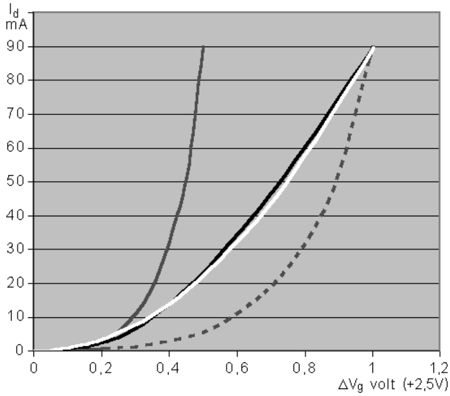
Single transistor LED driver

Field Effect Transistors have an inherent non-linearity.This can be used for gamma correction. It takes the form of a mathematical function, but in practice deviations are seen that are dependent on the transistor type. Here we measured the real curve of a real transistor. As some BUZ11 transistors were lying around, this type was chosen for a test circuit. It is a power-FET with a high amplification, which can handle currents as large as 30 Amps. The advantage is that rather low voltages on the input will cause the transistor to pass enough drain current to drive a 100 mA LED-cluster up to full white.

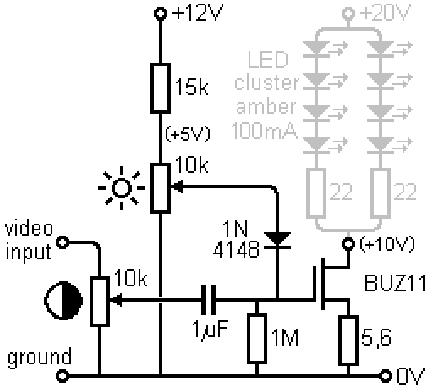
Measuring the transistor

The measurements showed us that 0 to 90 mA is obtained for an increase in gate voltage of 0.5 volts above 2.5V (grey curve). When we stretch the horizontal scale to 1 volt p.p. the dashed curve shows the LED-current. This is far too non-linear, because the white curve is the quadratic function (parabola) needed for true gamma correction. So we have to linearise the transistor. This is done by inserting a source resistor of 5.6 Ω. Now the almost hidden black curve is realised. Not bad.



The circuit

An unstabilised supply voltage of 20 volts was available for the LED clusters. High brightness amber LEDs drop a voltage of 2 volts each, at a current of 50 mA. About 10 volts over the transistor is needed for a proper characteristic, so two chains of 4 LEDs could be used. White LEDs need a voltage of about 4 V at 20 mA. In this case five chains of 2 LEDs are used. Both clusters run at 100 mA on the same driver. Stabilisation of this supply voltage isn't needed.

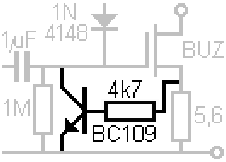


The circuit features simple DC-restoring with just one diode. It works much better than expected.

In operation

With a 1 volt video signal at the input the contrast control is set at maximum and the brightness a little above half way. But be careful with the settings! The BUZ11 can handle huge currents, which may ruin your LED cluster easily.

Overload protection circuit

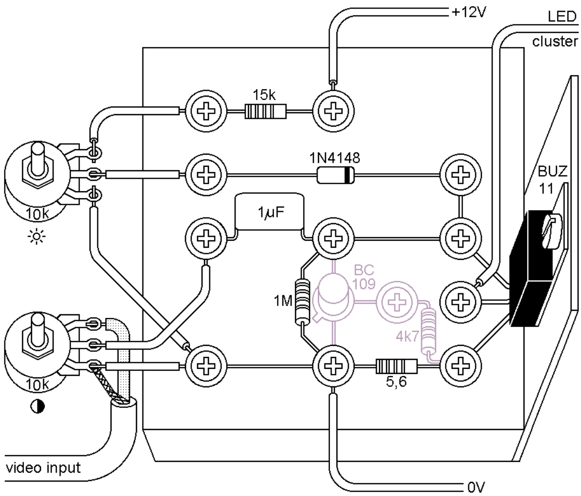


The addition of one transistor and one resistor will limit the LED current in case of voltage transients or excessive video signals. In grey are the components of the basic circuit, in black the addition. In some way the protection takes away the charming simplicity of the driver, so most people will add it after the basic circuit is functioning in a proper way.

Building on MDF

Medium-density fibreboard (MDF) is made of wood fibres and is a substitute for wooden boards. It is easily worked and ideal as a base for electronic circuits. Use small screws to clamp the wires together.

This MDF board measures 6 x 6 cm and the screws are placed in a 1 x 1cm grid. Drill 2 mm holes where screws should be placed. Use self-tapping screws and metal washers. Clip and bend the wires of the components so that they fit in the holes and then insert the screw in the same hole. Don't forget a washer and screw it tight. The washers will then make a firm electrical contact between the wires going into a hole.



Screw the transistor to a small piece of aluminium sheet so it can get rid of its excessive heat and fix the wires to the lugs of the potentiometers by soldering. The overload protection is shown in grey.

Starting up the circuit

Initially, insert a 100Ω protection resistor between the top of the LED-cluster and the +20V. Don't apply any video signal to the circuit and set the brightness potentiometer (the upper 10k) to its half way position.

Now apply the supply voltages. The LEDs should stay off. Slowly rotate the brightness potentiometer. If the LEDs light up when you turn it clockwise most things are working correctly. Adjust it to a setting where the LEDs are very dim. Now apply an NBTV video signal and turn the contrast control (the lower one) clockwise. The LED-cluster will brighten up. Now the 100Ω protection resistor may be removed, or better, replaced by an ammeter. The current should stay below 100mA. The protection circuit, if installed, will protect the LED cluster.