REVISIONS

REV.	DESCRIPTION	DATE	APPROVED
A	E0541		

1. **Specification subject to change without notice.**
2. **All dimensions and specifications apply to standard modules. This information may vary for modules with optional features.**
3. **All dimensions are in millimeters.**
4. **Precautions:These precautions apply equally to modules from all makers, not just Densitron. Violation of these guidelines may void the warranty and can cause problems ranging from erratic operation to catastrophic display failure.**

Handling precautions:

- This device is susceptible to Electro-Static Discharge (ESD) damage. Observe Anti-Static precautions.

Power supply precautions:

- Identify and, at all times, observe absolute maximum ratings for both logic and LC drivers. Note that there is some variance between models.
- Prevent the application of reverse polarity to V_{DD} and V_{SS}, however briefly.
- Use a clean power source free from transients. Power up conditions are occasionally “jolting” and may exceed the maximum ratings of the module.
- The +5V power of the module should also supply the power to all devices which may access the display. Don’t allow the data bus to be driven when the logic supply to the module is turned off.
- DO NOT install a capacitor between the V_O (contrast) pin and ground. V_{DD} must, at all times, exceed the V_O voltage level. The capacitor combines with the contrast potentiometer to form an R-C network which “holds-up” V_O, at power-down, possibly damaging the module.

Operating precautions:

- DO NOT plug or unplug the module when the system is powered up.
- Minimize the cable length between the module and host MPU. (Recommended max. length 30 cm).
- For models with EL backlights, do not disable the backlight by interrupting the HV line. Unloaded inverters produce voltage extremes which may arc within a cable or at the display.
- Operate the module within the limits of the modules temperature specifications.

Mechanical / Environmental precautions:

- Improper soldering is the major cause of module difficulty. Use of flux cleaner is not recommended as they may seep under the elastomeric connection and cause display failure. Densitron recommends the use of Kester “245” no-clean solder.
- Mount the module so that it is free from torque and mechanical stress.
- Surface of LCD panel should not be touched or scratched. The display front surface is an easily scratched, plastic polarizer. Avoid contact and clean only when necessary with soft, absorbent cotton dampened with petroleum benzene.
- ALWAYS employ anti-static procedure while handling the module.
- Prevent moisture build-up upon the module and observe the environmental constraints for storage temperature and humidity.
- DO NOT store in direct sunlight.
- If leakage of the liquid crystal material should occur, avoid contact with this material, particularly ingestion. If the body or clothing becomes contaminated by the liquid crystal material, wash thoroughly with water and soap.

Notes: (unless otherwise specified)

Unless otherwise specified:	APPROVALS	DATE	DENSITRON CORPORATION TORRANCE, CA	
Dimensions are mm Tolerances are: X = ± 3 .X = ± 0.5 .XX = ± 0.05	DRAWN			
	CHECKED		TITLE: 4 LINE X 40 CHARACTERS LCD MODULE	
	ISSUED		DWG. NO. LM2444	SHEET 1 OF 8

1.0 DESCRIPTION

Dot matrix display module consisting of a Liquid Crystal Display, CMOS driver and controller LSI, printed circuit board and metal support frame.

Available LC fluids types are: TN (twisted nematic), NTN (supertwisted nematic), NTN-H (extended temperature range NTN).

Options include electroluminescent (EL) backlighting and/or on-board negative voltage generation.

2.0 MECHANICAL CHARACTERISTICS

Item	Specifications	Unit
Package Dimensions	215.0(W) x 60.0(H) x 10.8 max (D)	mm
Display format	4 line x 40 characters	-
Character font format	5 (W) x 7 (H) with detached cursor	dots
Driving method	1/16	duty
Dot size	0.60(W) x 0.65(H)	mm
Dot pitch	0.65(W) x 0.70(H)	mm
Character Size	3.2(W) x 4.85(H)	mm
Active display area	149.45(W) x 27.25(H)	mm
Viewing area	160.0(W) x 34.0(H)	mm
Weight		g

Notes:W-Width;H-Height;D-Depth.

3.0 ABSOLUTE MAXIMUM RATINGS

V_{SS}=0V;T_a=25°C

Item	Symbol	TN, NTN		TN-H, NTN-H		Unit
		Min.	Max.	Min.	Max.	
Logic supply voltage	V_{DD}-V_{SS}	0	7	0	7	V
LC driver supply voltage	V_{DD}-V_O	0	6	0	13	V
Operating temperature Storage temperature (Note 1)	T_{OP} T_{ST}	0 -20	+50 +70	-20 -30	+70 (Note 3) +80	°C
Humidity: Operating (@40°C) Non-operating (@40°C)	- -	- -	85% 95%	- -	85% 95%	RH (Note 2) RH (Note 2)

Notes: 1: Tested to 100 hrs.
2: Refers to non-condensing conditions.
3. It is not recommended to operate EL lamp above 50°C.

4.0 ELECTRICAL CHARACTERISTICS

V_{DD}=5±0.25V;T_a=25°C

Item	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Input “High” voltage	V_{IH}	-	2.2	-	V_{DD}	V
Input “Low” voltage	V_{IL}	-	-	-	0.6	V
Output “High” voltage	V_{OH}	I_{OH}=0.205mA	2.4	-	-	V
Output “Low” voltage	V_{OL}	I_{OL}=1.2mA	-	-	0.4	V
Power supply current	I_{DD}	V_{DD}=5.0V	-	5	-	mA

5.0 RECOMMENDED LC DRIVE VOLTAGE (V_{DD}-V_O)

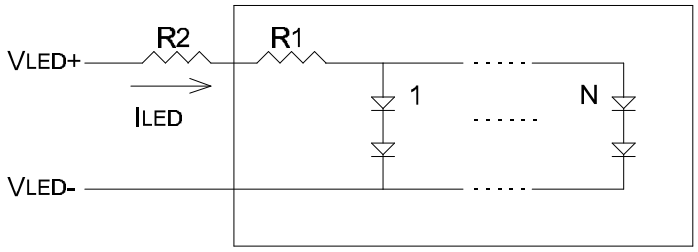
V_{DD}=5.0±0.25V

Temperature	TN	TN-H	NTN	NTN-H
Ta= -20°C	-	7.6	-	7.5
Ta= 0°C	5.0	7.3	4.8	7.1
Ta= 25°C	4.7	7.1	4.4	6.8
Ta= 50°C	4.5	6.8	4.1	6.5
Ta=70°C	-	6.5	-	6.3

6.0 BACKLIGHT SPECIFICATIONS:

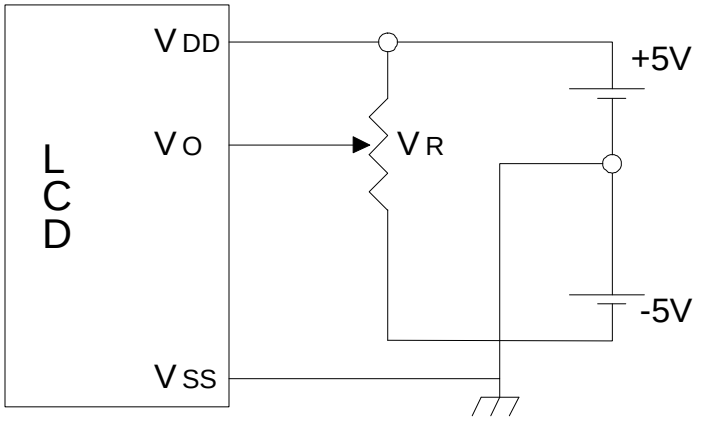
Ta=20°C,60%RH,Darkroom.

Item	Symbol	Typ.	Max.	Unit
EL lamp input voltage	V_{EL}	100	150	Vrms
EL lamp input current	I_{EL}	14.0	21.0	mA
EL lamp input frequency	F_{EL}	400	800	Hz
Life to half initial brightness	-	2500	3000	Hours
Recommended backlight inverter	-	DAS5V8	-	-

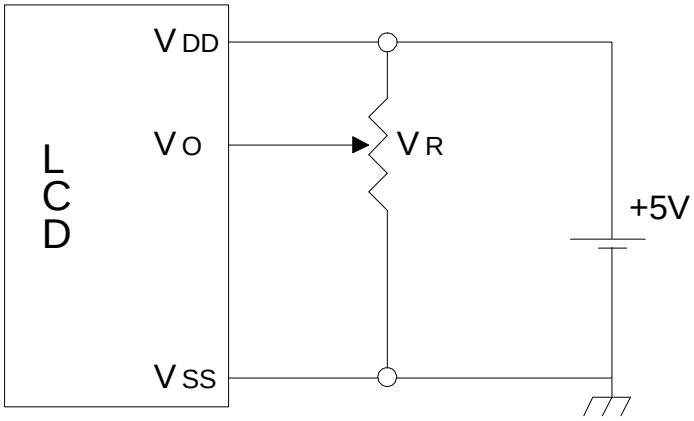


7.0 POWER SUPPLY

TN-H, NTN-H



TN, NTN

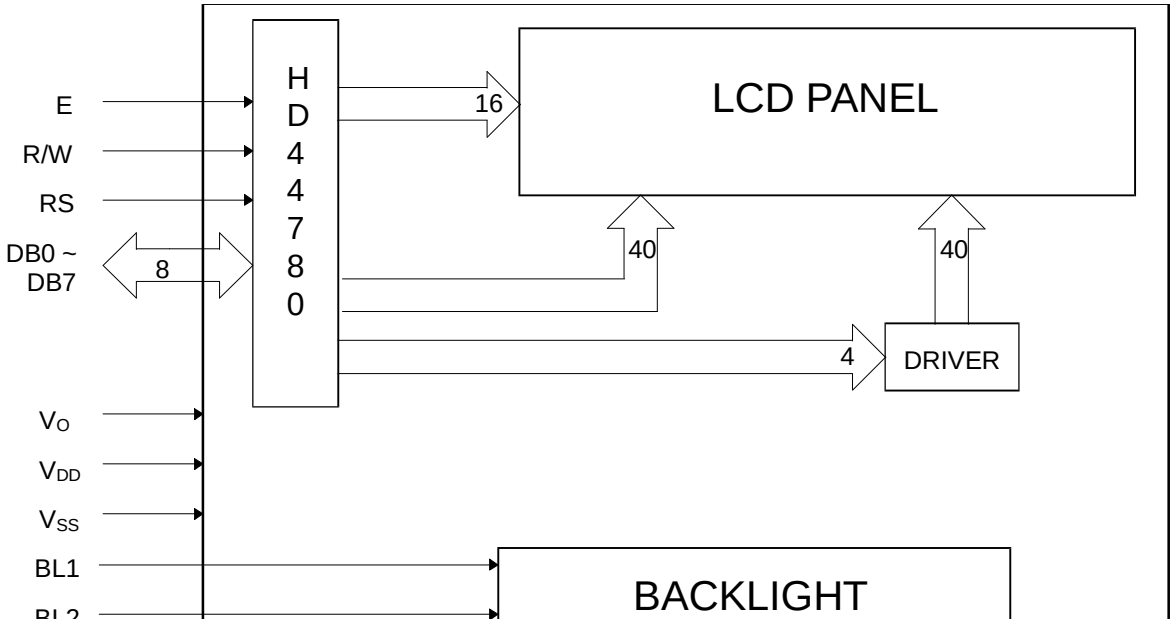


V_R = 10K - 20K ohm

8.0 INTERFACE DESCRIPTION

Pin No.	Symbol	I/O	Function
1	DB6	I/O	Bi-directional data bus line 6
2	DB7	I/O	Bi-directional data bus line 7
3	DB4	I/O	Bi-directional data bus line 4
4	DB5	I/O	Bi-directional data bus line 5
5	DB2	I/O	Bi-directional data bus line 2
6	DB3	I/O	Bi-directional data bus line 3
7	DB0	I/O	Bi-directional data bus line 0
8	DB1	I/O	Bi-directional data bus line 1
9	E1	I	Enable Signal 1 Active High (H→L)
10	E2	I	Enable Signal 2 Active High (H→L)
11	RS	I	Register Select 0: Instruction Register 1: Data Register
12	R/W	I	Read / Write 0: Data Write (Module←MPU) 1: Data Read (Module→MPU)
13	V_O	-	LC Drive voltage for contrast adjustment
14	V_{DD}	-	Logic Supply Voltage (+5V)
15	V_{SS}	-	Ground (0V)
16	V_{SS}	-	Ground (0V)
17	N/C(V_{EE})	- (O)	No Connection (Negative voltage output for models with on-board negative voltage generators)
18	N/C	-	No Connection
BL1	V_{EL}	-	EL Backlight input voltage (from output of DC-AC inverter)

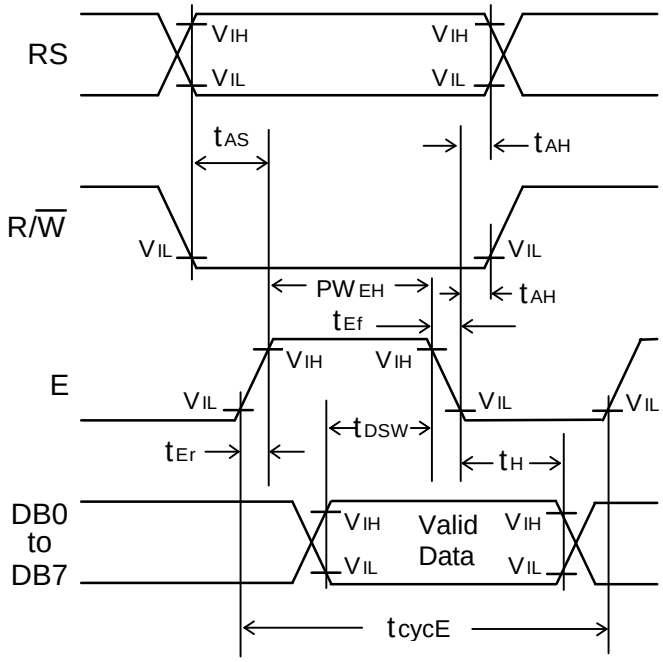
9.0 BLOCK DIAGRAM:



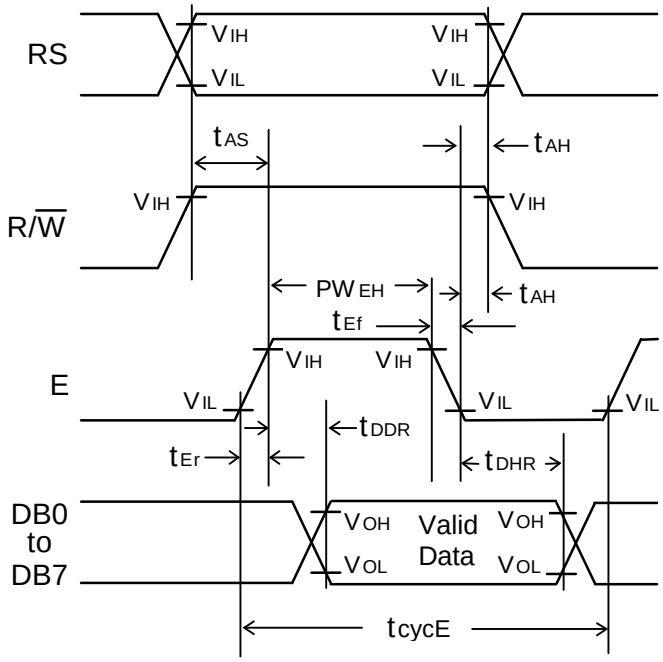
10.0 TIMING CHARACTERISTICS

Item	Symbol	Min.	Typ.	Max.	Unit
Enable cycle time	T_{cycE}	500	-	-	nS
Enable pulse width	PW_{EH}	230	-	-	nS
Enable rise / fall time	t_{Er}/t_{Ef}	-	-	20	nS
Address set-up time	t_{AS}	40	-	-	nS
Address hold time	t_{AH}	10	-	-	nS
Data delay time	t_{DDR}	-	-	160	nS
Data hold time (Write)	t_{DHW}	10	-	-	nS
Data hold time (Read)	t_{DHR}	5	-	-	nS
Data set-up time	t_{DSW}	80	-	-	nS

WRITE OPERATION



READ OPERATION



11.0 DD RAM ADDRESS vs. DISPLAY POSITION

Character	1	2	3	4	5	6	7	8	9	10	11	---	38	39	40
Line 1 *	00	01	02	03	04	05	06	07	08	09	0A	---	25	26	27
Line 2 *	40	41	42	43	44	45	46	47	48	49	4A	---	65	66	67
Line 3 **	00	01	02	03	04	05	06	07	08	09	0A	---	25	26	27
Line 4 **	40	41	42	43	44	45	46	47	48	49	4A	---	65	66	67

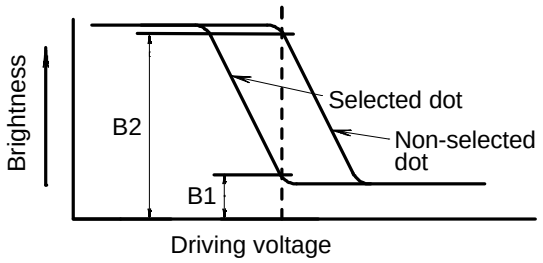
* - Controller 1 (E1)
** - Controller 2 (E2)

12.0 OPTICAL CHARACTERISTICS

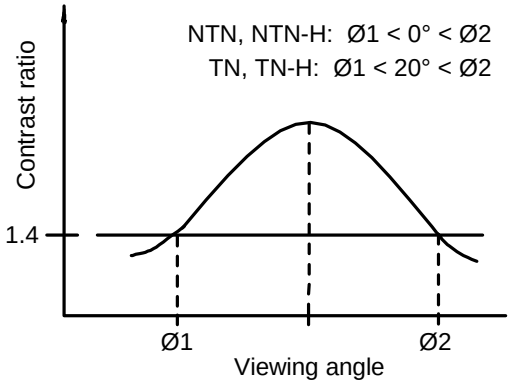
Item	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Contrast ratio TN, TN-H	K	Ø=20° θ=0°	3	-	-	-
Contrast ratio NTN	K	Ø=20° θ=0°	4	-	-	-
Contrast ratio NTN-H	K	Ø=20° θ=0°	5	-	-	-
Viewing angle TN, TN-H	Ø2-Ø1	θ=0° K≥1.4	20	-	-	Deg.
	θ	Ø=20° K=1.4	±30	-	-	Deg.
Viewing angle NTN	Ø2-Ø1	θ=0° K≥1.4	40	-	-	Deg.
	θ	Ø=20° K=1.4	±30	-	-	Deg.
Viewing angle NTN-H	Ø2-Ø1	θ=0° K≥1.4	40	-	-	Deg.
	θ	Ø=20° K=1.4	±40	-	-	Deg.
Response time Rise	t_r	Ø=20° θ=0°	-	150	250	mS
Fall	t_f	Ø=20° θ=0°	-	150	250	mS

DEFINITION OF CONTRAST RATIO (K)

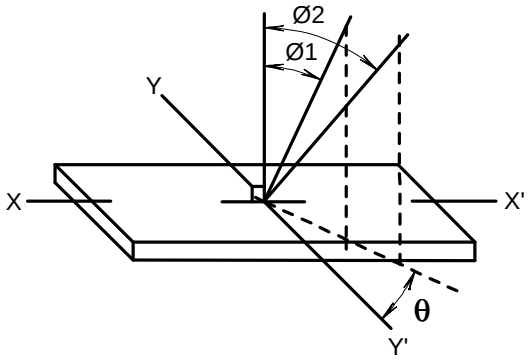
$$K = \frac{\text{Brightness of non-selected dots}}{\text{Brightness of selected dots}}$$



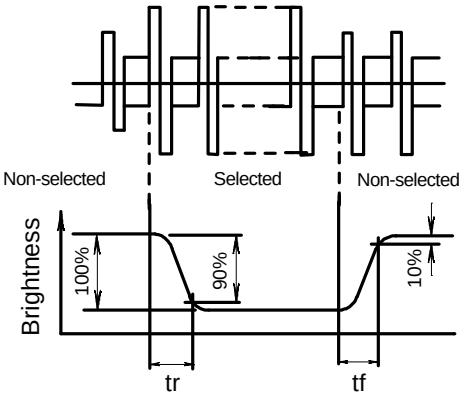
CONTRAST VERSUS VIEWING ANGLE



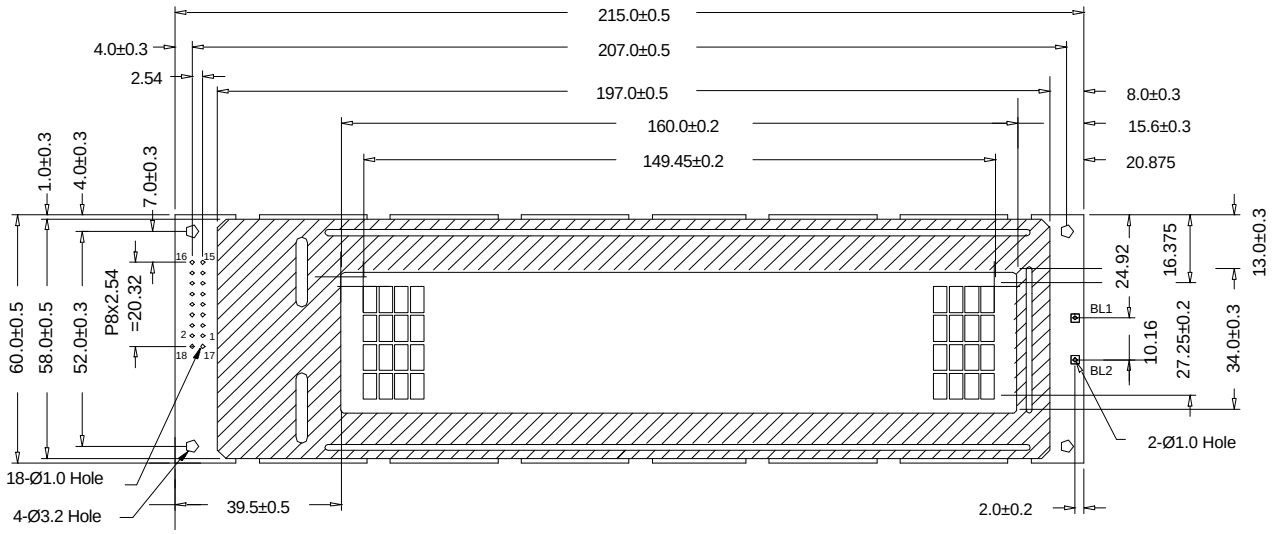
DEFINITION OF ANGLES Ø AND θ

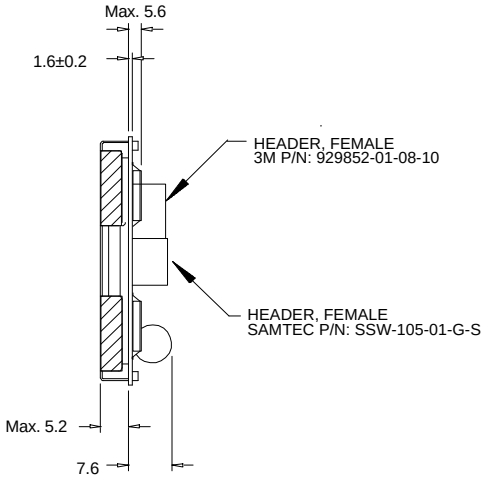


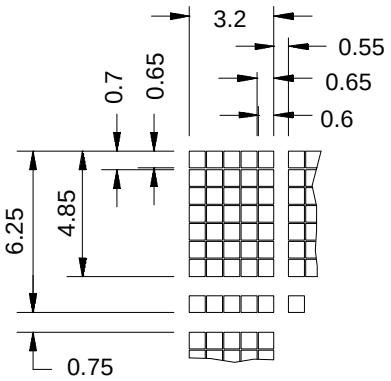
DEFINITION OF OPTICAL RESPONSE



13.0 MODULE DIMENSIONS







DWG. NO.		SHEET	REV.
	LM2444	7 OF 8	A

14.0 PART NUMBER DESCRIPTION FOR AVAILABLE OPTIONS

LM2444①②4C40③④⑤

OPTION 38.DOC

①

Polarizer Type

A = Reflective: light background, no backlight
B = Transflective: light background with blue-green EL backlight
E = Transmissive: dark background with blue-green EL backlight

②

Not applicable - LEAVE BLANK

③

Fluid Type and Power Supply

C = TN, TNH with +5VDC operation
S = NTN with +5VDC operation
H = NTN-H with ±5VDC operation
W = NTN-H fluid with +5VDC operation (on-board negative voltage generation)

④

Fluid Type/ TN, TNH Viewing Direction

B = TN,TNH bottom viewing
T = TN, TNH top viewing
N = NTN, NTN-H

⑤

Background Color for NTN Fluid

B = Blue background
G = Gray background
Y = Yellow background