source color devices are made with Gallium Phosphide Red Light Emitting Diode.
The Green source color devices are made with Gallium Phosphide Green Light Emitting Diode.
The High Efficiency Red source color devices are made with Gallium Arsenide Phosphide on Gallium Phosphide Orange Light Emitting Diode.
The Yellow source color devices are made with Gallium Arsenide Phosphide on Gallium Phosphide Yellow Light Emitting Diode.
The Super Bright Red source color devices are made with Gallium Aluminum Arsenide Red Light Emitting Diode.

Package Dimensions & Internal Circuit Diagram



Notes:
1. All dimensions are in millimeters (inches), Tolerance is ±0.25(0.01")unless otherwise noted.
2. Specifications are subjected to change whitout notice.

Internal Circuit Diagram



Selection Guide

Part No.	Dice	Iv (ucd) @ 10 mA		Description
		Min.	Max.	
SA39-11HWA SA39-12HWA	BRIGHT RED (GaP)	560	2200	Common Anode
SC39-11HWA SC39-12HWA				Common Cathode
SA39-11EWA SA39-12EWA	HIGH EFFICIENCY RED (GaAsP/GaP)	2200	9000	Common Anode
SC39-11EWA SC39-12EWA				Common Cathode
SA39-11GWA SA39-12GWA	GREEN (GaP)	1400	5600	Common Anode
SC39-11GWA SC39-12GWA				Common Cathode
SA39-11YWA SA39-12YWA	YELLOW (GaAsP/GaP)	1400	5600	Common Anode
SC39-11YWA SC39-12YWA				Common Cathode
SA39-11SRWA SA39-12SRWA	SUPER BRIGHT RED (GaAlAs)	9000	31000	Common Anode
SC39-11SRWA SC39-12SRWA				Common Cathode

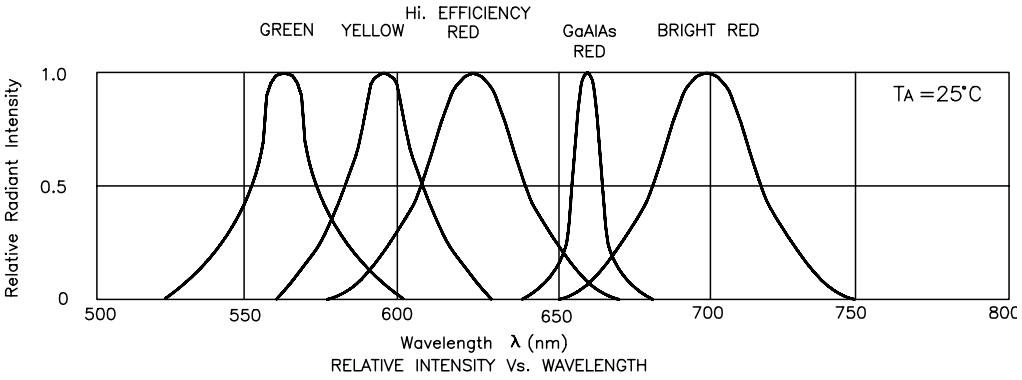
Electrical / Optical Characteristics at T_A=25°C

Symbol	Parameter	Device	Typ.	Max.	Units	Test Conditions
λ_{peak}	Peak Wavelength	Bright Red High Efficiency Red Green Yellow Super Bright Red	700 625 565 590 660		nm	IF=20mA
$\Delta\lambda_{1/2}$	Spectral Line Halfwidth	Bright Red High Efficiency Red Green Yellow Super Bright Red	45 45 30 35 20		nm	IF=20mA
C	Capacitance	Bright Red High Efficiency Red Green Yellow Super Bright Red	40 12 45 10 95		pF	VF=0V;f=1MHz
V_F	Forward Voltage	Bright Red High Efficiency Red Green Yellow Super Bright Red	2.0 2.0 2.2 2.1 1.85	2.5 2.5 2.5 2.5 2.5	V	IF=20mA
I_R	Reverse Current	All	10		uA	VR = 5V

Absolute Maximum Ratings at T_A=25°C

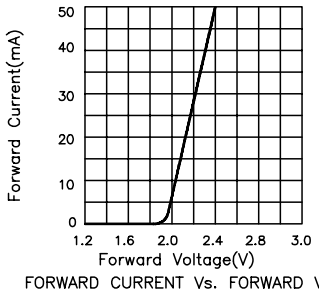
Parameter	Bright Red	High Efficiency Red	Green	Yellow	Super Bright Red	Units
Power dissipation	120	105	105	105	100	mW
DC Forward Current	25	30	25	30	30	mA
Peak Forward Current [1]	150	150	150	150	150	mA
Reverse Voltage	5	5	5	5	5	V
Operating/Storage Temperature	-40° C To +85 ° C					
Lead Soldering Temperature [2]	260° C For 5 Seconds					

Notes:
1.1/10 Duty Cycle, 0.1ms Pulse Width.
2. 4mm below package base.

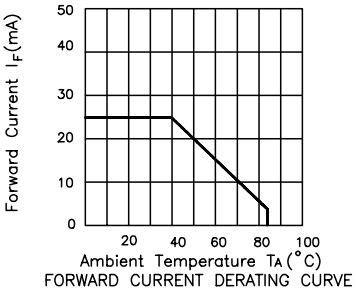


RELATIVE INTENSITY Vs. WAVELENGTH

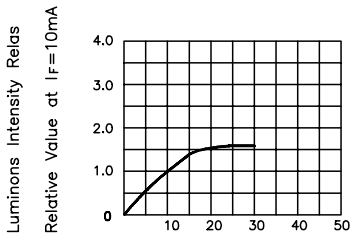
Bright Red



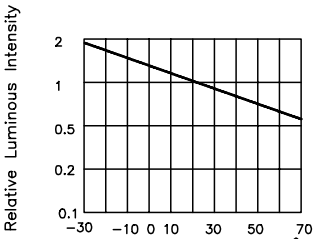
FORWARD CURRENT Vs. FORWARD VOLTAGE



FORWARD CURRENT DERATING CURVE

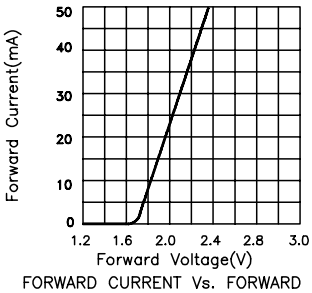


LUMINOUS INTENSITY Vs. FORWARD CURRENT



LUMINOUS INTENSITY Vs. AMBIENT TEMPERATURE

High Efficiency Red



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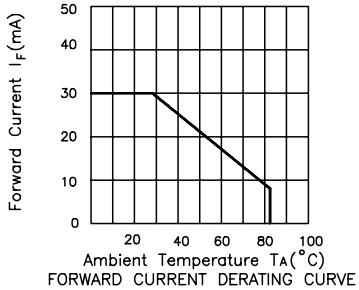

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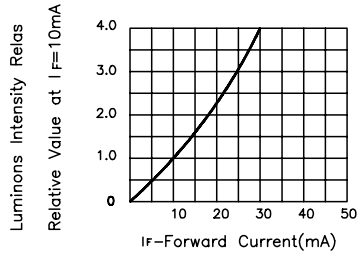
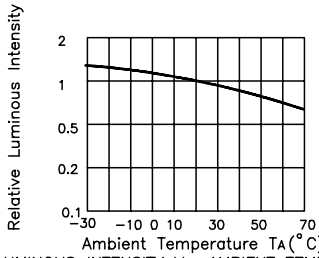
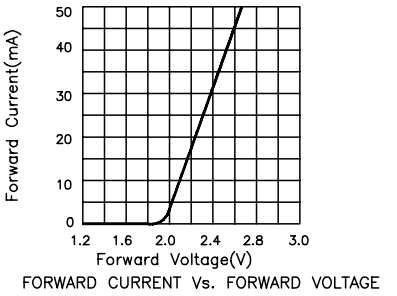


LUMINOUS INTENSITY Vs. FORWARD CURRENT



LUMINOUS INTENSITY Vs. AMBIENT TEMPERATURE

Green



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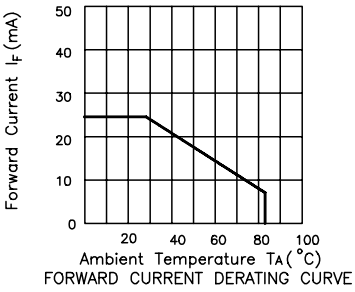

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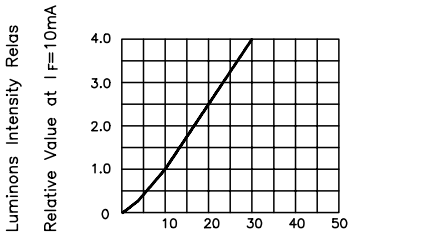
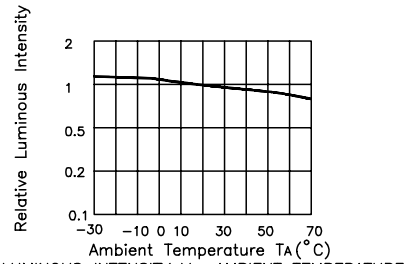
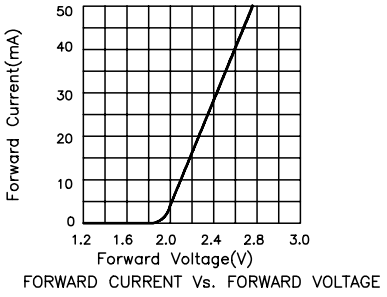


LUMINOUS INTENSITY Vs. FORWARD CURRENT



LUMINOUS INTENSITY Vs. AMBIENT TEMPERATURE

Yellow



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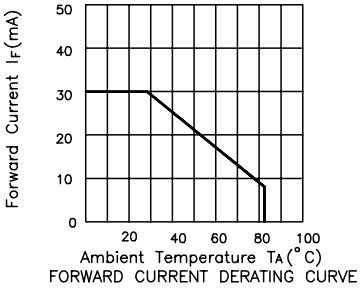

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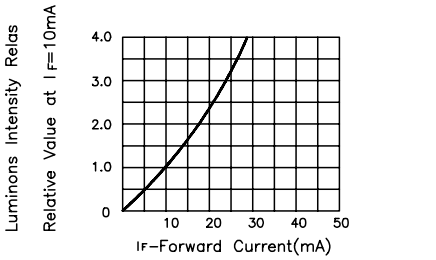

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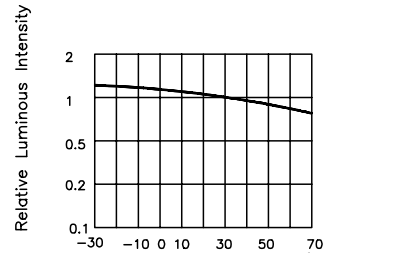
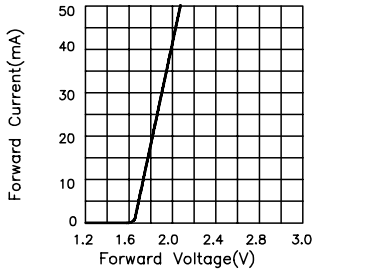


LUMINOUS INTENSITY Vs. AMBIENT TEMPERATURE

Super Bright Red



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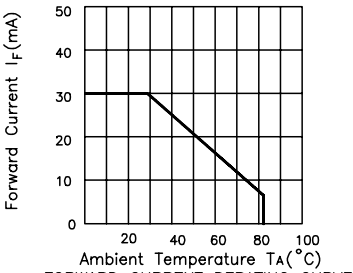

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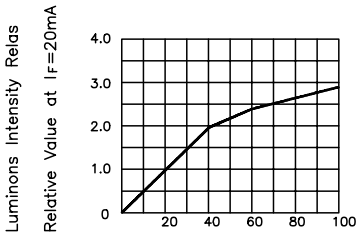
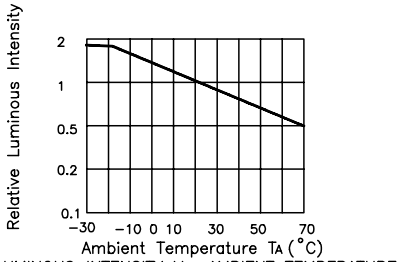


LUMINOUS INTENSITY Vs. FORWARD CURRENT



LUMINOUS INTENSITY Vs. AMBIENT TEMPERATURE