Locus Engineering Inc E2762

LED Tester

FEATURES

- **Characterize LEDs and PN devices for current, voltage, and light intensity**
- **0-120.0mA adjustable current source with 0.1mA resolution**
- **0-4.950V Vf measurement**
- **Measures light intensity according to human eye response over 5 decades (optional)**
- **Selectable min/max If currents**
- **Calculates series current limiting resistor**
- **Setup parameters are saved**
- **Scan function with 57.6Kbaud serial output**
- **X-Y Plot of If-Vf for oscilloscope**
- **Backlit LCD display**
- **9V 200mA power**
- **5.5/2.1mm DC jack**
- **70g, 3.6"L 2.2"W1.8"H**

DESCRIPTION

The E2762 LED Tester allows LEDs to be easily characterized for brightness and for matching different color intensities. A simple setup menu allows the current range, driver Rds or Vce values, and design supply voltage to be set. Parameters can be saved to internal flash memory. In Run mode, the LED current is manually adjustable between the setpoints in 0.1mA or 1.0mA steps. The test current can also be quickly switched between the minimum and maximum setpoints. The Scan mode provides a serial output of results as the test current is incremented between the setpoints. The Plot mode provides a continuous X-Y DAC output of test current and forward voltage to an oscilloscope. LED intensity approximating the human eye response can also be measured over 5 decades. The series current limiting resistor value is automatically calculated as the test current is varied.

APPLICATIONS

- Engineering development
- Production testing

Table 1. Electrical Characteristics

Test Conditions: Supply Voltage V_{dd} = +9.0V, $T_{ambient}$ = 25° C, unless otherwise specified

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{dd}	Supply voltage	8.5	9.0	10V	V
I_{dd}	Supply current	20		140	mA
I_{test}	Output test current	0.0		120.0	mA
V_f	Measured forward voltage range	0.0		4.950	V
E_e	Measured light intensity range (Irradiance) TSL235R	0.00		430	μW/cm^2
Baud Rate	Serial port baud rate		57.6		Kbaud
$V_{O\ DAC}$	Plot DAC Output Voltage	0.000		1.200	V
$R_{L\ DAC}$	Plot DAC Load Resistance	2.4			KΩ
$T_{operate}$	Operating temperature	-10		+30	°C

General Precautions

Charged devices and circuit boards can discharge without warning. Proper ESD precautions should be followed to avoid failure.

This device is not authorized for use in any product where the failure or malfunction of the product can reasonably be expected to cause failure in a life support system or to significantly affect its operation.

Locus Engineering Inc. reserves the right to make changes at any time without notice to improve product features or reliability.

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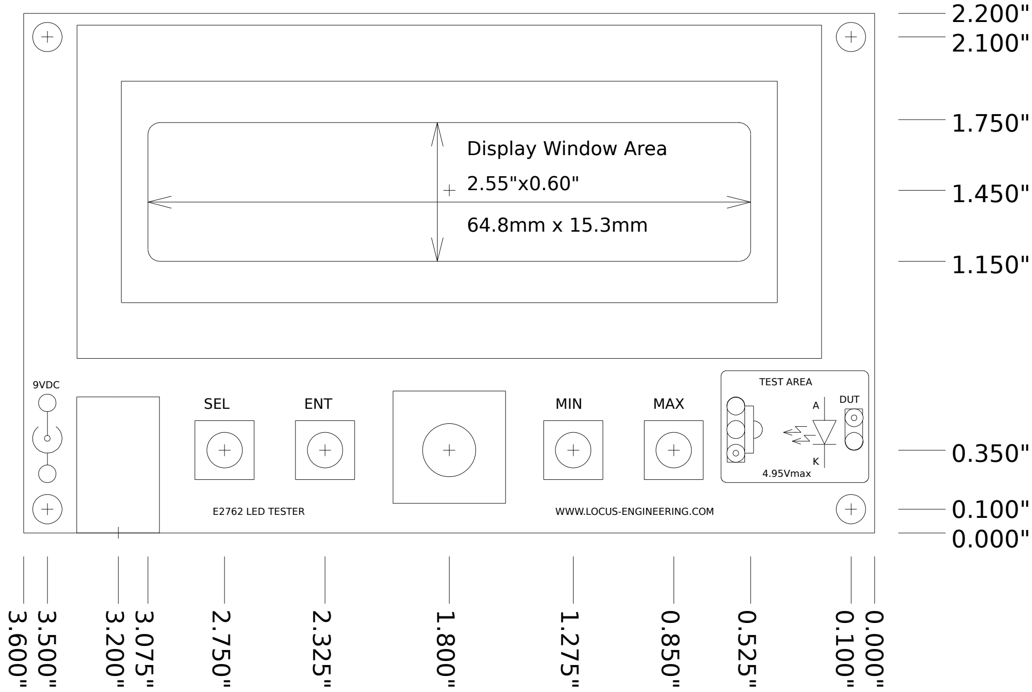


Figure 1 Dimensions including switch centers and display window

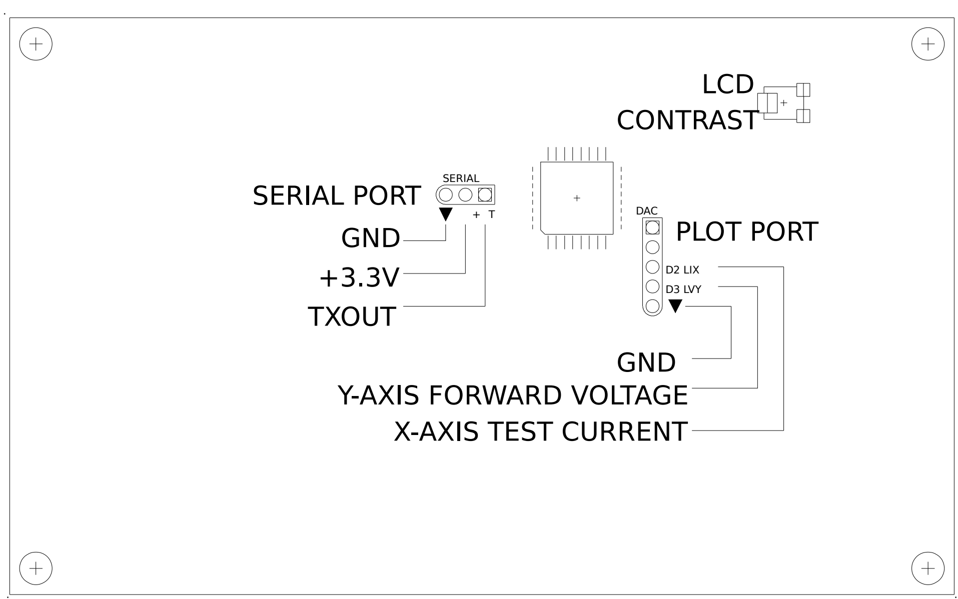


Figure 2. Port Pinouts & LCD Contrast, PCB backside

Functional Description

The E2762 LED Tester includes a 12 bit programmable current source for driving the LED under test, a 12 bit voltmeter for measuring the LED forward voltage, and an optional human eye response compensated light intensity sensor for measuring the LED output. The LED test current can be varied between the user selected minimum and maximum setpoints. The LED can be tested manually in Run Mode, or automatically in either Scan (with serial port output) or Plot (with X-Y DAC outputs) Modes. The Select and Enter keys are used for menu navigation, the rotary encoder is used for user settings, and the Min/Max keys used to quickly set the LED current to the minimum/maximum settings.

The programmable current source to the LED can be varied between 0.0mA and 120.0mA with 12 bit resolution. The LED forward voltage is measured with a 12 bit ADC over a 0.0V to 4.950V range. When there is no load across the LED test terminals, a 5.1V zener diode limits the ADC input voltage and turns off the current source. No damage results from a shorted load as the load current is limited.

The E2762 LED Tester can also be used to characterize other PN junction devices such as germanium, Schottky, or silicon diodes up to 4.95Vf and 120mA test current.

Of note are the separate circuit ground and the power input ground used in this circuit. The circuit ground is one diode drop above the power input ground- this allows the op amps (whose negative rail is connected to power input ground) extra headroom when measuring or outputting signals near circuit ground. The X-Y DAC output ground is at circuit ground potential, so this needs to be taken into consideration when interfacing to external op amps. External op amps should have their negative supply connected to the DC power input return.

The optional TSL235 light intensity sensor provides a linear ~0.6KHz/μW/cm^2 frequency output compensated for human eye response. This frequency is measured and converted to the intensity units format. The human eye is suitable for most test applications when determining an appropriate LED brightness. For repeatable testing, the TSL235 sensor is recommended, and this should be used in a light shielded enclosure with the LED under test. See the Test Area section for additional information.

Several variables affect the perceived brightness of an LED. The human eye spectral response perceives green more than red or blue for example. LEDs also have different luminous efficacies and have their own spectral response. LED brightness is linearly proportional to current so using a variable current source allows the suitable brightness to be found, and also allows the series current limiting resistor to be calculated. The emission angle also affects the brightness, with narrow beam LEDs having a higher light intensity than a wider focussed LED.

The E2762 LED Tester calculates the series current limiting resistor using the intended supply voltage Vs, LED current at the desired brightness, the associated voltage drop across the LED at the test current, and either a bipolar transistor's collector to emitter saturated on-voltage Vce or a FET switch's "on-resistance" Rds according to these equations:

Rlim=(Vs-Vf-Vce)/If	or	Rlim=(Vs-Vf-If*Rds)/If
Bipolar transistor		FET

Mounting Considerations

The E2762 LED Tester can be mounted using #4 or 2.5mm hardware. Refer to Figure 1 for dimensions and center locations for the switches, connectors, and display. The rotary encoder knob is easily removed if the unit is to be mounted behind a panel.

Hardware Descriptions

Power
A 9V power supply is required capable of at least 250mA. Exceeding the supply voltage input will cause overheating in the current source pass element. The DC power input jack accepts a center positive 2.1mm/5.5mm plug. Note that the circuit ground is one diode drop above the power supply ground. This is to provide the op-amps negative supply with -0.7V which allows better linearity when the input or outputs are operating near ground. A 3.3V regulator runs the microcontroller and display while the 9V runs the programmable current source.

LCD Display
The display is a two line 16 character backlit LCD. It is used to navigate the menu, setup parameters, and monitor results.

LCD Contrast
The LCD display contrast can be adjusted with a small 1/16" or 1.6mm wide flat screwdriver behind the board.

Select Key
The Select Key is used to navigate between menu screens and adjust some settings.

Enter Key
The Enter Key is used to enter a menu screen and accept settings.

Rotary Encoder
The rotary encoder allows settings to be adjusted. Pressing the knob toggles the built in switch which selects between the slow or fast settings adjustment rate.

Min Key
This key sets the current source to the minimum user setting when in Run Mode.

Max Key
This key sets the current source to the maximum user setting when in Run Mode.

Test Area
The Test Area includes a connector space for the optional TSL235 light intensity detector and a connector space for the LED under test. Due to the large number of LED types and measurement setups possible, this area is best customized by the user to suit their needs. The TSL235 connection and the LED/device under test connection are on separate 0.1"/2.54mm pin spacings.
The TSL235 sensor and LED under test should be in an ambient light protected enclosure for best results. Keep any cables to a remote test area short, and shield the TSL235 output from the current source to the LED under test. Fluorescent light which fluctuates at 100/120Hz will cause variations in readings from the sensor so a "DC" ambient light source is best if no protective enclosure is available. The "DC" ambient light reading can then be subtracted from the readings measuring LED intensity. Since ambient light can vary greatly, it is best to put the sensor and LED in a light shielded enclosure for consistent results.

Serial Port
A 57.6Kbaud TTL serial port on a 3x2.0mm connector is available behind the board. Note that is it unbuffered and requires a MAX3232 or equivalent RS232 driver to interface it to the external world. The connector provides Ground, +3.3V, and TxOut. Care should be provided in making this connection. Keep leads and external circuitry nearby. This output is active during the Scan function.

X-Y DAC Plot Port
Two DAC outputs are provided on a 5x2.00mm connector behind the board. The D2 LIX pin represents the LED current , and the D3 LVY pin represents the LED forward voltage. These outputs are unbuffered with low drive capability (R_L>2.4KΩ), and require an oscilloscope for viewing. The DAC output voltage ranges between 0.0V and 1.2V with 12 bit resolution. Care should be provided in making this connection. This output is active during the Plot function. Using a 41.25 ohm 1W resistor (4.950V/120mA) in place of the LED under test allows the full output range to be seen as a straight line on an oscilloscope. Note that DAC ground is one diode drop above power input ground so if external op amps are to be used, ensure their negative supply pins use either the power input ground or a more negative supply. This maintains op amp output linearity when the DAC output is near circuit ground.

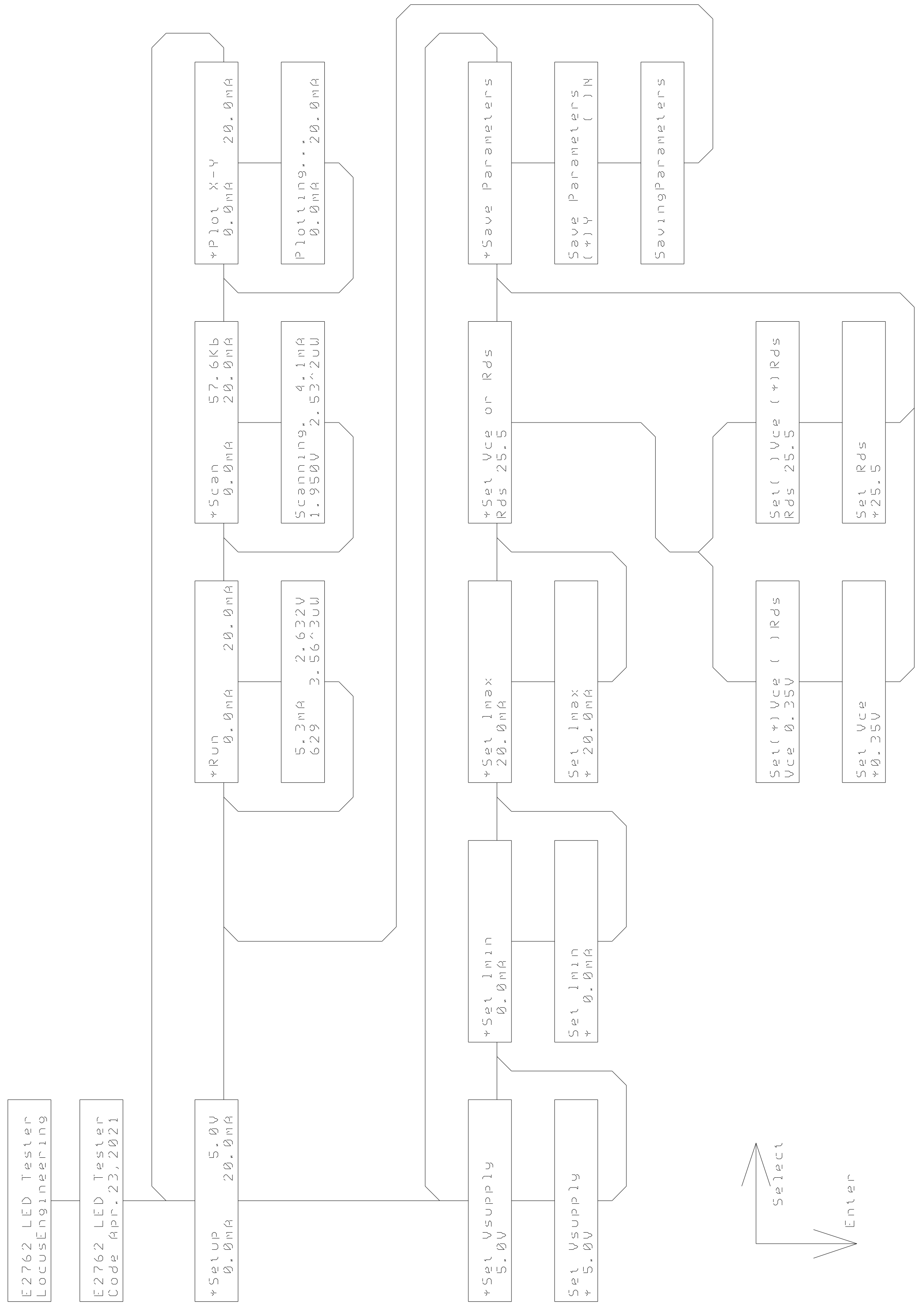


Figure 3. Screen Map

Screen Descriptions

Screen menu navigation is simple using the Enter and Select keys. Pressing Enter goes into the screen (down on the Figure 3 Screen Map) while pressing Select goes to the next screen (to the left on the Figure 3 Screen Map). An "*" indicates a screen change or variable change is possible with the Select key. After a value is adjusted, pressing Enter accepts it and the next screen is selected.

*Setup

On power up, the display indicates the Setup option after the Introduction screens. The Setup option allows the design supply voltage, minimum test current, maximum test current, bipolar on voltage, and FET on resistance values to be set. Pressing Enter allows the settings to be changed and saved. The Setup screen indicates the intended supply voltage for the LED and the minimum and maximum LED current setting.

Setup, *Set Vsupply

Pressing Enter allows the intended LED supply voltage to be adjusted using the rotary encoder. This setting is used to calculate the series current limiting resistor. The adjustment range is 0.00V to 25.5V in 0.10V steps. Pressing Enter again accepts the LED supply voltage setting and goes to the next screen.

Setup, *Set Imin

Pressing Enter allows the minimum LED current to be adjusted using the rotary encoder. Pressing Enter again accepts the minimum current setting and goes to the next screen. The minimum current is adjustable between 0.0mA and 120.0mA with 12 bit resolution.

Setup, *Set Imax

Pressing Enter allows the maximum LED current to be adjusted using the rotary encoder. Pressing Enter again accepts the maximum current setting and goes to the next screen. The maximum current is adjustable between 0.0mA and 120.0mA with 12 bit resolution.

Setup, *Set Vce or Rds

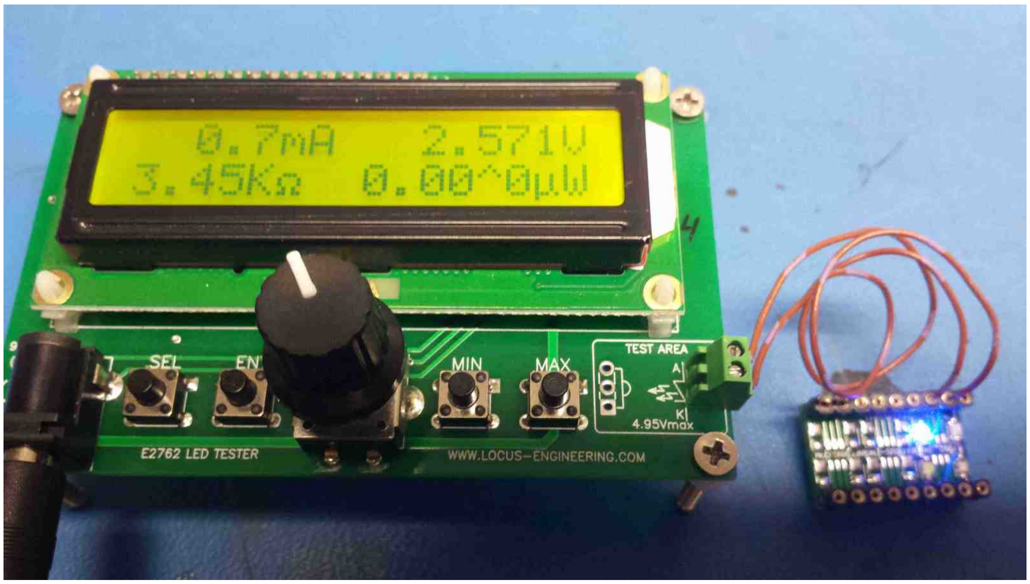
As most LEDs are driven from a bipolar transistor or FET switch, it is useful to take these values into consideration when calculating the series current limiting resistor, especially for low LED supply voltage applications. Pressing Enter prompts the user to select either the transistor on voltage drop Vce or the FET on resistance Rds. The Vce is adjustable between 0.00V and 2.55V while the Rds is adjustable between 0.0ohms and 25.5ohms.

Setup, *Save Parameters

Pressing Enter provides the option to save the settings and exit the Settings menu. When the parameters are saved, they will be used on the subsequent power up. If they are not saved, the settings will only be valid while power is on. On the next power up the previously saved settings will be used.

***Run**

Pressing Enter indicates the Run screen with the test LED current source operable manually. On entry the LED current is set at the minimum, and the LED forward voltage, the calculated series current limiting resistor value, and the intensity value are indicated. The following is a high efficiency blue SMD LED running at 0.8mA. At the design supply of 5V and a FET on resistance of 3.6 ohms, a Vf of 2.583V is measured at 0.7mA If and the series limiting resistor is 3.45K ohms.
Note that there is a small offset current of ~80uA which is enough to light some LEDs at the 0.00mA and lower current settings.



***Scan**

The Scan function increments the current source from the minimum setting to the maximum setting while outputting a serial stream of the results at 57.6Kbaud in Comma Delimited Format with Carriage Return/Line Feed after each current setting. The serial output appears as follows:

```
If(mA), Vf(V), L(uW/cm^2)
012.2,  0.492,  1.97^3
012.3,  0.496,  1.99^3
012.4,  0.499,  2.00^3
012.5,  0.501,  2.01^3
012.6,  0.508,  2.03^3
012.7,  0.510,  2.02^3
```

***Plot X-Y**

The Plot function provides a graphical representation of forward current If vs forward voltage Vf. The test current is incremented in a ramp between minimum and maximum settings and this process takes ~ 40.5msec for the maximum current range 0 to 120mA. The plot function continues until the Enter key is pressed. An oscilloscope plot for a 1N4148 diode with 0-120mA test current is shown. The forward current If is on the vertical axis at 200mV/div and the forward voltage Vf is on the horizontal axis at 50mV/div.

Both DAC outputs have a 0-1200mV output range. The DAC output representing If is 120mA/1200mV or 0.1mA/1mV If. The DAC output representing Vf is 4950mV/1200mV or 4.125V/V Vf. In this example, the vertical axis representing current is 6 divisions *200mV/div *0.1mA/mV, or 120mA. The horizontal axis is ~3 divisions to the knee, 3*50mV/div *4.125V/V or ~0.62V.