Preliminary

ED1001 – Linear Graph Driver

Highlights

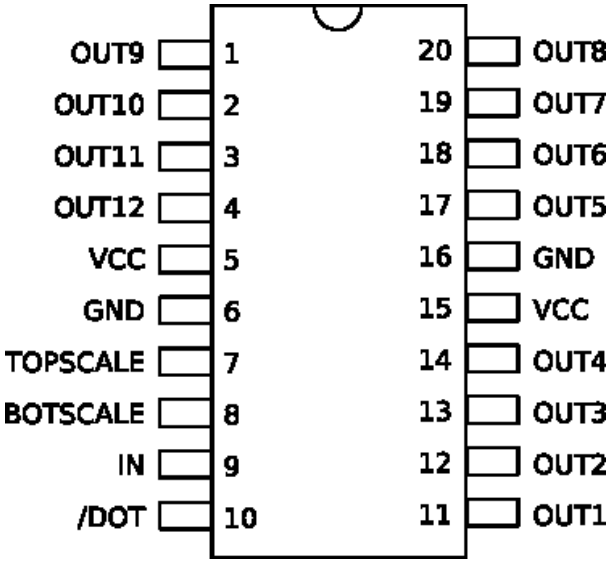
- Up to 12 outputs.
- Analog voltage input, from GND to VCC.
- Adjustable bottom and top of scale.
- Bar or dot output.
- Dot mode dead time between output switches.
- Voltage supply (VCC): 4.5V to 5.5V.
- 40mA maximum current drive per output in non-inverted dot mode, 15mA in bar mode.
- Based on ATMEL ATtiny26® AVR®.

Functional Description

The ED1001 is a general-purpose output driver, linearly controlling a set of outputs displaying the voltage level on a positive input.
The display can be as a bar or a dot and the 2 scale limits are user-defined.
All the selections are made through chip pins and can be set dynamically at run-time, with immediate change.
In DOT mode there's a nominal 1ms dead time when switching from one output to another.

Further details on specific hardware characteristics can be found on ATtiny26® datasheet in ATMEL's site http://www.atmel.com.

Pin Description



`OUT1` to `OUT12`
: Driver outputs. If connecting LEDs, do it via current limiting resistors.

`TOPSCALE`
: Set the **top** of the **scale** for the IN pin. Set here the desired top-of-scale voltage value, with resistor divider. TOPSCALE value must not exceed VCC.

`BOTSCALE`
: Set the **bot**tom of the **scale** for the IN pin. Set here the desired bottom-of-scale voltage value, with resistor divider. BOTSCALE value must not be below GND. BOTSCALE should not be higher than TOPSCALE.

`IN`
: **In**put signal. Graph displays relative to the voltage value in this pin. A series resistor of 1K to 10K should be added for protection, if input voltage range cannot be guaranteed to be in range GND to VCC.

`/DOT`
: Select the graph style type. Leave unconnected or connect to VCC for *bar*, connect to GND for *dot*.

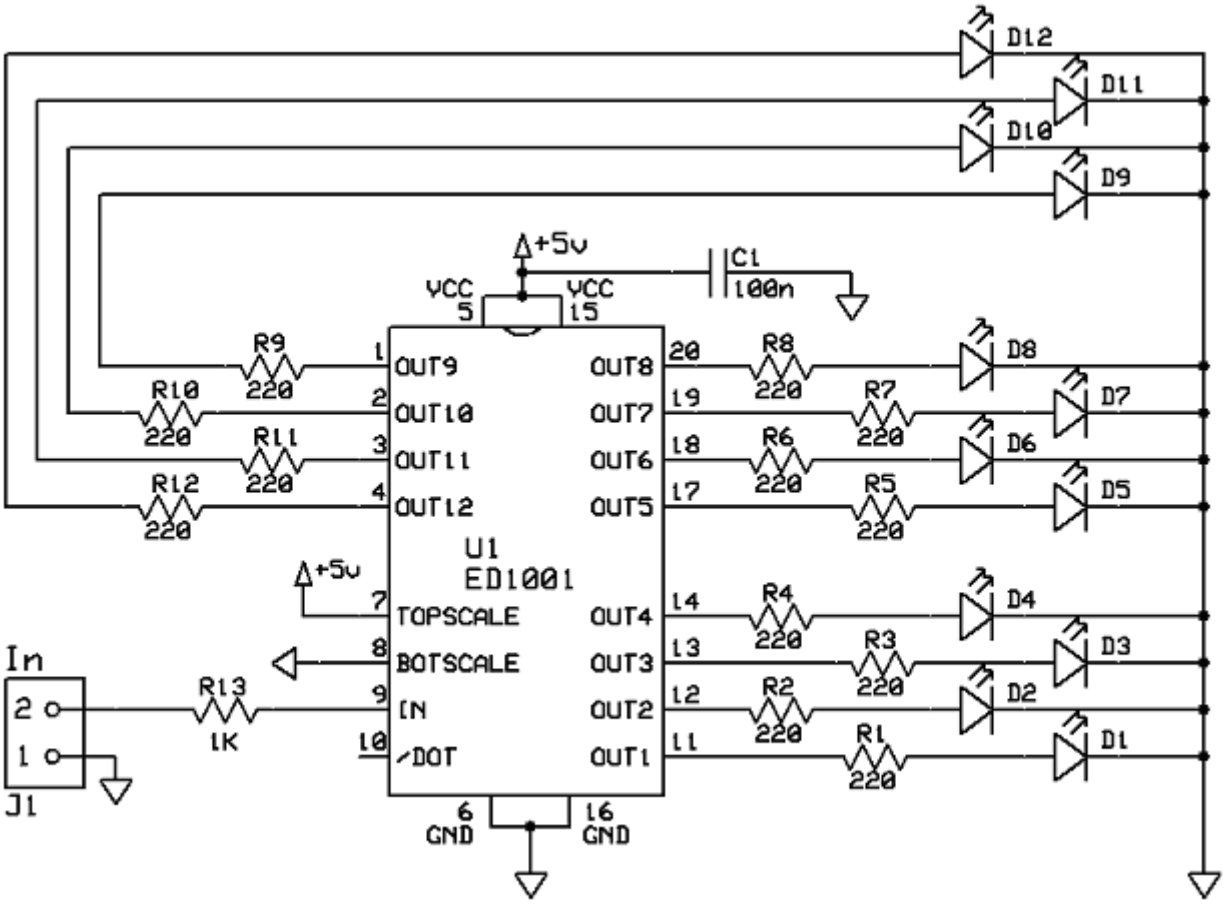
`GND` & `VCC`
: The chip's power supply pins. Connect the two GND and the two VCC.

Using Less Outputs

If less than the 12 outputs is desired, TOPSCALE and BOTSCALE must be set a bit higher than the desired limit, taking into account the unused outputs. For example, let's suppose we need only 10 outputs, to display a voltage of 1V to 3V. When using 12 outputs and setting TOPSCALE to 3V, each output corresponds roughly to a `(3 – 1) / 12 ~ 0.167 V` difference. Since we only need 10, we need to choose TOPSCALE such that OUT10 gets active when IN = 3 V. This means that `10 x (TOPSCALE – BOTSCALE) / 12 + BOTSCALE = 3 V`. Solving the equation to find TOPSCALE we get `TOPSCALE = 12 x (3 – 1) / 10 + 1 =` **`3.4`** `V`. Generalizing, given the desired number of outputs N_{out}, the desired TOPSCALE is

$$TOPSCALE = 12 \times (TOPSCALE - BOTSCALE) / N_{out} + BOTSCALE$$

Typical Applications



Circuit A - Basic 12-Led bargraph displays the input voltage, from 0V to 5V.

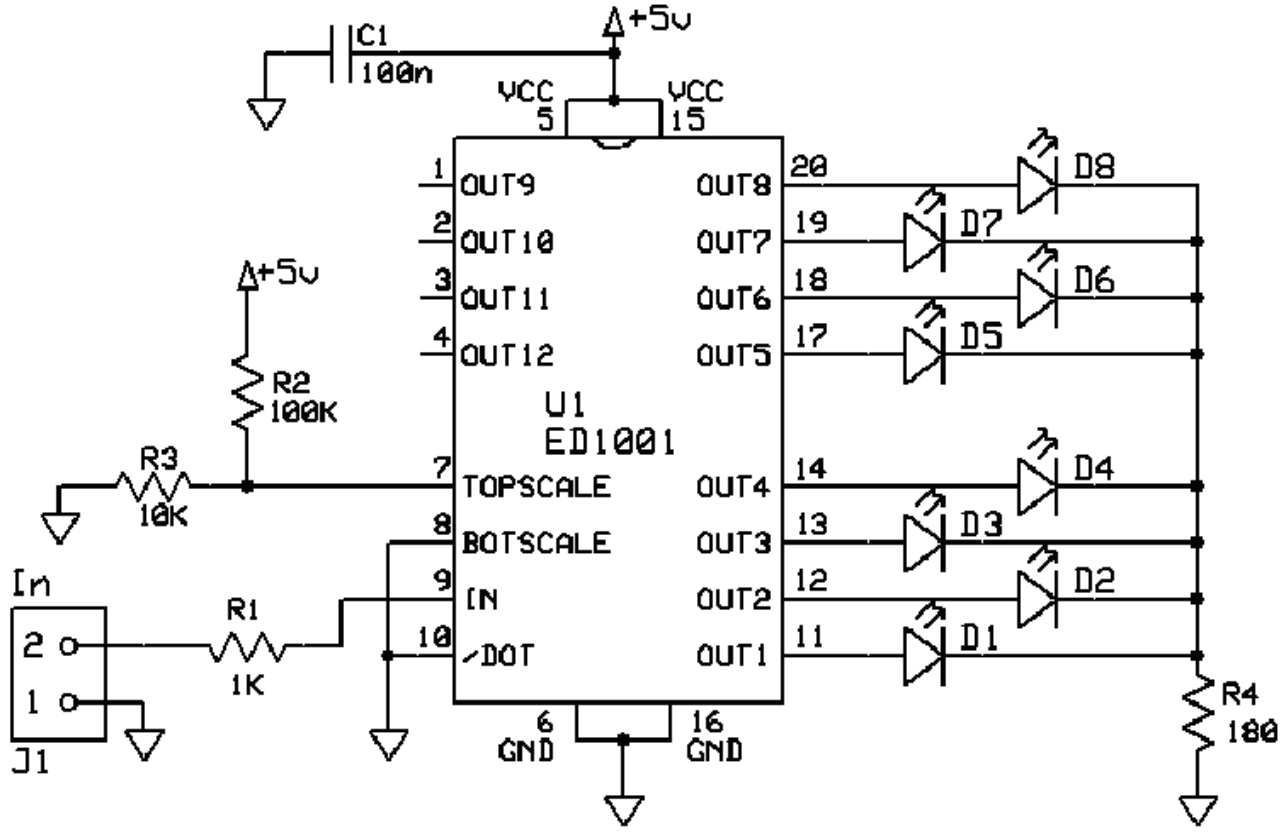
Basic Led Bar Graph 0-5V

This is the simplest application, providing a bargraph reading of an input voltage from 0V to +5V. The top of the scale value is defined in `TOPSCALE` that is connected to +5V. The bottom scale is defined as GND by grounding `BOTSCALE`. `/DOT` is left floating (unconnected), selecting, respectively, bar type of graph and normal non-inverted display.

Note that the 220ohm resistors were calculated for an approximate 15mA Led current on red Leds, which present a typical 1.8V voltage drop. Knowing the voltage drop of a Led (V_{LED}) and ED1001 supply voltage (V_{cc}), the formula below calculates an approximate resistor value for 15mA (maximum allowed) Led current:

$$R = (V_{CC} - V_{LED}) / 0.015A$$

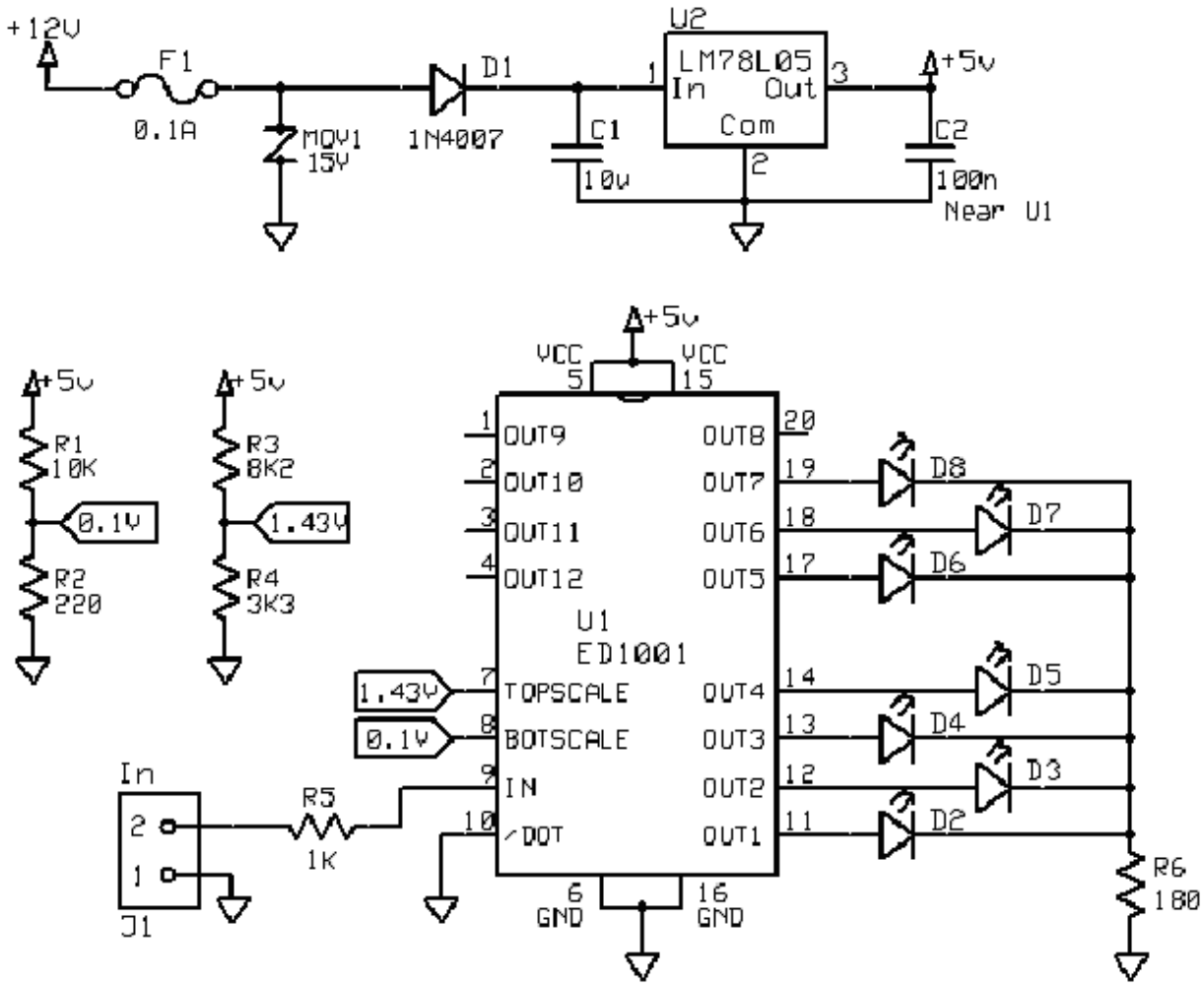
The nearest commercial value should be used, preferably one above the calculated value.



Circuit B - 8 leds dot-graph displays the input voltage, from 0V to 300mV.

Music VU

Displaying a voltage between 0 and 300mV should allow music display from most small devices or lineout signals with 10K or less output impedance. Since only 8 outputs are used, TOPSCALE was set according to the formula given earlier, to 12 x (0.3 – 0) / 8 + 0 = 0.45 V. The top of the scale is then set to 450mV which is easier to get common resistors for, by means of the resistor divider R2-R3, which divides the +5V supply down and feeds it to the TOPSCALE pin. The graph was set to dot mode, and this also allows having only 1 Led-current limiting resistor, since only 1 Led will be lit at a time. The resistor was calculated for a Led current of 20mA. The guaranty of a dead time between output switching in dot mode makes sure that only 1 output is active at a time.



Circuit C – Lambda-meter displays a voltage in the range 0.1V to 0.9V in 7 LEDs.

Lambda-meter

A *lambda-meter* is an automotive device that provides a visual indication of instantaneous emissions status. It measures the signal from the lambda sensor (oxygen sensor) and displays it as luminous dot in a scale. The dot moves very closely around the centre LED when the car is working on the most environmental friendly regime.

The typical lambda sensor output range is between 0.1V and 0.9V. Since only 7 outputs are used, TOPSCALE was set according to the formula given earlier, to 12 x (0.9 – 0.1) / 7 + 0.1 = 1.47 V. The top of the scale is then set to 1.43 V which is easier to get common resistors for, by means of the resistor divider R3-R4, which divides the +5V supply down and feeds it to the TOPSCALE pin.

Special attention is given to the power supply. A common regulator to generate 5V from the battery's 12V (nominal), and a MOV device (varistor) protects the circuit and the lambda-sensor from the harsh electric automotive environment, especially *load dump* events. D1 protects against power supply reversal and, together with C1 keeps the circuit working under short power outages. R1 to R4 may need adjustment depending on the particular lambda-sensor; they should be adjusted to get the central LED(s) lit when the engine is ON with the vehicle stopped after a few minutes (warm engine).

= Revision History ==========

17-04-2007: Revision A. Original release.
15-05-2007: Revision B. Added dead time in dot mode and optimized schematics.
28-05-2007: Revision C. Clarified that the configuration made through pins can be set dynamically. Shown how Led current limiting resistors were calculated on the example circuits. Slight Disclaimer change.
01-02-2008: Revision D. Changed the meaning of the `INVERT` input pin. Removed the requirement of grounding unused outputs (unnecessary). Added more electrical specs.
02-03-2008: Revision E. Replaced `/INVERT` by `BOTSCALE`. Re-added requirement of grounding the 1st unused pin, read at power-up. Setting `BOTSCALE` higher than `TOPSCALE` now controls negated mode.
16-06-2008: Revision F. Removed inverted mode feature; original implementation doesn't work and didn't find one that does, yet. Added section on how to calculate the `TOPSCALE` for less than 12 outputs. Added reference to base microcontroller. Updated disclaimer.
03-04-2009: Revision G. Changed Vcc range to the correct values supported by ATtiny26.
27-04-2013: Revision H. Corrected mentioned DOT mode dead time, which is 1ms instead of 10ms. No firmware changes.

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