Contrast Control for STN LCD Modules

Introduction

Contrast, as well as viewing angle and brightness, is one of the most important optical parameters of a display. The contrast has an immediate effect on readability and with it the usability of the display. However, contrast depends on several parameters such as viewing angle and brightness (both, ambient and display brightness). Furthermore everybody has a different perception of contrast due to the individual characteristics of the human eye.
Because of these reasons the contrast of a display should be adjustable either automatically or manually to adapt to ambient changes in brightness & temperature. This Application Note discusses ways in which the contrast on Hitachi STN liquid crystal displays can be controlled. Please find more information about the definition of contrast, brightness and viewing angle in the Application Note AN-008

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1 Four Different Configurations

The contrast on STN displays is always controlled by varying an external voltage. The range of variation is typically around +/- 1 V. This variation results in a small decrease or increase of the display's liquid crystal driving voltages.

There are four different configurations we recommend for Hitachi STN LCD modules including built-in DC/DC circuits and dedicated contrast control pins. Therefore Hitachi recommends four circuits for power supply. These circuits can also be found in the particular datasheet in the chapter "Power Supply for LCM Example".

The contrast control circuit is part of the power supply circuit. To put the emphasis on those parts dealing with contrast control a red dashed outline is used.

1.1 Circuit for modules with built-in DC/DC Converter

These devices have a fully integrated DC/DC converter circuit. The LCD driving voltages are generated on board and only a single voltage has to be applied externally (typically +3.3V or +5V). The contrast control is very easy due to the dedicated contrast control pin of the device. Figure 1 shows the recommended power supply circuit and the contrast control circuit with a voltage divider and a variable resistor. The resistors should be chosen so that the contrast control voltage V_{Con} is in the range of 0.8 V to 2.8 V (typically 2 V).

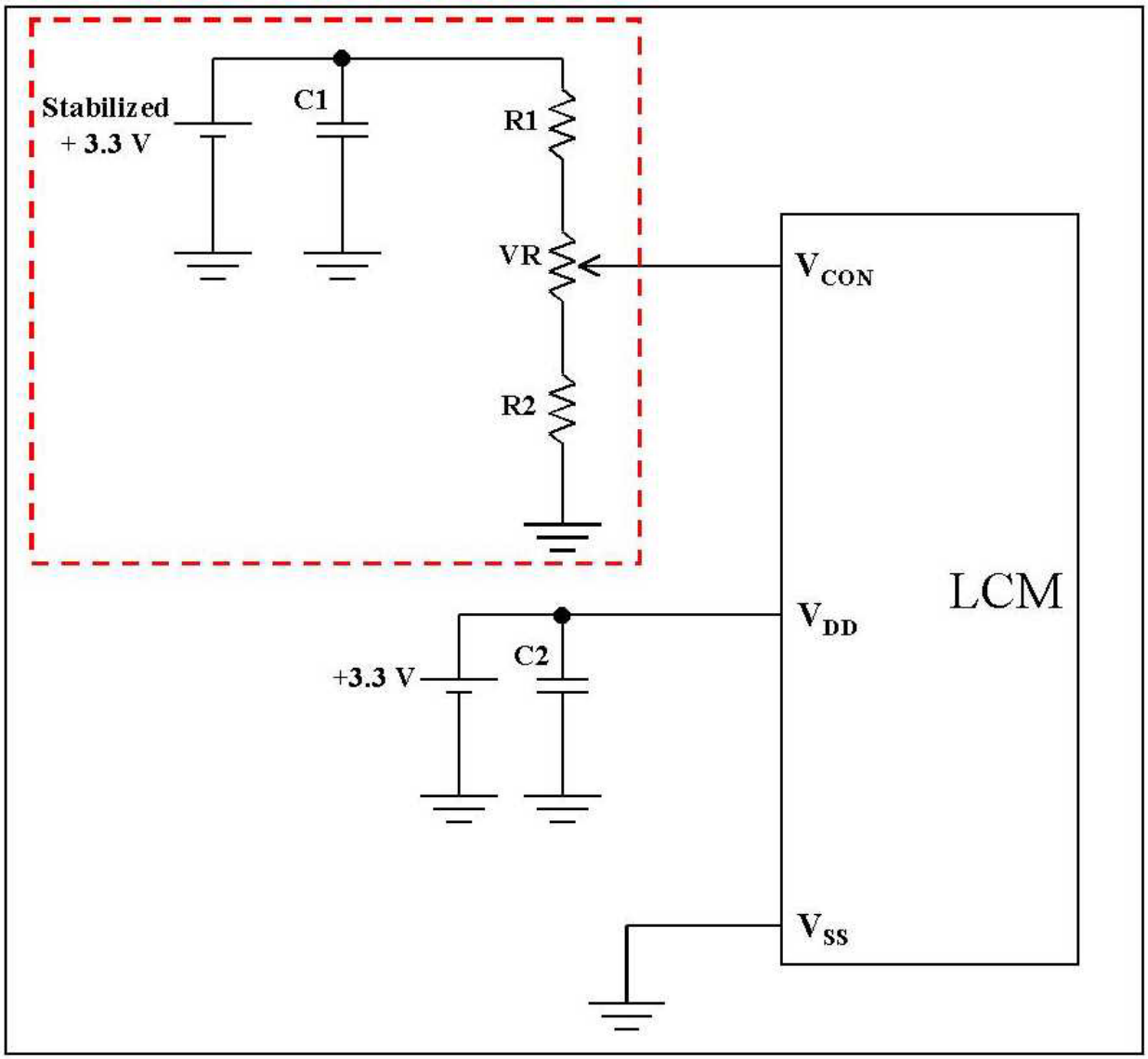

Figure 1: Circuit for modules with build-in DC/DC Converter

Note 1: C1 and C2 = 3.3µF
Note 2: Example values are valid for liquid crystal module SX14Q001

1.2 Circuit for modules with no DC/DC Converter

Some modules do not have a DC/DC converter on-board to generate the LCD voltage V_{EE}. The voltage must be applied externally and the contrast voltage V_O is controlled via a dedicated pin as in the first circuit. Figure 2 shows an appropriate example.

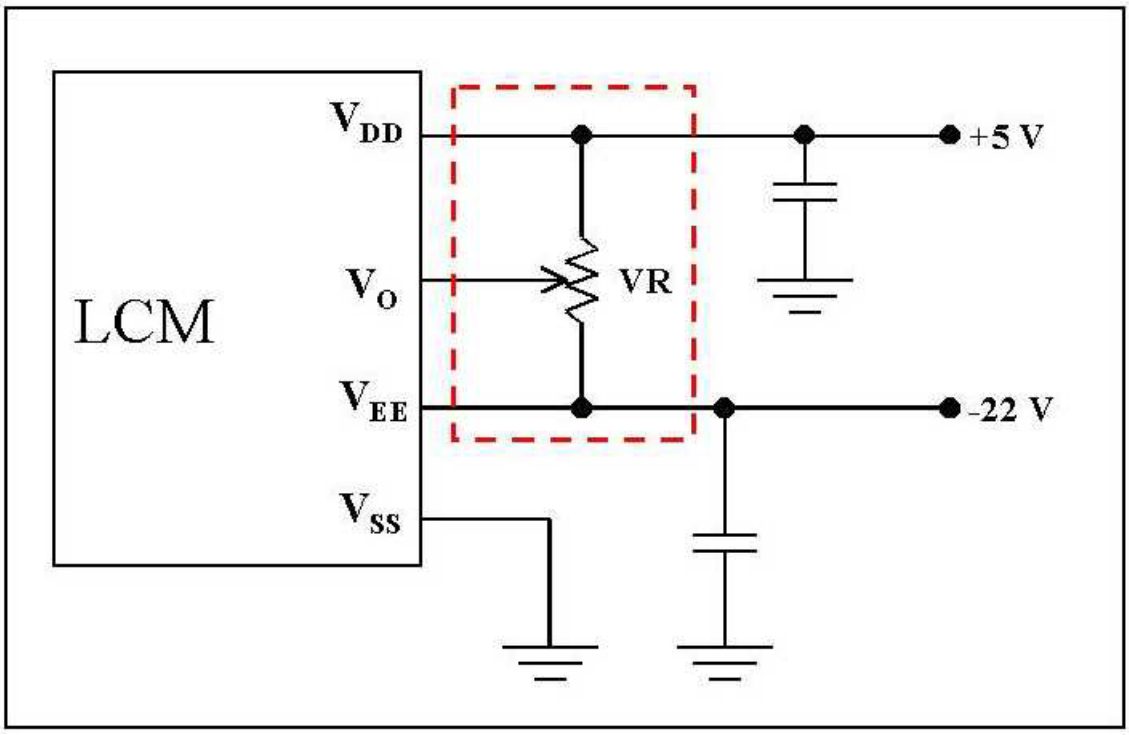

Figure 2: Circuit for modules without build-in DC/DC Converter

Note 1: VR = 10 kΩ
Note 2: Example values are valid for liquid crystal module SP14Q006

1.3 Circuit for modules without DC/DC Converter or Contrast Pin

For modules with no built-in DC/DC converter and no dedicated contrast control pin the LCD voltage V_{EE} must be varied directly. The circuit is similar to the previous example but pay attention to the buffer transistor and to the missing V_O pin.

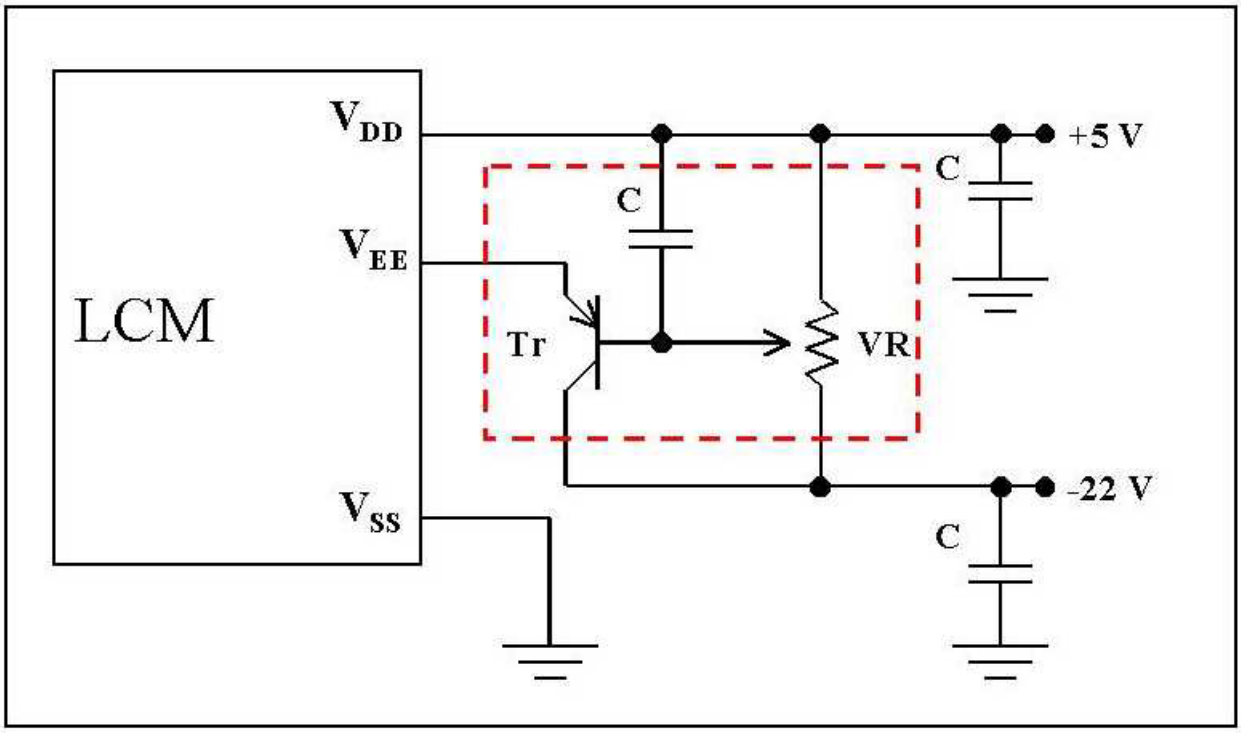

Figure 3: Circuit for modules without DC/DC Converter and Contrast Control Pin

Note1: VR = 10 kΩ – 20 kΩ
C = 3.3 µF (Aluminium electrolytic)
Tr = 2SA673APKC (hFE=100, I_C=500 mA) or equivalent

Note2: There are other recommendations for circuits in some LCD module datasheets. The LCD voltage V_{EE} is called V_{LCD}, the transistor is a NPN type and there is a fuse between transistor and LCM. Basically it is the same circuit but for a positive LCD driving voltage. It is not –22 V as in the circuit in Figure 3 but around +30 V. Always use the circuit from the LCD datasheet as reference for your particular module.

Note3: Example values are valid for liquid crystal module SP10Q002-T

1.4 Modules without any LC BIAS Voltage Circuits on board

The previous two modules do not have a DC/DC converter on-board to generate the high negative or positive LCD voltages. However, they have a resistor and op amp network on board to generate the LC bias voltages with an externally applied voltage Vee. There are some modules where all the LC voltages are required to be generated externally. Contrast is adjusted by varying the overall voltage to the circuit. This circuit is necessary for chip on glass modules for example.

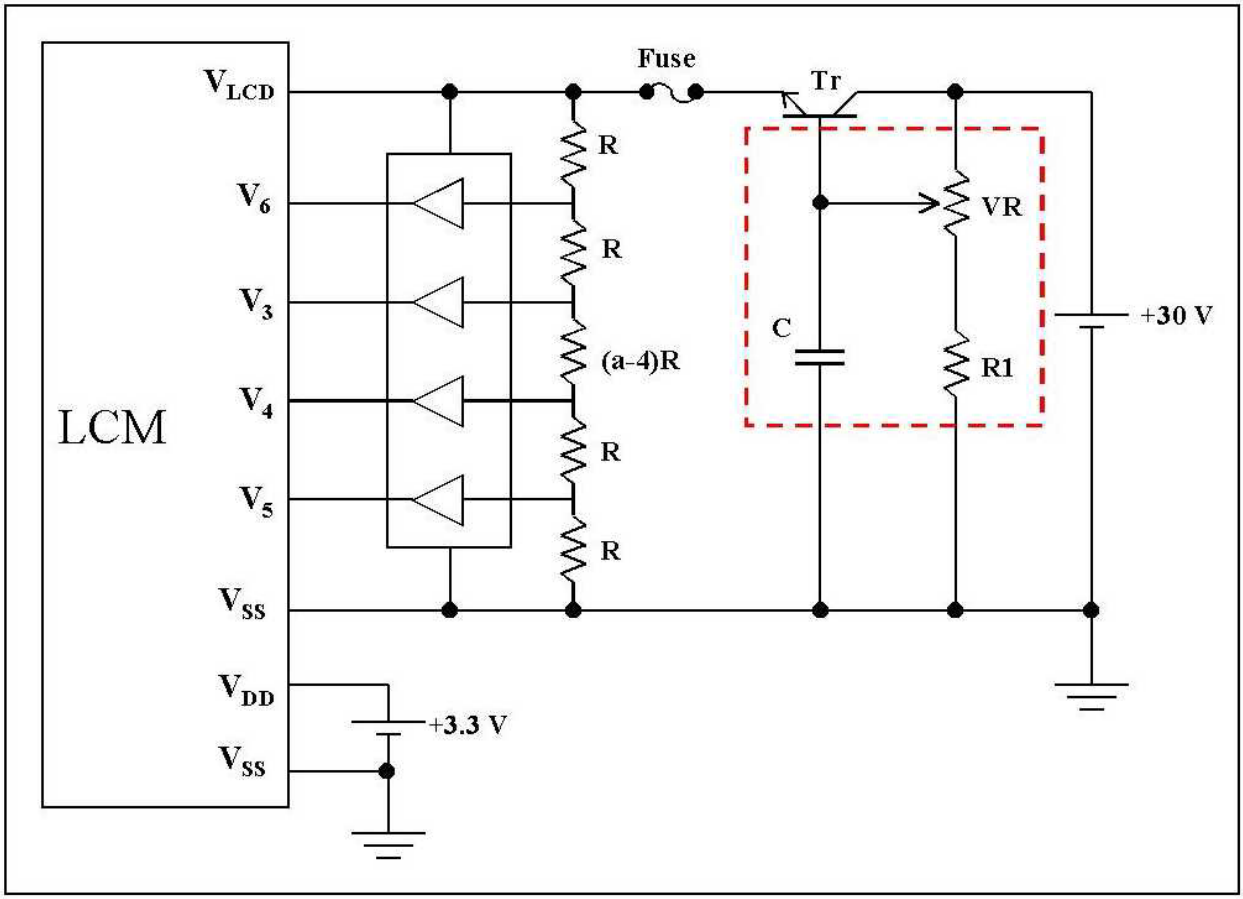

Figure 4: Circuit for modules without any DC/DC circuits on board.

Note 1: R = 3 kΩ
VR = 20 kΩ
R1 = 10 kΩ
C = 3.3 µF
Tr = 2N3904
a = 13

Note 2: Example values are valid for liquid crystal module SP10Q010

2 Assignment of Display Devices and Circuits

Always check the datasheet of the particular device for the latest recommendations. The datasheets can be found on http://www.hitachi-displays-eu.com

Circuit	Device
1	SP14N001, SX14Q001, SX14Q004, SX16H006
2	SP12N001-T, SP12N002, SP14N001-Z1, SP14N002, SP14N003, SP14Q002-A1, SP14Q002-C1, SP14Q002-T, SP14Q003, SP14Q003-C1, SP14Q005, SP14Q006, SP14Q006-T
3	LMG7520RPFC, LMG7525RPFF, LMG7550XUFC, SP10Q002-T, SP10Q002-Z1, SP10Q005-T, SP24V001, SP24V001-A
4	SP10Q010, SP10Q010-T, SX09Q005

Table 1: Display devices and the appropriate power supply circuit

Note: The touch screen versions of the displays are not listed in the table. However, a touch panel does not affect the power supply circuit.

3 In the case of “No idea”

It is important that the contrast of a STN display can be controlled. But sometimes it is not clear how to achieve this. Maybe the datasheet of a certain module is not available or it is not clearly described in the datasheet. Try the following steps to find out what type of circuit is appropriate.

- If the display needs only one voltage (+5 V or +3.3 V) and has a pin labelled V_{CON} or V_O you need to use something similar to circuit 1.
- If the display requires logic voltage and a relatively high negative voltage (for example –22 V) externally applied but has a pin labelled V_{CON} or V_O you need to use something similar to circuit 2.
- If there is no pin labelled V_{CON} or V_O and the LCD voltage must be applied externally (either a relative high positive or negative voltage). You need to vary this LCD voltage with something similar to circuit 3.
- If all (up to 6 different) LCD driving voltages must be applied externally, you need to use something similar to circuit 4 to vary the overall circuit voltage. The display is probably a chip on glass module.

Of course these steps and circuits are only valid for STN displays. The contrast for TFT displays is controlled in a different way.

When you have chosen the right circuit it is possible that the additional component values (resistors, capacitors) must be varied to get the best performance. There are always tolerances in components and modules.

If you have a lot of noise and ripple on your cables, additional capacitors may be necessary to decouple and filter it. The LCD and contrast control voltages are all analogue, noise, voltage peaks & other distortions affect the quality of the display image. Flicker and other defects may occur. See below an example of bad decoupling on a display used with circuit 4.

Figure 5: Result of bad decoupling of a power supply circuit.

Cautions

Keep safety first in your circuit designs!

Hitachi Europe Ltd. puts the maximum effort into making display products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with display products may lead to personal injury, fire or property damage. Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of nonflammable material or (iii) prevention against any malfunction or mishap.

Notes regarding these materials

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