

APPLICATION NOTE – REFERENCE DESIGN

MODEL NAME : 4.01inch e-Paper (F)

1 About This Application Note

This document describes a reference design system that integrates E Ink’s N-Color 4.01” display (7 colors). It includes an application circuit, timing information, pin assignments and software programming guide for the ePaper display module.

2 Overview

The N-Color 4.01” is a 640x400 ePaper display with integrated timing control and power management circuitry. Each pixel on the display has the capability of showing seven states – black, white, blue, orange, yellow, green and red. The N-Color 4.01” panel is ideal for applications such as signage for retail pricing with the ability to highlight promotions with other 5 colors, blue, orange, yellow, green and red.

3 Device Interface

This section describes the interface and pin assignments of the N-Color 4.01” panel.

Table 1 Pin descriptions for N Color

Pin Assignment				
Pin#	Type	Signal	Description	Remark
1	I	MFCSB	MCU to flash/EEPROM chip select	
2	O	GDR	N-Channel MOSFET Gate Drive Control	
3	O	RESE	Current sense input for the control loop	
4	P	VSL_LV	Negative source driver voltage (low voltage)	
5	P	VSH_LV	Positive source driver voltage (low voltage)	
6	O	TSCL	I2C interface to digital temperature sensor Clock pin	
7	I/O	TSDA	I2C interface to digital temperature sensor Data pin	
8	I	BS1	Bus selection pin; L: 4-wire IF. H: 3-wire IF (Default)	
9	O	BUSY	Busy state output pin	
10	I	RES#	Reset	
11	I	D/C #	Data / Command control	
12	I	CS #	Chip select input pin (SPI)	
13	I	SCL	Serial clock pin (SPI)	
14	I/O	SDA	Serial data pin (SPI)	
15	P	VDDIO	Power for interface logic pins	
16	P	VCI	Power supply pin for the chip	
17	P	VSS	Ground	
18	P	VDD	Core logic power pin	
19	O	FMSDO	Flash/EEPROM to MCU data output	Don't share this pin with SDA of SPI.
20	P	VSH	Positive source driving voltage	
21	P	VGH	Positive gate driving voltage	
22	P	VSL	Negative source driving voltage	
23	P	VGL	Negative gate driving voltage	
24	P	VCOM	VCOM driving voltage	

I: Input Pin; O: Output Pin; I/O: Input/Out Pin; P: Power Pin

3.1 SPI Interface Timing

Figure 1 3-wire SPI Timing Diagram

3-WIRE SPI

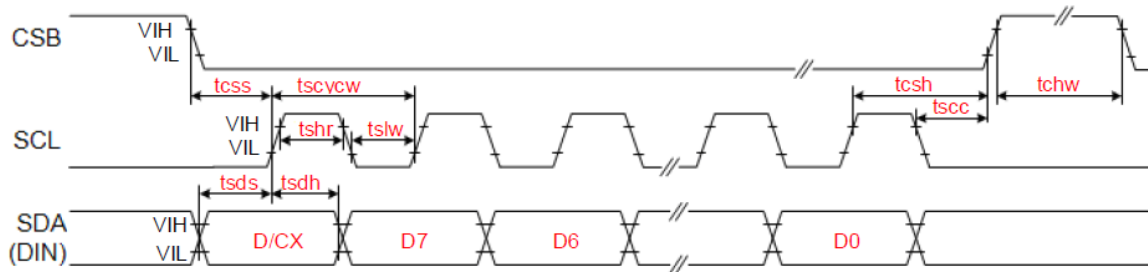


Figure : 3-wire Serial Interface – Write

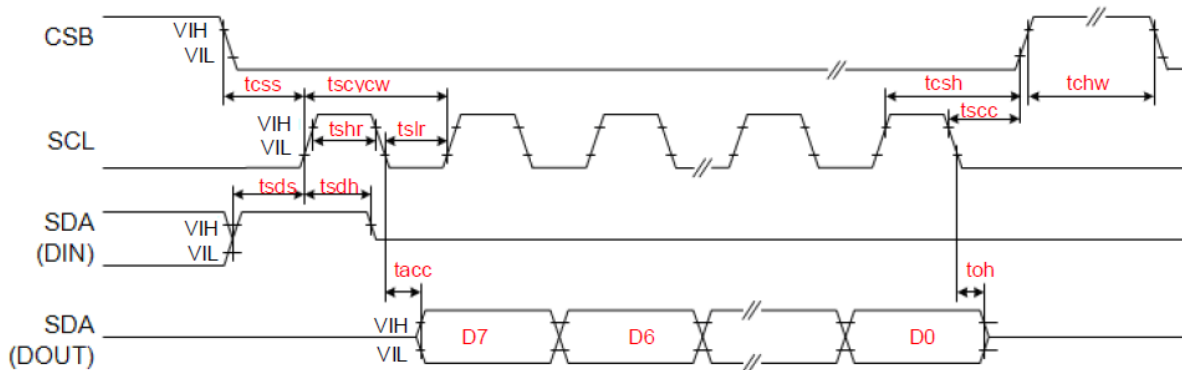
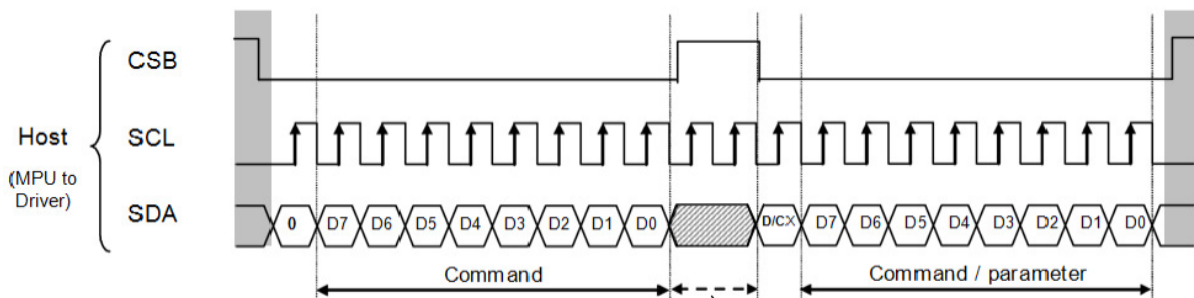


Figure : 3-wire Serial Interface – Read

Figure 2 Host Communications Timing Diagram



CSB can be "H" between parameter-command and command-parameter SCL and SDA during CSB="H" is invalid.

Figure 3 4-wire SPI Timing Diagram

4-WIRE SPI

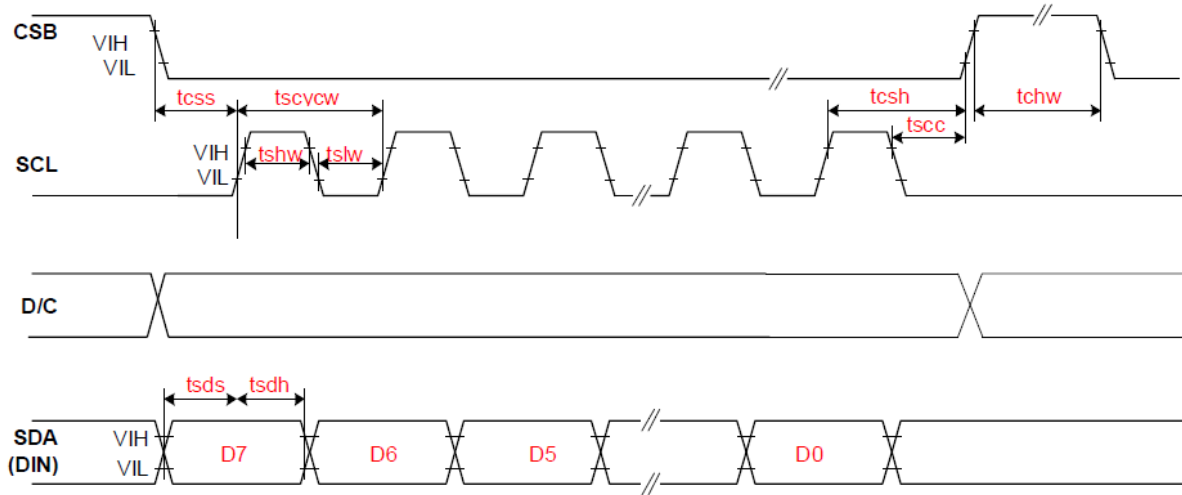


Figure : 4-wire Serial Interface – Read

Figure 4 Host Communications Timing Diagram

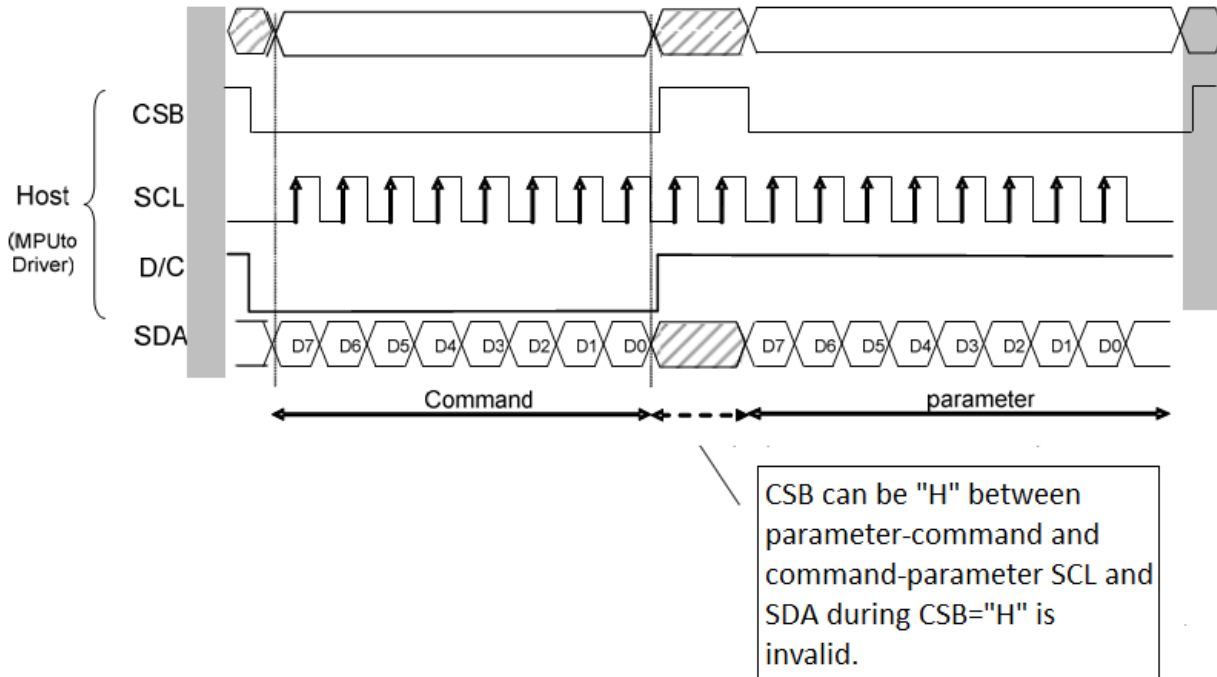


Table 2 Timing Table

Symbol	Signal		Min	Typ	Max	Unit
SERIAL COMMUNICATION						
tCSS	CSB	Chip select setup time	60			ns
tCSH		Chip select hold time	65			ns
tSCC		Chip select setup time	20			ns
tCHW		Chip select setup time	40			ns
tSCYCW	SCL	Serial clock cycle (Write)	100			ns
tSHW		SCL "H" pulse width (Write)	35			ns
tSLW		SCL "L" pulse width (Write)	35			ns
tSCYCR		Serial clock cycle (Read)	150			ns
tSHR		SCL "H" pulse width (Read)	60			ns
tSLR		SCL "L" pulse width (Read)	60			ns
tSDS	SDA (DIN) (DOUT)	Data setup time	30			ns
tSDH		Data hold time	30			ns
tACC		Access time	10			ns
tOH		Output disable time	15			ns

4 Command Table

4-1) R02H (POF): POWER OFF COMMAND

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Turning OFF the power	0	0	0	0	0	0	0	0	1	0

4-2) R04H (PON): POWER ON COMMAND

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Turning ON the power	0	0	0	0	0	0	0	1	0	0

4-3) R06H (BTST): BOOSTER SOFT START

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Starting data transmission	0	0	0	0	0	0	0	1	1	0
	0	1	1	1	0	0	0	1	1	1
	0	1	1	1	0	0	0	1	1	1
	0	1	0	0	0	1	1	1	0	1

4-4) R07H (DSLPE): DEEP SLEEP

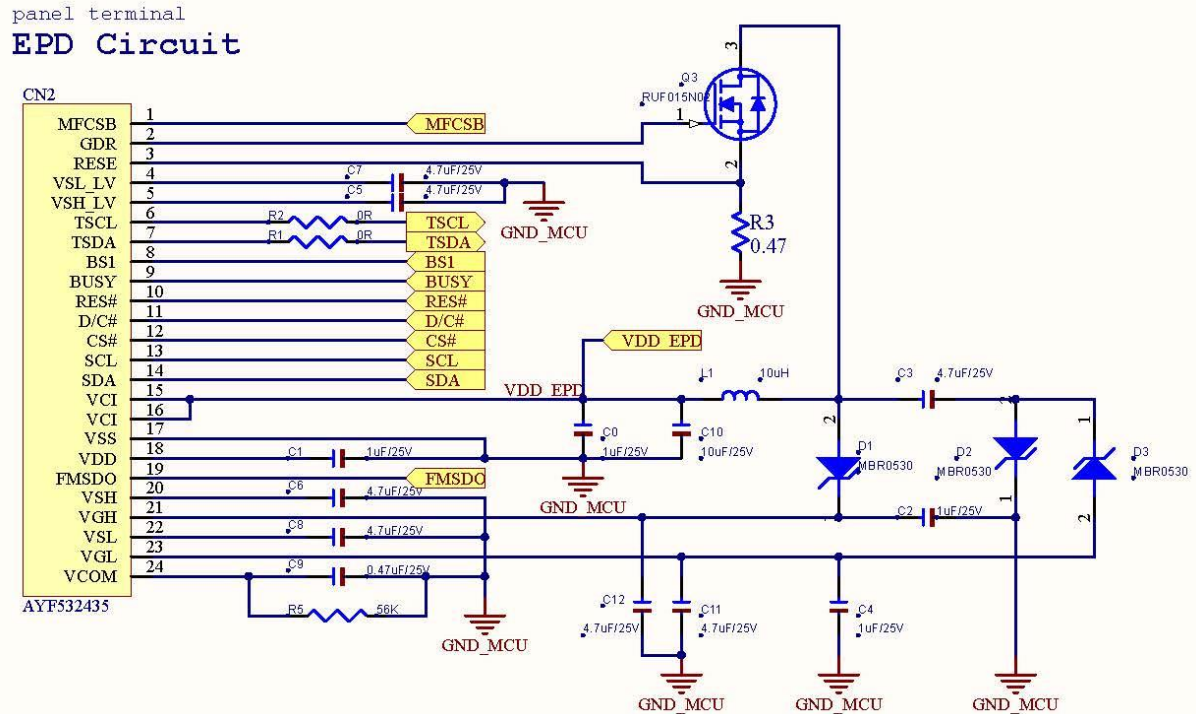
Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Deep sleep	0	0	0	0	0	1	0	0	0	0
	0	1	1	0	1	0	0	1	0	1

This command makes the chip enter the deep-sleep mode. The deep sleep mode could return to stand-by mode by hardware reset assertion.

The only one parameter is a check code, the command would be executed if check code is A5h

5 Reference circuit

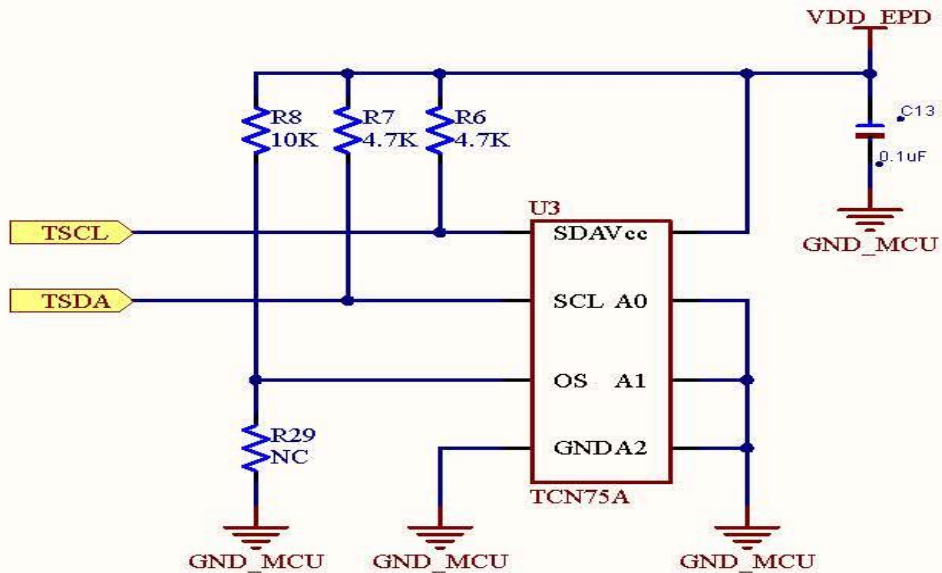
Figure 5 N-Color 4.01" Reference Circuit



Remark: It is recommended to use X7R capacitor for C9. It could reduce power consumption significantly in comparison with X5R or Y5V.

Figure 6 Temperature Sensor Circuit (optional)

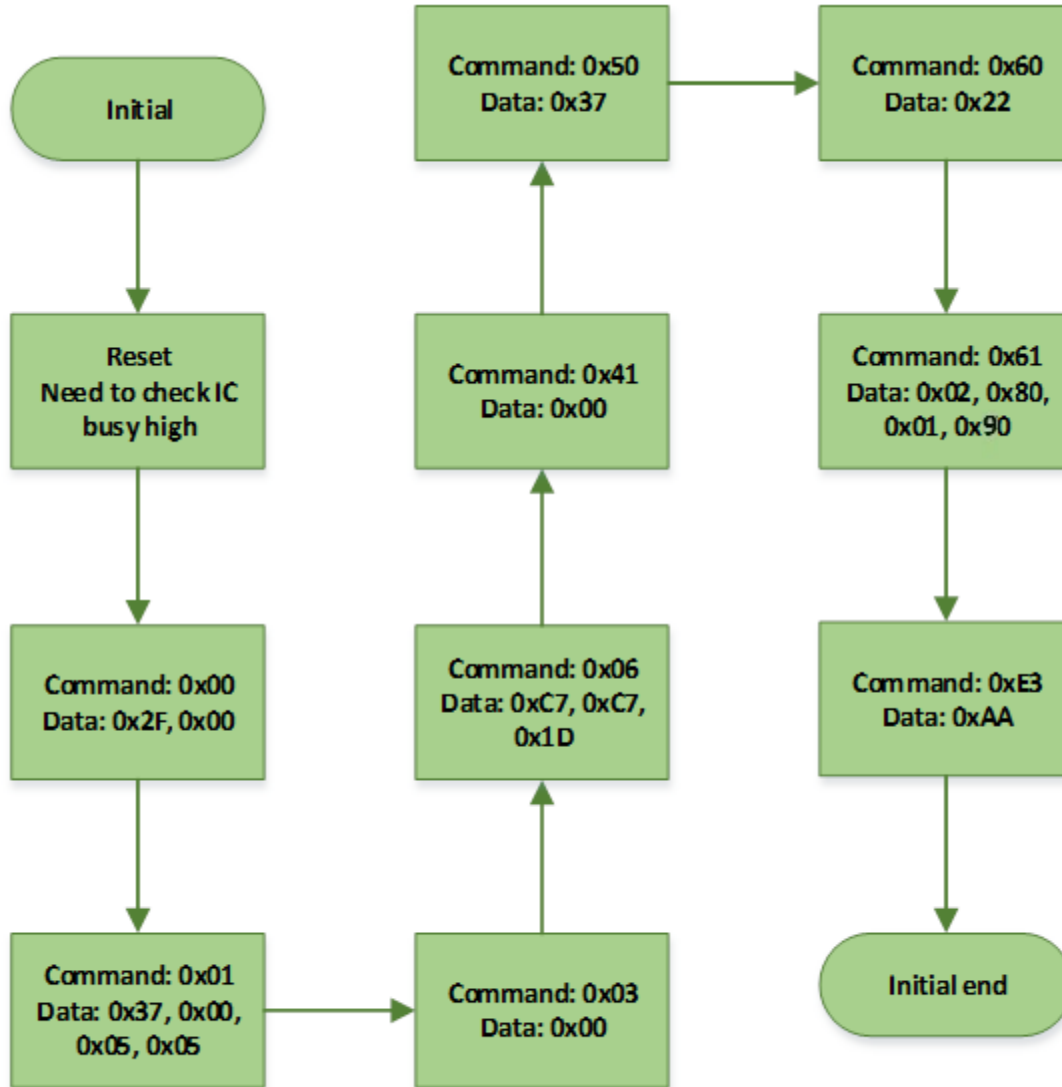
Option : Temperature Sensor



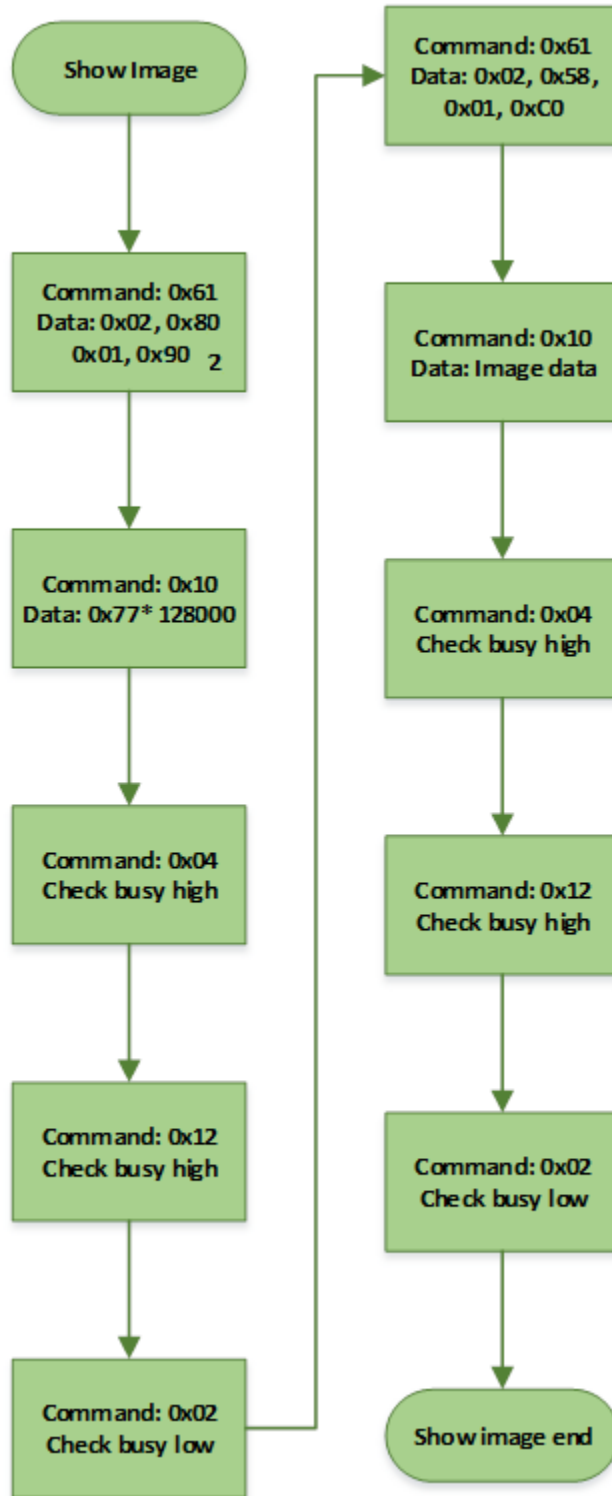
6 Software Programming Guide

This section describes the image update flow for the N-Color 4.01". After the system MCU sends seven color image to the driver IC, the BUSY signal from the panel should be monitored and used to indicate the completion of the update.

6.1 Initial



6.2 Show Image



7 Color Mapping table for N-Color 4.01”

Color images (24 bit RGB) require conversion into the seven colors supported by this display. The color mapping is shown in the below.

Color	Color index	Raw data of image
Black	000000	000
White	FFFFFF	001
Green	00FF00	010
Blue	0000FF	011
Red	FF0000	100
Yellow	FFFF00	101
Orange	FF8000	110
Clear	-	111

Remark

The waveform to show image is designed such that every update must comprise a clear and a color. No update should be performed without clear or there would be noticeable ghosting. Show image flow in sec 5.2 comprises the clear.