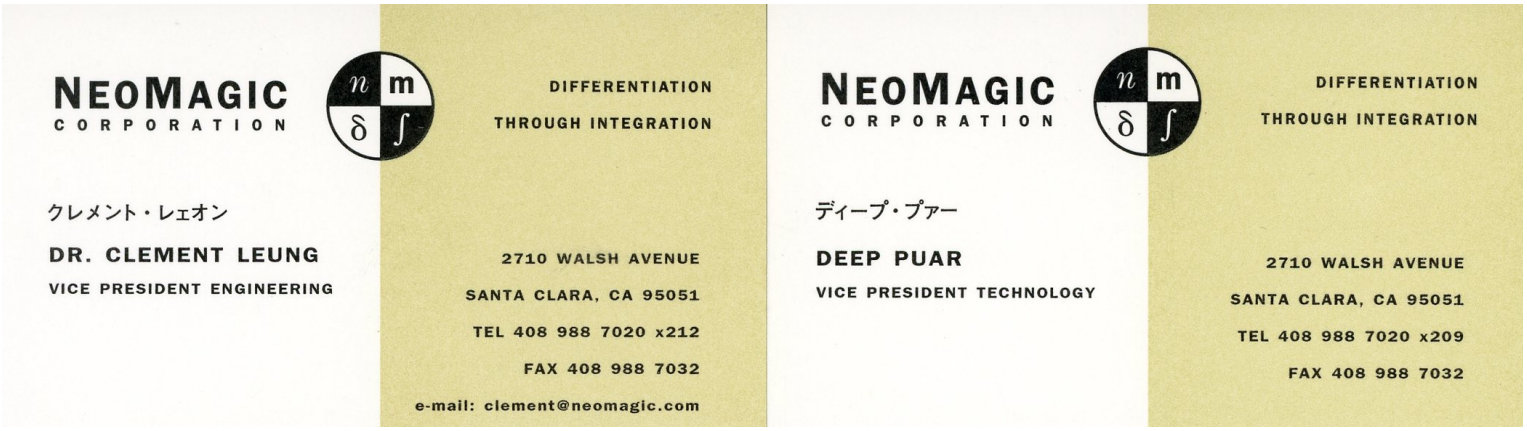
Probing VGA/SVGA/XGA Video Signals

In 1998, I bought an IBM ThinkPad 380XD Windows 98 lap-top PC (800 x 600 SVGA color TFT panel driven by NeoMagic VGA flat panel controller LSI (MagicGraph128XD) which integrated on-chip 256KB DRAM graphics memory (up to 800 x 600 x 4 planes) achieving 128 bit (unlike regular 16 bit) video data bandwidth tying up with Mitsubishi Electric Japan who were merged by Hitachi (renamed to Renesas Technology) in 2002.

I have visited NeoMagic in 1994 before they shipped the first sample to IBM Japan in 1995.



In case of lap-top PC such as IBM ThinkPad 380XD, no video signals are output through VGA connector when display devices are not connected because own flat panel is being enabled.

When a certain display device is connected to VGA connector, Windows 98 checks signals transferred by the display device and determines the display parameters to be output utilizing so-called “Plug & Play”.

IBM ThinkPad 380XD allows shortcut key operation below to manually switch target display device.

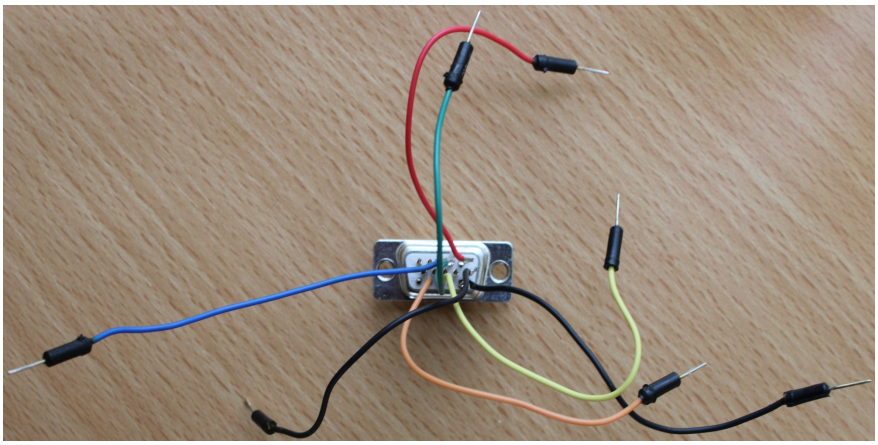
Display device switching by shortcut key operation (FN + F7)			**Sequence**			
			Power on	1st	2nd	(Go to Power on)
Target Display Device	No device connected to VGA connector	Own TFT panel	Yes	No	Yes	(Yes)
		External display device	No	Yes	Yes	(No)
	Device connected to VGA connector	Own TFT panel	Yes*	Yes	No	(Yes)
		External display device	Yes*	No	Yes	(Yes)

* : As a result of “Plug & Play”, sequence starts from “2nd” as “No device connected to VGA connector”.

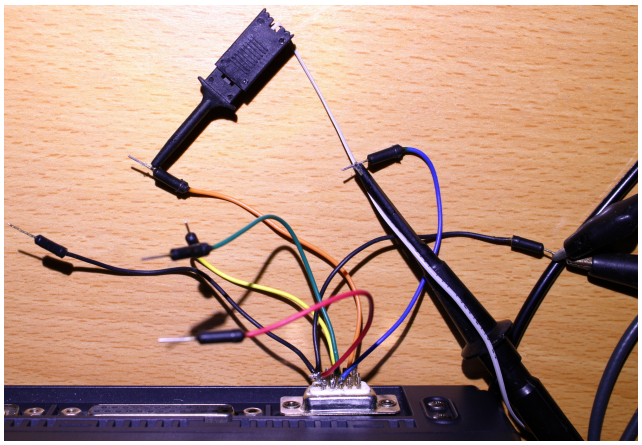
IBM ThinkPad 380XD Keyboard

F7 (FN is at lower left corner of the keyboard)

Male VGA connector (HD(High Density)15P D-Sub)

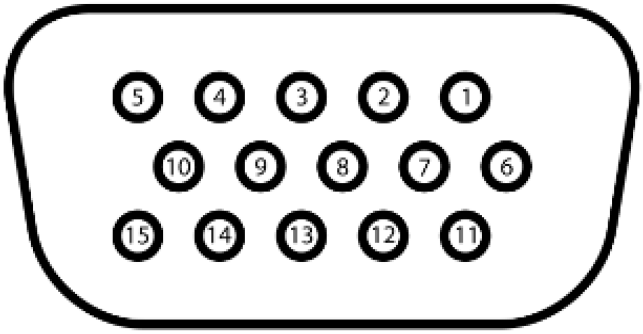


Soldered VGA connector pins (R, G, B, H Sync, V Sync, Ground)



Probing VGA video and sync signals

VGA Connector Spec



Female connector HD15S D-Sub (Both PC and monitor device implement)

Pin #	I/O	A/P/N	Description	Pin #	I/O	A/P/N	Description	Pin #	I/O	A/P/N	Description
1	O	A	Red video	**6**	--	--	Red GND	**11**	I	P	DDC ID0
2	O	A	Green video	**7**	--	--	Green GND	**12**	I	P	DDC ID1
3	O	A	Blue video	**8**	--	--	Blue GND	**13**	O	P/N	Horizontal Sync
4	I	P	DDC ID2	**9**	--	--	(+5V possible)	**14**	O	P/N	Vertical Sync
5	--	--	Hsync GND	**10**	--	--	Vsync/DDC GND	**15**	I	P	DDC ID3

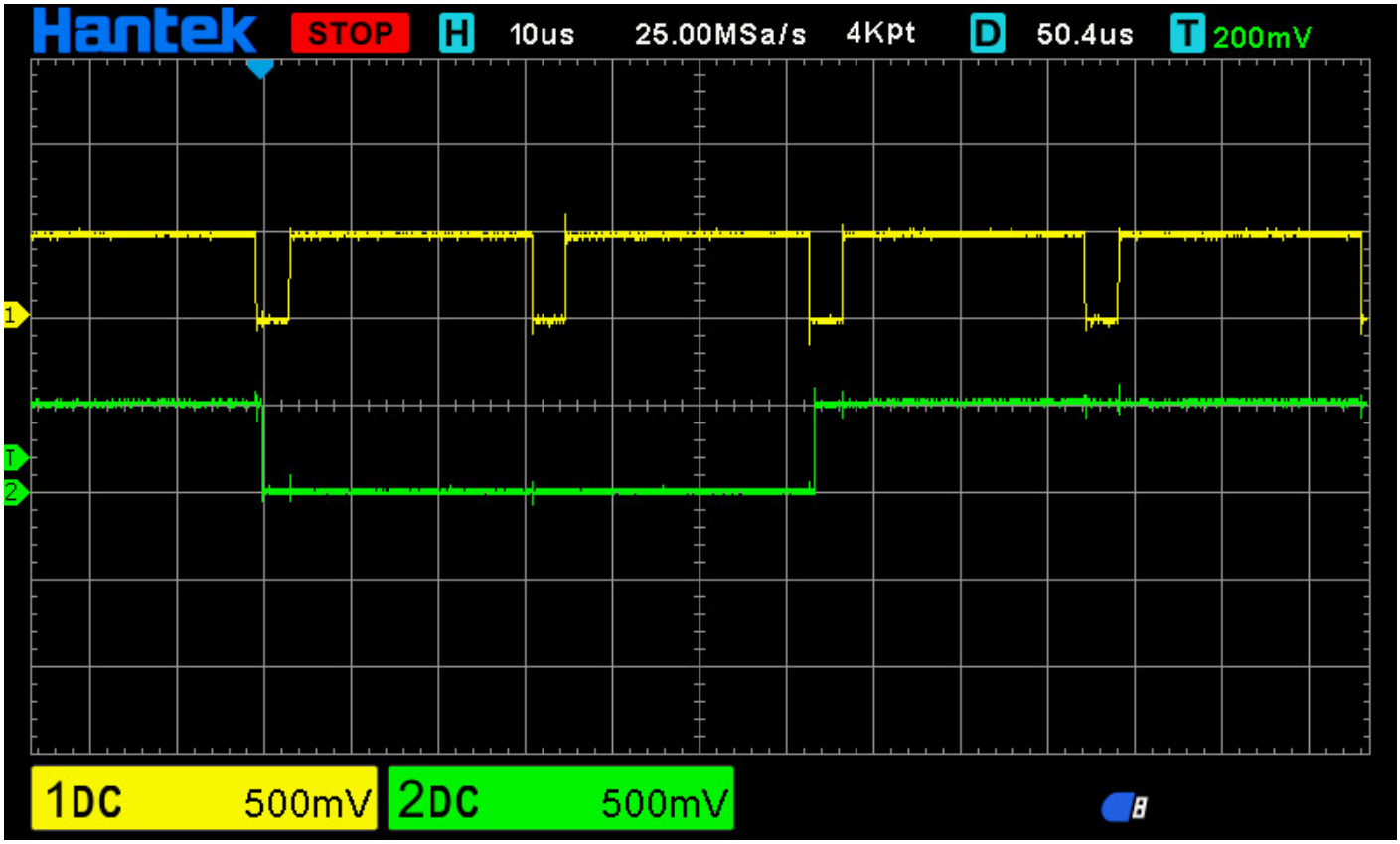
A : Analog 0.7 Vpeak-to-peak when 75 ohm load impedance
P : Positive Digital 5V TTL
N : Negative Digital 5V TTL

Display Data Channel (DDC)

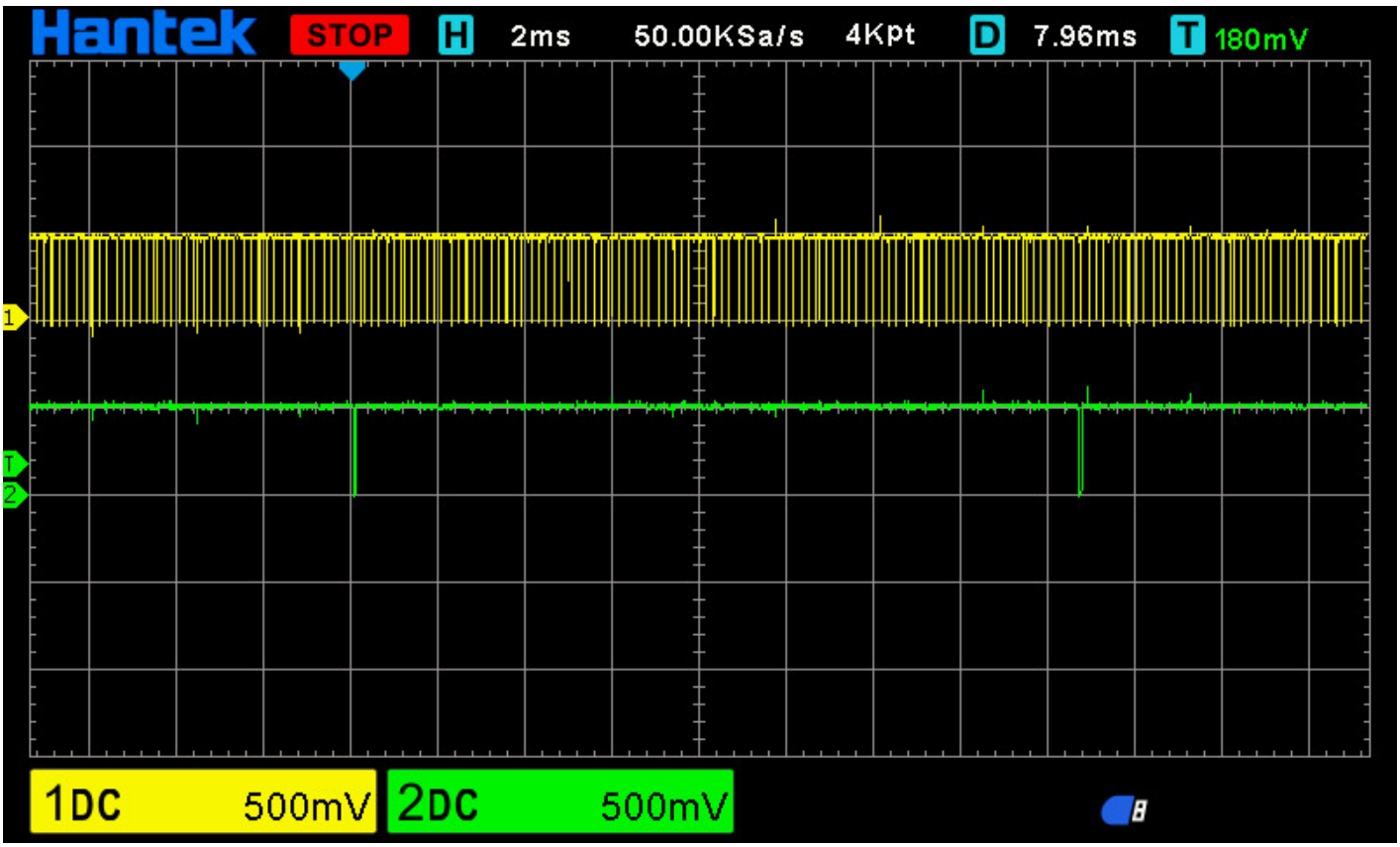
ID3 (15)	ID2 (4)	ID1 (12)	ID0 (11)	Monitor TV	
				Color/Monochrome	Resolution
N/C	N/C	N/C	N/C	Not connected	
N/C	N/C	**GND**	N/C	Monochrome	< 1024 x 768
N/C	N/C	N/C	**GND**	Color	
N/C	**GND**	N/C	**GND**	Color	≥ 1024 x 768

(A) Wave Forms

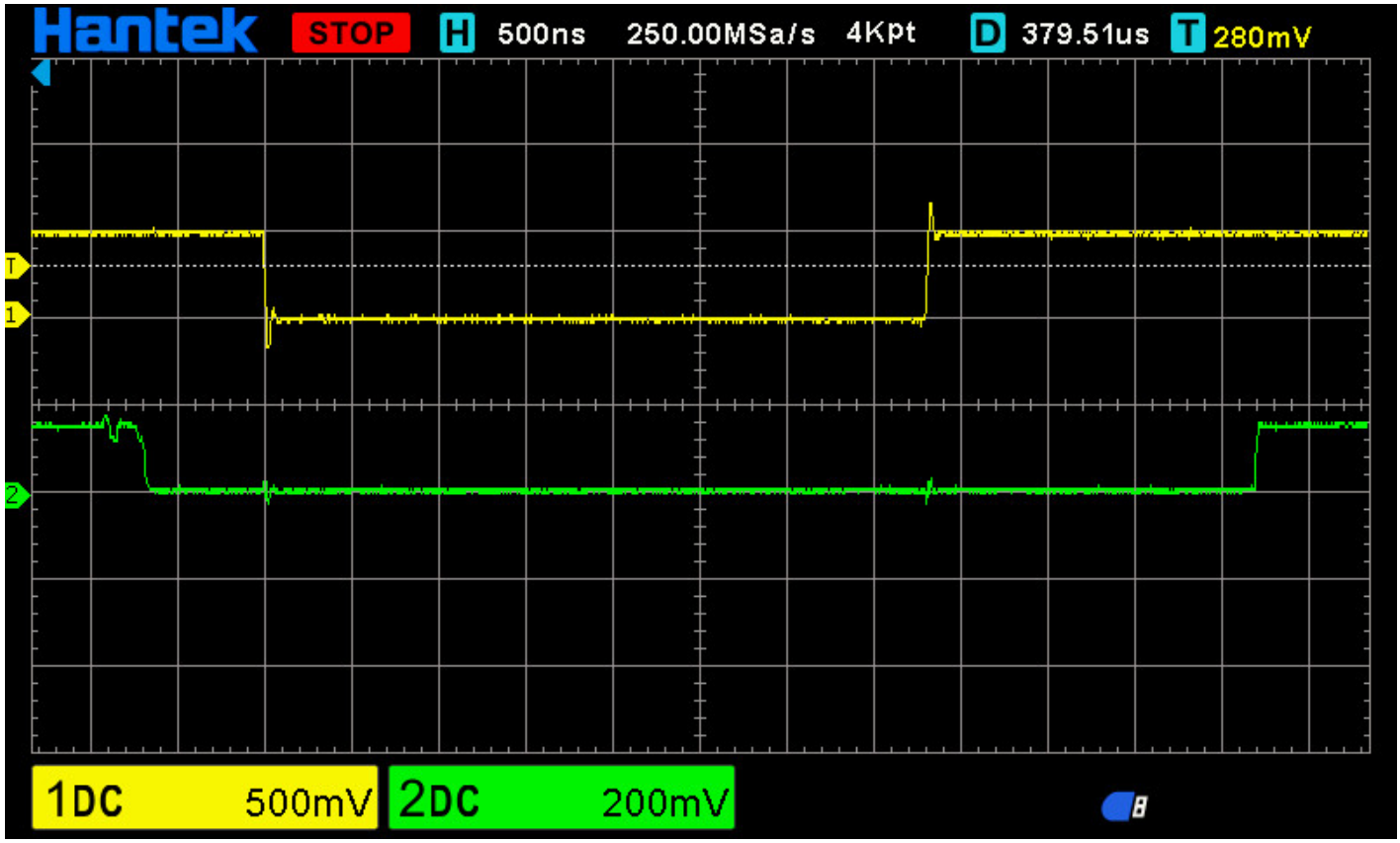
(1) VGA (640 x 480)



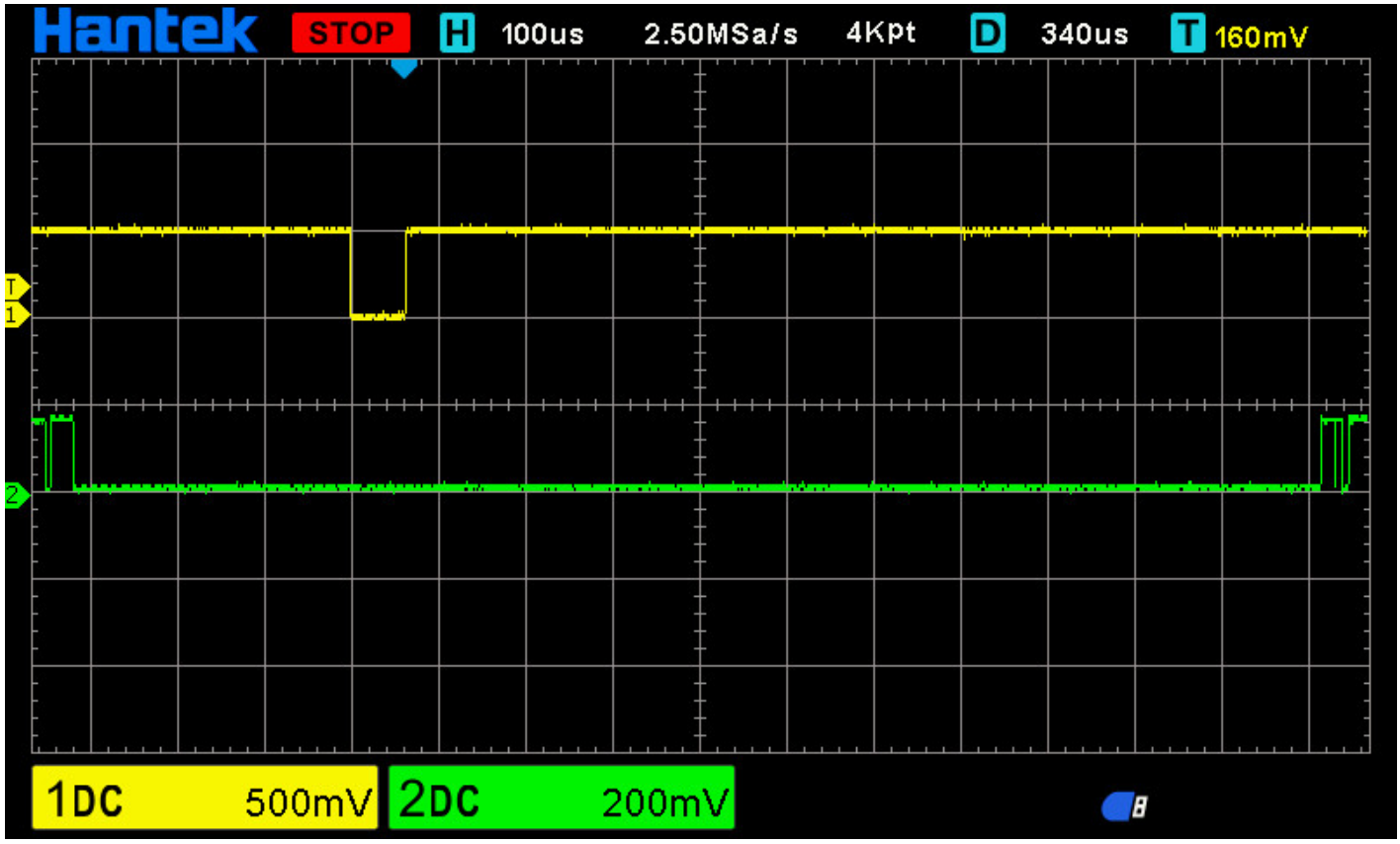
Vertical sync width = 2H (Negative H Sync & Negative V Sync), 1H = 31.778 μsec



1V = 16.683 msec

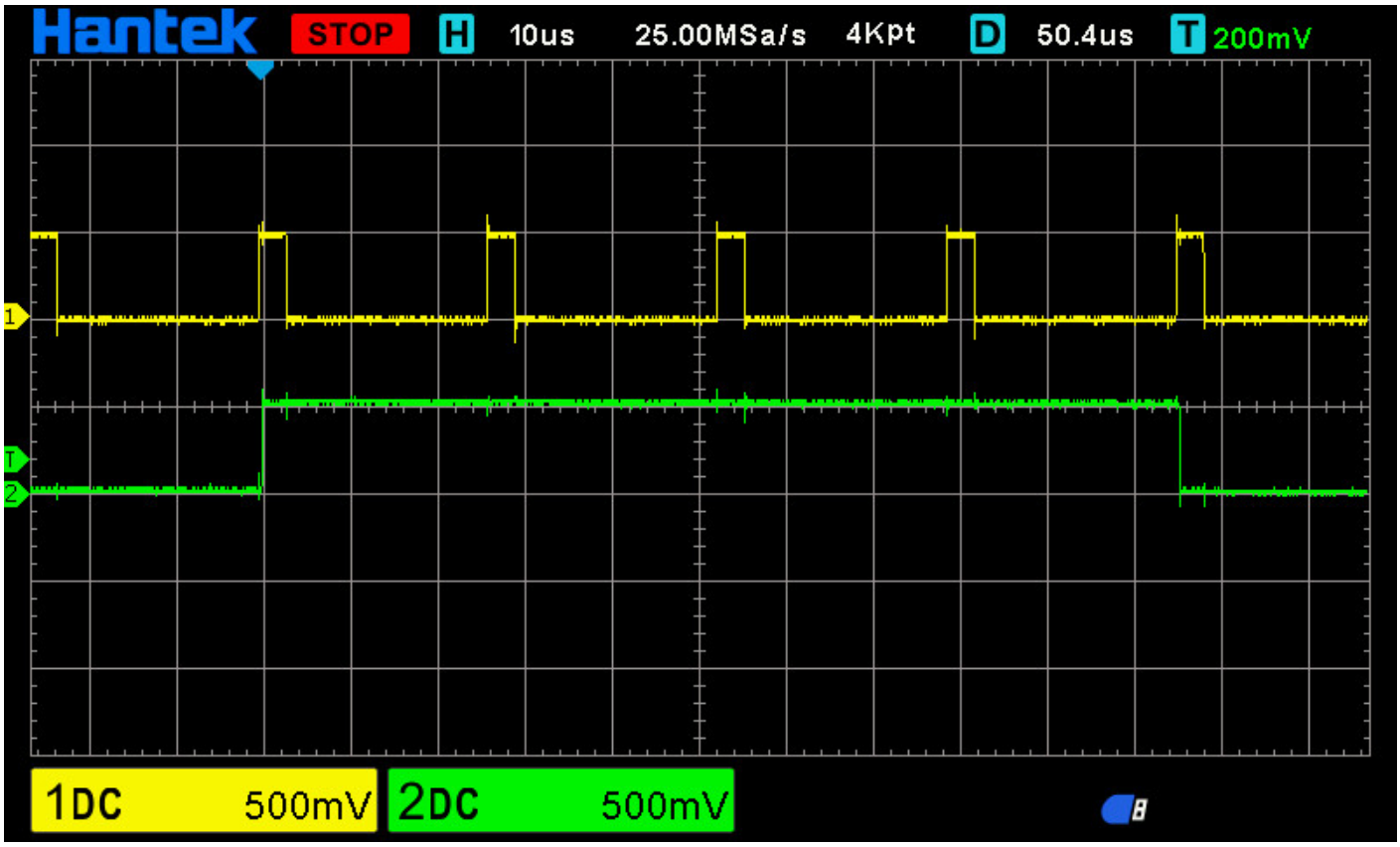


Horizontal front porch width = 0.636 µsec (16 pclks; 2 chrclks)
Horizontal sync width = 3.813 µsec (96 pclks; 12 chrclks)
Horizontal back porch width = 1.907 µsec (48 pclks; 6 chrclks)



Vertical front porch width = 10H (317.78 µsec)
Vertical sync width = 2H (63.555 µsec)
Vertical back porch width = 33H (1048.7 µsec)

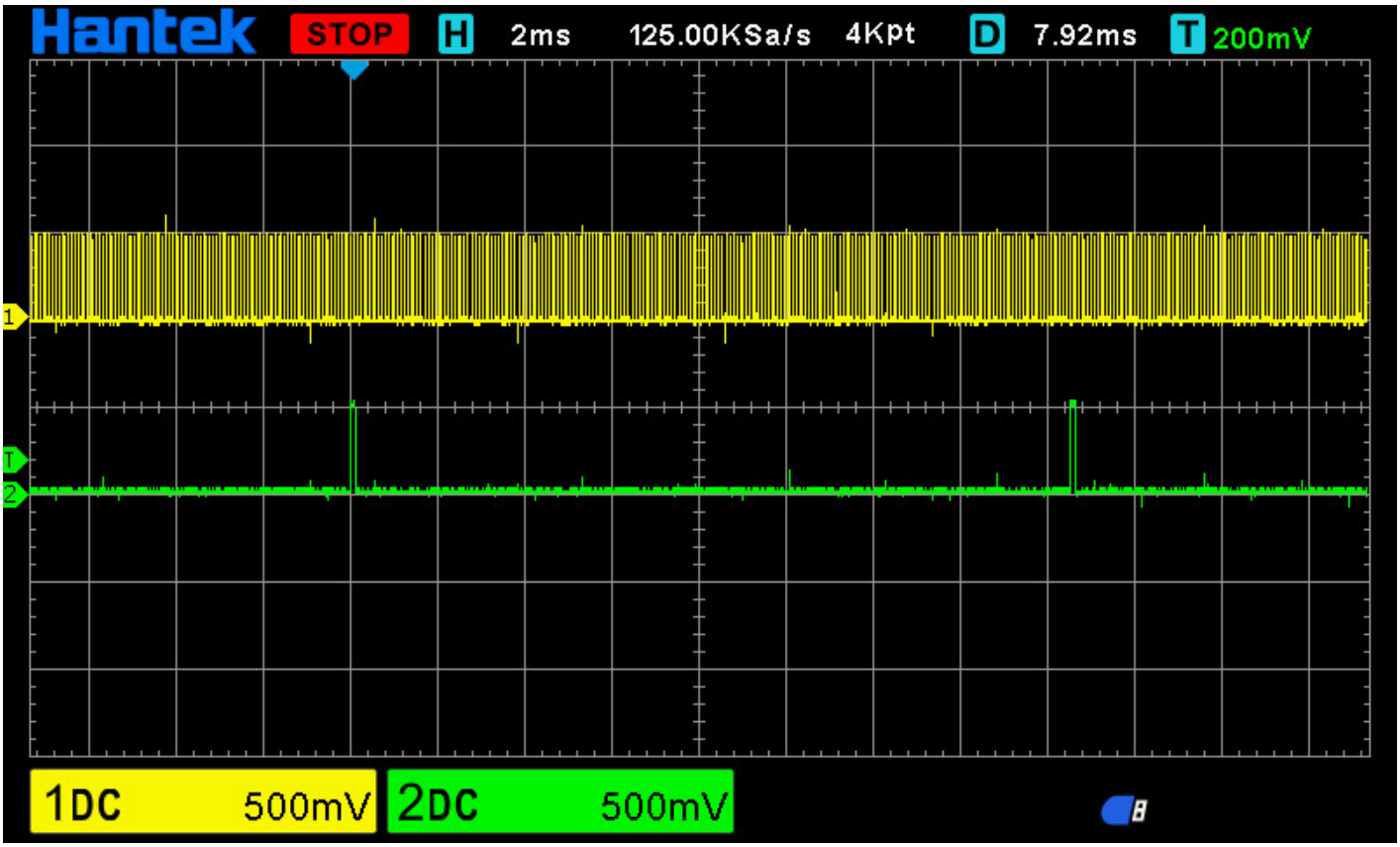
(2) SVGA (800 x 600)



H Sync

V Sync

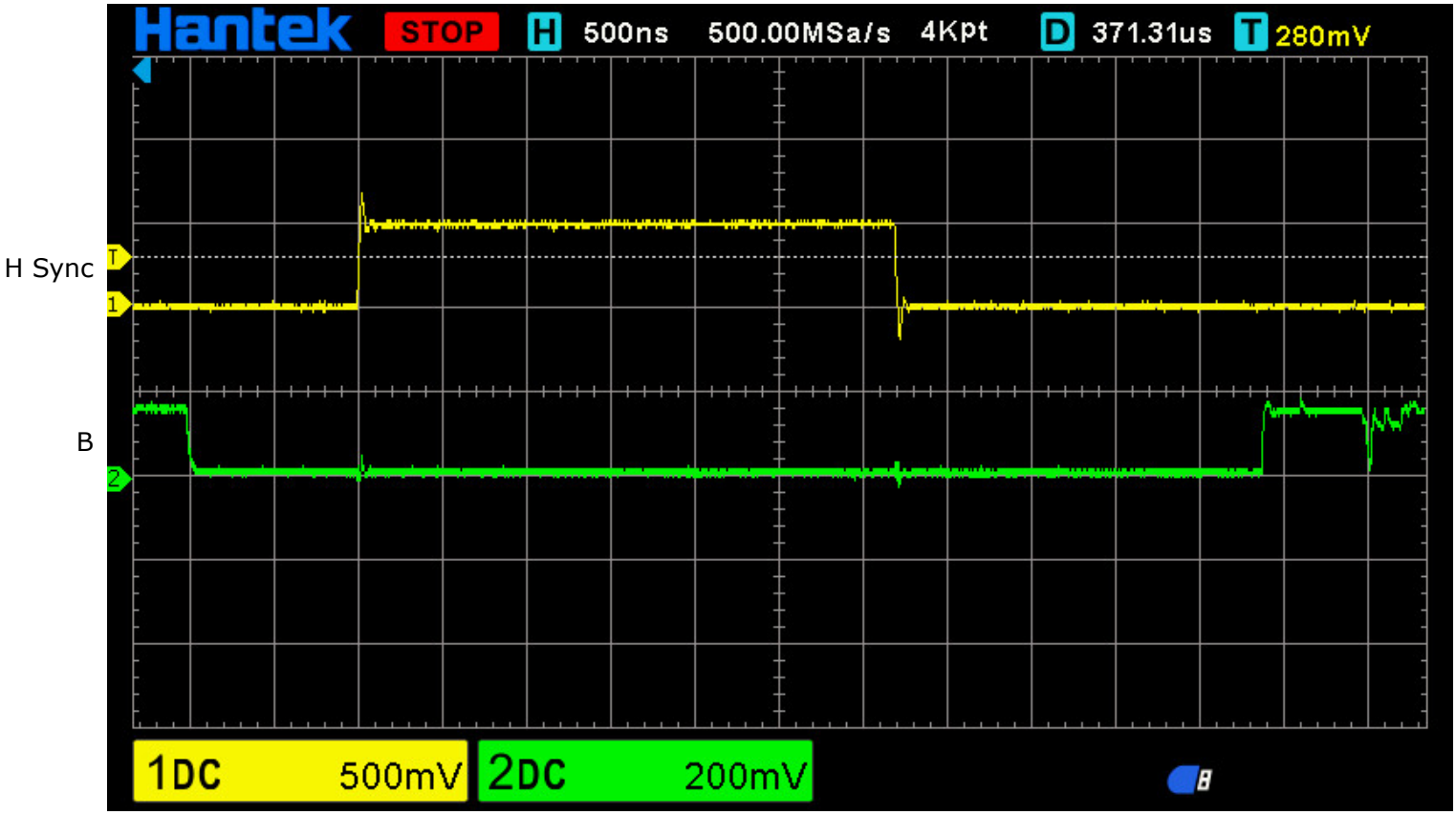
Vertical sync width = 4H (Positive H Sync & Positive V Sync), 1H = 26.4 µsec



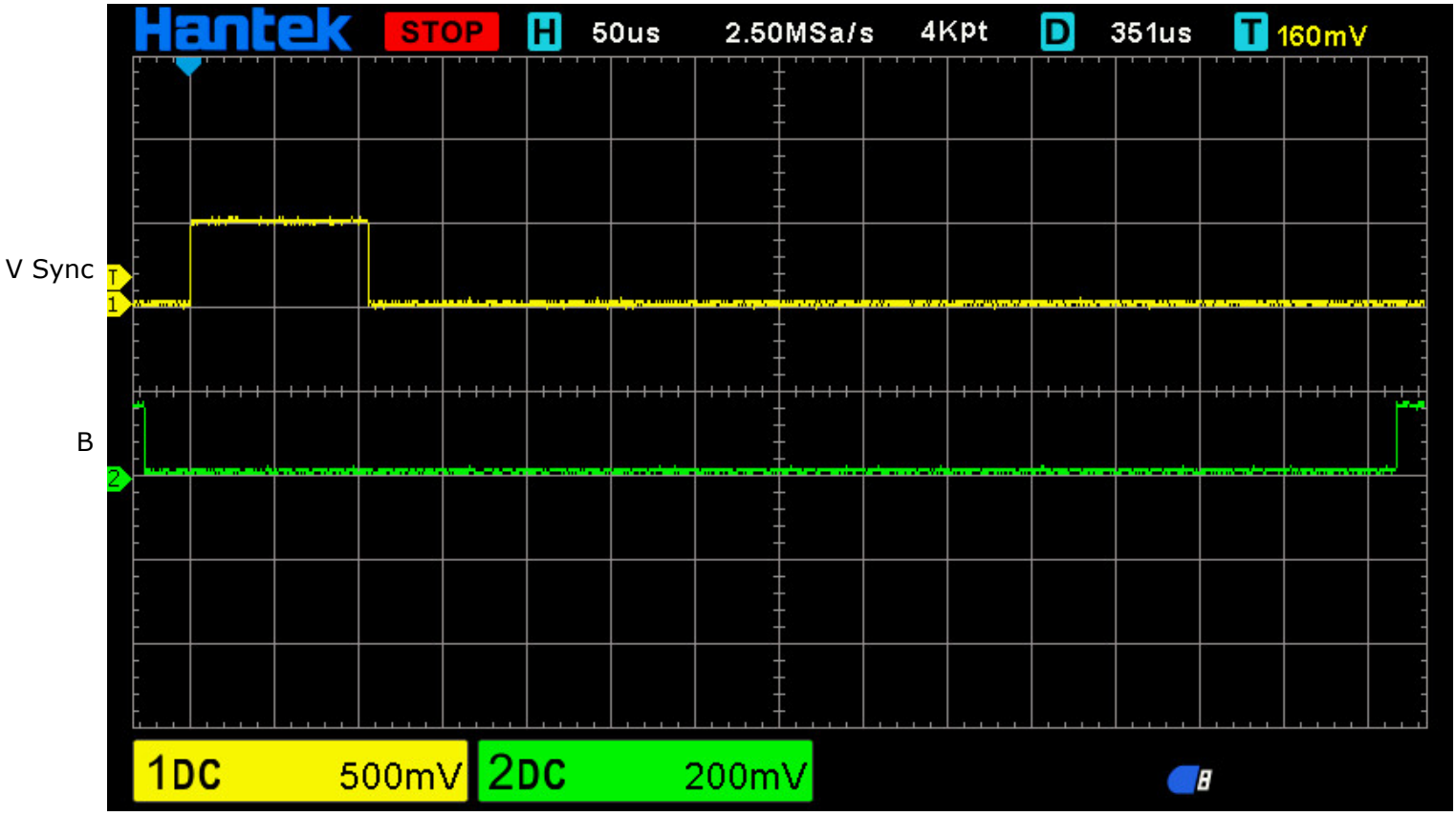
H Sync

V Sync

1V = 16.58 msec

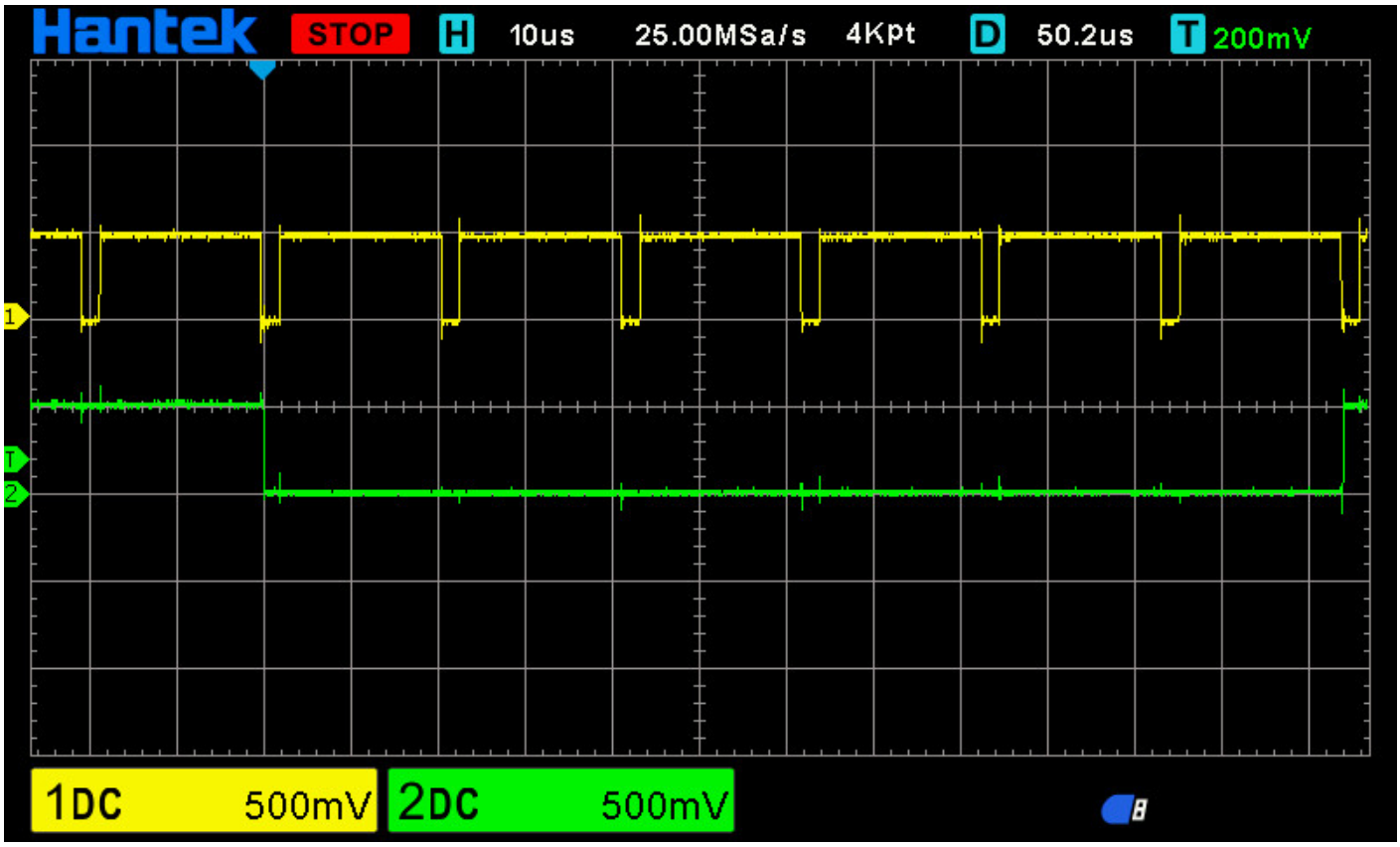


Horizontal front porch width = 1.0 µsec (40 pclks; 5 chrclks)
Horizontal sync width = 3.2 µsec (128 pclks; 16 chrclks)
Horizontal back porch width = 2.2 µsec (88 pclks; 11 chrclks)



Vertical front porch width = 1H
Vertical sync width = 4H
Vertical back porch width = 23H

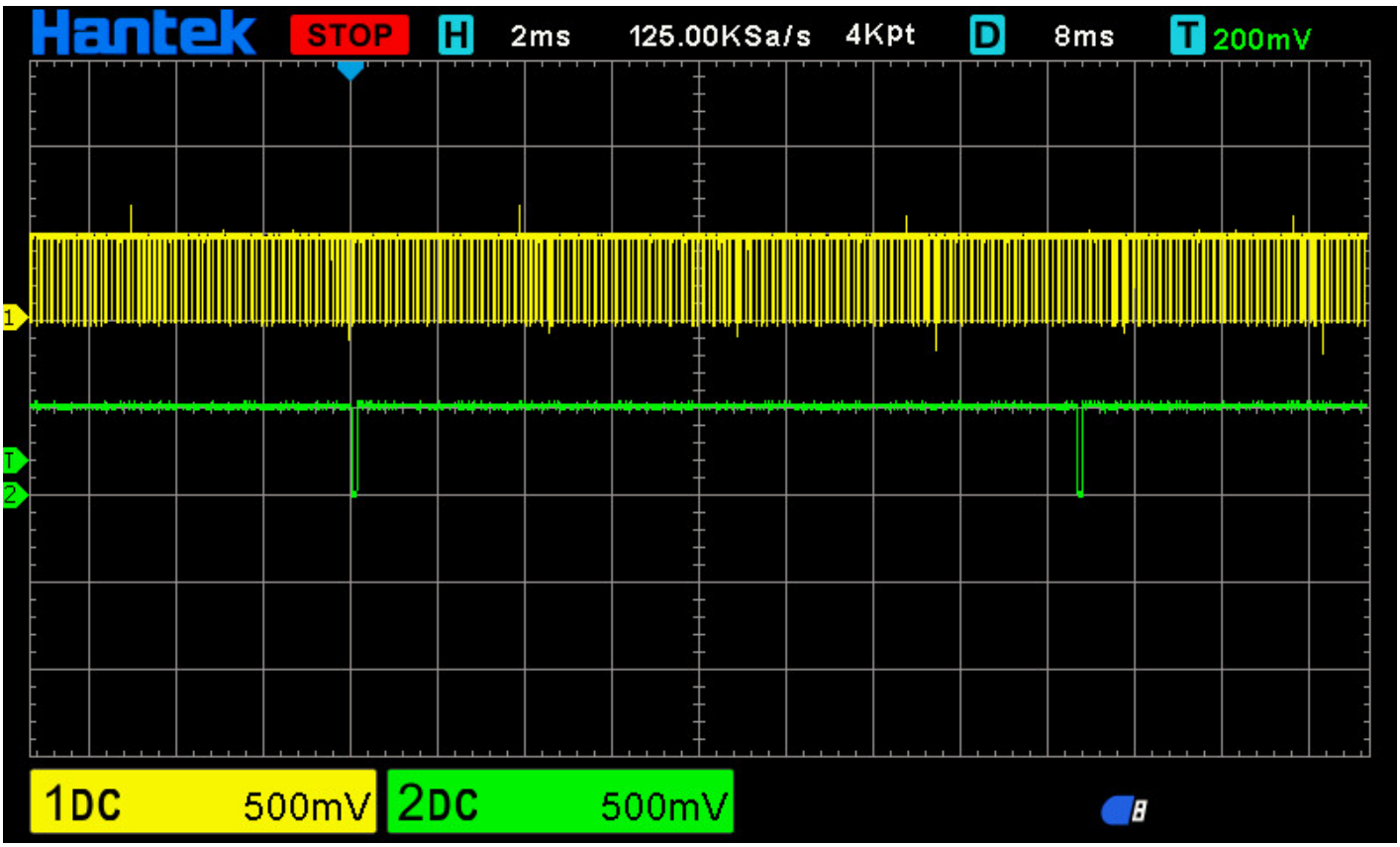
(3) XGA (1024 x 768)



H Sync

V Sync

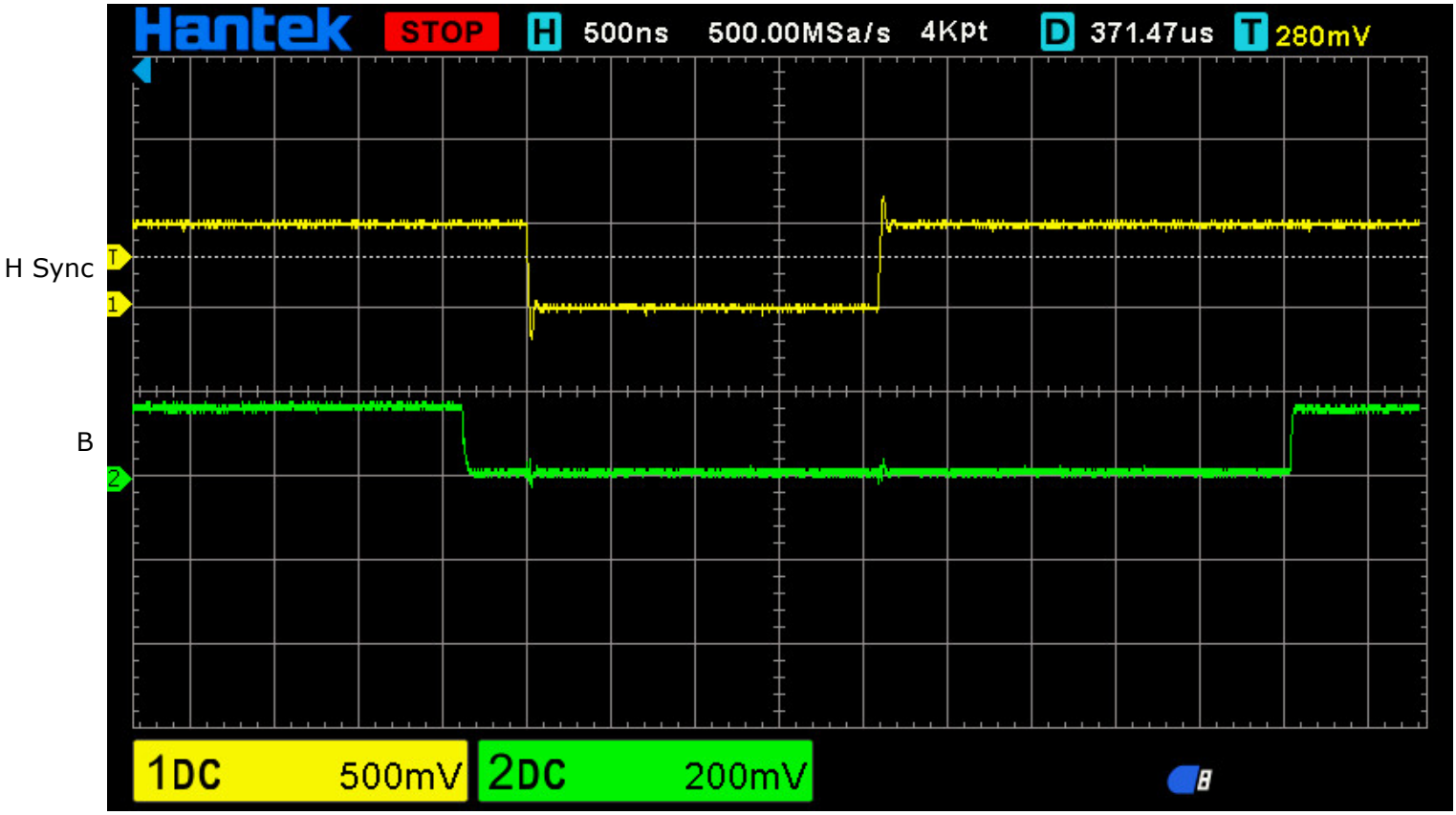
Vertical sync width = 6H (Negative H Sync & Negative V Sync), 1H = 20.68 μsec



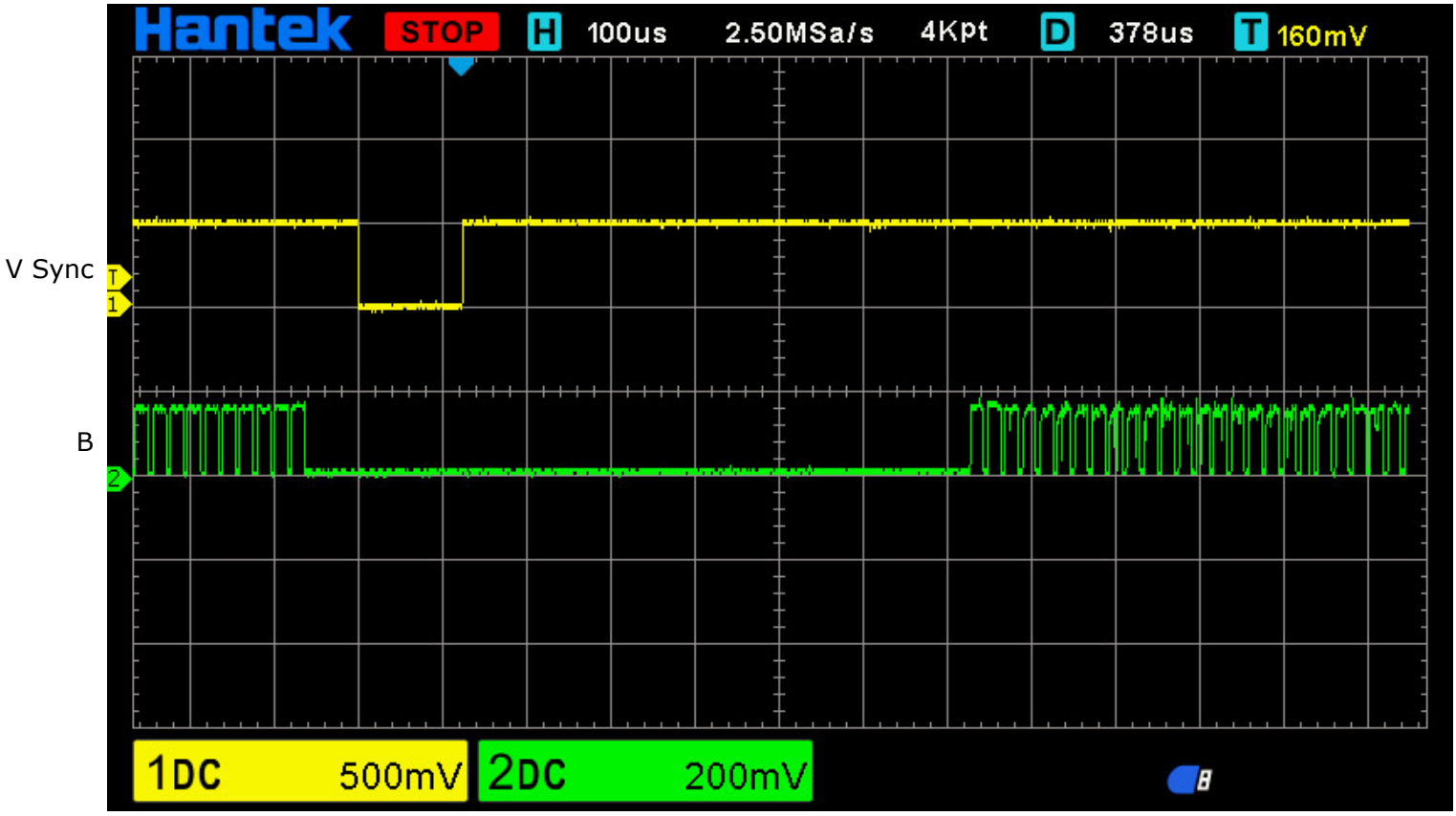
H Sync

V Sync

1V = 16.67 msec

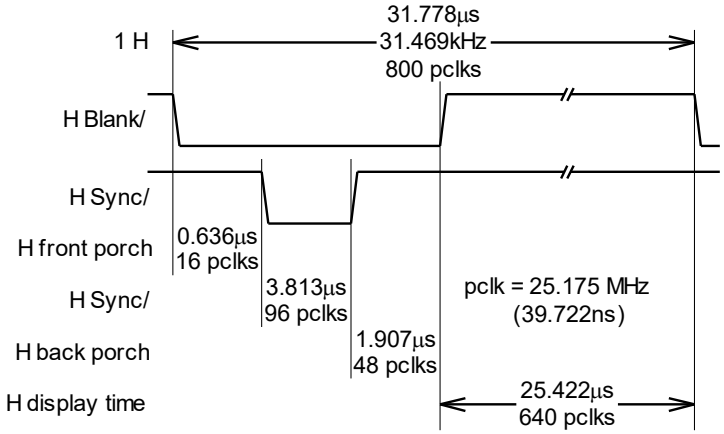


Horizontal front porch width = 0.37 µsec (24 pclks; 3 chrclks)
Horizontal sync width = 2.09 µsec (136 pclks; 17 chrclks)
Horizontal back porch width = 2.46 µsec (160 pclks; 20 chrclks)

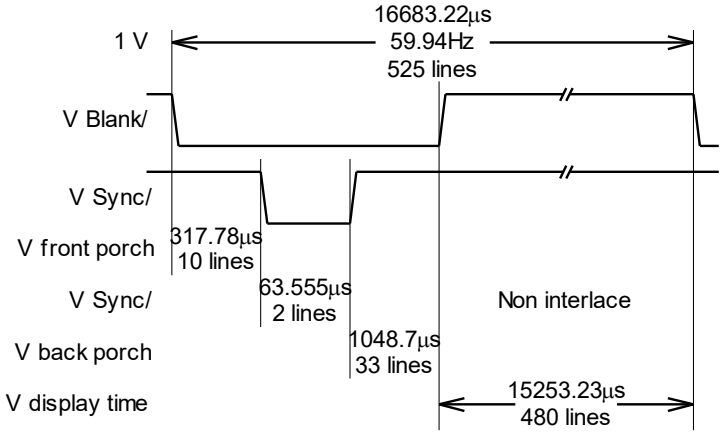


Vertical front porch width = 3H
Vertical sync width = 6H
Vertical back porch width = 29H

Details of Timing Parameters (Summary)

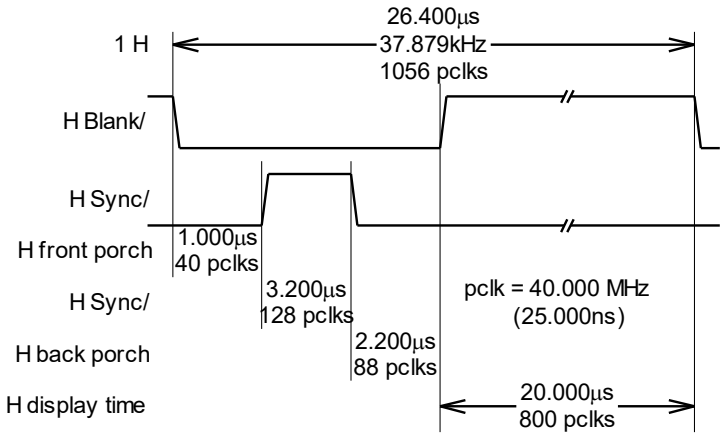


Horizontal Parameters

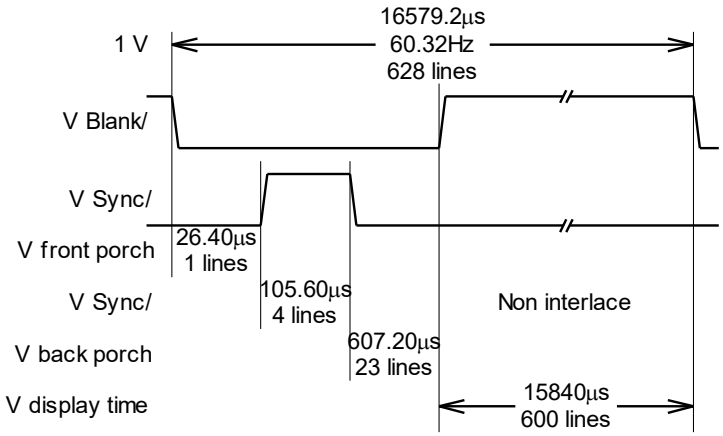


Vertical Parameters

VGA 640 x 480 @60Hz

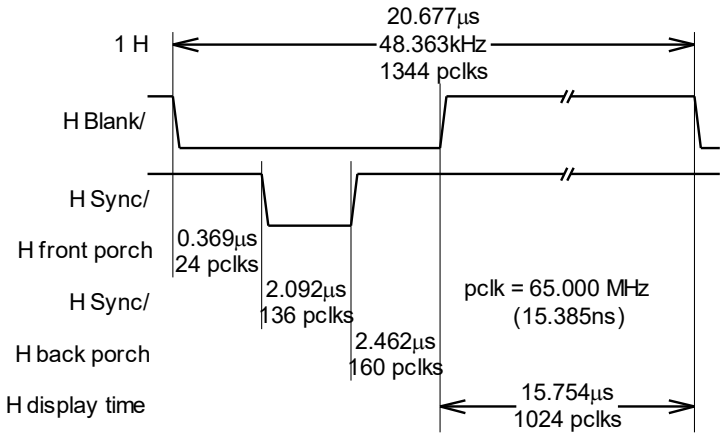


Horizontal Parameters

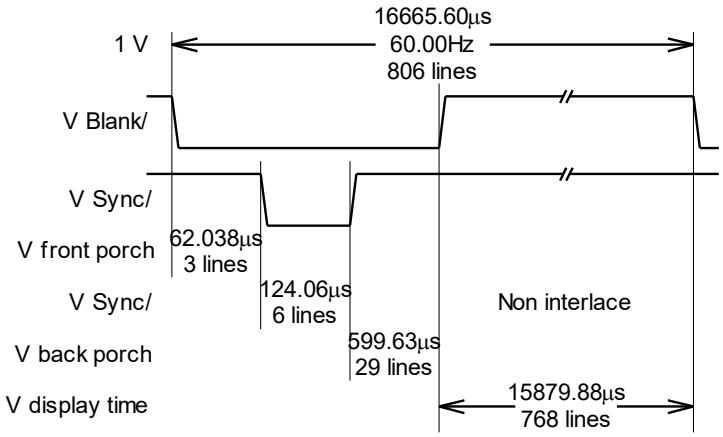


Vertical Parameters

SVGA 800 x 600 @60Hz



Horizontal Parameters



Vertical Parameters

XGA 1024 x 768 @60Hz

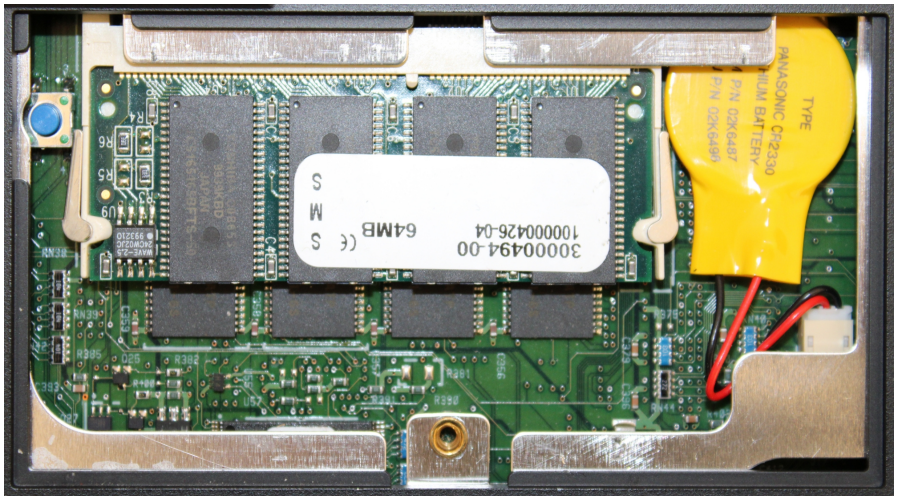
(Appendix–1) CMOS Battery Replacement

Because I have not used IBM ThinkPad 380XD for a long time, a CMOS battery has been discharged.

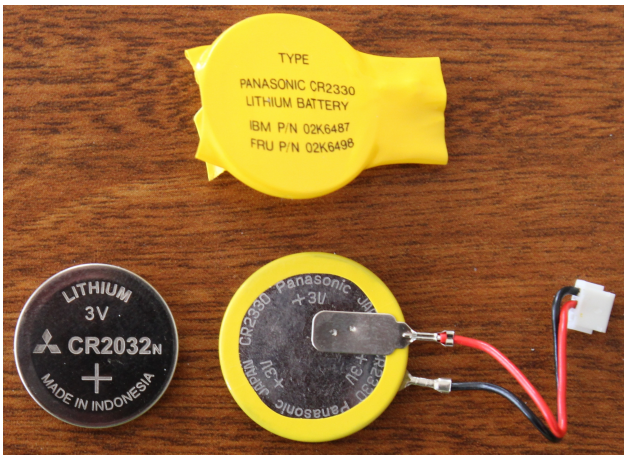
If CMOS battery discharges, error message appears

Then, BIOS urges to input date & time

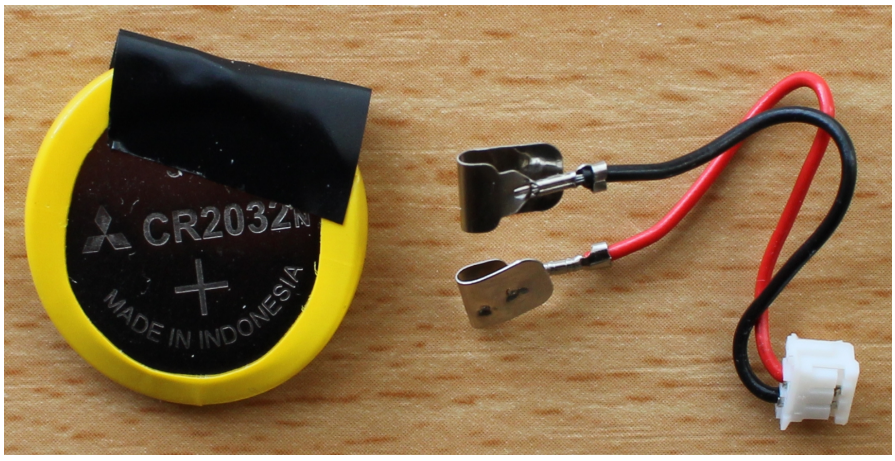
Rear view (Main battery already removed)



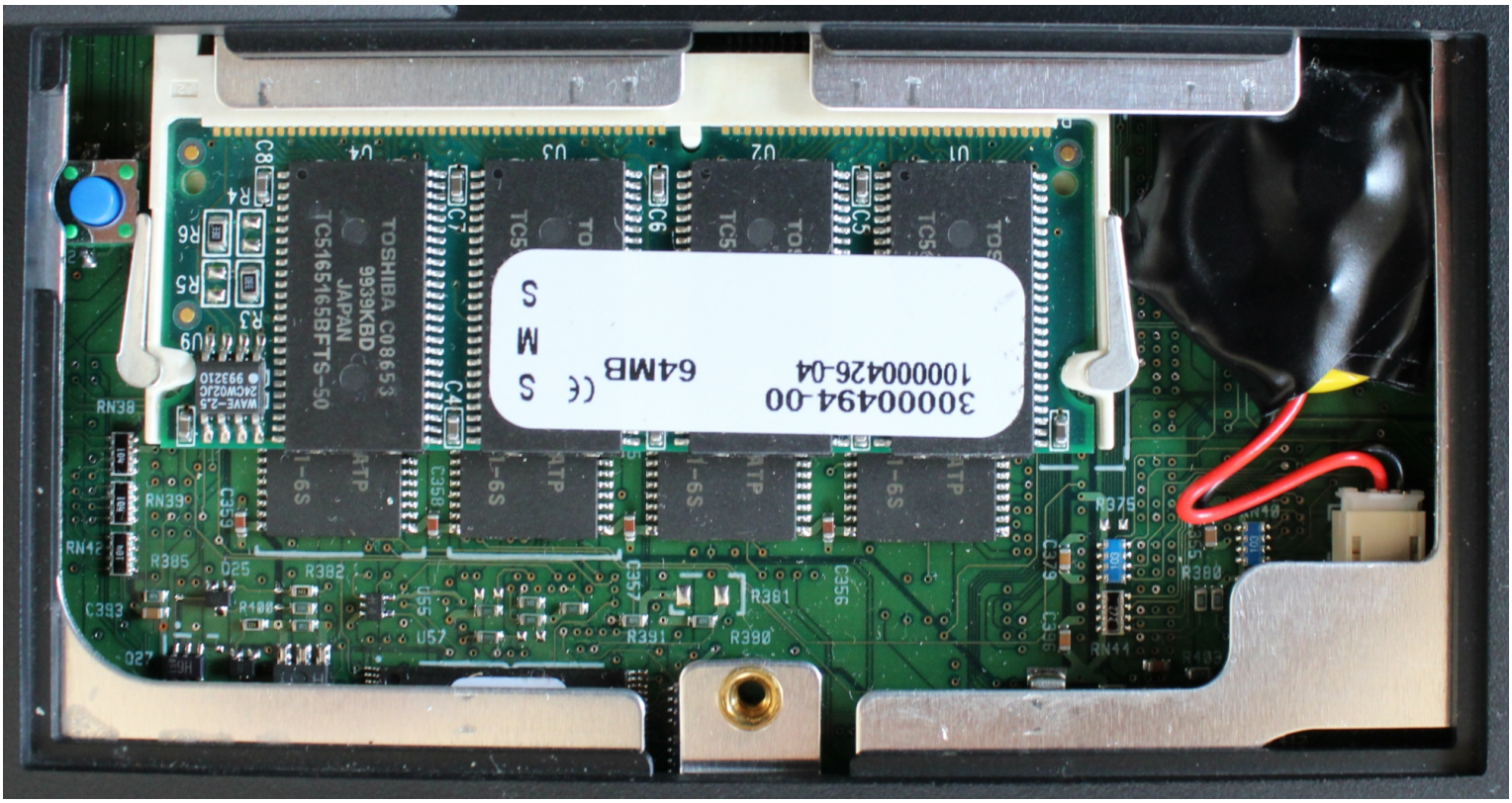
Remove upper left lid. CMOS battery appears (yellow one)



New (CR2032) & Old (CR2330)
"To Mitsubishi with Love..."



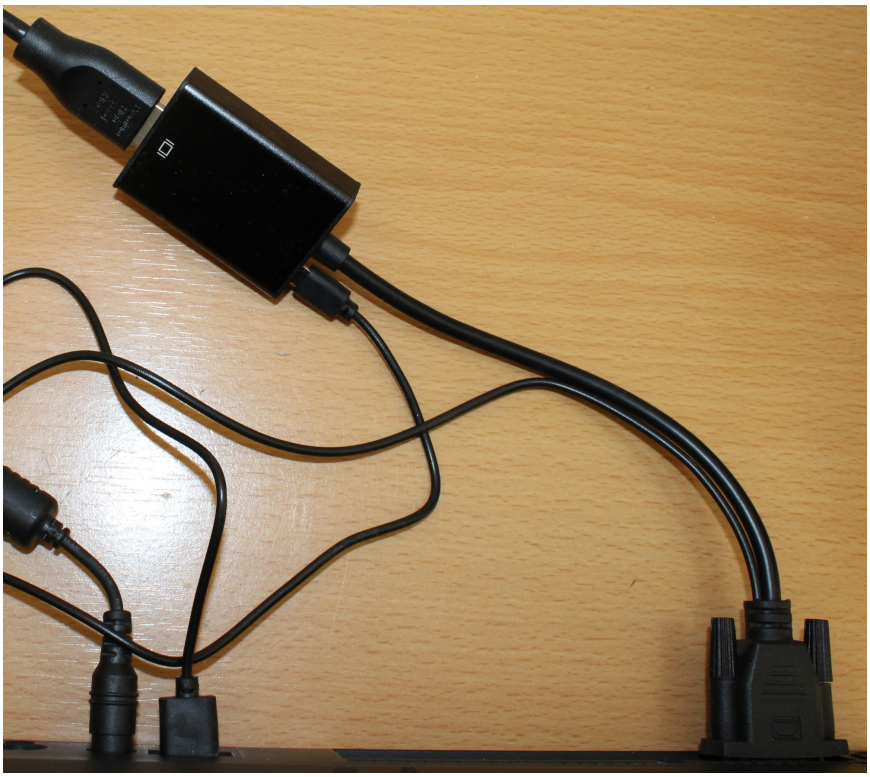
Utilize original yellow edge cover and tab connector assembly



Replaced (next to 96MB (32MB on board + 64MB in expansion slot) main memory)

(Appendix–2) VGA to HDMI Adapter with Audio

VGA connector does not have pins for audio signals.
When connecting to HDMI through VGA, audio signals must be combined using this sort of adapter now available.



VGA to HDMI with Audio Adapter from IBM ThinkPad 380XD VGA to monitor TV HDMI input

IBM ThinkPad 380XD VGA connector > “VGA to HDMI adapter” > LCD monitor TV (Resolution: 800 x 600 SVGA)

Downloadable Files