LCD Module
C-Berry28

DATA SHEET

Product specification V 1.0

This product complies to EU directive 2002/95/EC (RoHS) of January 27th, 2003.

Revision record

Table 0.1: Revision record

Rev.	Date	Chapter	Description
1.0	2014-08-14	all	initial release

Table of content

Subject   Page

1 General data

Table 1.1: General data

No.	Item	Content
1.	module size	85.0 mm (W) * 56.0 mm (H) * 17 mm (D)
2.	active area	43.2 mm (W) * 57.6 mm (H)
3.	pixel size	0.18 mm (W) * 0.18 mm (H)
4.	number of dots	240 * 3 (RGB) (W) * 320 (H)
5.	LCD typ	TFT color 262k, transmissive
6.	backlight	LED white
7.	graphic controller	ST7789
8.	interface	4-wire SPI
9.	weight	36g (approx.)

2 Absolute maximum ratings

Within this specification all voltages are referred to ground (GND).
Absolute maximum ratings are defined ratings, which when being exceeded may cause permanent damage to the device. Moreover, this device is not guaranteed to operate properly at the maximum ratings. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated under '3 Electrical characteristics' is not implied.

2.1 Electrical absolute maximum ratings

Table 2.1: Electrical absolute maximum ratings

Item	Symbol	Min.	Max.	Unit	Comment
power supply	V_{cc}	-0.3	4.0	V	--
input voltage	V_I	-0.5	$V_{CC}+0.3$	V	--
static electricity	--	--	--	--	see note

Note: LCM should be grounded during handling.

2.2 Environmental absolute maximum ratings

Table 2.2: Environmental absolute maximum ratings

Item	Symbol	Min.	Max.	Unit	Comment
operating temperature	T_{OP}	-20	70	°C	--
storage temperature	T_{ST}	-30	80	°C	--

Note: Background color might change slightly depending on ambient temperature (Ta).
      That phenomenon is reversible.

3   Electrical characteristics

3.1 Electrical characteristics of C-Berry28

Table 3.1: Electrical characteristic of C-Berry28

Ta=25°C

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
power supply for logic	V_{cc}	--	2.6	2.8	3.3	V
input voltage	V_{IH}	H-level	$0.8V_{CC}$	--	V_{CC}	V
	V_{IL}	L-level	GND	--	$0.2V_{CC}$	
power supply current	I_{CC}	$V_{CC}=2.8V$	--	10	--	mA

3.2 Electrical characteristics of backlight

Table 3.2: Electrical characteristics of backlight

Item	Symbol	Min.	Typ.	Max.	Unit	Condition
applied forward voltage	V_{AC}	3.0	3.2	3.3	V	at 100%PWM
applied forward current	I_{AC}	--	80	--	mA	

4   Optical characteristics of TFT

Table 4.1: Optical characteristics

Ta=25°C

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
viewing angle Cr≥10	Θ	$\theta(\varphi = 0°)$	--	65	--	°
		$\theta(\varphi = 180°)$	--	55	--	°
		$\theta(\varphi = 90°)$	--	60	--	°
		$\theta(\varphi = 270°)$	--	60	--	°
contrast ratio	Cr	--	--	250	--	°
surface luminance of LCM	L_I	at 100% PWM	--	270	--	cd/m²

Note 1: Definition of viewing angle $\theta(\varphi)$
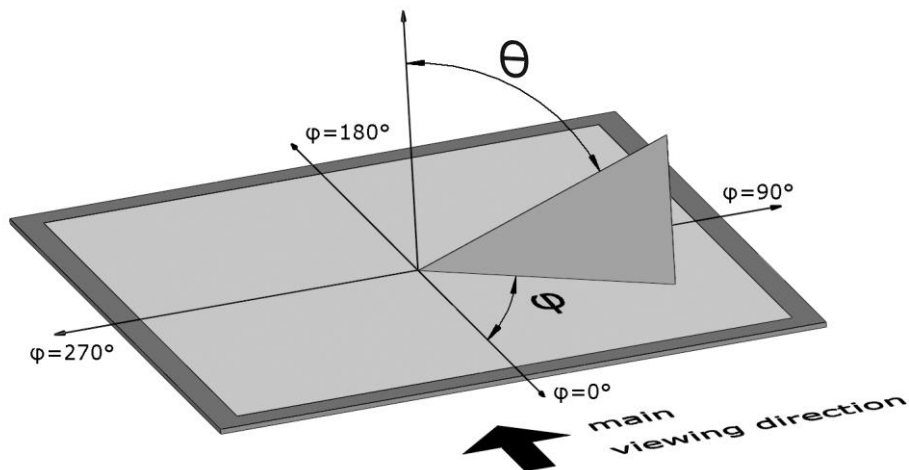
Note 2: Definition of contrast ratio (Cr)

The brightness is measured with a TOPCON BM-7 at the center point of the TFT. The contrast is defined by the following equation:

$$Cr = \frac{Brightness\ when\ TFT\ is\ at\ ''White''\ state}{Brightness\ when\ TFT\ is\ at\ ''Black''\ state}$$
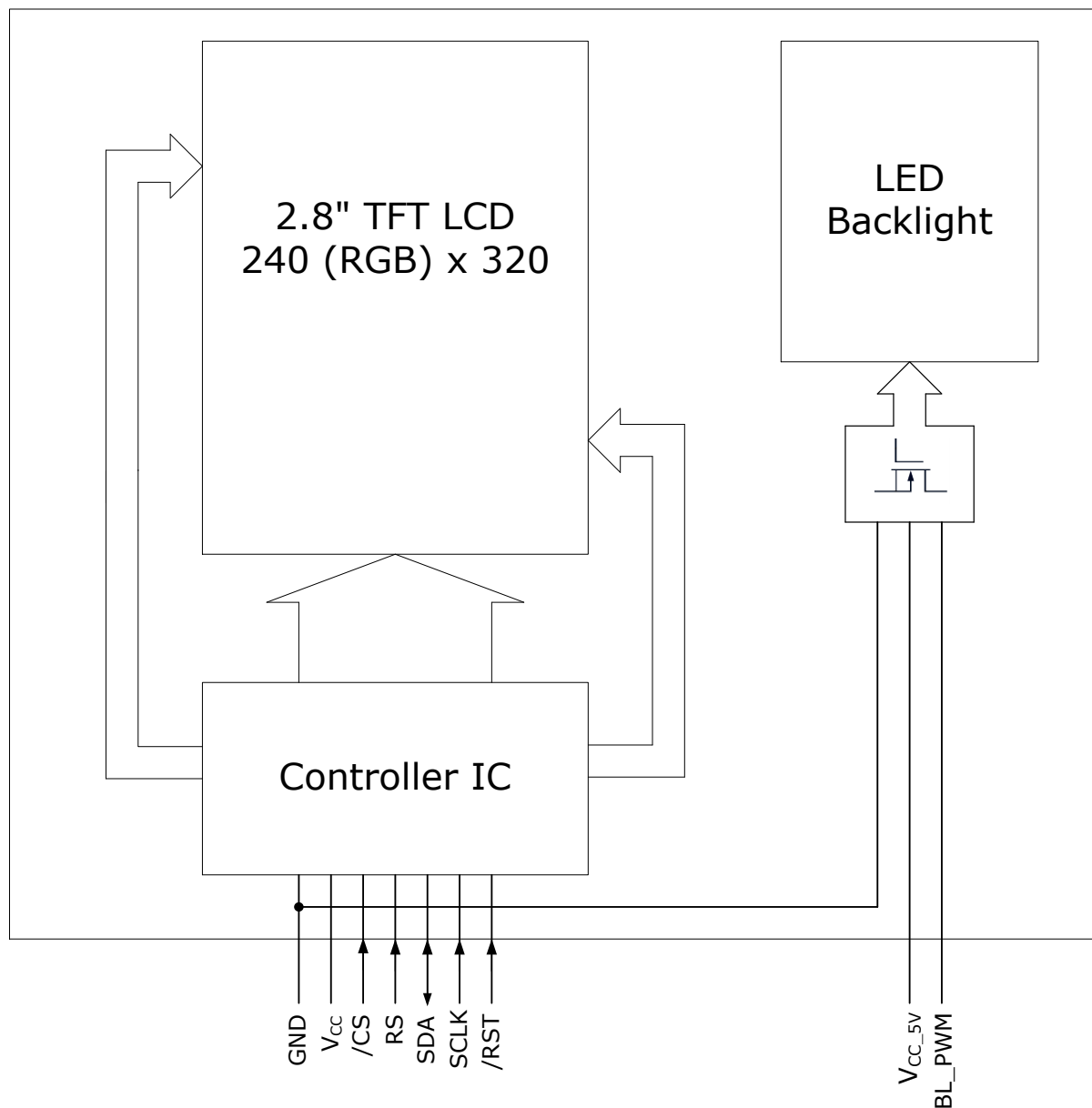
5   Block diagram

Figure 5.1 : Block diagram of C-Berry28

6 Interface description

6.1 Interface of C-Berry28 connector X2 and X3

Table 6.1: LCD interface description

Symbol	Pin no.	IO	Function
V_{CC}	1	PWR	power supply 3.3V
V_{CC_5V}	2	PWR	power supply 5V
GPIO2	3	I/O	raspberry pi GPIO port
V_{CC_5V}	4	PWR	power supply 5V
GPIO3	5	I/O	raspberry pi GPIO port
GND	6	PWR	ground
GPIO4	7	I/O	raspberry pi GPIO port
GPIO14	8	I/O	raspberry pi GPIO port
GND	9	PWR	ground
GPIO15	10	I/O	raspberry pi GPIO port
GPIO17	11	I/O	raspberry pi GPIO port
BL_PWM	12	I	PWM for backlight control
GPIO21	13	I/O	raspberry pi GPIO port
GND	14	PWR	ground
RS	15	I	register select 'H' = control word 'L' = display data
GPIO23	16	I/O	raspberry pi GPIO port
V_{CC}	17	PWR	power supply 3.3V
GPIO24	18	I/O	raspberry pi GPIO port
SDA	19	I/O	serial data
GND	20	PWR	ground
GPIO9	21	I/O	raspberry pi GPIO port
/RST	22	I	reset
SCLK	23	I	serial clock
/CS	24	I	chip select
GND	25	PWR	ground
GPIO7	26	I/O	raspberry pi GPIO port

Female connector: 2x13 pin, 2.54 mm pitch

connect it to Raspberry Pi$^{©}$ Model B port P1

7   Hardware

7.1 Schematic of C-Berry28

Figure 7.1 : Schematic for C-Berry28

7.2 PCB of C-Berry28

The layout of the C-Berry28 is depicted by Figure 7.2. The connector X2 will be used to connect the C-Berry28 to the Raspberry Pi Module. On the bottom is an additional connector X3. It is the same connector as P1 from the Raspberry Pi module. For detailed information about X2 and X3 see chapter
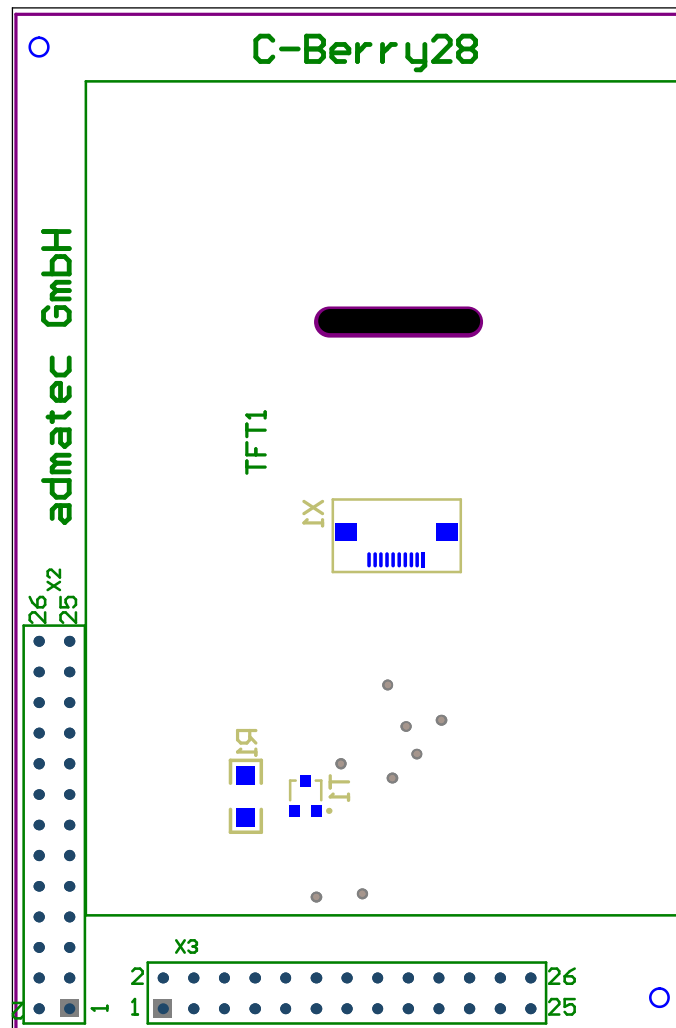"6 Interface description".

Figure 7.2 : PCB for C-Berry28

8 Software

8.1 C-Berry28 example

An example software for C-Berry28 is available for download. Please follow this > **link** < or use the following install guide:

- start LXTerminal
- download the package
  ```
  wget http://admatec.de/sites/default/files/downloads/C-Berry28.tar.gz
  ```
- unzip the package
  ```
  tar zxvf C-Berry28.tar.gz
  ```
- compile the test software
  ```
  cd C-Berry28/SW/tft_test
  make
  ```
- start the programm
  ```
  sudo ./tft_test
  ```

To use this example it is required that the BCM2835 library is successfully installed.
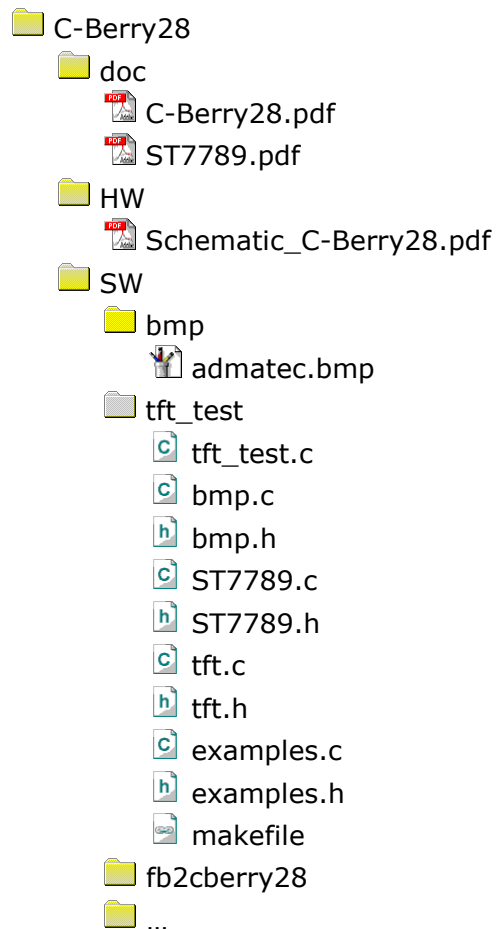
The package contains the folder structure like Figure 8.1.

📁 C-Berry28
    📁 doc
        📄 C-Berry28.pdf
        📄 ST7789.pdf
    📁 HW
        📄 Schematic_C-Berry28.pdf
    📁 SW
        📁 bmp
            🖼 admatec.bmp
        📁 tft_test
            📄 tft_test.c
            📄 bmp.c
            📄 bmp.h
            📄 ST7789.c
            📄 ST7789.h
            📄 tft.c
            📄 tft.h
            📄 examples.c
            📄 examples.h
            📄 makefile
    📁 fb2cberry28
    📁 …

Figure 8.1: Folder structure

In the doc folder is the specification of the C-Berry28 and the lcd driver ST7789. The HW folder contains the schematic of the C-Berry28.

The SW folder contains the source code. The source code consists of ST7789.c, tft.c, bmp.c, example.c and the corresponding header files, as well as tft_test.c and a makefile. A short description of each file is given in Table 8.1. The program allows displaying BMP files.

Table 8.1: Functions of the different source files

File	Function
bmp.h / bmp.c	Image processing for showing BMP file on the TFT. The BMP files must have a dimension of 320 x 240 pixel and a color depth of 24Bit.
ST7789.h / ST7789.c	Contains the definitions of the ST7789 register and several functions to control the lcd driver ST7789.
tft.h / tft.c	Responsible for the SPI communications and for the initialization of the GPIO Pins.
examples.h / examples.c	Contains functions to demonstrate some opportunities
tft_test.c	This file contains the main loop. The program shows one BMP file on the TFT.

8.2 Additional software

The package will be expanded with additional software examples on demand, like fb2cberry28.

8.3 Timing characteristics

Please refer to the specification of IC ST7789.

9   Reliability data for TFT

9.1 Test condition

Table 9.1: Test condition

No.	Item	Condition		Standard	Note
1.	high temp. storage	80°C	240h		--
2.	low. temp storage	-30°C	240h		--
3.	high temp. & high humid. storage	60°C 90%RH	240h		--
4.	high temp. operating	70°C	240h	appearance w/o defect	--
5.	low temp. operating	-20°C	240h		--
6.	thermal shock	30min@-30°C → 30min@25°C (1 cycle) 30min@25°C ← 30min@80°C			10 cycles

Note 1:   In the standard condition, there shall be no practical problem that may affect the display function. After the reliability test, the product only guarantees operation, but doesn´t guarantee to fulfill all of the cosmetic specifications.

Note 2:   Before cosmetic and function test, the product must have enough recovery time, at least 4 hours at room temperature.

10 Assembly

Switch off the power of the Raspberry Pi. Plug the C-Berry28 with the Raspberry Pi such as shown in the Figure 10.1. The final assembled module is depicted in Figure 10.2.
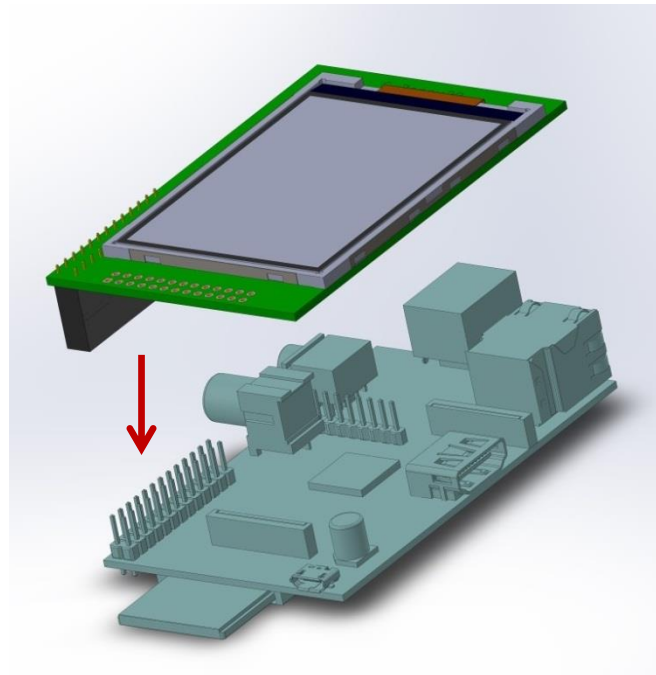

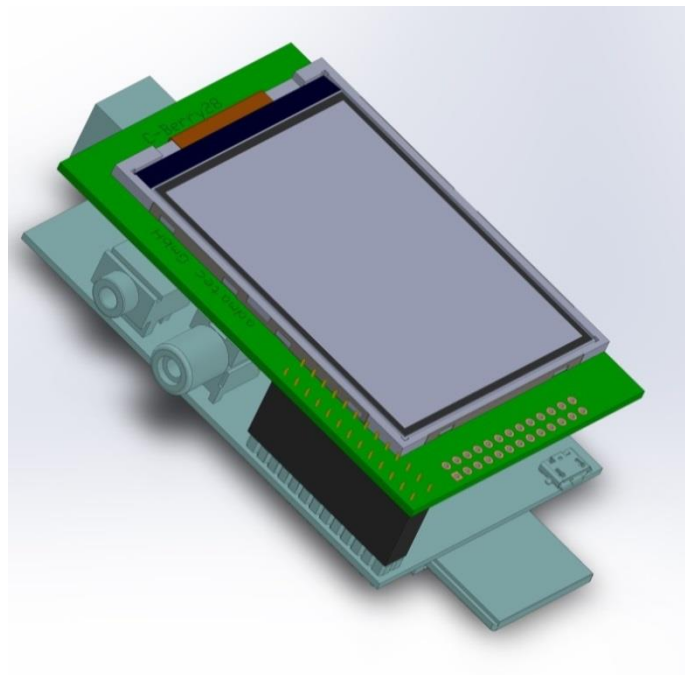**Figure 10.1: Plug C-Berry28 to Raspberry Pi**

Figure 10.2: Final assembly

11 Drawing

11.1 Drawing of TFT Module with TFT Adapter

Fig 11.1: Drawing of TFT Module with TFT Adapter

12 LCM handling

LCMs and especially LC-glasses are very fragile and easy to damage.
Please follow this > *link* < to find a guideline for recommended LCM handling.
Its purpose is to help customers best in handling LCMs correctly to avoid any malfunction of LCMs due to incorrect handling.

1st Choice for Display Solutions