

**J D I 720 X 720 LCD Specification for External Release**  
**LCD-49754-000**

**REV 1 Version B**

**January 2, 2014**

Date:
Vendor Signature:
Comments:

**Confidential and Proprietary**

**Revision History**

<b>Date</b>	<b>Changes</b>	<b>Revision</b>
May 3, 2012	Initial release	<b>A</b>
March 12, 2013	B.1 – updated Mech dwg revision to Rev 1 Updated Cascade Specification doc status from Draft to released to Rev 1 by TSD record	<b>1</b>
January 2, 2014	Updated for External Release	<b>1B</b>

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## A. Introduction

This document defines the requirements for a 720X720 color LCD module code-named “Cascade”.

Each specification has the word SHALL or SHOULD. Specifications with the word SHALL are mandatory, the words SHOULD implies an optional requirement.

## B. Applicable Documents

The following documents are an integral part of this specification. The module shall conform to all of the requirements listed in each document.

1. LCD-49754-000\_Rev1\_Ver1\_lcd-cascade.pdf Mechanical Drawing

Other requirements/specifications (quality, optical measurement methods) can be obtained by contacting BlackBerry.

## C. Design Guidelines

Deleted

## D. General Requirements

1. All specifications defined in this document are measurable and shall be evaluated based on BlackBerry’s measurement methods defined in the reference documents listed in Section B.
2. All specifications shall be met concurrently. (For example the display must meet the power requirements over the defined operating temperature range).
3. **NO CHANGES TO CRITICAL MATERIALS OR SUPPLIERS SHALL BE MADE WITHOUT WRITTEN CONSENT FROM BLACKBERRY.** Critical components and materials and suppliers are defined in Appendix A. Minor material changes can affect the RF performance of the BLACKBERRY product. Prior to changing a material or supplier, BLACKBERRY requires a sample LCD lot with the suggested changes incorporated. BLACKBERRY will then test and approve the changes. Also, no changes to test limits or process parameters may be made without prior notification to BLACKBERRY.
4. No changes to test limits, materials or process parameters may be made without BLACKBERRY’s approval.
5. The vendor shall provide a complete BOM identifying all part numbers of materials used to construct the module.
6. The vendor shall provide the specifications for all critical materials (listed in Appendix A) on the BOM.
7. The vendor shall provide a compliance document PROVING each specification has been met.
8. The vendor shall provide the following documentation relating to the manufacture of this module:
  - a. Process FMEA
  - b. Design FMEA
  - c. Quality control plans and process flow charts for the entire process (Glass and module assembly)
9. The vendor shall send BLACKBERRY measured data (on a regular sampling basis) for critical items. Critical specifications are marked with the symbol ▼. (Power consumption can be pass/fail only.)
10. The module shall be completely “lead-free” and shall be EU-RoHs compliant (PFOS, Deca-BDE, etc).
11. Deleted

12. Deleted

## E.Physical Attributes

1. The module shall meet the requirements shown in the mechanical drawing.

2. The module shall only have the following permanent markings:

a. BLACKBERRY's Part number

Vendor A	Vendor B
LCD-49754-001/111	LCD-49754-002/111

b. Vendor Part number

c. Date code (Year/Week #/Lot Code/Manufacturing location code)

d. Sample status (e.g. TS, ES1, CS, etc)

e. Sample batch # (e.g. A, B, C, etc)

3. Deleted

4. Deleted

## F.Optical Characteristics

1. The display shall be optimized for viewability in the 12, 3, 6, and 9 o'clock viewing directions.

2. The display shall be a normally black transmissive module.

3. The display shall have 720 pixels by RGB by 720 pixels. The pixels shall be 0.02575mm x RGB wide and 0.07725mm tall.

4. The display shall support 24 bits of colour depth per pixel

▼ 5. The display shall have a contrast of 800:1 minimum in transmissive mode.

6. Deleted

7. Deleted

8. Deleted

9. Deleted

10. Deleted

11. Deleted

12. Deleted

13. Based on C.I.E. 1976, the display module shall be able to reproduce the following colours when the backlight is on (no ambient light):

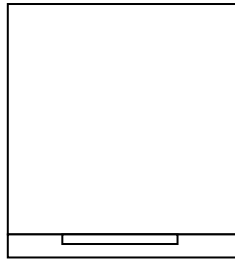
	u'	v'
RED	0.425± 0.025	0.524±0.015
GREEN	0.137± 0.015	0.560±0.015
BLUE	0.164± 0.040	0.197±0.040

These colour coordinates shall typically reproduce 70% of the NTSC colour gamut in C.I.E. 1976.

- ▼ 14. WHITE POINT: Based on C.I.E. 1976, the colour of the display with all of the primary colours on, when the backlight is on (no ambient light) shall be:

	u'	v'
WHITE	0.196± 0.02	0.468± 0.02

15. Deleted
16. The gamma measured normal to the display for grey shall be  $2.4 \pm 0.2$ .
17. Deleted
18. Deleted
19. The display shall be readable when the user is wearing polarizing sunglasses and the unit is oriented in portrait. Portrait orientation defined in below image;



20. The crosstalk shall be less than 2%.
21. Deleted
22. The display shall have a maximum response time (measured 10% to 90% at 25°C):
- Trise < 16.7ms max.
  - Tfall < 16.7ms max.
23. Deleted
24. The display shall exhibit NO FLICKERING under any conditions, including 50Hz and 60Hz light sources. See Appendix C for minimum test patterns requirements.

## G. Backlight

- The LCD module shall have an integrated backlight.
- The LCD backlight shall use 6 white LEDs all connected in parallel. See pin out.
- ▼ The LCD backlight shall have a MINIMUM luminance of 450cd/m<sup>2</sup> as measured from the front of the LCD module at 13mA/LED (measured with a constant current source).
- The LCD backlight design shall support a maximum current of 25mA/LED.
- The LCD backlight shall have a minimum uniformity of 85%.
- The LCD backlight shall have a minimum hotspot uniformity of 85%.
- LED colour or brightness ranks shall not be mixed on any given module.

## H. Electrical & Control Modes

1. The electrical interface shall include the following pins:  
< LCD FPC >

No.	PIN Name	Pin Description	Host Connection MIPI DSI Interface	No.	PIN Name	Pin Description	Host Connection MIPI DSI Interface
30	GND	Ground	GND	29	GND	Ground	GND
28	ANODE 6	LCD Backlight LED Anode	LED_A6	27	CATHODE 2	LCD Backlight LED Cathode	LED_C2
26	ANODE 5	LCD Backlight LED Anode	LED_A5	25	CATHODE 1	LCD Backlight LED Cathode	LED_C1
24	ANODE 4	LCD Backlight LED Anode	LED_A4	23	GND	Ground	GND
22	ANODE 3	LCD Backlight LED Anode	LED_A3	21	D0_P	MIPI Data differential line	LCD_D0_F_P
20	ANODE 2	LCD Backlight LED Anode	LED_A2	19	D0_N	MIPI Data differential line	LCD_D0_F_N
18	ANODE 1	LCD Backlight LED Anode	LED_A1	17	GND	Ground	GND
16	VSP	LCD_SOURCE_+5V_POS	LCD_5V_POS_F	15	D1_P	MIPI Data differential line	LCD_D1_F_P
14	GND	Ground	GND	13	D1_N	MIPI Data differential line	LCD_D1_F_N
12	VSN	LCD_SOURCE_-5V_NEG	LCD_5V_NEG_F	11	GND	Ground	GND
10	GND	Ground	GND	9	CLK_P	MIPI Strobe differential signal line	LCD_CLK_F_P
8	PWM	PWM output for CBABC backlight control	LCD_CBABC_PWM	7	CLK_N	MIPI Strobe differential signal line	LCD_CLK_F_N
6	GND	Ground	GND	5	GND	Ground	GND
4	RST	LCD_RESET_N	LCD_RST_N	3	VCC	VOLTAGE_INPUT (System) 2.85V +/-3%	DISP_2V85
2	GND	Ground	GND	1	VIO	VOLTAGE_INPUT (Interface) 1.8V +/-3%	DISP_1V8

2. The LCD flex shall include a 30 pin connector; Hirose BM14B(0.8)-30DP-0.4V(51).
3. LCD reset and PWM shall be capable of operating using 1.8V and 2.85V (+/-3%). The logic 1 and 0 shall be greater than  $0.75 * VIO$  and less than  $0.25 * VIO$  respectively.
4. The MIPI DSI interface shall be powered by the 1.8V rail.
5. When the module is in sleep mode (not displaying any information) the device shall draw less than  $3\mu W$ .
6. When the display is active with a still picture image (backlight off) the consumed power shall be 85mW MAX total on all rails with a white pattern displayed.
7. When the module is held in reset, the display shall draw less than 150uW.
8. Deleted
9. Deleted
10. Power up time (software initialization sequence) shall be less than 150ms (from deep sleep mode to full image display).
11. The IC shield tape shall be electrically connected to the main flex GND with a resistance  $< 2\Omega$  with or without external force applied to the module
12. The display shall not draw any peak current which exceeds the following requirements:
  - a. VCC – shall not exceed 700mA inrush current during power up based on a minimum voltage rise time of 20us from 0 to 2.85V.
  - b. IOVCC – shall not exceed 500mA inrush current during power up based on a minimum voltage rise time of 10us from 0 to 1.8V.
  - c. VSP – shall not exceed 300mA inrush current during power up based on a minimum voltage rise time of 120us from 0 to +4.4V.
  - d. VSN – shall not exceed 200mA inrush current during power up based on a minimum voltage rise time of 120us from 0 to -4.4V.
  - e. VSP – should not exceed 150mA while the panel is entering sleep out (charge pumps charging)
  - f. VSN – should not exceed 150mA while the panel is entering sleep out (charge pumps charging)
  - g. VSP – shall not exceed 100mA while the panel is on displaying an image. Peaks  $>50mA$  shall not exceed 2.5us in width.
  - h. VSN – shall not exceed 100mA while the panel is on displaying an image. Peaks  $>50mA$  shall not exceed 2.5us in width.
  - i. VCC – shall not exceed 50mA while the panel is on displaying an image.
  - j. IOVCC – shall not exceed 15mA while the panel is on displaying an image.



## I. Driver IC Requirements

1. The vendor shall provide the power-up/sleep/awake routine for the module with each batch of samples delivered during the development phase.
2. The driver IC shall support MIPI DSI interface
3. The driver IC MIPI DSI interface shall support a minimum bandwidth of 720 x 720 x 24bits x 1.2 overhead x 60fps
4. The driver IC or LCD shall require NO manual adjustments at BLACKBERRY in order to optimize its operating parameters.
5. Gamma = 2.4 shall be supported in the driver IC.
6. The driver IC shall support a method to identify the driver IC model.
7. The driver IC shall support sufficient non-volatile memory to store a unique serial number for each module including (See Appendix K – Module ID Format) :
  - a. manufacturing date code.
  - b. Vendor ID
  - c. Sample Status (e.g. TS, ES1, etc)
8. The driver IC shall support CBABC (Content Based Automatic Backlight Control).
9. The driver IC shall support PWM output and a readable data register to communicate the backlight CBABC scaling value to the host processor.
10. The CBABC scaling value register/PWM resolution shall be at least 8bits.
11. The PWM frequency shall be tuneable to a value greater than 40KHz.
12. The Driver IC shall support a method via register write to enable/disable CBABC.
13. The CBABC control block shall provide tuning registers to allow BLACKBERRY to modify the power savings vs. image quality level. These settings shall be tuneable such the CBABC control block provides a 100% scaling value/PWM output on a full white screen image.
14. When the display is inactive, the CBABC-PWM pin should be high impedance or ground.
15. The PWM output signal shall be either high impedance or active-high by default immediately after the power up sequence is sent to the display.
16. The Driver IC shall support Colour Saturation Enhancement

## J. Environment

1. The operating environment shall be  $-10^{\circ}\text{C}$  to  $60^{\circ}\text{C}$  and relative humidity between 5% and 95%.
2. The storage environment range shall be  $-30^{\circ}\text{C}$  to  $70^{\circ}\text{C}$  and relative humidity between 5% and 95%.
3. The following optical characteristics shall not change by more than the tolerances listed below within the temperature range indicated when reference to the modules performance at  $25^{\circ}\text{C}$ (initial measurement):

<b>Characteristics</b>	<b><math>-10^{\circ}\text{C}</math> to <math>60^{\circ}\text{C}</math></b>
Luminance	-30% / +40%
Contrast	-30% / +40%
The white point colour	$\pm 0.020$
Power	$\pm 20\%$

## K. Packaging

Deleted

**Appendix A) Critical Items for RF Compatibility**

<b>COMPONENT</b>	<b>Vendor</b>	<b>spec sheet</b>	<b>Notify BLACKBERRY of any changes</b>
Glass cell	Define	Layer drawings	Yes
Driver IC	Define	Yes	Yes
Front polarizer	Define	Yes	Yes
Rear polarizer	Define	Yes	Yes
ACF	Define	Yes	Yes
Tape	Define	Yes	Yes
Optical Films	Define	Yes	Yes
Light Guide	Define	Yes	Yes
PCB/flex	Define	Layer drawings	Yes
Light guide frame	Define	Yes	Yes
LED flex	Define	Layer drawings	Yes
Bezels	Define	Yes	Yes

<b>PCB Components</b>	<b>Vendor</b>	<b>Spec sheet</b>	<b>Notify BLACKBERRY of any changes</b>
<b><i>LCD circuit</i></b>			
Cap	Generic	No	No
Resistors	Generic	No	No
White LED	Define	Yes	Yes

## **Appendix B) Deleted**

## **Appendix C) Test Images**

The list of test patterns below is not intended as a complete list.

- a) white screen
- b) black screen
- c) RGB stripe screen
- d) Fade to black screen (gray scale)
- e) Four quadrant: 25% gray, 50%, 75%, black
- f) Horizontal MTF screen. Horizontal bars with lines getting closer.
- g) Vertical MTF screen.
- h) Face
- i) Text on white background. Vary font size
- j) Small text on varying background.
- k) Complex image (combination of several of the above images)
- l) Flicker test pattern (excluded for “No Flickering” spec F.26, flickering should be MINIMIZED for this pattern.)
- m) Typical Blackberry Ribbon screen

## **Appendix D) Deleted**

## **Appendix E) Deleted**

## **Appendix F) Deleted**

## **Appendix G) Deleted**

## **Appendix H) Deleted**

## **Appendix I) Deleted**

## **Appendix J) Deleted**

### Appendix K) Module ID Format

	7	6	5	4	3	2	1	0
A1h parameter1	Year				Month			
A1h parameter2	Day				Vendor ID			
A1h parameter3	MDL		Serial Number (upper)					
A1h parameter4	Serial Number (lower)							
A1h parameter5	Manufacturing line / testing fixture							
A1h parameter6	Manufacturer's Status				RIM's Status			

**Detail descriptions**

A1h parameter1	0	0	0	1	0	1	0	1
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**Year**

0001 = 2012  
 0010 = 2013  
 0011 = 2014  
 0100 = 2015  
 ...  
 1111 = 2026

**Month**

0001 = Jan  
 0010 = Feb  
 0011 = Mar  
 0100 = Apr  
 0101 = May  
 0110 = June  
 0111 = July  
 1000 = Aug  
 1001 = Sep  
 1010 = Oct  
 1011 = Nov  
 1100 = Dec

A1h parameter2	1	1	1	0	0	0	1	0
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**Day**

00001 = 1st  
 00010 = 2nd  
 00011 = 3rd  
 00100 = 4th  
 00101 = 5th  
 ....  
 11111 = 31st

**Vendor ID**

1<sup>st</sup> vendor = 001  
 2<sup>nd</sup> vendor = 010

A1h parameter3	MDL	Serial Number(upper)						
A1h parameter4	Serial Number (lower)							

**MDL**

00 = Module site A  
 01 = Module site B  
 10 = Module site C

A1h parameter5	Manufacturing line /testing fixture
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inspection equipment No.  0000 = No. 0 0001 = No. 1 0010 = No. 2 0011 = No. 3 .....
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Glass  0000 = Glass manufacturing site A 0001 = Glass manufacturing site B ...
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A1h parameter6	Manufacturer's Status	RIM's Status
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Manufacturer's Rev  0000 = Normal used for MP version 0001 = Rev 1 0011 = Rev 2 0100 = Rev 3 0101 = Rev 4 - 1111 = ...
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RIM Status  TS:"00", ES:"01", CS:"10", MP:"11"  "00" & "00" = TS1 "00" & "01" = TS2 "01" & "00" = ES1 "01" & "01" = ES2 "01" & "10" = ES3 "01" & "11" = ES4 "10" & "00" = CS1 "11" & "00" = MP
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