

JAN. 2000
Ver 0.1

DATA SHEET

KB2514
Preliminary



VIDEO AMP MERGED OSD PROCESSOR

The KB2514 is a very high frequency video amplifier & wide range OSD processor 1 chip system with I²C Bus control used in monitors. It contains 3 matched R/G/B video amplifiers with OSD processor and provides flexible interfacing to I²C Bus controlled adjustment systems.

FUNCTIONS

- R/G/B video amplifier
- OSD processor
- I²C bus control
- Cut-off brightness control
- R/G/B sub contrast/cut-off control
- Half tone

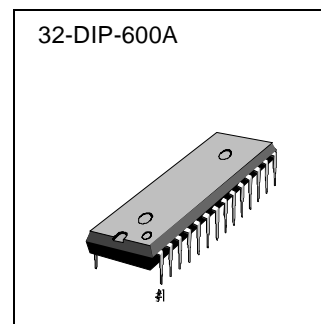
FEATURES

VIDEO AMP PART

- 3-channel R/G/B video amplifier, 150MHz @f-3dB
- I²C bus control items
 - Contrast control: -38dB
 - Sub contrast control for each channel: -12dB
 - Brightness control
 - OSD contrast control: -38dB
 - Cut-off brightness control (AC coupling)
 - Cut-off control for each channel (AC coupling)
 - Switch registers for SBLK and video half tone and CLP/BLK polarity selection and INT/EXT CLP selection
- Built in ABL (automatic beam limitation)
- Built in video input clamp, BRT clamp
- Built in video half tone (3mode) function on OSD pictures
- Capable of 8.0Vp-p output swing
- Improvement of rise & fall time (2.2ns)
- Cut-off brightness control
- Built in blank gate with spot killer
- Clamp pulse generator
- OSD intensity
- BLK, CLP polarity selection
- Clamp gate with anti OSD sagging

ORDERING INFORMATION

Device	Package	Operating Temperature
KB2514	32-DIP-600A	-20 °C ~ +75 °C



OSD PART

- Built in 1K-byte SRAM
- 256 ROM fonts (each font consists of 12 × 18 dots.)
- Full screen memory architecture
- Wide range PLL available (15kHz ~ 90kHz, Reference 800 X 600)
- Programmable vertical height of character
- Programmable vertical and horizontal positioning
- Character color selection up to 16 different colors (in a units of character)
- Programmable background color (up to 16 colors)
- Character blinking and shadowing
- Character scrolling
- 72MHz pixel frequency from on-chip PLL (Reference 800 X 600)
- Full white pattern generation function

The diagram illustrates the internal architecture of the T6963C LCD controller, showing the flow of data and control signals between various components and pins.

Internal Components:

- ROM (448 x 18 x 12):** Provides Font Data (12 bits) to the Output Stage.
- ROM (480 x 16):** Provides Ctrl Font to the Display Controller.
- Data Receiver:** Receives RAM Data (16 bits) from the Control Register.
- Display Controller:** Manages Frame Ctrl, ROM Ctrl, and H/V/CLK Ctrl signals.
- Control Register:** Receives Ctrl Data (16 bits) and provides Frame Ctrl and ROM Ctrl signals.
- Timing Controller:** Provides H/V/CLK Ctrl signals to the Display Controller.
- Output Stage:** Receives Display Ctrl and Font Data signals.
- Band Gap Ref:** Provides R/G/B OSD, FBLK, and Intensity signals.
- Multi (3 mode) Half Tone:** Provides RGB OSD, FBL, INTE, and HT DET. signals.
- ABL:** Provides ABL signal to the Clamp Pulse Gen.
- Clamp Pulse Gen.:** Provides CLP signal to the Video Contrast and Video Input Clamp.
- Video Contrast:** Receives Video Contrast and Video Input signals.
- Video Input Clamp:** Receives CLP signal.
- Video Half Tone SW:** Receives FBLK and I²C signals.
- Sub Cont. Control:** Receives I²C signals.
- OSD Input Clp.:** Receives HT DET. signal.
- OSD Half Tone SW:** Receives FBLK and I²C signals.
- OSD Cont. Control:** Receives I²C signals.
- Bright Control:** Receives CLP and I²C signals.
- Amp Out:** Provides R OUT signal.
- Latches:** Provides SDA and SCL signals.
- i²C bus decoder D/A:** Provides R cut off, G cut off, and B cut off signals.

Pin Connections:

- VDD (31), VSS (28), VCC3 (11), GND3 (9), VREF1 (4), VREF (5), ABL (8), CONT_CAP (7), RIN (12), GND1 (15), VCC1 (13), GIN (14), BIN (16):** Power and ground pins on the left side.
- VDDA (6), VSSA (2), HFLB (32), VFLB (1), VCO_IN_P (3), SDA (30), SCL (29), RCT (27), GCT (26), BCT (25), CLP_IN (10), VCC2 (22), GND2 (19), G CLP (20), G OUT (21), B CLP (17), B OUT (18):** Power, control, and data pins on the right side.

Signal Flow:

- Power and Ground:** VDD, VSS, VCC3, GND3, VREF1, VREF, ABL, CONT_CAP, RIN, GND1, VCC1, GIN, BIN.
- Control Signals:** HFLB, VFLB, VCO_IN_P, SDA, SCL, RCT, GCT, BCT, CLP_IN, VCC2, GND2, G CLP, G OUT, B CLP, B OUT.
- Data Signals:** ROM Address (9), RAM Data (16), Ctrl Font, Ctrl Data (16), Frame Ctrl, ROM Ctrl, H/V/CLK Ctrl, R/G/B OSD, FBLK, Intensity, RGB OSD, FBL, INTE, HT DET., CLP, Video Contrast, Video Input, OSD Input Clp., OSD Half Tone SW, OSD Cont. Control, Bright Control, Amp Out.

Figure 1. Functional Block Diagram

PIN CONFIGURATION

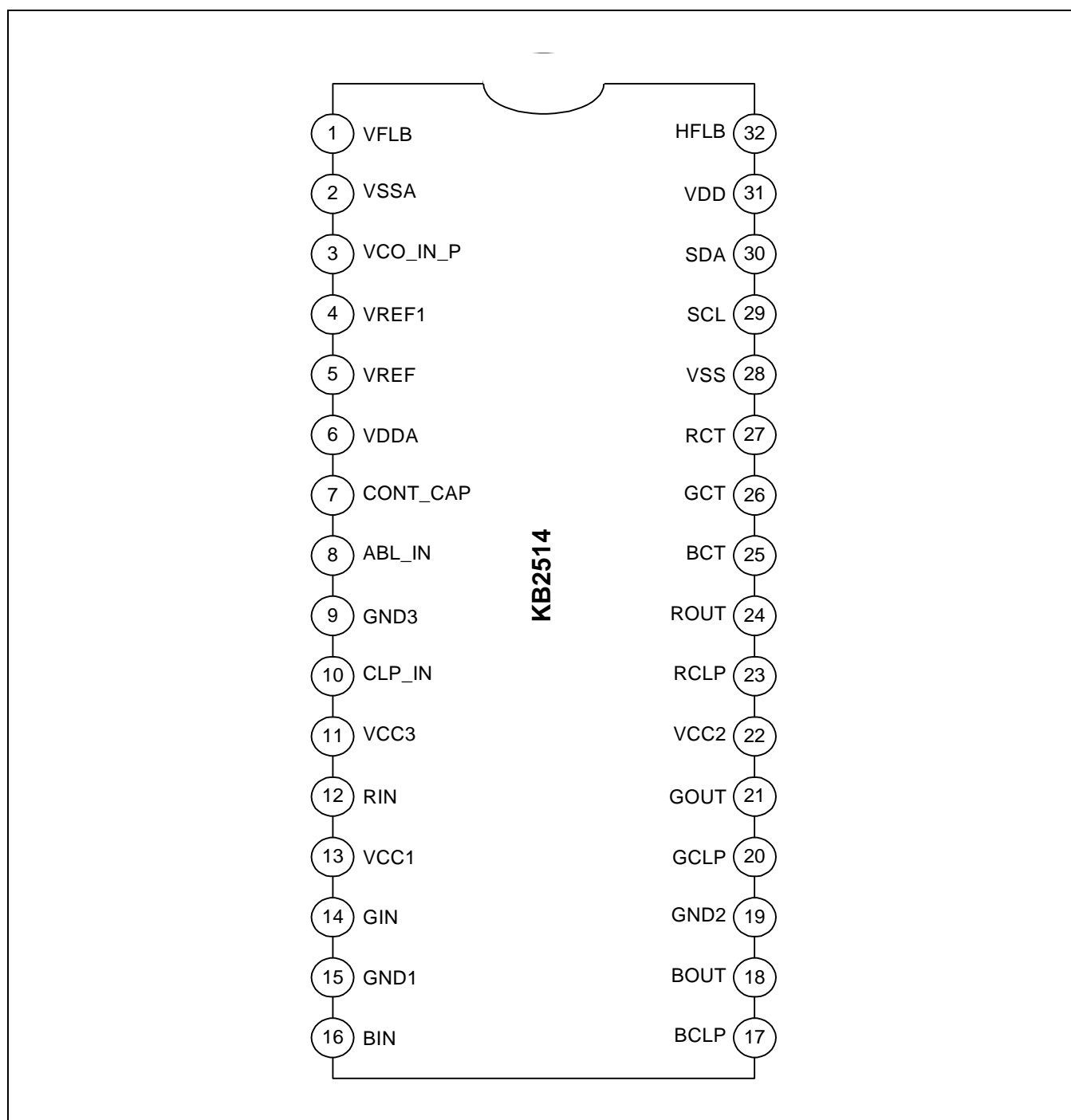


Figure 2. Pin Configuration

Table 1. Pin Configuration

Pin No.	Symbol	I/O	Configuration
1	VFLB	I	Vertical flyback signal
2	VSSA	-	Ground (PLL part)
3	VCO_IN_P	I	This voltage is generated at the external loop filter and goes into the input stage of the VCO.
4	VREF1	O	Charge pump output
5	VREF	O	PLL regulator filter
6	VDDA	-	+5V supply voltage for PLL part
7	CONT_CAP	-	Contrast control for AMP part
8	ABL	-	Auto beam limit.
9	GND3	-	Ground for video AMP part(for AMP control)
10	CLP_IN	-	Video clamp pulse input
11	VCC3	-	+12V supply voltage for video AMP part(for AMP control)
12	RIN	I	Video signal input (red)
13	VCC1	-	+12V supply voltage for video AMP(for main video signal process)
14	GIN	I	Video signal input (green)
15	GND1	-	Ground for video AMP part(for main video signal process)
16	BIN	I	Video signal input (blue)
17	BCLP	-	B output clamp cap
18	BOUT	O	Video signal output (blue)
19	GND2	-	Ground for video AMP part(for video output drive)
20	GCLP	-	G output clamp cap
21	GOUT	O	Video signal output (green)
22	VCC2	-	+12V supply voltage for video AMP part(for video output drive)
23	RCLP	-	R output clamp cap
24	ROUT	O	Video signal output (red)
25	BCT	-	B cut-off output
26	GCT	-	G cut-off output
27	RCT	-	R cut-off output
28	VSS	-	Ground for digital part
29	SCL	I	Serial clock (I ² C)
30	SDA	I/O	Serial data (I ² C)
31	VDD	-	+5V supply voltage for digital part
32	HFLB	I	Horizontal flyback signal

PIN DESCRIPTION

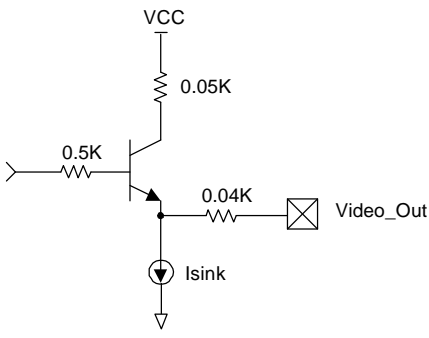
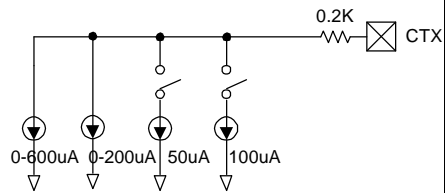
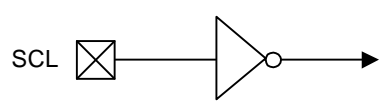
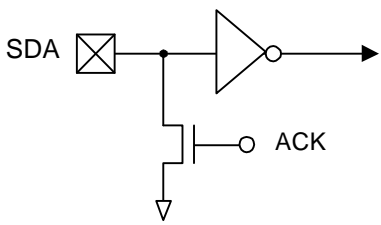
Table 2. Pin Description

Pin No	Pin Name	Schematic	Description
1 32	VFLB HFLB	<p>VFLB HFLB</p>	FLB signal is in TTL level Multi polarity input
3 4 5	VCO_IN_P VPEF1 VREF		PLL loop filter output BandGap ref. output
7	Contrast cap (CONT_CAP)	<p>I²C Data 4.0K 100μA</p>	Contrast cap range (0.1uF ~ 5uF)
8	ABL_IN	<p>VCC 100K 2K 250μA</p>	ABL input DC range (1 ~ 4.5V)

Table 2. Pin Description (Continued)

Pin No	Pin Name	Schematic	Description
10	CLP_IN		<p>Multi polarity input</p> <p>Clamp gate pulse TTL level input</p>
12	Red video input (RIN)		<p>Max input video signal is 0.7 Vpp</p>
14	Green video input (GIN)		
16	Blue video input (BIN)		
17	Blue (B clamp cap)		<p>Brightness controlling actives by charging and discharging of the external cap. (0.1μF) (During clamp gate)</p>
20	Green (G clamp cap)		
23	Red (R clamp)		

Table 2. Pin Description (Continued)

Pin No	Pin Name	Schematic	Description
18 21 24	Blue video output (BOUT) Green video output (GOUT) Red video output (ROUT)		Video signal output
27 26 25	Red cut-off control (RCT) Green cut-off control (GCT) Blue cut-off control (BCT)		Cut-off control output
29	SCL		Serial clock input port of I ² C bus
30	SDA		Serial data input port of I ² C bus

ABSOLUTE MAXIMUM RATINGS (see 1)

(Ta = 25 °C)

Table 3. Absolute Maximum Ratings

No	Item	Symbol	Value			Unit
			Min	Typ	Max	
1	Maximum supply voltage	V _{CC}	-	-	13.2	V
		V _{DD}	-	-	6.5	
2	Operating temperature (see 2)	T _{opr}	-20	-	75	°C
3	Storage temperature	T _{stg}	-65		150	°C
4	Operating supply voltage	V _{CCop}	11.4	12.0	12.6	V (see 3)
		V _{DDop}	4.75	5.00	5.25	
5	Power dissipation	P _D	-	-		W

THERMAL & ESD PARAMETER
Table 4. Thermal & ESD Parameter

No	Item	Symbol	Value			Unit
			Min	Typ	Max	
1	Thermal resistance (junction-ambient)	θ _{ja}	-	48	-	°C/W
2	Junction temperature	T _j	-	150	-	°C
3	Human body model (C = 100p, R = 1.5k)	HBM	2	-	-	KV
4	Machine model (C = 200p, R = 0)	MM	300	-	-	V
5	Charge device model	CDM	800	-	-	V

ELECTRICAL CHARACTERISTICS

DC ELECTRICAL CHARACTERISTICS

(Tamb = 25 °C, V_{CC} = 12V, V_{DD} = V_{DDA} = 5V, ABL input voltage = 5V, HFLB input signal = S3, load resistors = 470Ω, except OSD part current 35mA, unless otherwise stated)

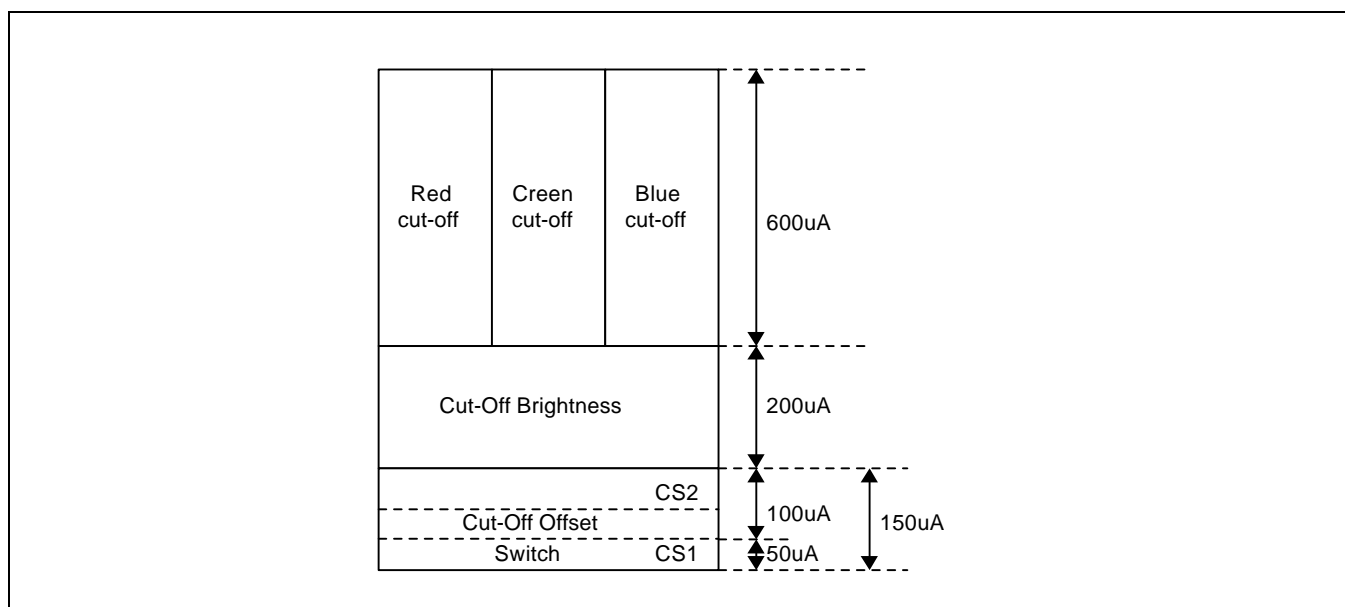
Table 5. DC Electrical Characteristics

Parameter	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Supply current	I _{CC} (see 4)		100	125	130	mA
Minimum supply current	I _{CC} min	V _{CC} = 11.4V	95	110	120	mA
Maximum supply current	I _{CC} max	V _{CC} = 12.6V	105	130	140	mA
ABS supply current	I _{CC} abs	V _{CC} = 13.2V	-	-	175	mA
Video input bias voltage	V bias		1.8	2.1	2.4	V
Video black level voltage (POR)	V blackpor		1.20	1.50	1.80	V
Black level voltage channel difference (POR)	Δ V blackpor (see 5)		Δ 10	-	-	%
Video black level voltage (FFH)	V blackff	04 = FFH (see 13)	2.2	2.7	3.2	V
Black level voltage channel difference (FFH)	Δ V blackff		Δ 10	-	-	%
Video black level voltage (00H)	V black00	04 = 00H	-	0.2	0.5	V
Black level voltage channel difference (00H)	Δ V black00		Δ 10	-	-	%
Spot killer voltage	Vspot	V _{CC} = Var.	9.20	10.4	11.2	V
Cut-off current (FFH)	ICTff	Pin25, 26, 27 = 12V 09 ~ 0B: FFH 0C: 00H	500	625	750	μA
Cut-off current (00H)	ICT00	Pin25, 26, 27 = 12V 09 ~ 0C: 00H	-	2.0	5.0	μA
Cut-off brightness current (FFH)	ICTBRTff	Pin25, 26, 27 = 12V 09 ~ 0B: 00H 0C: FFH	100	180	260	μA
Cut-off brightness current (80H)	ICTBRT80	Pin25, 26, 27 = 12V 09 ~ 0B: 00H 0C: 80H	50	90	130	μA
Cut-off offset current 1	ICS1	Pin25, 26, 27 = 12V 09 ~ 0C: 00H 0E: 11H	25	50	75	μA

Table 5. DC Electrical Characteristics(Continued)

Parameter	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Cut-off offset current 2	ICS2	Pin25, 26, 27 = 12V 09 ~ 0C: 00H 0E: 12H	50	100	130	μ A
Soft BLK output voltage	Vsblk	0D: 80H 0E: 14H	-	0.2	0.5	V
Clamp cap voltage (POR)	Vcap		6.0	7.0	8.0	V

Total external cut-off current range



AC ELECTRICAL CHARACTERISTICS

(Tamb = 25 °C, V_{CC} = 12V, V_{DD} = V_{DDA} = 5V, ABL input voltage = 5V, HFLB input signal = S3, load resistors = 470Ω, Vin = 0.7V_{pp} manually adjust video output pins 18, 21 and 24 to 4V DC for the AC test (see 11) unless otherwise stated (see 12))

Table 6. AC Electrical Characteristics

Parameter	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Contrast max. output voltage	Vc _{ff}	03, 05, 06, 07 = FFH	5.0	5.7	6.4	V _{pp}
Contrast max. output channel difference	Δ Vc _{ff}	04, 08 ~ 0C = 80H RGB input = S1	Δ 10	-	-	%
Contrast center output voltage	Vc ₈₀	03, 04, 08 ~ 0C = 80H	2.5	2.85	3.2	V _{pp}
Contrast center output channel difference	Δ Vc ₈₀	05, 06, 07 = FFH RGB input = S1	Δ 10	-	-	%
Contrast max. - Center attenuation	C	C = 20log (Vc ₈₀ /Vc _{ff})	-8	-6	-4	dB
Sub contrast center output voltage	Vd ₈₀	03 = FFH	2.3	2.6	2.9	V _{pp}
Sub contrast center output channel difference	Δ Vd ₈₀	04 ~ 0C = 80H RGB input = S1	Δ 10	-	-	%
Sub contrast min. output voltage	Vd ₀₀	03 = FFH, 05 ~ 07: 00H	1.3	1.6	1.9	V _{pp}
Sub contrast min. output channel difference	Δ Vd ₀₀	04, 08 ~ 0C = 80H RGB input = S1	Δ 10	-	-	%
Sub contrast max. - min. attenuation	D	D = 20log (Vd ₀₀ /Vc _{ff})	-14	-12	-10	dB
ABL control range	ABL	(see 15)	-12	-10	-8	dB
R/G/B video rising time (see 7)	tr (video)	03, 05 ~ 07: FFH	-	2.2	2.8	ns
R/G/B video falling time (see 7)	tf (video)	04, 08 ~ 0C: 80H RGB input = S2	-	2.2	2.8	ns
R/G/B blank output rising time (see 7)	tr (blank)	POR	-	6.0	12.0	ns
R/G/B blank output falling time (see 7)	tf (blank)	HFLB: S4	-	8.0	15.0	ns
R/G/B video band width (see 7, 8)	f (-3dB)	(see 16)	150	-	-	MHz
Video AMP 50MHz cross talk	CT_50M (see 7, 9)	(see 17)	-	-25	-20	dB
Video AMP 130MHz cross talk	CT_130M (see 7, 9)	(see 18)	-	-15	-10	dB
Absolute gain match	Avmatch (see 6)		-1	-	1	dB
Gain change between amplifier	Avtrack (see 7)		-1	-	1	dB

OSD ELECTRICAL CHARACTERISTICS

(Tamb = 25 °C, V_{CC} = 12V, V_{DD} = V_{DDA} = 5V, HFLB input voltage = S3, load resistors = 470Ω, V-AMP test register's FBLK, OSD input conditions unless otherwise stated)

Table 7. OSD Electrical Characteristics

Parameter	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
OSD contrast max. output voltage	Vocff	08 = FFH	5.4	6.4	7.4	Vpp
OSD contrast max. output channel difference	Δ Vocff	OSD RGB output conditions	Δ 10	-	-	%
OSD contrast center output voltage	Voc80	08 = 80H	2.7	3.2	3.7	Vpp
OSD contrast center output channel difference	Δ Voc80	OSD RGB output conditions	Δ 10	-	-	%
R/G/B OSD rising time	tr (OSD)	08: FFH	-	4.0	5.0	ns
R/G/B OSD falling time	tf (OSD)		-	4.0	5.0	ns
HT video level	HTvideo	ABL = 6V RGB input = S1 03, 05 ~ 08: FFH 0D: 01H OSD black conditions input HTvideo = 20log(V _{htvideo} /V _{cff})	-6.0	-4.5	-3.0	dB
HT video output channel difference	Δ HTvideo		Δ 15	-	-	%
HT OSD level	HTosd	ABL = 6V 05 ~ 08: FFH 0D: 0FH OSD white condition input HTosd = 20log (V _{htosd} /V _{ocff})	-7.0	-5.5	-4.0	dB
HT OSD output channel difference	Δ HTosd		Δ 15	-	-	%

OPERATION TIMINGS

Table 8. Operation Timings

Parameter	Symbol	Min	Typ	Max	Unit
Input Signal HFLB, VFLB					
Horizontal flyback signal frequency	f_{HFLB}	-	-	120	kHz
Vertical flyback signal frequency	f_{VFLB}	-	-	200	Hz
I²C Interface SDA, SCL (Refer to Figure 3)					
SCL clock frequency	f_{SCL}	-	-	300	kHz
Hold time for start condition	t_{hs}	500	-	-	ns
Set up time for stop condition	t_{sus}	500	-	-	ns
Low duration of clock	t_{low}	400	-	-	ns
High duration of clock	t_{high}	400	-	-	ns
Hold time for data	t_{hd}	0	-	-	ns
Set up time for data	t_{sud}	500	-	-	ns
Time between 2 access	t_{ss}	500	-	-	ns
Fall time of SDA	t_{fSDA}	-	-	20	ns
Rise time of both SCL and SDA	t_{rSDA}	-	-	-	ns

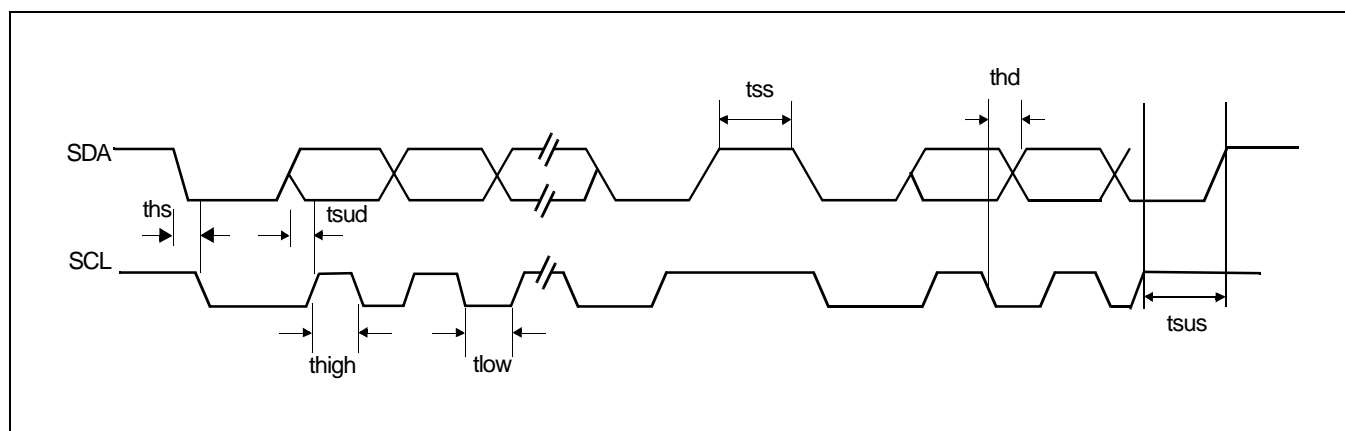


Figure 3. I²C Bus Timing Diagram

OSD PART ELECTRICAL CHARACTERISTICS

OSD PART DC ELECTRICAL CHARACTERISTICS

(Ta = 25 °C, V_{DDA} = V_{DD} = 5V)

Table 9. OSD Part DC Electrical Characteristics

Parameter	Symbol	Min	Typ	Max	Unit
Supply voltage	V _{DD}	4.75	5.00	5.25	V
Supply current (no load on any output)	I _{DD}	-	-	25	mA
Input voltage	V _{IH}	0.8V _{DD}	-	-	V
	V _{IL}	-	-	V _{SS} + 0.4	V
Output voltage (I _{out} = ±1mA)	V _{OH}	0.8V _{DD}	-	-	V
	V _{OL}	-	-	V _{SS} + 0.4	V
Input leakage current	I _{IL}	-10	-	10	μA
VCO input voltage	V _{VCO}		2.5		V

NOTES:

1. Absolute maximum rating indicates the limit beyond which damage to the device may occur.
2. Operating ratings indicate conditions for which the device is functional but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the electrical characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.
3. VCC supply pins 11, 13, and 22 must be externally wired together to prevent internal damage during VCC power on/off cycles.
4. The supply current specified is the quiescent current for VCC1/VCC2 and VCC3 with $R_L = \infty$. The supply current for VCC2 (pin 22) also depends on the output load.
5. Output voltage is dependent on load resistor. Test circuit uses $R_L = 47\Omega$.
6. Measure gain difference between any two amplifiers $V_{in} = 700mV_{pp}$.
7. When measuring video amplifier bandwidth or pulse rise and fall times, a double sided full ground plane printed circuit board without socket is recommended. Video amplifier 50MHz cross talk test also requires this printed circuit board. The reason for a double sided full ground plane PCB is that large measurement variations occur in single sided PCBs.
8. Adjust input frequency from 10MHz (AV max reference level) to the -3dB frequency (f_{-3dB}).
9. Measure output levels of the other two undriven amplifiers relative to the driven amplifier to determine channel separation. Terminate the undriven amplifier inputs to simulate generator loading. Repeat test at $f_{in} = 50MHz$ for cross talk 50MHz.
10. A minimum pulse width of 200 ns is guaranteed for a horizontal line of 15kHz. This limit is guaranteed by design. If a lower line rate is used a longer clamp pulse may be required.
11. During the AC test the 4V DC level is the center voltage of the AC output signal. For example. If the output is 4Vpp the signal will swing between 2V DC and 6V DC.
12. These parameters are not tested on each product which is controlled by an internal qualification procedure.
13. The conditions block's 03, 04, 05... etc. signify sub address' 0F03, 0F04, 0F05... etc.
14. Sub address 0F03, 0F05 ~ 0F07: FFH
0F04, 0F08 ~ 0F0C: 80H
RGB input = S1,
When the ABL input voltage is 0V, the R/G/B's output voltage is $V_R/V_G/V_B$ and uses the formula $ABLR = 20\log(V_R/V_{effR})$
15. OSD TST mode = High, CLP operation off,
RGB input = S5 (frequency sweep),
RGB input clamp cap = 2.1V DC,
RGB clamp cap (pin 23/20/17) = Vcap voltage (7.0V),
S5's frequency 1MHz → 130MHz sweep, -3dB point = $20\log(V_{130MHz}/V_{1MHz})$
03, 05 ~ 07: FFH
04, 08 ~ 0C: 80H
0F: 80H
16. OSD TST mode = High, CLP operation off,
RGB input clamp cap = 2.1V DC,
RGB clamp cap (pin 23/20/17) = Vcap voltage (7.0V),
03, 05 ~ 07: FFH
04, 08 ~ 0C: 80H
0F: 80H
R input = S5 (50MHz)
 $CT_{50M} = 20\log(V_{outG}/V_{outR})$ or $20\log(V_{outB}/V_{outR})$
17. OSD TST mode = High, CLP operation off,
RGB input clamp cap = 2.1V DC,
RGB clamp cap (pin 23/20/17) = Vcap voltage (7.0V),
03, 05 ~ 07: FFH
04, 08 ~ 0C: 80H
0F: 80H
R input = S5 (130MHz)
 $CT_{150M} = 20\log(V_{outG}/V_{outR})$ or $20\log(V_{outB}/V_{outR})$

TEST SIGNAL FORMAT

Table 10. Test Signal Format

Signal Name	Input Signal Format	Signal Description
S1		Video gain measurement Video = 1MHz/0.7Vpp Sync = 50kHz
S2		Video Tr/Tf measurement f = 200kHz V = 0.7Vpp Duty = 50%
S3		HFLB (posi & nega.) input f = 50kHz t = 2μs V = 0V/5V
S4		OSD level measurement Blank Tr/Tf measurement f = 50kHz V = 0V/5V
S5		Crosstalk test Bandwidth measurement 1MHz/10MHz/50MHz/ 130MHz Vref = input clamp voltage Vi = 0.7Vpp

- S1, S2 signal's low level must be synchronized with the S3 signal's sync. term.
- The input signal level uses the IC pin as reference.

TEST CIRCUIT

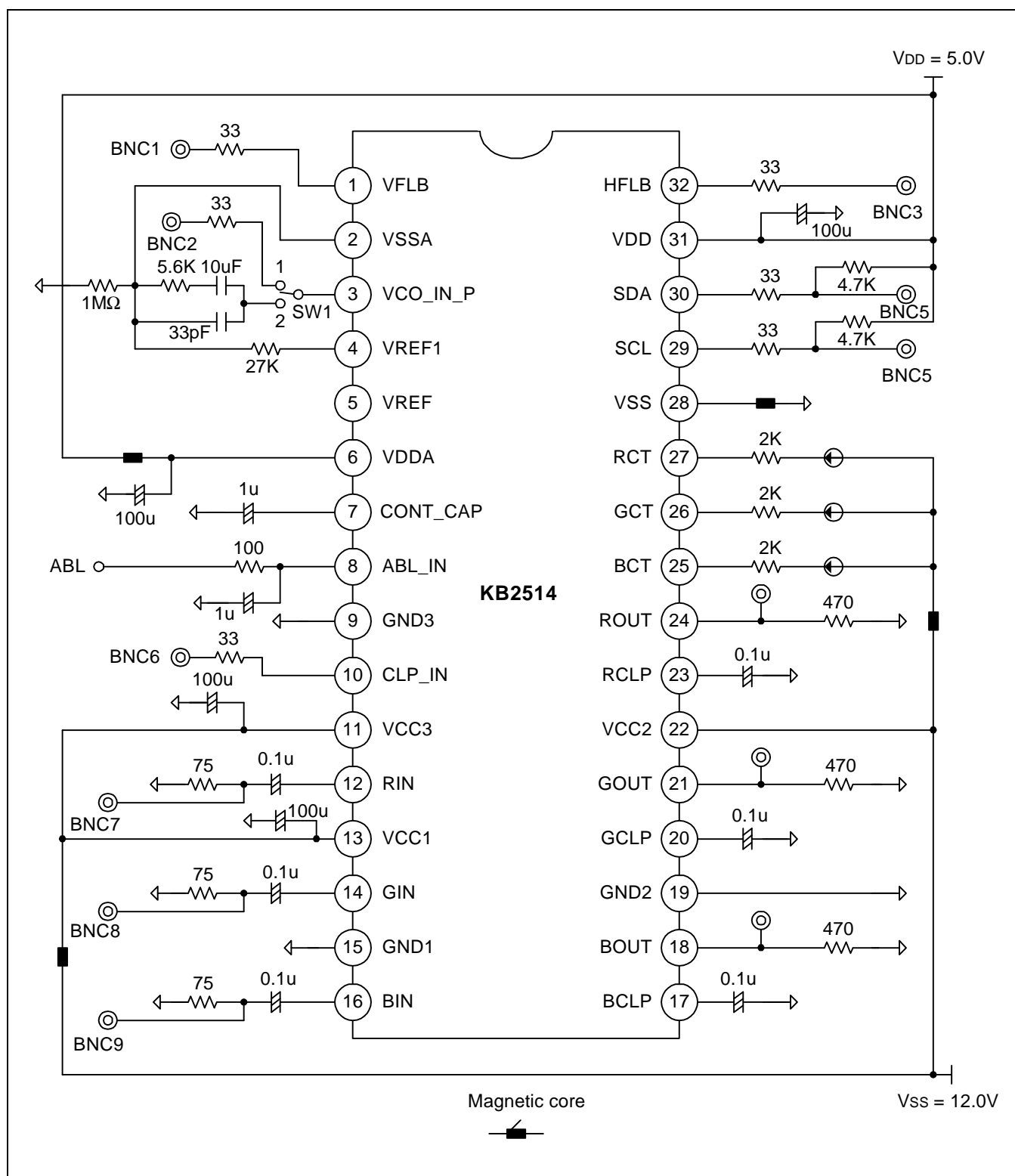


Figure 4. Test Circuit

FUNCTIONAL DESCRIPTIONS

DATA TRANSMISSION

The interface between KB2514 and MCU follows the I²C protocol. After the starting pulse, the transmission takes place in the following order: Slave address with R/W bit, 2-byte register address, 2-byte data, and stop condition. an acknowledge signal is received for each byte, excluding only the start/stop condition. The 2-byte register address is composed of an 8-bit row address, and an 8-bit column address. The order of transmission for a 2-byte register address is 'Row address → Column address'. The 2 bytes of data is because KB2514 has a 16-bit base register configuration. KB2514's slave address is BAh. It is BBh in read mode, and BAh in write mode.

- Address Bit Pattern for Display Registers Data**

(a) row address bit pattern

R3 - R0: Valid data for row address

A15	A14	A13	A12	A11	A10	A9	A8
X	X	X	X	R3	R2	R1	R0

(b) Column address bit pattern

C4 - C0: Valid data for column address

A7	A6	A5	A4	A3	A2	A1	A0
X	X	X	C4	C3	C2	C1	C0

X: Don't care bit

- Data Transmission Format**

Start → Slave address → ACK → Row address → ACK → Column address → ACK
 Data byte N → ACK → Data byte N+1 → ACK → Stop

Figure 5. Data Transmission Format at Writing Operation

Start → Slave address → ACK → Row address → ACK → Column address → ACK → Stop
 Start → Slave address → ACK → Data byte N → ACK → Data byte N+1 → ACK → Stop

Figure 6. Data Transmission Format at Reading Operation

• **SDA / SCL Signal At Communication**

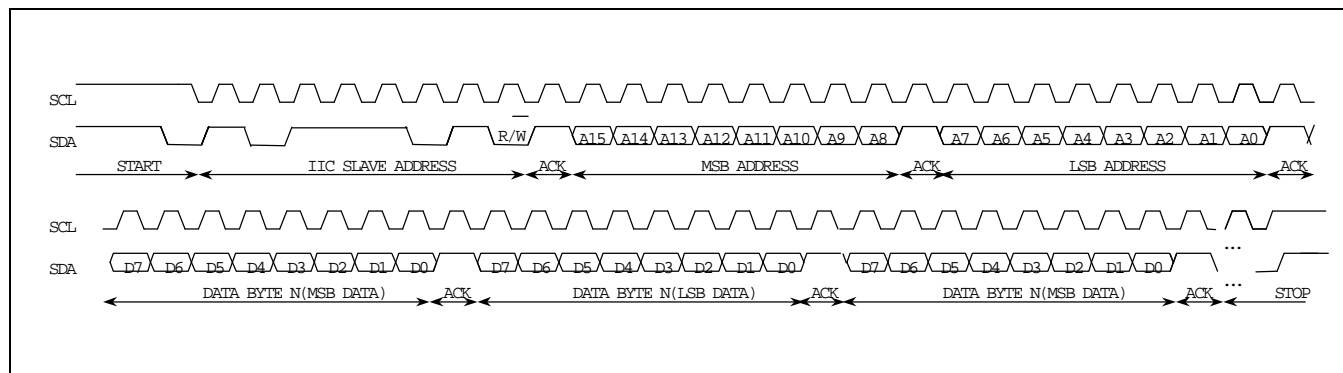


Figure 7. SDA line and SCL line (Write Operation)

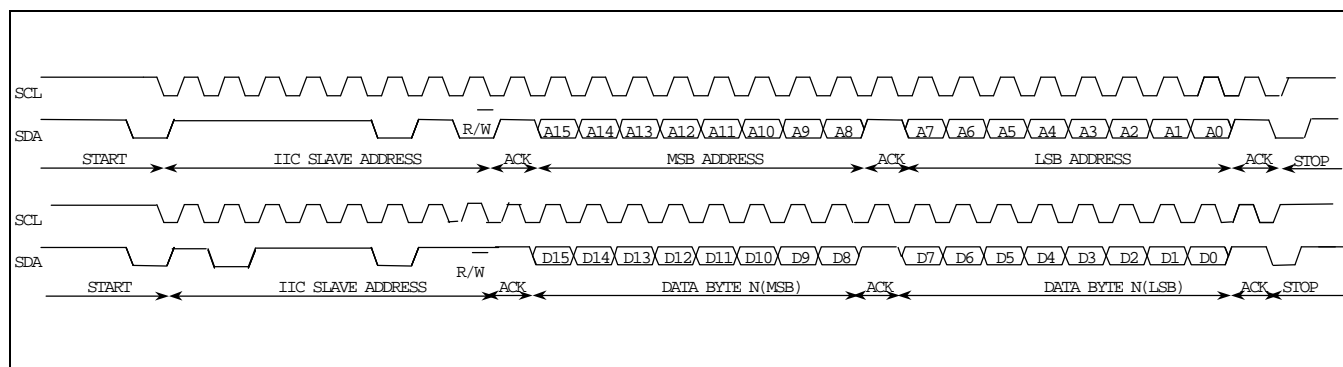
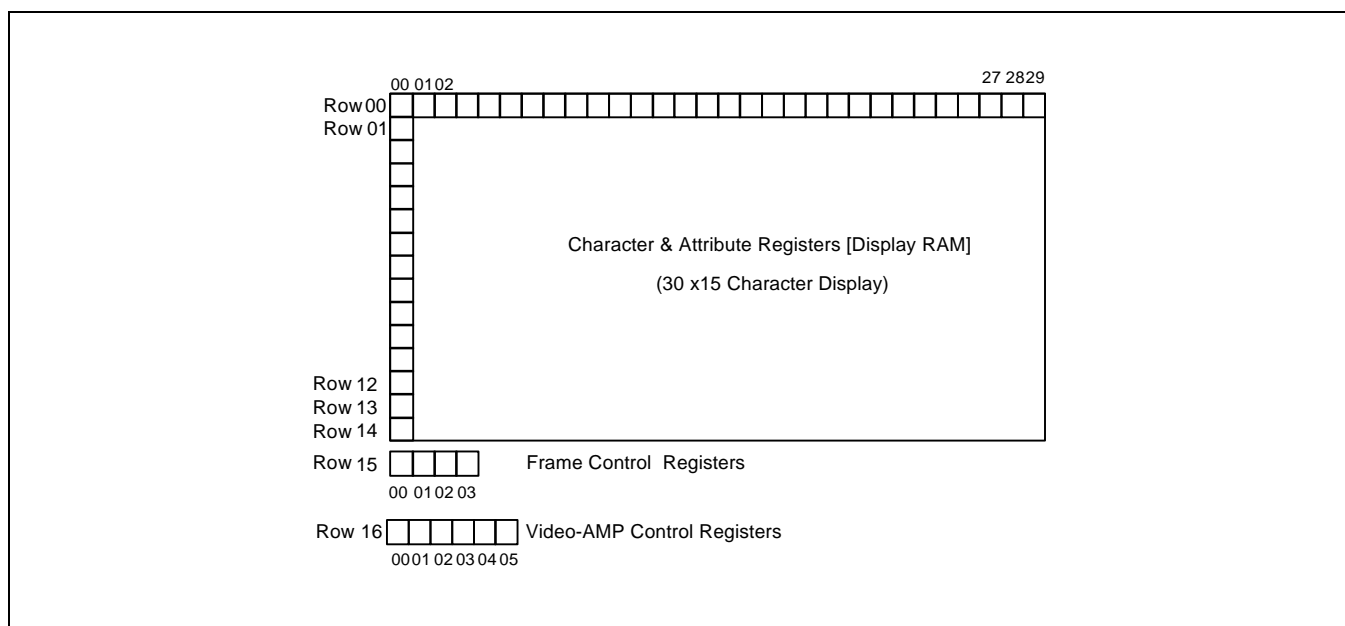


Figure 8. SDA line and SCL line (Read Operation)

MEMORY MAP

Figure 9. Memory Map of Display Registers

The display RAM's address of the row and column number are assigned in order. The display RAM is composed of 3 register groups (character & attribute register, frame control register and V-AMP control register).

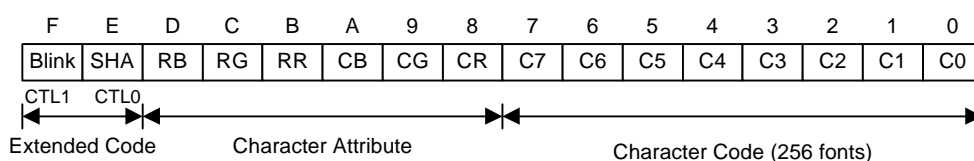
The display area in the monitor screen is 30 column \times 15 row, so the related character & attribute registers are also 30 column \times 15 row. Each register has a character address and characteristics corresponding to the display location on the screen, and one register is composed of 16 bits. The lower 8 bits select the font from the 256 ROM fonts, and the upper 8 bits give font characteristics to the selected font.

The frame control registers are in the 16th row. It controls OSD's display location, character height and scroll in units of frame.

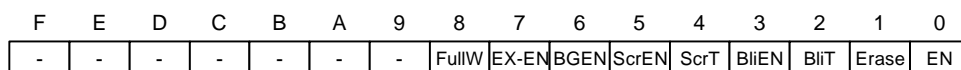
The V-AMP control registers are also located in the 17th row.

REGISTER DESCRIPTION

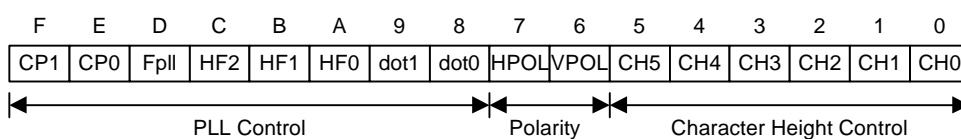
Character & Attribute Register: Row00 ~ 14, Column00 ~ 29



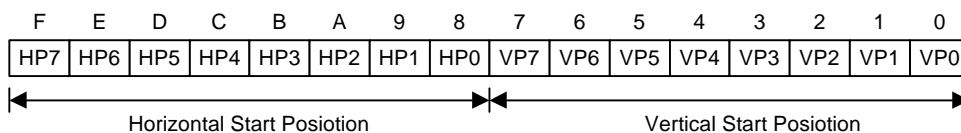
Frame Control Register 0: Row15, Column00



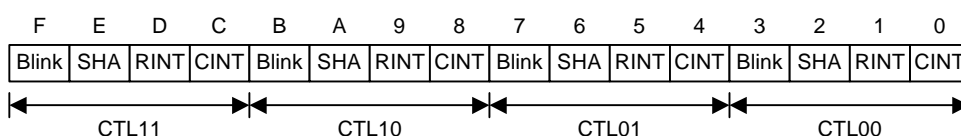
Frame Control Register 1: Row15, Column01

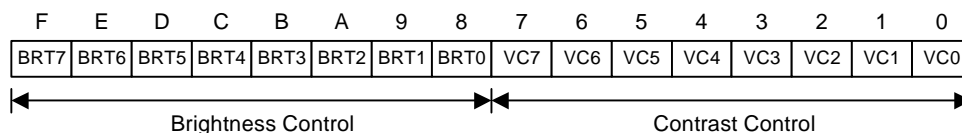
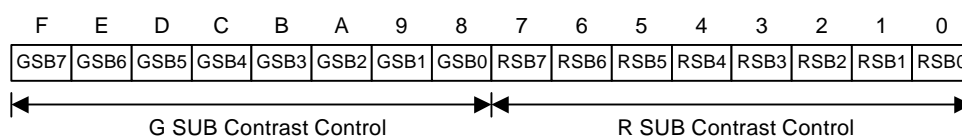
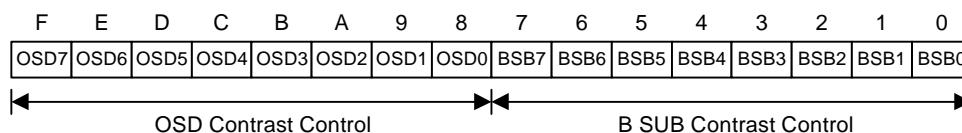
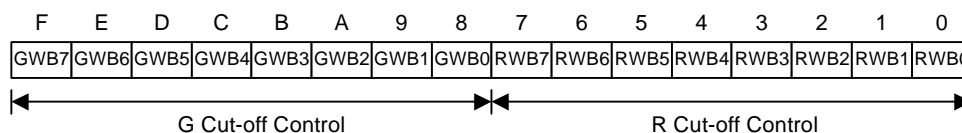
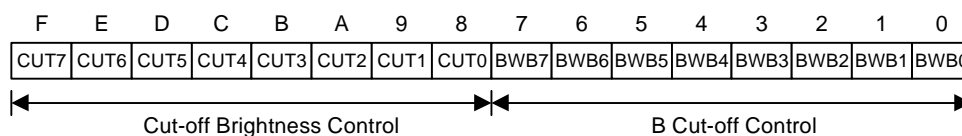
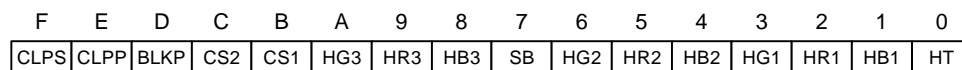


Frame Control Register 2: Row15, Column02



Frame Control Register 3: Row15, Column03



Video AMP Control Register: Row 16, Column 00 - 05
Column 00

Column 01

Column 02

Column 03

Column 04

Column 05


' - ' ; Don't care bit

Figure 10. Register Description

Table 11. Register Description

Registers	Bits	Description
Character & Attribute Registers (Row 00 ~ 14, Column 00 ~ 29)	C7 ~ C0 (Bit 7 ~ 0)	Character code address This is the address of 256 ROM fonts.
	CB, CG, CR (Bit A ~ 8)	Character color The character color is chosen from 16 colors using these 3 bits and the frame control register 3's CINT bit.
	RB, RG, RR (Bit D ~ B)	Raster color is determined by these bits. The raster color is chosen from out of 16 colors using these 3 bits and the frame control register 3's RINT bit.
	SHA / CTL0 (Bit E)	Character shadowing / CTL0(Extended Code) If you set the frame control register 0's EX-EN bit to '0', this bit carries out character shadowing feature.(If SHA bit is '1', the character shadowing is shown) If you set the frame control register 0's EX-EN bit to '1', this bit is used for extended code.
	Blink / CTL1 (Bit F)	Character blinking / CTL1(Extended Code) If you set the frame control register 0's EX-EN bit to '0', this bit carries out character blinking feature.(If Blink bit is '1', the character blinking feature is shown) If you set the frame control register 0's EX-EN bit to '1', this bit is used for extended code.

If you set the Frame Control Register 0's 'EX-EN' bit as '1', the Character & Attribute Register's 'SHA' and 'Blink' bits are used to call the Extended Code.

In other words, the combination of SHA and Blink bits can call four kind Extended Code 'CTL00', 'CTL01', 'CTL10' and 'CTL11', the CINT, RINT, SHA and Blink features can be carried out in a unit of character fonts.

Table 11. Register Description(Continued)

Registers	Bits	Description
Frame Control Registers - 0 (Row15, Column00)	EN (Bit 0)	OSD enable OSD is enabled when this bit is '1'. In other words, if this bit isn't '1' OSD is not output in spite of writing control data. We recommend that you enable the OSD after setting the control registers (such as the character & attribute register) because of video and OSD output timing.
	Erase (Bit 1)	RAM erasing If this bit is '1', the RAM data (character & attribute registers) is erased. The time spent in carrying out this operation is called erasing time, which can be calculated as follows. <div style="border: 1px solid black; padding: 5px; margin: 5px 0;"> Erasing time = RAM clock × 480 (RAM cell no.) RAM clock = 12 dot clock Dot clock = 1/(dot frequency) Dot frequency = Horizontal frequency × resolution (mode) </div> Therefore, the maximum erasing time value is: <div style="border: 1px solid black; padding: 5px; margin: 5px 0;"> (Erasing Time)_{MAX} = (12 × 480) / (15k × 320) = 1.2ms </div>
	BliT (Bit 2)	Blink time control If this bit is '1', blink time is 0.5sec, and if not, 1sec.
	BliEN (Bit 3)	Blinking enable Blinking effect is controlled by this bit. If this bit is '1', blinking effect is enabled. If this bit is '0', a full OSD screen blinking effect is disabled.
	ScrT (Bit 4)	Scroll time control If this bit is '1', scroll time is 0.5sec, and if not, 1sec.
	ScrEN (Bit 5)	Scroll enable Scrolling effect is controlled by this bit. If this bit is '1', scrolling effect is enabled. You must remember that scrolling can be turned on/off only when OSD is enabled/disabled.
	BGEN (Bit 6)	Back ground enable If the BGEN bit is '1' and the raster color is black, the raster is transparent. That is, the video back ground is shown. If not, the OSD raster covers the video's back ground. Refer to other color effect.
	EX-EN (Bit 7)	Extended code enable If the EX-EN bit is '1', the Character & Attribute register's Blink, SHA bits carry out Extended Code features instead of Blink and SHA features.
	FullW (Bit 8)	Full white pattern enable If the FullW bit is '1', the full white pattern is displayed in the screen.

Table 11. Register Description(Continued)

Registers	Bits	Description															
Frame Control Registers - 1 (Row15, Column01)	CH5 ~ CH0 (Bit 5 ~ 0)	Character height control While the purpose of VZ[1:0] (vertical character height) is to control the absolute size of the character, the purpose of CH[5:0] (Character Height) is to output OSD of a uniform size even if the resolution changes. If you adjust the value in the range of CH = 18 ~ CH = 63, each line's repeating number is decided (standard height CH = 18 is the reference value), by which the line is repeated. For more information on repeating number selection, refer to character height.															
	VPOL (Bit 6)	Polarity of vertical fly back signal If this bit is '1', VFLB's polarity is positive, and if '0', it is negative. In other words, this bit is set to '1' if active high, and '0' if active low.															
	HPOL (Bit 7)	Polarity of horizontal fly back signal If this bit is '1', HFLB's polarity is positive, and if '0', it is negative. In other words, this bit is set to '1' if active high, and '0' if active low.															
	dot1, dot0 (Bit 9, 8)	Resolution control (dots/line) <table border="1"><thead><tr><th>Dot1</th><th>Dot0</th><th>No. of Dots</th></tr></thead><tbody><tr><td>0</td><td>0</td><td>320 dots/line</td></tr><tr><td>0</td><td>1</td><td>480 dots/line</td></tr><tr><td>1</td><td>0</td><td>640 dots/line</td></tr><tr><td>1</td><td>1</td><td>800 dots/line</td></tr></tbody></table> As shown above, the number of dots per horizontal line is decided by a combination of these two bits.	Dot1	Dot0	No. of Dots	0	0	320 dots/line	0	1	480 dots/line	1	0	640 dots/line	1	1	800 dots/line
	Dot1	Dot0	No. of Dots														
0	0	320 dots/line															
0	1	480 dots/line															
1	0	640 dots/line															
1	1	800 dots/line															
HF2~HF0 (Bit C ~ A)	Horizontal frequency PLL's horizontal frequency is decided by the combination of these 3 bits. This is related to the selection of DOT[1:0], so you can't numerically express the frequency range with only the HF[2:0] selection. For more information, please refer to HF Bits Selection.																
	FPLL (Bit D)	Full range PLL If this bit is '1', the OSD_PLL block's VCO operates at full range (4.8MHz - 96MHz). If it is '0', it operates within the region decided by the HF bit [C:A] explained above. if you can't optimize OSD screen decided by the HF bit in the high region, you may set the FPLL bit to '1'.															

Table 11. Register Description(Continued)

Registers	Bits	Description															
Frame Control Registers - 1 (Row15, Column01)	CP1, CP0 (Bit F, E)	<p>Charge pump output current control This is the PLL block's internal phase detector output status, converted into current. Refer to PLL control.</p> <table border="1"> <thead> <tr> <th>CP1</th><th>CP0</th><th>Charge Pump Current</th></tr> </thead> <tbody> <tr> <td>0</td><td>0</td><td>0.50 mA</td></tr> <tr> <td>0</td><td>1</td><td>0.75 mA</td></tr> <tr> <td>1</td><td>0</td><td>1.00 mA</td></tr> <tr> <td>1</td><td>1</td><td>1.25 mA</td></tr> </tbody> </table> <p>The output is decided by the combination of these two bits.</p>	CP1	CP0	Charge Pump Current	0	0	0.50 mA	0	1	0.75 mA	1	0	1.00 mA	1	1	1.25 mA
CP1	CP0	Charge Pump Current															
0	0	0.50 mA															
0	1	0.75 mA															
1	0	1.00 mA															
1	1	1.25 mA															

The purpose of bits 'HPOL', and 'VPOL' is to provide flexibility when using the KB2514 IC. No matter which polarity you choose for the input signal, the IC will handle them identically, so you can select active high or active low according to your convenience.

Tabel 4. Register Description (Continued)

Registers	Bits	Description
Frame Control Registers - 2 (Row 15, Column 02)	VP7 ~ VP0 (Bit 7 ~ 0)	Vertical start position control (= VP[7:0] × 4) Signifies top margin height from the V-Sync reference edge.
	HP7 ~ HP0 (Bit F ~ 8)	Horizontal start position control (= HP[7:0] × 6) Signifies delay of the horizontal display from the H-Sync reference edge to the character's 1st pixel location.
Frame Control Registers - 3 (Row 15, Column 03)	CTL 00 (Bit 3 ~ 0)	Extended code In case the EX-EN bit is '1' and the Character & Attribute register's E and F bits are '0', these bits have meanings. If you set the CINT(character color intensity) bit '1', the character color intensity feature is carried out. If you set the RINT(raster color intensity) bit '1', the raster color intensity feature is carried out. If you set the SHA(character shadowing) bit '1', the character shadowing feature is carried out. If you set the Blink(character blinking) bit '1', the character blinking feature is carried out.
	CTL 01 (Bit 7 ~ 4)	Extended code In case the EX-EN bit is '1' and the Character & Attribute register's E bit is '1' and F bit is '0', these bits have meanings. If you set the CINT(character color intensity) bit '1', the character color intensity feature is carried out. If you set the RINT(raster color intensity) bit '1', the raster color intensity feature is carried out. If you set the SHA(character shadowing) bit '1', the character shadowing feature is carried out. If you set the Blink(character blinking) bit '1', the character blinking feature is carried out.
	CTL 10 (Bit B ~ 8)	Extended code In case the EX-EN bit is '1' and the Character & Attribute register's E bit is '0' and F bit is '1', these bits have meanings. If you set the CINT(character color intensity) bit '1', the character color intensity feature is carried out. If you set the RINT(raster color intensity) bit '1', the raster color intensity feature is carried out. If you set the SHA(character shadowing) bit '1', the character shadowing feature is carried out. If you set the Blink(character blinking) bit '1', the character blinking feature is carried out.

Tabel 4. Register Description (Continued)

Registers	Bits	Description
Frame Control Registers - 3 (Row 15, Column 03)	CTL 11 (Bit F ~ C)	<p>Extended code</p> <p>In case the EX-EN bit is '1' and the Character & Attribute register's E and F bits are '1', these bits have meanings.</p> <p>If you set the CINT(character color intensity) bit '1', the character color intensity feature is carried out.</p> <p>If you set the RINT(raster color intensity) bit '1', the raster color intensity feature is carried out.</p> <p>If you set the SHA(character shadowing) bit '1', the character shadowing feature is carried out.</p> <p>If you set the Blink(character blinking) bit '1', the character blinking feature is carried out.</p>

Tabel 4. Register Description (Continued)

Registers	Bits	Description
V-AMP Control Registers - 0 (Row 16, Column 00)	VC7 ~ VC0 (Bit7 ~ 0)	The contrast adjustment is made by controlling simultaneously the gain of three internal variable gain amplifiers. The contrast adjustment allows to cover a typical range of 38dB.
	BRT7 ~ BRT0 (BitF ~ 8)	The brightness adjustment controls to add the same black level (pedestal) to the 3-channel R/G/B signals after contrast amplifier.
V-AMP Control Registers - 1 (Row 16, Column 01)	RSB7 ~ RSB0 (Bit7 ~ 0)	R channel SUB contrast control. The SUB contrast adjustment is used to adjust the white balance, and the gain of each channel is controlled. The SUB contrast adjustment allows you to cover a typical range of 12dB.
	GSB7 ~ GSB0 (BitF ~ 8)	G channel SUB contrast control. The SUB contrast adjustment is used to adjust the white balance, and the gain of each channel is controlled. The SUB contrast adjustment allows you to cover a typical range of 12dB.
V-AMP Control Registers - 2 (Row 16, Column 02)	BSB7 ~ BSB0 (Bit7 ~ 0)	B channel SUB contrast control. The SUB contrast adjustment is used to adjust the white balance, and the gain of each channel is controlled. The SUB contrast adjustment allows you to cover a typical range of 12dB.
	OSD7 ~ OSD0 (BitF ~ 8)	The OSD contrast adjustment is made by controlling simultaneously the gain of three internal variable gain amplifiers. The OSD contrast adjustment allows to cover a typical range of 38dB.
V-AMP Control Registers - 3 (Row 16, Column 03)	RWB7 ~ RWB0 (Bit7 ~ 0)	R channel cut-off control. The cut-off adjustment is used to adjust the raster white balance.
	GWB7 ~ GWB0 (BitF ~ 8)	G channel cut-off control. The cut-off adjustment is used to adjust the raster white balance.
V-AMP Control Registers - 4 (Row 16, Column 04)	BWB7 ~ BWB0 (Bit7 ~ 0)	B channel cut-off control. The cut-off adjustment B used to adjust the raster white balance.
	CUT7 ~ CUT0 (BitF ~ 8)	The cut-off brightness adjustment is made by simultaneously controlling the external cut-off current.

Tabel 4. Register Description (Continued)

Registers	Bits	Description																																																																											
V-AMP Control Registers - 5 (Row 16, Column 05)	HT (Bit 0)	Video & OSD half tone enable. If you set this bit to '1', the half tone function is on. Then you can see the video signal & OSD raster.																																																																											
	HG1 ~ HB1 (Bit3 ~ 1)	HG1 ~ HB1 bits select OSD raster color 1 to be half tone. To carry out half tone function, set the HT bit to '1'.																																																																											
		<table><tr><th rowspan="2">HG1</th><th rowspan="2">HR1</th><th rowspan="2">HB1</th><th colspan="3">OSD</th><th rowspan="2">Raster Color 1</th><th rowspan="2">POR</th></tr><tr><th>G</th><th>R</th><th>B</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>Black</td><td>O</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>Blue</td><td></td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>Red</td><td></td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>Magenta</td><td></td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>Green</td><td></td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>Cyan</td><td></td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>Yellow</td><td></td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>White</td><td></td></tr></table>	HG1	HR1	HB1	OSD			Raster Color 1	POR	G	R	B	0	0	0	0	0	0	Black	O	0	0	1	0	0	1	Blue		0	1	0	0	1	0	Red		0	1	1	0	1	1	Magenta		1	0	0	1	0	0	Green		1	0	1	1	0	1	Cyan		1	1	0	1	1	0	Yellow		1	1	1	1	1	1	White	
		HG1				HR1	HB1	OSD			Raster Color 1	POR																																																																	
			G	R	B																																																																								
		0	0	0	0	0	0	Black	O																																																																				
		0	0	1	0	0	1	Blue																																																																					
		0	1	0	0	1	0	Red																																																																					
		0	1	1	0	1	1	Magenta																																																																					
		1	0	0	1	0	0	Green																																																																					
		1	0	1	1	0	1	Cyan																																																																					
	1	1	0	1	1	0	Yellow																																																																						
	1	1	1	1	1	1	White																																																																						
	HG2 ~ HB2 (Bit6 ~ 4)	HG2 ~ HB2 bits select OSD raster color 2 to be half tone. To carry out half tone function, set the HT bit to '1'.																																																																											
		<table><tr><th rowspan="2">HG2</th><th rowspan="2">HR2</th><th rowspan="2">HB2</th><th colspan="3">OSD</th><th rowspan="2">Raster Color 2</th><th rowspan="2">POR</th></tr><tr><th>G</th><th>R</th><th>B</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>Black</td><td>O</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>Blue</td><td></td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>Red</td><td></td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>Magenta</td><td></td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>Green</td><td></td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>Cyan</td><td></td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>Yellow</td><td></td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>White</td><td></td></tr></table>	HG2	HR2	HB2	OSD			Raster Color 2	POR	G	R	B	0	0	0	0	0	0	Black	O	0	0	1	0	0	1	Blue		0	1	0	0	1	0	Red		0	1	1	0	1	1	Magenta		1	0	0	1	0	0	Green		1	0	1	1	0	1	Cyan		1	1	0	1	1	0	Yellow		1	1	1	1	1	1	White	
HG2		HR2				HB2	OSD				Raster Color 2	POR																																																																	
			G	R	B																																																																								
0		0	0	0	0	0	Black	O																																																																					
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0		1	0	0	1	0	Red																																																																						
0		1	1	0	1	1	Magenta																																																																						
1	0	0	1	0	0	Green																																																																							
1	0	1	1	0	1	Cyan																																																																							
1	1	0	1	1	0	Yellow																																																																							
1	1	1	1	1	1	White																																																																							
SB (Bit 7)	Soft blanking enable If you set this bit '1', the R/G/B outputs go to GND.																																																																												

Tabel 4. Register Description (Continued)

Registers	Bits	Description																																																																											
V-AMP Control Registers - 5 (Row 16, Column 05)	HG3 ~ HB3 (BitA ~ 8)	<div>HG3 ~ HB3 bits select OSD raster color 3 to be half tone. To carry out half tone function, set the HT bit to '1'.</div> <table><tr><th rowspan="2">HG3</th><th rowspan="2">HR3</th><th rowspan="2">HB3</th><th colspan="3">OSD</th><th rowspan="2">Raster Color 3</th><th rowspan="2">POR</th></tr><tr><th>G</th><th>R</th><th>B</th></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>Black</td><td></td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>Blue</td><td></td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>Red</td><td></td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>Magenta</td><td></td></tr><tr><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>Green</td><td>O</td></tr><tr><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>Cyan</td><td></td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>Yellow</td><td></td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>White</td><td></td></tr></table>	HG3	HR3	HB3	OSD			Raster Color 3	POR	G	R	B	1	0	0	0	0	0	Black		1	0	1	0	0	1	Blue		1	1	0	0	1	0	Red		1	1	1	0	1	1	Magenta		0	0	0	1	0	0	Green	O	0	0	1	1	0	1	Cyan		0	1	0	1	1	0	Yellow		0	1	1	1	1	1	White	
HG3	HR3	HB3				OSD					Raster Color 3	POR																																																																	
			G	R	B																																																																								
1	0	0	0	0	0	Black																																																																							
1	0	1	0	0	1	Blue																																																																							
1	1	0	0	1	0	Red																																																																							
1	1	1	0	1	1	Magenta																																																																							
0	0	0	1	0	0	Green	O																																																																						
0	0	1	1	0	1	Cyan																																																																							
0	1	0	1	1	0	Yellow																																																																							
0	1	1	1	1	1	White																																																																							
	CS2 ~ CS1 (BitC ~ B)	<div>Cut-off offset current control</div> <table><tr><th>CS2</th><th>CS1</th><th>Cut-off Offset Current</th><th>POR</th></tr><tr><td>0</td><td>0</td><td>100μA</td><td></td></tr><tr><td>0</td><td>1</td><td>150μA</td><td></td></tr><tr><td>1</td><td>0</td><td>0μA</td><td>O</td></tr><tr><td>1</td><td>1</td><td>50μA</td><td></td></tr></table>	CS2	CS1	Cut-off Offset Current	POR	0	0	100μA		0	1	150μA		1	0	0μA	O	1	1	50μA																																																								
CS2	CS1	Cut-off Offset Current	POR																																																																										
0	0	100μA																																																																											
0	1	150μA																																																																											
1	0	0μA	O																																																																										
1	1	50μA																																																																											
	BLKP (Bit D)	<div>Polarity of horizontal fly back signal If this bit is '0', HFLB's polarity is negative, and if '1', it is positive.</div>																																																																											
	CLPP (Bit E)	<div>Polarity of clamp pulse signal If this bit is '0', CLP's polarity is positive, and if '1', it is negative. This bit has meaning only if the CLPS bit is set to '1'.</div>																																																																											
	CLPS (Bit F)	<div>Clamp pulse generation enable If this bit is '0', clamp signal is made using the HFLB signal, so there is no need to supply the clamp signal. and if '1' you must supply external clamp signal.</div>																																																																											

VIDEO AMP PART ADDRESS MAP*Register sub address***Table 12. VideoAMP Part Address Map**

SUB Address [Hex]	Function																POR Value [Hex]
	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0	
1000	Brightness control								Contrast control								8080
1001	SUB contrast control (G)								SUB contrast control (R)								8080
1002	OSD contrast control								SUB contrast control (B)								8080
1003	Cut-off control (G)								Cut-off control (R)								8080
1004	Cut-off brightness control								Cut-off control (B)								8080
1005	CLPS	CLPP	BLKP	CS2	CS1	HG3	HR3	HB3	SB	HG2	HR2	HB2	HG1	HR1	HB1	HT	1800

Contrast Register (SUB ADRS: 00H) (Vin = 0.7Vpp, bright: 80H, subcont: FFH)

Hex	B7	B6	B5	B4	B3	B2	B1	B0	Contrast (Vpp)	Gain (dB)	int. Value (Hex)
00	0	0	0	0	0	0	0	0	0	-	
80	1	0	0	0	0	0	0	0	2.85	-	O
FF	1	1	1	1	1	1	1	1	5.2	-	
Increment/bit									0.0223		

Brightness Register (3-ch) (SUB ADRS: 00H) (cont: 80H, subcont: 80H)

Hex	B7	B6	B5	B4	B3	B2	B1	B0	Brightness (Vpp)	Int. Value (Hex)
00	0	0	0	0	0	0	0	0	0.2	
80	1	0	0	0	0	0	0	0	1.5	O
FF	1	1	1	1	1	1	1	1	2.7	
Increment/bit									0.01055	

SUB Contrast Register (R/G/B-ch) (SUB ADRS: 01/02H)

(Vin = 0.7Vpp, bright: 40H, cont: FFH)

Hex	B7	B6	B5	B4	B3	B2	B1	B0	SUB Contrast (Vpp)	Gain (dB)	Int. Value (Hex)
00	0	0	0	0	0	0	0	0		-	
80	1	0	0	0	0	0	0	0		-	O
FF	1	1	1	1	1	1	1	1		-	
Increment/bit											

OSD Contrast Register (SUB ADRS: 02H) (VOSD = TTL, bright: 80H, subcont: 80H)

Hex	B7	B6	B5	B4	B3	B2	B1	B0	OSD Contrast (Vpp)	Gain (dB)	Int. Value (Hex)
00	0	0	0	0	0	0	0	0	0	-	
80	1	0	0	0	0	0	0	0	3.2	-	O
FF	1	1	1	1	1	1	1	1	6.4	-	
Increment/bit									0.025		

Cut-Off Brightness Register (3-ch) (SUB ADRS: 04H)

Hex	B7	B6	B5	B4	B3	B2	B1	B0	Cut-Off Brightness (μA)	Int. Value (Hex)
00	0	0	0	0	0	0	0	0	0	
80	1	0	0	0	0	0	0	0	100	O
FF	1	1	1	1	1	1	1	1	200	
Increment/bit									0.781	

Cut-Off Register (R/G/B-ch) (SUB ADRS: 03/04H)

(cont = 80H, subcont: 80H)

Hex	B7	B6	B5	B4	B3	B2	B1	B0	Cut-Off EXT (μA)	Int. Value (Hex)
00	0	0	0	0	0	0	0	0	0	
80	1	0	0	0	0	0	0	0	300	O
FF	1	1	1	1	1	1	1	1	600	
Increment/bit									2.344	

ADDRESSING

- ROM Fonts**

KB2514 provides 256 Rom fonts for displaying OSD Icons, which allows the use of multi-language OSD Icons. Font \$000 is reserved for blank data.

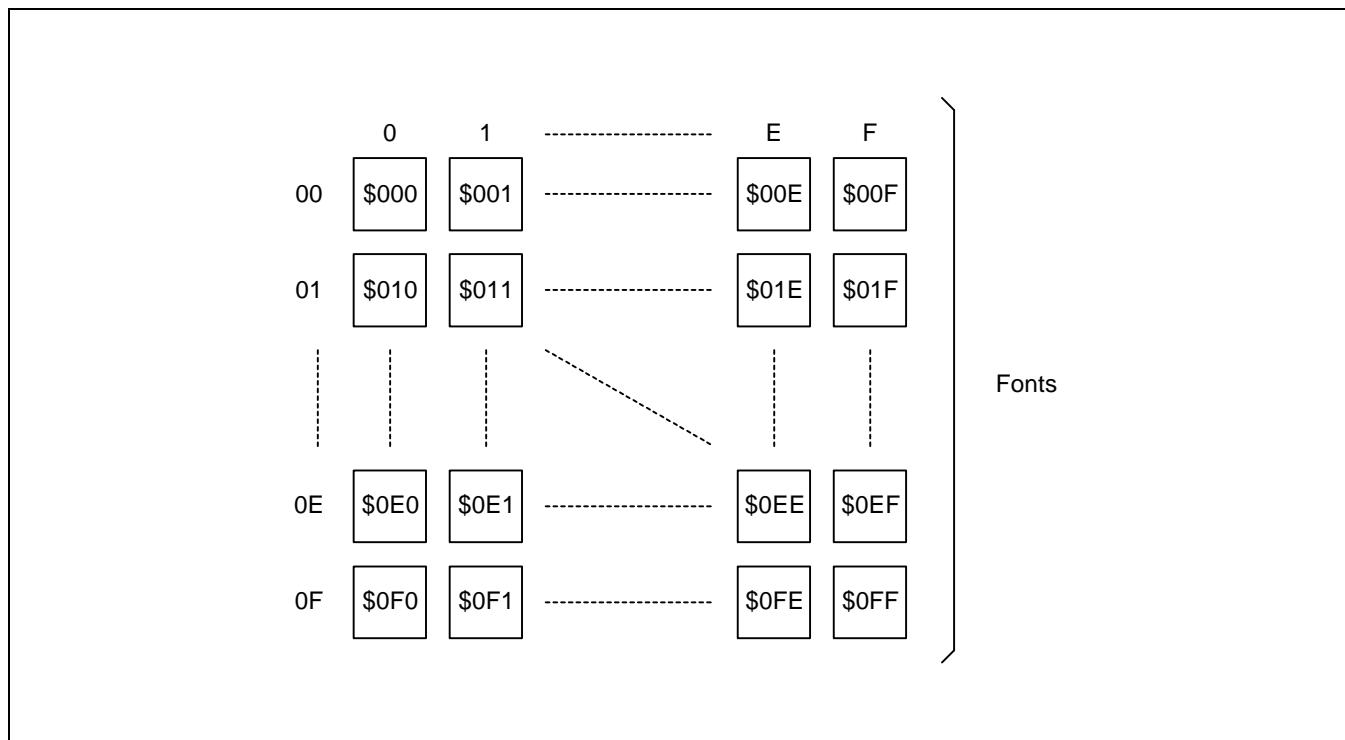


Figure 11. Composition of the ROM Fonts

COLORING

If you have an Intensity feature, the number of possible colors you can express becomes doubled. In other words, the number of colors you can represent with three colors blue, green, and red is 8 ($= 2^3$), but with the intensity feature, it is 16 ($= 2^4$).

- **Character Color**

Character color is assigned for each font, and the 4 components for expressing a color are listed below.

Blue	Character & attribute register's CB bit[A]
Green	Character & attribute register's CG bit[9]
Red	Character & attribute register's CR bit[8]
Intensity	If the EX-EN bit is '1' and the Frame Control Register 3 CTL's CINT bit called by Character & Attribute register's Blink, SHA bits is '1', the character intensity feature is enabled.

- **Raster Color**

Blue	Character & Attribute register's RB bit[D]
Green	Character & Attribute register's RG bit[C]
Red	Character & Attribute register's RR bit[B]
Intensity	If the EX-EN bit is '1' and the Frame Control Register 3 CTL's RINT bit called by Character & Attribute register's Blink, SHA bits is '1', the RASTER intensity feature is enabled.

According to the 'EX-EN', 'RINT' and 'CINT' bits setting, raster and character color intensity can be assigned in units of character.

Notes for When Making KB2514 Fonts
Address 000h is appointed as blank data. RAM's initial values are all 0, and all bits are written as 0 when you erase the RAM, so blank data means the initial value. In other words, blank data means 'do nothing'. You don't need to write any data for the space font, except for 000h. It just needs to be an undotted area.

- **Other Color Effect**

The Frame Control Register 0 'BGEN' bit's function is shown in the Figure below. If you set the 'BGEN' bit as '0' after selecting A's raster color as black, the raster color black will be displayed. But if you set the 'BGEN' bit as '1', after selecting B's raster color as black, the raster color black becomes invisible, so the video back ground color (gray) is displayed as if it is the raster color.

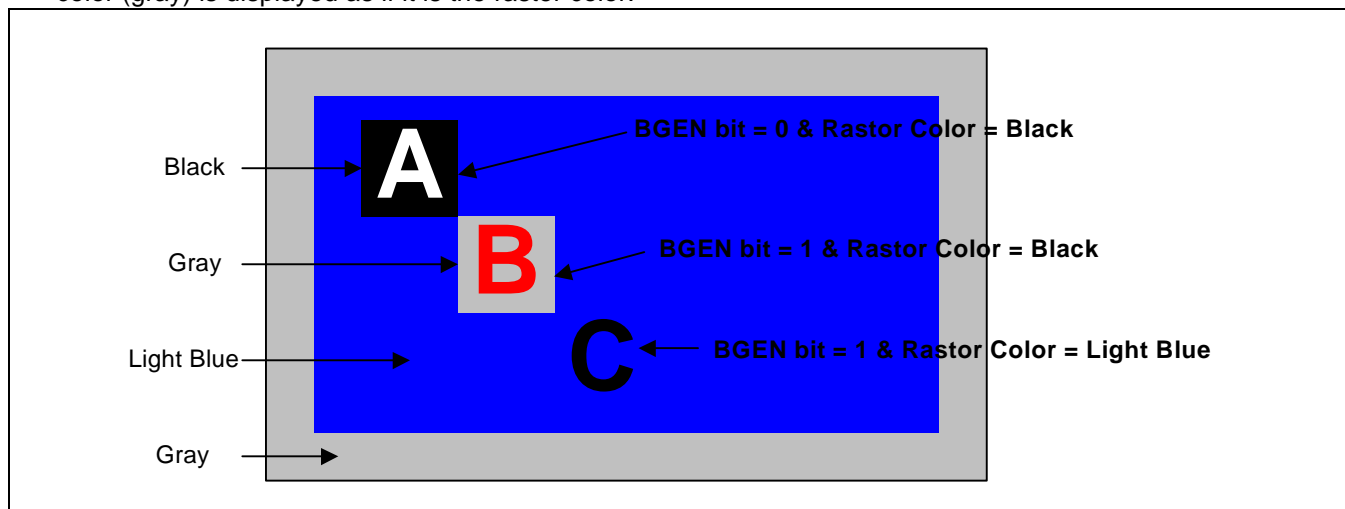


Figure 12. Color Effect by BGEN Bit

HEIGHT/POSITIONING

Character Height

The purpose of CH[5:0] (Character Height) is to output a uniformly sized OSD even if the resolution changes. To express a Character Height of CH = 18 ~ CH = 63 after receiving CH[5:0]'s input from the frame control register-1, decide on each line's repeating number (Standard Height CH = 18) and repeat the lines.

The following Figure shows two examples of a height-controlled character. height control is carried out by repeating some of the lines.

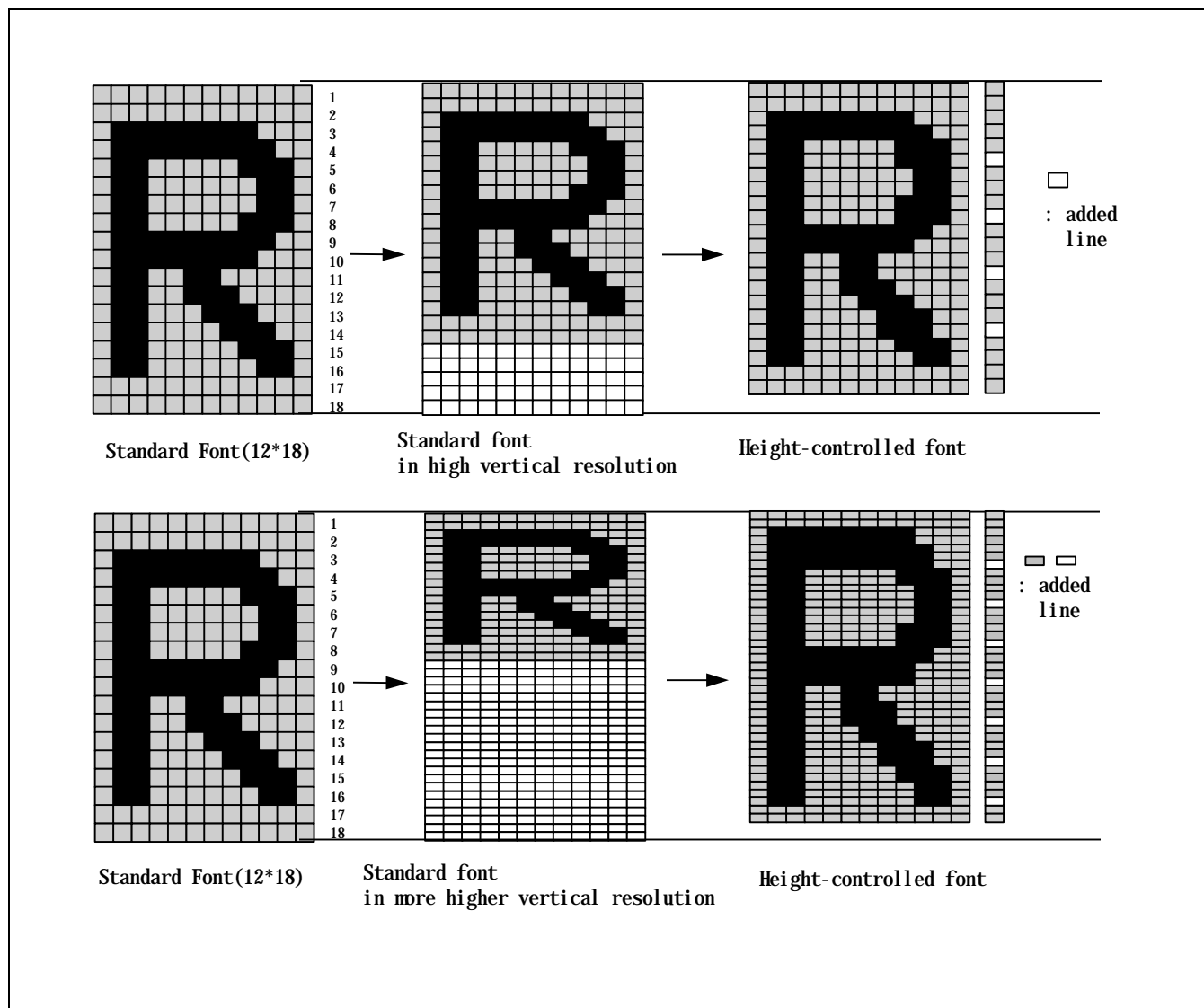


Figure 13. Character Height

Repeating line-number can be found by the following formula.

$$[\# \text{ of the repeating lines} = 2 + N \times M],$$

where $N = 1, 2, 3, \dots$ and $M = \text{round}\{14 \leq (CH[5:0]-18)\}$.

1. If $CH[5:0]$ is greater than 32 and less than or equal to 46 ($32 < CH[5:0] \leq 46$), all lines are repeated once or twice. The lines that are repeated twice are chosen by the following formula.

$$[\# \text{ of the repeating lines} = 2 + N \times M],$$

where $N = 1, 2, 3, \dots$ and $M = \text{round}\{14 \leq (CH[5:0]-32)\}$.

2. If $CH[5:0]$ is greater than 46 and less than or equal to 60 ($46 < CH[5:0] \leq 60$), all lines are repeated two or three times. The lines that are repeated three times are chosen by the following formula.

$$[\# \text{ of the repeating lines} = 2 + N \times M],$$

where $N = 1, 2, 3, \dots$ and $M = \text{round}\{14 \leq (CH[5:0]-46)\}$.

3. If $CH[5:0]$ is greater than 60 and less than or equal to 64 ($60 < CH[5:0] \leq 64$), all Lines are repeated three or four times. The lines that are repeated four times are chosen by the following formula.

$$[\# \text{ of the repeating lines} = 2 + N \times M],$$

where $N = 1, 2, 3, \dots$ and $M = \text{round}\{14 \leq (CH[5:0]-60)\}$.

CH's reference value is 18, and even if you input 0, it operates in the same way as when $CH = 18$. The repeating line-number is limited to 16. If the M value is less than or equal to 1, all lines of the standard font are repeated more than once.

Table 13. Repeating Line as Controlling by CH bits

Character Height	Repeating Line
CH = 18	-
CH = 19	9
CH = 20, 21	6, 13
CH = 22	5, 11, 17
CH = 23	4, 9, 14, 19
CH = 24	3, 7, 11, 15, 19, 21
CH = 25, 26, 27	3, 7, 11, 13, 15, 19, 22
CH = 28	3, 6, 9, 12, 14, 18, 20, 23, 25
CH = 29	3, 6, 9, 11, 13, 15, 18, 21, 23, 25, 26
CH = 30	3, 6, 8, 10, 12, 14, 16, 18, 20, 22, 25, 27
CH = 31	2, 5, 7, 9, 11, 13, 15, 17, 21, 23, 25, 27, 28
CH = 32, 33, 34, 35	2, 5, 7, 9, 11, 13, 15, 18, 21, 23, 25, 27, 28, 29
CH = 36	-
CH = 37	18

Table 13. Repeating Line as Controlling by CH bits

Character Height	Repeating Line (Continued)
CH = 38, 39	12, 25
CH = 40	10, 20, 30
CH = 41	8, 16, 24, 32
CH = 42	6, 12, 18, 24, 30, 36
CH = 43, 44, 45	6, 12, 18, 24, 30, 36, 41
CH = 46	4, 8, 12, 17, 21, 25, 29, 33, 37, 41
CH = 47	4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44
CH = 48	4, 8, 12, 16, 20, 23, 26, 29, 33, 37, 41, 45
CH = 49	4, 8, 12, 16, 19, 22, 25, 28, 31, 35, 39, 43, 47
CH = 50, 51, 52, 53	4, 8, 12, 15, 18, 21, 24, 27, 30, 33, 36, 40, 44, 48
CH = 54	-
CH = 55	27
CH = 56, 57	18, 36
CH = 58	14, 28, 42
CH = 59	12, 23, 34, 45
CH = 60	9, 18, 26, 34, 43, 52
CH = 61, 62, 63	8, 16, 23, 30, 37, 44, 51

- Positioning**

The frame control register-2's HP Bit [F:8] signifies delay of the horizontal display from the H-Sync reference edge to the character's 1st pixel location, and is controlled by multiplying HP [F:8]'s range value by 6. Also, VP bit[7:0] signifies the top margin height from the V-Sync reference edge, and is controlled by multiplying 4 to the VP [7:0]'s range value. Refer to the Figure shown below.

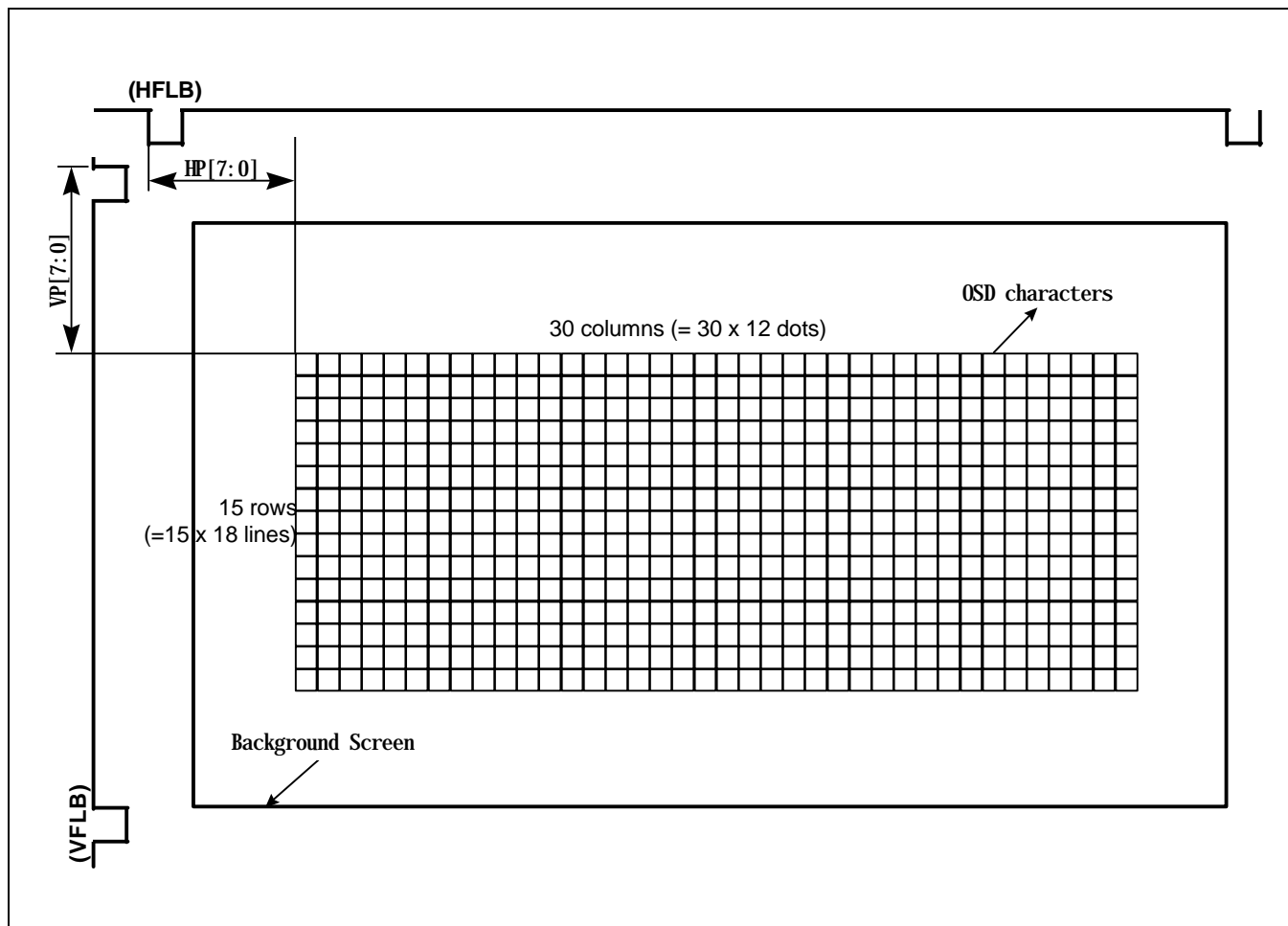


Figure 14. Frame Composition with the OSD Characters

VISUAL EFFECTS

- **Shadowing**

The character shadow can only be black. Character shadow is making 1 pixel to the right and below the character.

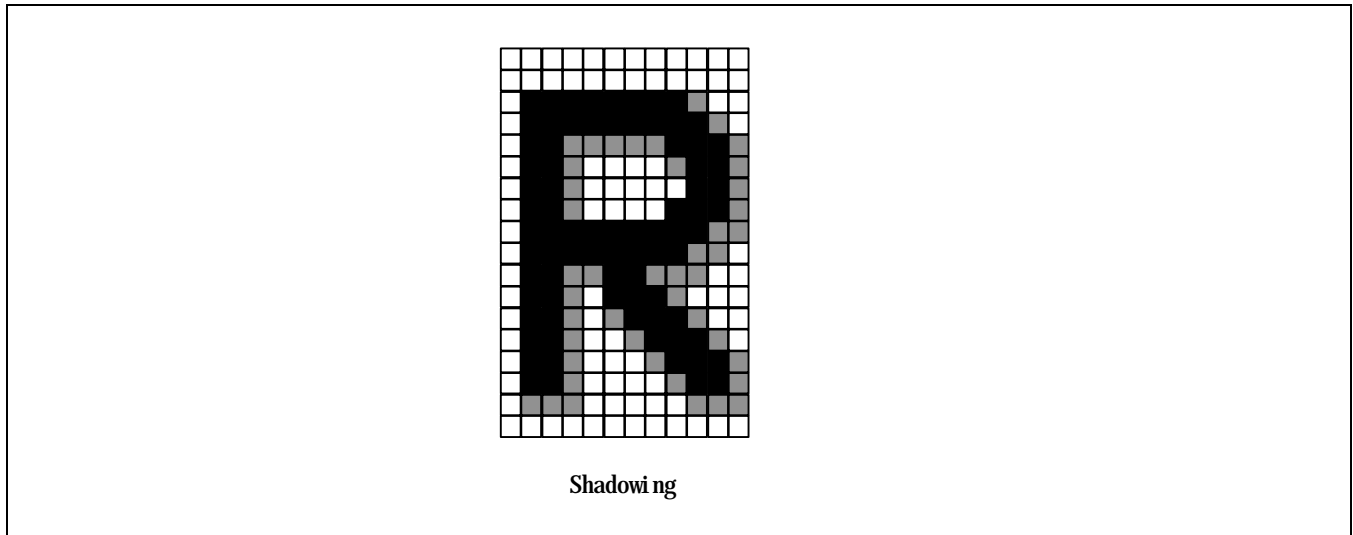


Figure 15. Character Shadowing

- **Scrolling**

Scrolling is slowly displaying or erasing a character from the top line to the bottom. This effect makes it look as if 1 character line is scrolling up or down.

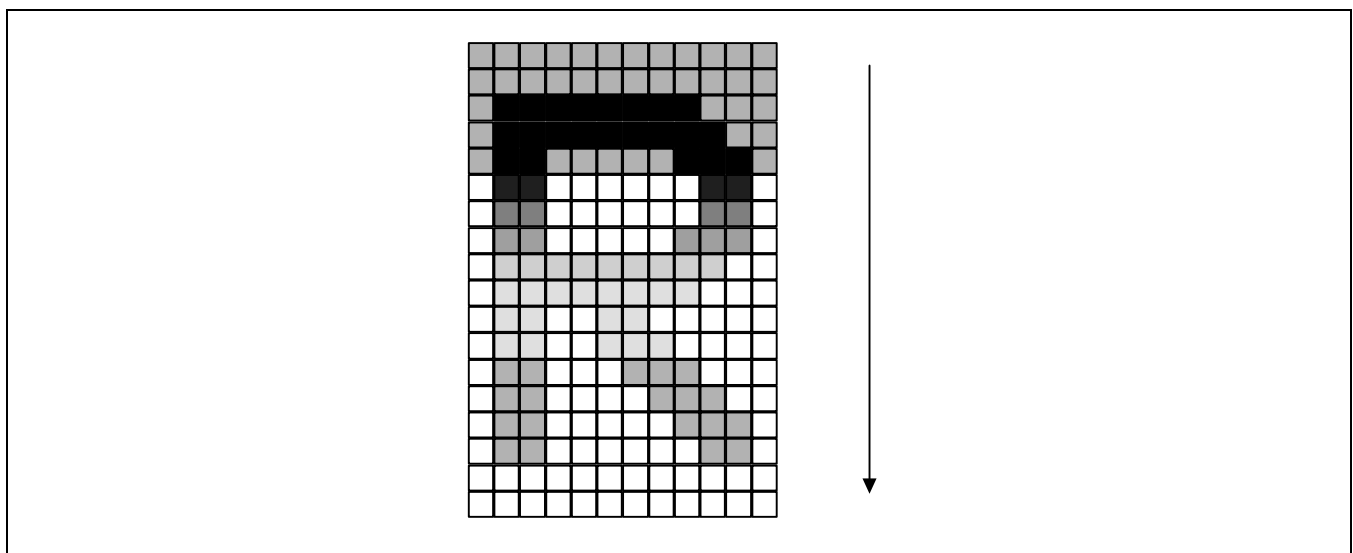


Figure 16. Scrolling

PLL CONTROL

- Introduction**

PLL (Phase Lock Loop) is feedback controlled circuit that maintains a constant phase difference between a reference signal and an oscillator output signal.

Generally, PLL is composed as follow Figure.

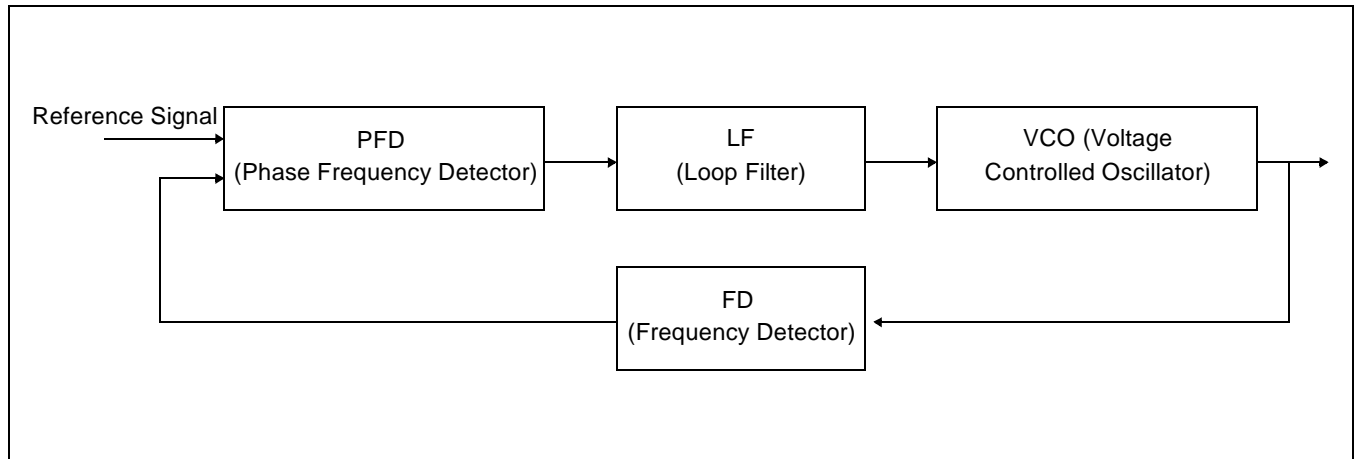


Figure 17. Block Diagram of General PLL

- PFD (Phase Frequency Detector)

PFD compares the phase of the VCO output frequency, with the phase of a reference signal frequency output pulse is generated in proportion to that phase difference.

- LF (Loop Filter)

LF smooths the output pulse of the phase detector and the resulting DC component is the VCO input.

- VCO (Voltage Controlled Oscillator)

VCO is controlled by loop filter output. The output of the VCO is fed back to the phase frequency detector input for comparison which in turn controls the VCO oscillating frequency to minimize the phase difference.

- FD (Frequency Divider)

FD divides too much different frequency that is oscillated from the VCO to compare it with reference signal frequency.

- **PLL of the KB2514**

PLL is composed of the phase detector, charge pump, VCO, and N-divider as 4 sub-blocks.

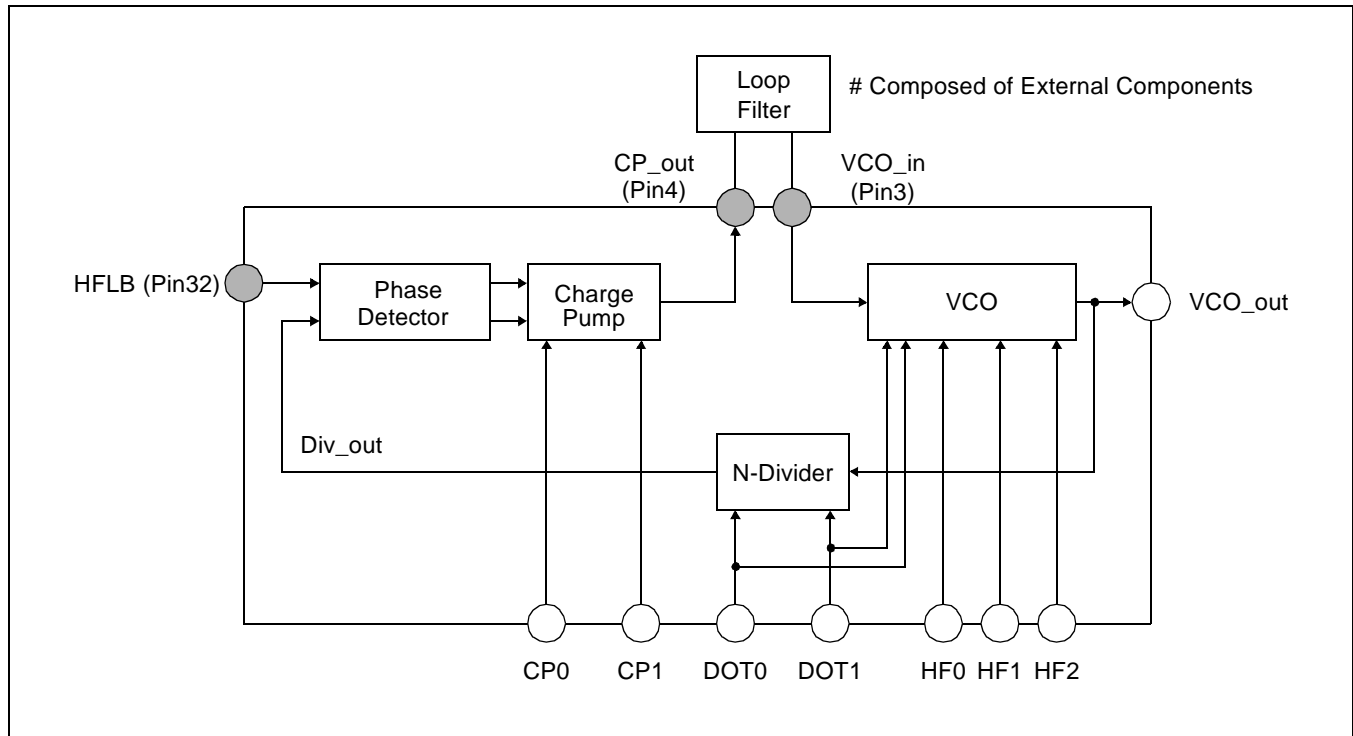


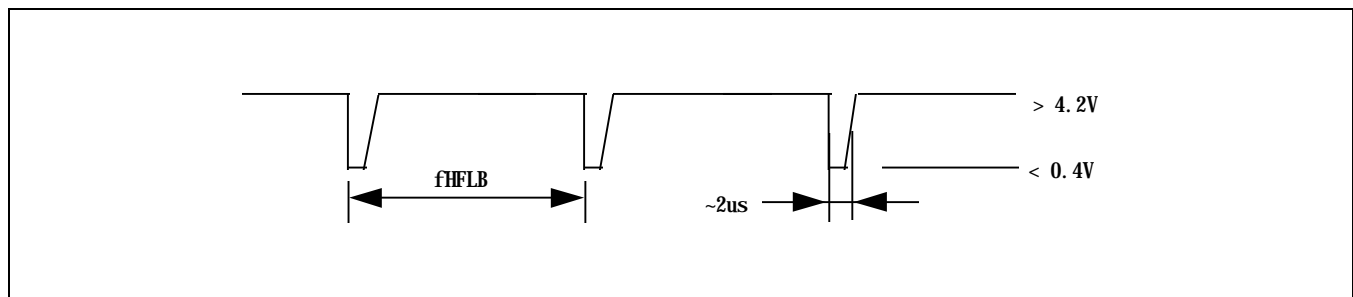
Figure 18. Block Diagram of the PLL Built in KB2514

The following is the description of the input/output signals.

- **HFLB (Input)**

Horizontal flyback signal is reference signal of the PLL built in KB2514.

The HFLB signal's frequency range is 15 ~ 90kHz, so the PLL block must be a wide range PLL that can cover HFLB's entire frequency range.



- **VCO (Input)**

Error signal that passes through an external loop filter is input into VCO.

Operation voltage range is 1-4V. You can raise immunity towards external noise by lowering VCO sensitivity. You can do this by making it have the maximum operation voltage range possible in the 5V power voltage.

- DOT0, 1 (Input)

Mode control signal that controls the number of dots per line in the frame control register. There are 4 modes: 320, 480, 640, and 800 dots/line.

According to your choice of mode, the OSD_PLL block's N-Divider is controlled by one of $\div 320$, $\div 480$, $\div 640$, or $\div 800$ Divider.

- HF0, 1, 2 (Input)

The horizontal Sync frequency information is received from the micro controller through the frame control registers-1's bit C-A.

- CP0, 1 (Input)

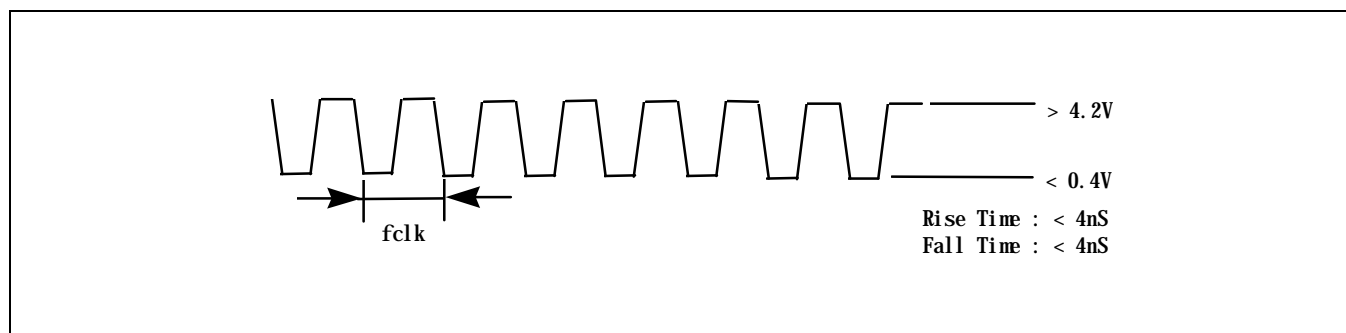
Charge Pump's output sourcing (or sinking) current control pin.

This control data is received through frame control registers-1's bits E-D.

- VCO_OUT (Output)

VCO output that becomes a system clock. It is the OSD R, G, B output signal's dot frequency, and the standard signal for OSD's various timings.

Also, it is input into the N-Divider and makes a PLL loop



- CP_OUT (Output)

Charge Pump circuit's output. input into external loop filter. It becomes one of 3 states according to the standard signal input into the phase detector (HFLB) and the divider output (Div_Out).

- HFLB Div_Out is lead: Current sink
- HFLB Lag: Current source
- HFLB In-Phase: High impedance

TUNNING FACTORS OF THE KB2514 PLL

• PLL External Circuit

You may follow the recommendations for PCB art work and input/output signal characteristic improvement in recommendation.

The external circuit that has the most influence on KB2514 PLL block operation is pin 3 (VCO_IN) and pin 4 (CP_OUT)'s surrounding circuit. Refer to OSD PLL block.

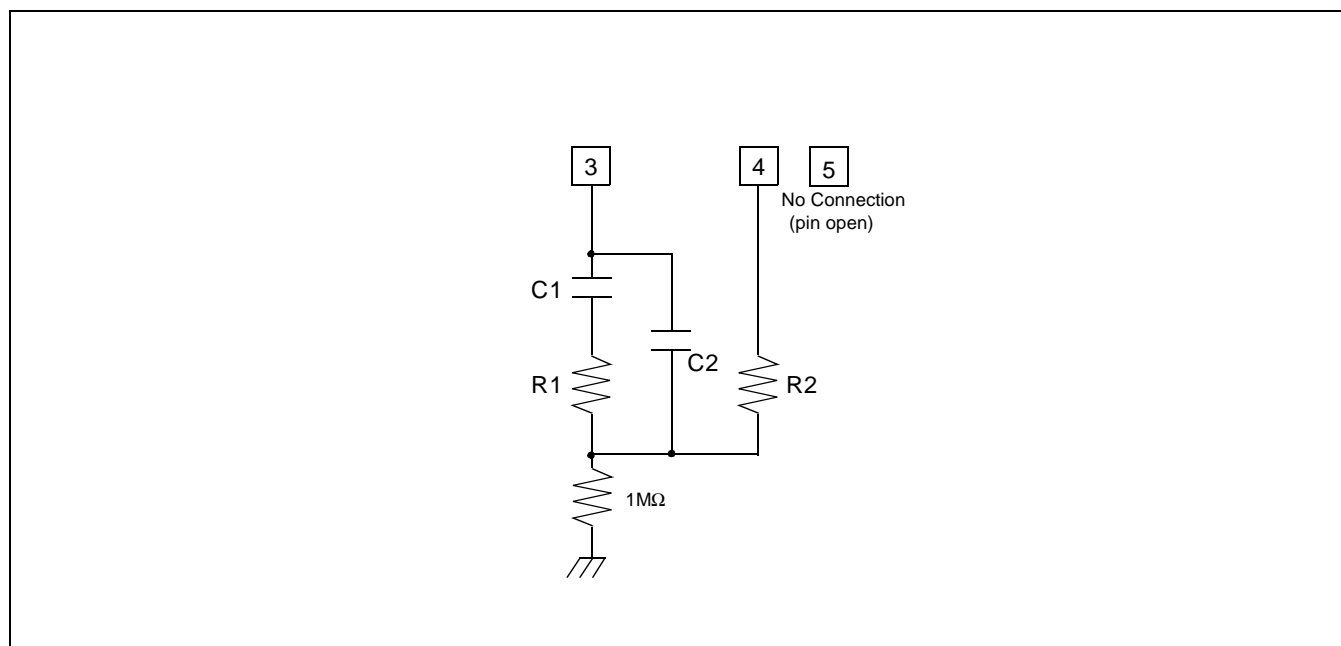


Figure 19. PLL External Circuit

Because the PLL circuit is basically a feedback circuit, there are many components that influence the characteristics. C1, C2, R1, and R2 do not have a localized effect.

As you can see, they are connected to the PLL control bits and influence the characteristics through their complicated relationships. The main functions of the time constant and their reference values are as follows.

Table 14. Main Function of Time Constant in PLL External Circuit

Time Canstant	Recommended Value	Main Function
C1	10uF	Influences the damping ratio and controls the PLL response time
R1	5.6KΩ(7.5KΩ)	Same as C1
R2	27KΩ (or 33KΩ)	Charge pump current adjustment
C2	33pF	Removes ripple caused by R-C circuit

- PLL Control Bit**

After configuring an external circuit using the recommended values, carry out programming using the recommended values for frequency range and control bits given in the Table below.

Table 15. Recommend Values of PLL Control Bit

Register Set	PLL Control Bit								
Freq. Range	CP1	CP0	FPLL	HF2	HF1	HF0	DOT1	DOT0	Hex
Below 40kHz	0	0	0	0	1	0	1	1	0B
40 - 50kHz	1	0	0	1	0	0	1	1	93
50 - 70kHz	1	1	0	1	0	1	1	1	A7
Above 70kHz	1	1	0	1	1	1	1	1	AF

(Ref: 800×600 , C1: 10uF, R1: 5.6K, R2: 27K, C2: 33pF)

- Locking Range**

As you can see the figure below, it is 2.35V that measured voltage at pin-3 to optimize OSD quality. The proper voltage range is 1.5 ~ 3.25V.

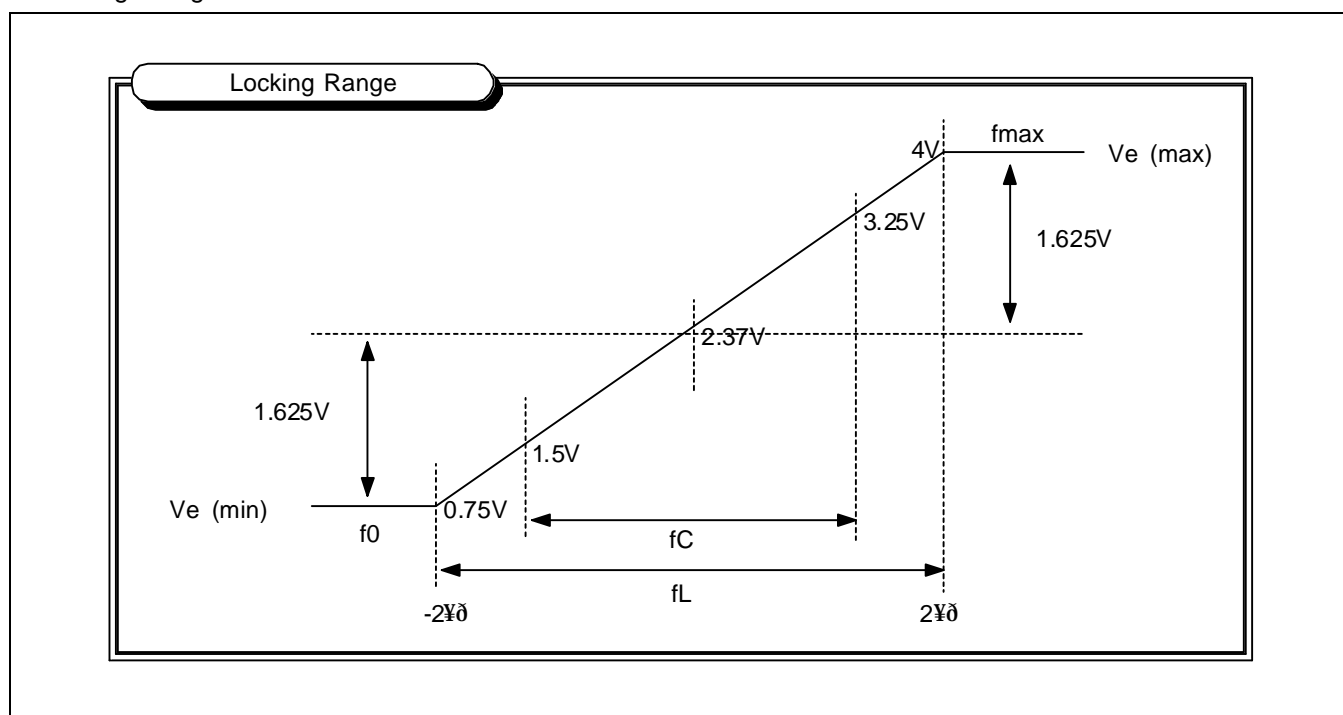


Figure 20. Locking Range

- **HF Bits Selection**

HF bits is not selecting from out of 8 (2^3) steps uniformly, but selecting the step shown in figure below. In example, at 800 mode, there are 5 steps that the frequency range is controlled by HF bits.

Table 16. HF Bits Selection

DIV	DOT1	DOT0	HF2	HF1	HF0
320	0	0			
480	0	1			
640	1	0			
800	1	1			

After fixing time constants of the external circuit and PLL control bits except HF bits, if HF bits are stepped up, the voltage measured at pin-3 drops. On the contrary, if HF bits are stepped down, the voltage rises.

The voltage measured at pin-3 don't change by changing CP bits.

- **External Register at pin-4**

The external register at pin-4 is the factor that changes greatly at PLL tuning. The initial value of this external register value is decided as follows.

At first, the external register is replaced variable-register (about 50K Ω range).

and then, set the lowest PLL control bits at the lowest frequency allowed by set.

and then, change variable-register to be 2.35V that optimum voltage is locking.

and then, measure register value at this time.

also, set the highest PLL control bits at the highest frequency allowed by set.

and then, change variable-register to be 2.35V that optimum voltage is locking.

and then, measure register value at this time.

You may decide the average of these two registers' value to initial value.

The table below shows that other factors change as changing external register's value.

Fixing Factor	Variable Factor	Change	Voltage	Current	Lock Range
Time constants of the external circuit and PLL control bits except	Rext	↑	↑	↓	↓ (shift)
		↓	↓	↑	↑ (shift)

RECOMMENDATION

5V Power Routing

KB2514's OSD part power is composed of analog VDD and digital VDD. To eliminate clock noise influence in the digital block, you need to separate the analog VDDA and digital VDD.

(BD102 use: Refer to Application Circuit)

12V Power Routing

Because KB2514 is a wideband AMP of above 150MHz, 12V power significantly affects the video characteristics. The effects from the inductance and capacitance are different for each board, and , therefore, some tuning is required to obtain the optimum performance. The output power, VCC2, must be separated from VCC1 and VCC3 using a coil, which is parallel-connected to the damping resistor. The appropriate coil value is between 20uH - 200uH. Parallel-connected a variable resistor to the coil and control its resistance to obtain the optimum video waveform.

(Moreover, BD103 can tune using a coil and variable resistor to obtain the optimum video waveform.
L103, R124, BD103: Refer to application circuit)

VCC1, VCC3 12V Power

Use a 104 capacitor and large capacitor greater than 470uH for the power filter capacitor.

12V Output Stage Power VCC2

Do not use the power filter capacitor.

5V Digital Power VDD

Don't use a coil or magnetic core to the VDD input. Make the power filter capacitor, an electric capacitor of greater than 50uF, single and connect it to VSS, the digital GND.

Output Stage GND2

Care must be taken during routing because it ,as an AMP output stage GND, is an important factor of video oscillation. R/G/B clamp cap and R/G/B load resistor must be placed as close as possible to the GND2 pin. GND2 must be arranged so that it has the minimum GND loop, which at one point must be connected to the main GND.

Digital GND VSS

When this is to be connected directly to the GND2, it can cause the OSD clock noise, so the loop connection should be routed as far away as possible. If the OSD clock noise affects the screen, separate VSS GND from all GND and connect it to the main board using a bead. Again, the bead connection point should be placed as far away as possible to the GND2.

Analog Block

The PLL built in to KB2514 is sensitive to noise due to the wide range PLL characteristics. Therefore, you need to isolate the analog block in the following manner. First make a separate land for the analog block (pin2 - pin6)'s ground, and connect it to the main ground through a 1M Ω resistor. The analog GND of both sides of a double faced PCB must be separated from the main ground. (Separate pin 2's 5V analog GND, which is the GND for OSD PLL, from the main and digital GNDs and connect it to the main GND using about 1M Ω resistor. GND for pins 2 - 6 is the No. 2 VSSA GND.)

I²C Control Line (SCL, SDA Line)

I²C communication noise (noise generated in the OSD display pattern when data is transmitted in the I²C line) may be generated because of an I²C control line that passes near the analog block. The I²C control lines near KB2514 must be separated from the analog block as much as possible.

Furthermore, the I²C bus interference can be prevented by inserting a series resistor in the line.

Horizontal Flyback Signal

Display jittering can be generated if the horizontal signal (HFLB) input to KB2514 is not a clean signal.

We recommend a short path and shielded cable for obtaining a clean signal.

Generally, the input horizontal signal (HFLB) is generated by using a high voltage horizontal flyback signal. The effect from the high voltage flyback signal can be reduced by separating the R115 and R117 GND, which determines the flyback signal slice level, from the transistor GND, which generates the actual KB2514 input horizontal signal. Furthermore, the flyback signal sharpness must be maintained by minimizing the values of R115, R116 and R117 resistors, which set the horizontal signal slice level. values.

(R115, R116, R117: Refer to application circuit)

HFLB Input Signal Generator

You can correct the circuit by reducing the resistors that sets the slice level of the horizontal signal in the HFLB-generating circuit.

APPLICATION BOARD CIRCUIT

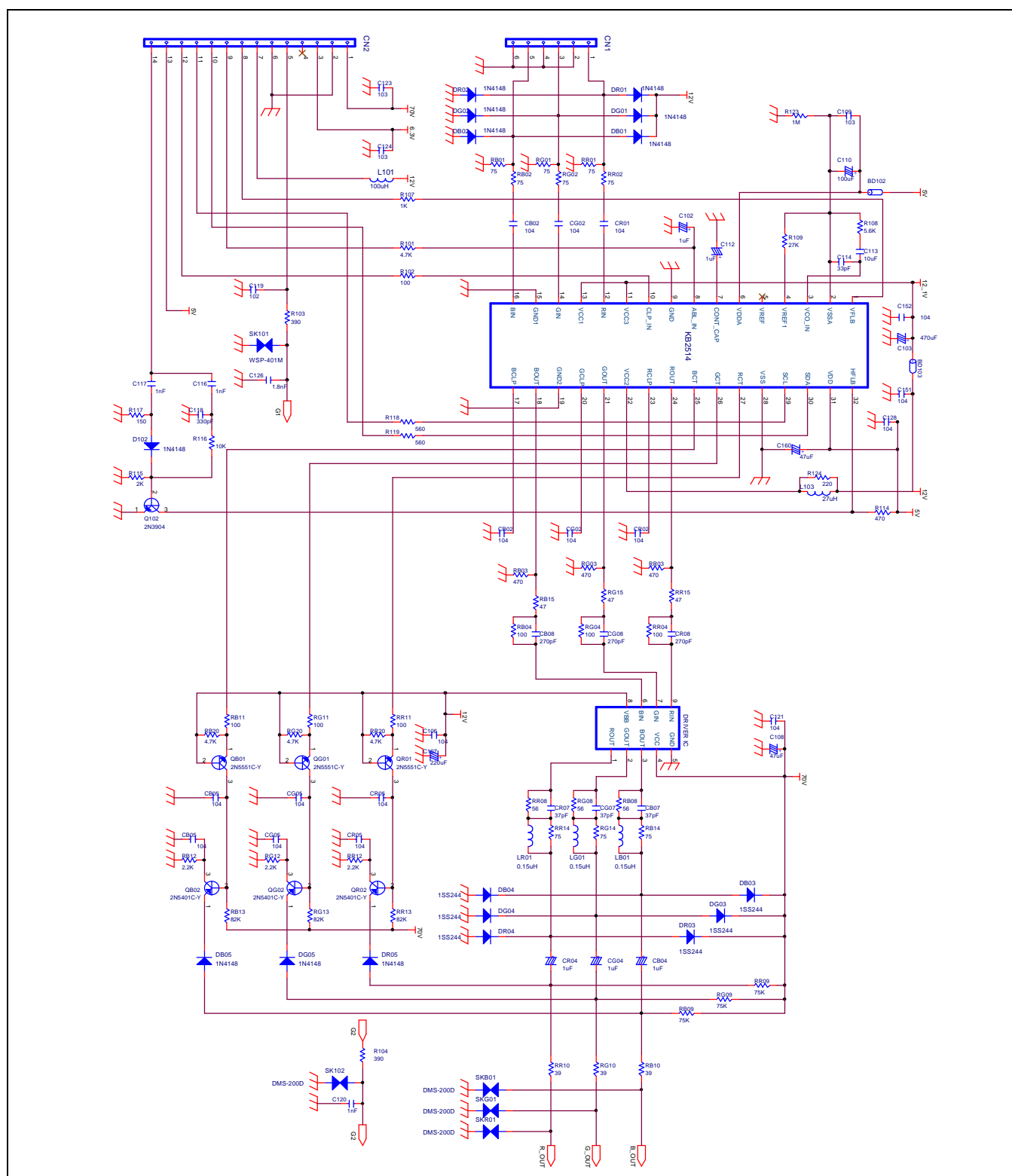
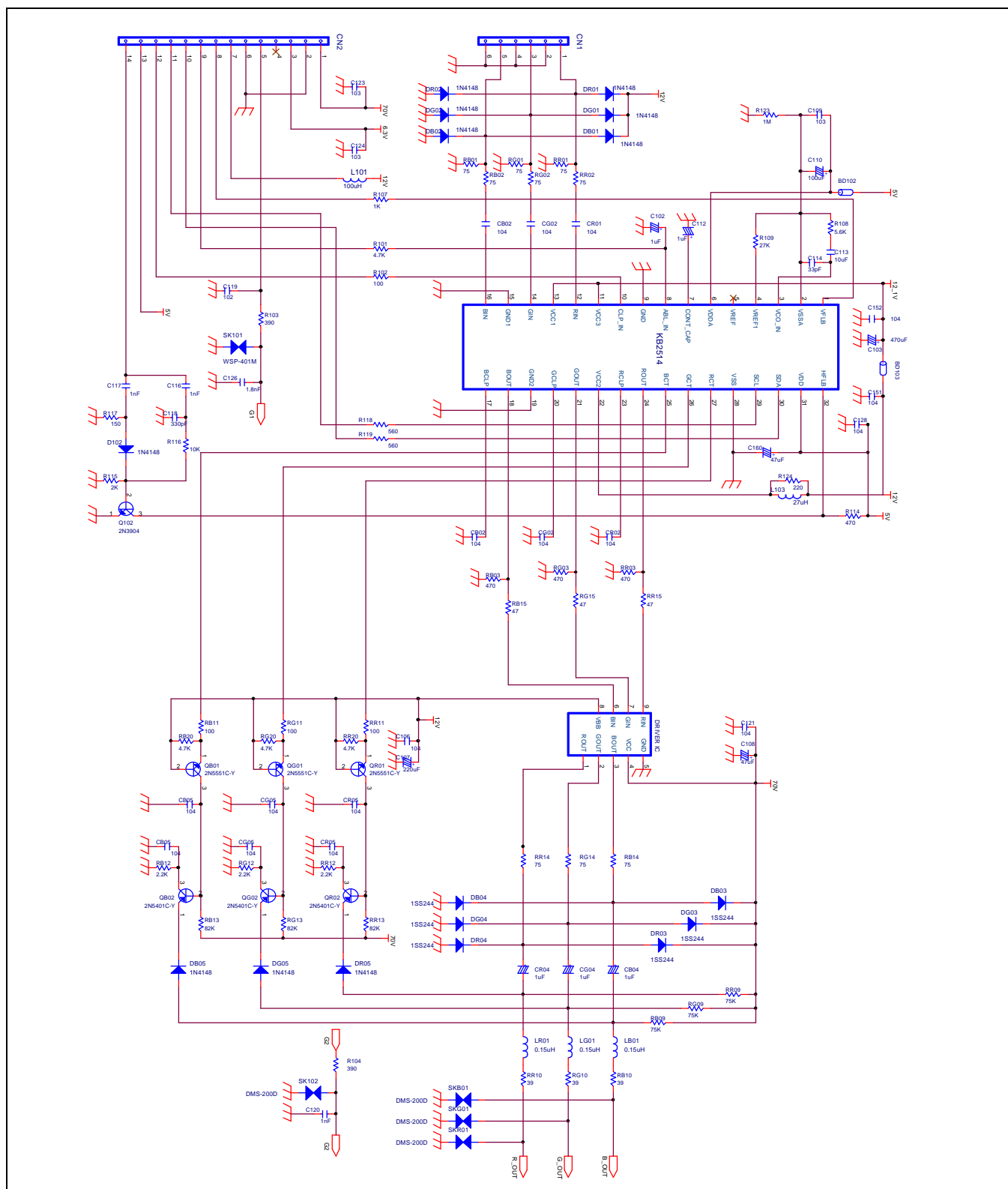


Figure 21. Application Board Circuit

TYPICAL APPLICATION CIRCUIT

Figure 22. Typical Application Circuit

ROM FONTS

000	001	002	003	004	005	006	007	008	009	00A	00B	00C	00D	00E	00F
010	011	012	013	014	015	016	017	018	019	01A	01B	01C	01D	01E	01F
020	021	022	023	024	025	026	027	028	029	02A	02B	02C	02D	02E	02F
030	031	032	033	034	035	036	037	038	039	03A	03B	03C	03D	03E	03F
040	041	042	043	044	045	046	047	048	049	04A	04B	04C	04D	04E	04F
050	051	052	053	054	055	056	057	058	059	05A	05B	05C	05D	05E	05F
060	061	062	063	064	065	066	067	068	069	06A	06B	06C	06D	06E	06F
070	071	072	073	074	075	076	077	078	079	07A	07B	07C	07D	07E	07F

Figure 23. ROM Fonts

Ä	Ë	İ	Ö	Ü	Â	Ê	Î	Ô	Û	Á	É	Í	Ó	Ú	Ç
080	081	082	083	084	085	086	087	088	089	08A	08B	08C	08D	08E	08F
ä	ë	ï	ö	ü	â	ê	î	ô	û	á	é	í	ó	ú	ç
090	091	092	093	094	095	096	097	098	099	09A	09B	09C	09D	09E	09F
À	È	Ì	Ò	Ù	Ã	Õ	Ñ	Å	Š	Ž	Ÿ	ß			
0A0	0A1	0A2	0A3	0A4	0A5	0A6	0A7	0A8	0A9	0AA	0AB	0AC	0AD	0AE	0AF
à	è	ì	ò	ù	ã	õ	ñ	å	š	ž	ÿ	œ			
0B0	0B1	0B2	0B3	0B4	0B5	0B6	0B7	0B8	0B9	0BA	0BB	0BC	0BD	0BE	0BF
Ⓔ	Ⓢ	Ⓜ	Ⓜ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ
0C0	0C1	0C2	0C3	0C4	0C5	0C6	0C7	0C8	0C9	0CA	0CB	0CC	0CD	0CE	0CF
Ⓜ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ
0D0	0D1	0D2	0D3	0D4	0D5	0D6	0D7	0D8	0D9	0DA	0DB	0DC	0DD	0DE	0DF
Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ
0E0	0E1	0E2	0E3	0E4	0E5	0E6	0E7	0E8	0E9	0EA	0EB	0EC	0ED	0EE	0EF
Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ	Ⓢ
0F0	0F1	0F2	0F3	0F4	0F5	0F6	0F7	0F8	0F9	0FA	0FB	0FC	0FD	0FE	0FF