

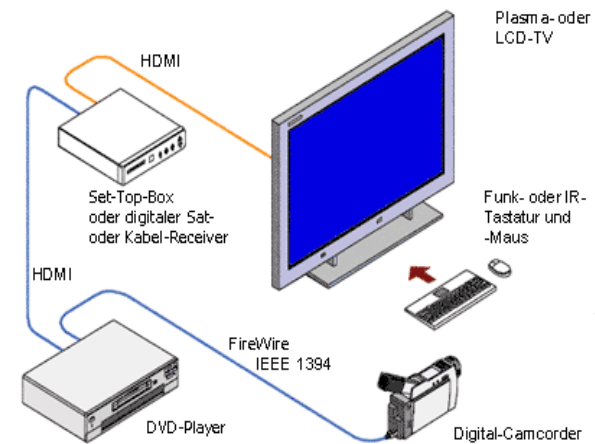
USB 3.1 / HDMI 2.0 / MHL 3.0 / SATA 3.2規範說明

研討會主題

- 一、 HDMI 2.0 線材應用與測試說明
- 二、 MHL 3.0 線材應用與測試說明
- 三、 USB 3.1 線材應用與測試說明
- 四、 SATA 3.2 線材應用與測試說明

HDMI 2.0 線材應用與測試說明

- 一、 HDMI 2.0 特性簡介
- 二、 HDMI 2.0 的傳輸架構
- 三、 HDMI 2.0 的線材與連接器
- 四、 HDMI 2.0 線材高頻量測



HDMI 2.0 特性簡介

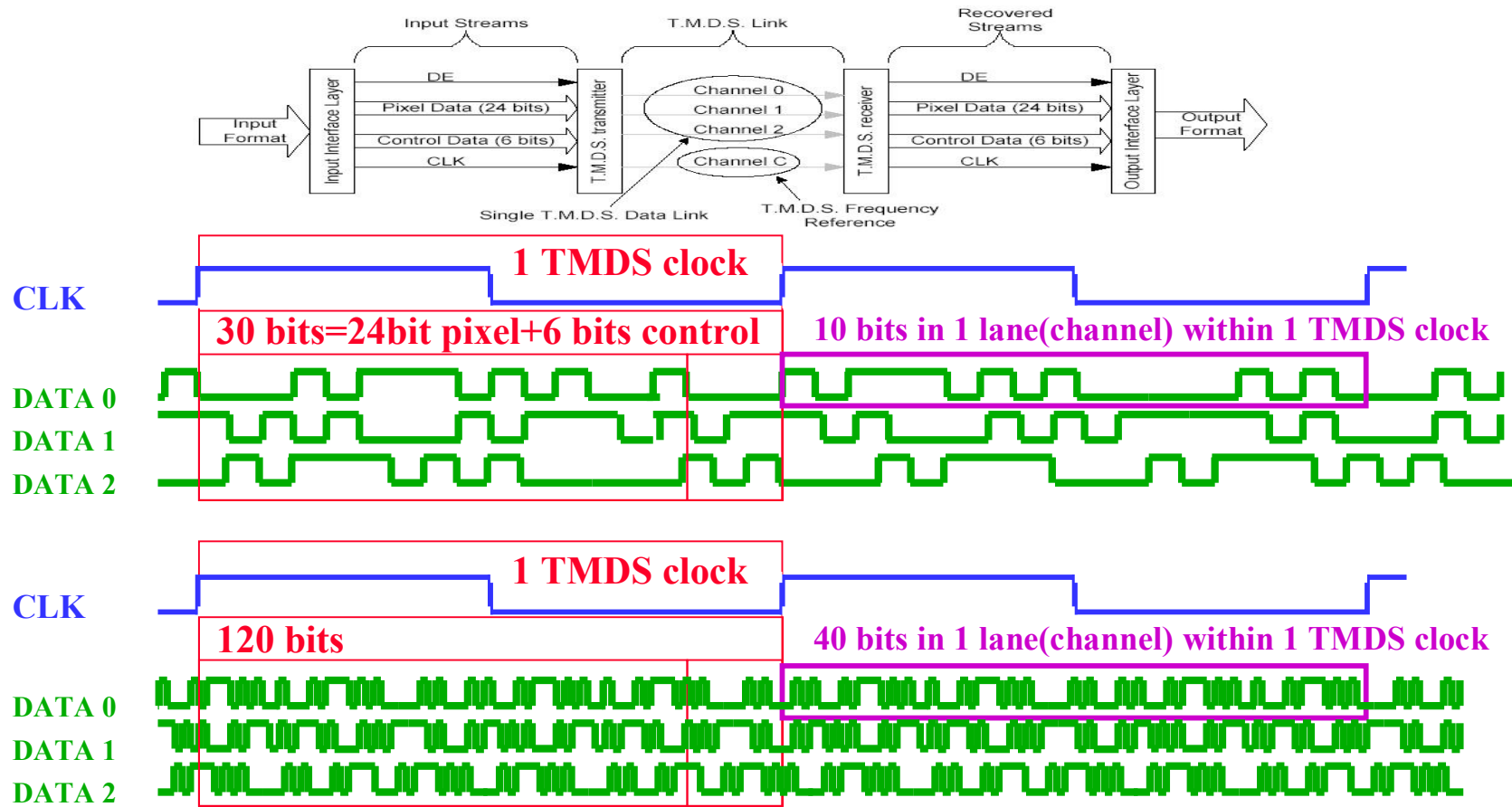
HDMI 2.0 特色如下：

1. 單通道3.4Gbps(10.2Gbps/cable)提升到6Gbps(18Gbps/cable)
2. 支持 4K (Ultra HD, 超高解析度) 顯示，支援2160p,60Hz,24bit
1080p,60Hz,24bit = 148.5MHz pixel rate
2160p,60Hz,24bit = 4*1080p=594MHz pixel rate
3. 支援雙顯示可同步傳送雙視訊串流給多使用者
4. 21:9 長寬比顯示
5. 提升最高音訊通道為32 個
6. 提升最高的音頻取樣率為1536KHz
7. 支援多串流音訊給多使用者
8. 動態自動對嘴同步
9. CEC 功能擴充使人機互動更完善、支援

故本次升級，線材及連接器規格同HDMI 1.4的CAT 2等級,即針對線材及連接器不需要改變舊有規格。但必須2 端都要使用HDMI 2.0規格的終端設備才能實現，最大6Gbps 的傳輸頻寬

HDMI 2.0 線材應用與測試說明

TMDS 的傳輸架構：TMDS Clock 與 Pixel Rate

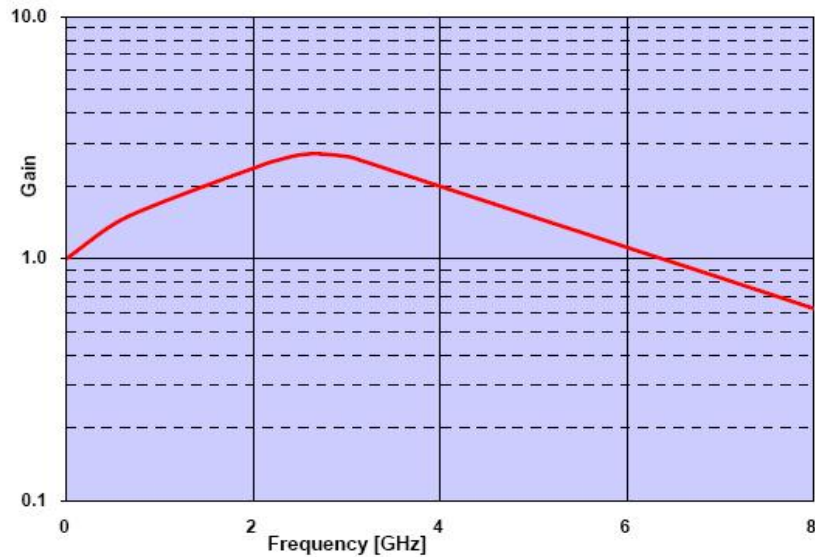


TMDS Character rate < 340 MHz:維持 HDMI 1.4之傳輸條件，TMDS Clock= TMDS Character rate

TMDS Character rate >=340 MHz:時，新做法 TMDS Clock= Character rate/4，而bit rate仍=10* Character rate

HDMI 2.0 線材應用與測試說明

EQ for 1.65G ~ 3.4Gbps



EQ for 3.4G ~ 6Gbps

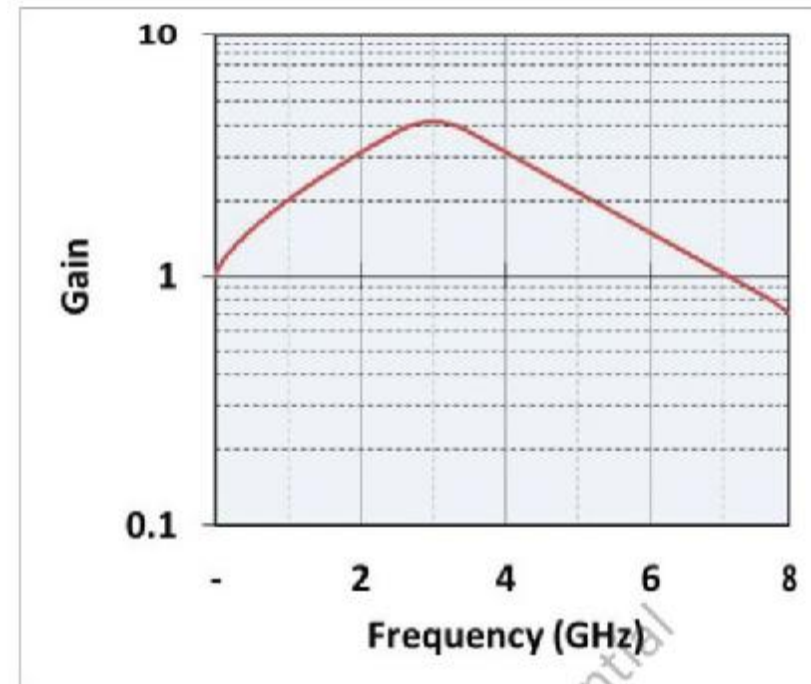


Figure 6-2: Reference Cable Equalizer for 3.4 Gbps ~ 6.0 Gbps

6.1.1.1 TMDS Overview

The operation of the TMDS link at TMDS Bit Rates ranging from 3.4 Gbps to 6.0 Gbps is similar to that described by HDMI 1.4b. Test points TP1 and TP2 are system reference points for specifications and measurements and are connected by an HDMI Cable.

Specifications for TP1 and TP2 are provided in the following sections. An Eye Diagram is provided for TP2 only.

The Cable shall meet the Category 2 specifications defined in HDMI 1.4b.

HDMI 2.0 線材的高頻量測



線材量測參數注意事項：

線材使用HDMI 1.4 cat 2 線材

HDMI 2.0 規格表

Max test freq. for NA test **~5.1 GHz**

Min risetime for TDR test **Tr = 200ps(10-90%)**

MHL 3.0 線材應用與測試說明

- 一、MHL 3.0 特性簡介
- 二、MHL 3.0 的傳輸架構
- 三、MHL 3.0 的線材與連接器
- 四、MHL 3.0 線材高頻量測

MHL directly



MHL with dongle

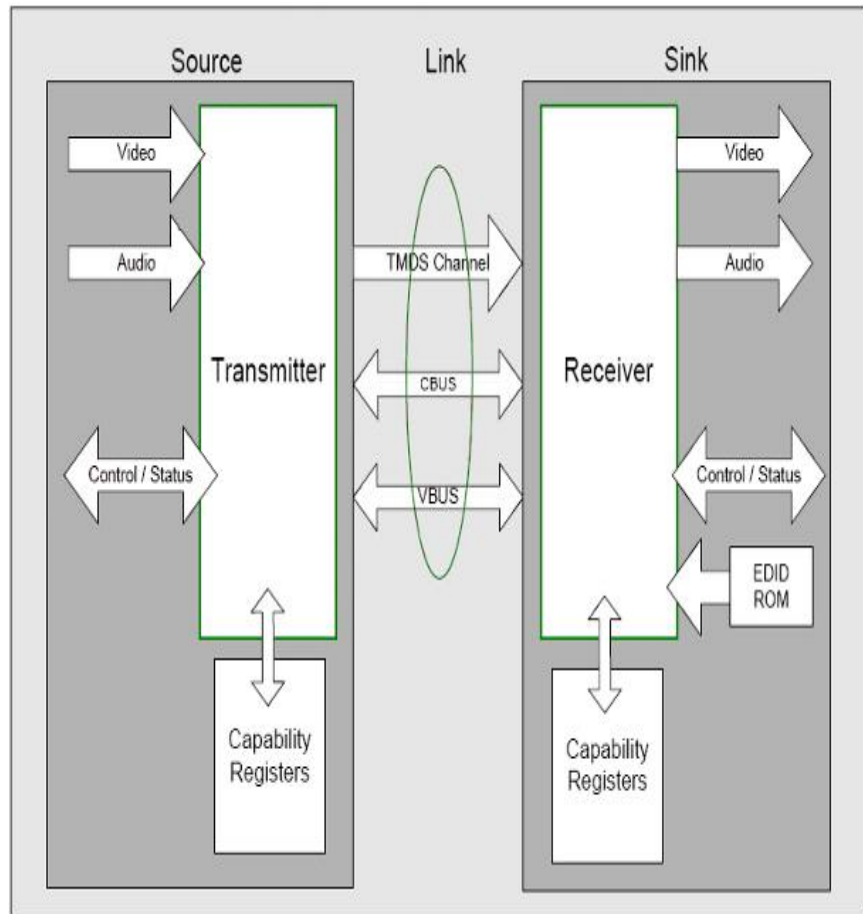
MHL 3.0 特性簡介

MHL 3.0 新規格的主要特點如下：

1. 支持4K（UHD，超高解析度）顯示，支援**2160p,30Hz (2K x 4K) (3Gbps→6Gbps)**
2. 提升音頻系統，支持Dolby TrueHD 和 DTS-HD，使環繞音效更為突出
3. **提升充電速度，最高達10瓦(5V, 2A)**，以因應行動裝置耗電量增大的需求。
4. **支持高速同步資料傳輸，可傳輸最高750Mbps的資料頻寬**，並支持雙向傳輸。
5. 提升遙控技術規格，**不局限於傳統的遙控器的控制**，以因應多種互動操作的方便性
6. 新增支援多種周邊設備：
包括**觸控螢幕、鍵盤、滑鼠等**
7. 保持向下相容：
MHL 3.0向下相容 MHL 1.0 和 MHL 2.0 規格
8. 支持最新版本的高頻寬數位內容保護協議 **HDCP 2.2**
9. 支持多屏顯示：
可應用於雙3D顯示、同步多屏及子母畫面的使用
10. **不限定連接器：**
MHL 3.0維持和MHL 1.0及MHL 2.0一樣不限定連接器的要求，源端可以使用5 pin 以上的各種連接器，**例如採用業界常用的USB 2.0 micro B 5-pin 連接器，但將無法使用 eCBUS-D的傳輸功能**，或採其他7pin以上連接器，以使用MHL 3.0的所有傳輸功能。



MHL 3.0 的傳輸架構



MHL 1.0~2.1 的影像傳輸最大傳輸 3Gbps，但在CBUS上，只有CEC、DDC 等低速資料傳輸

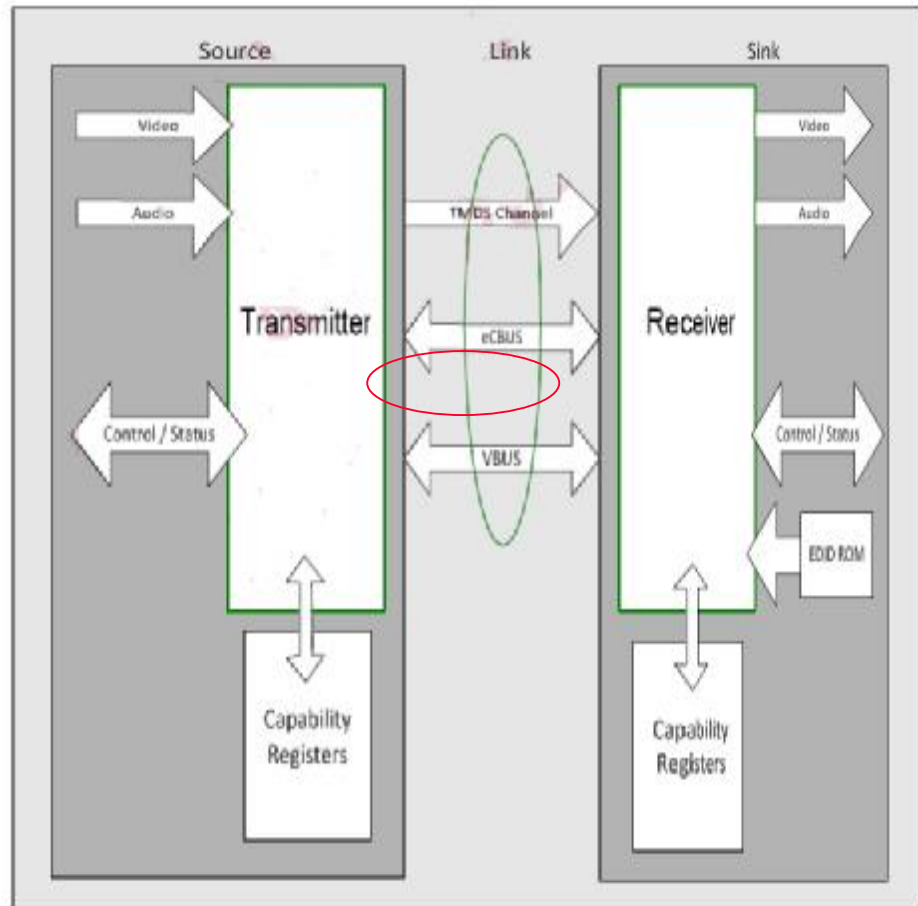
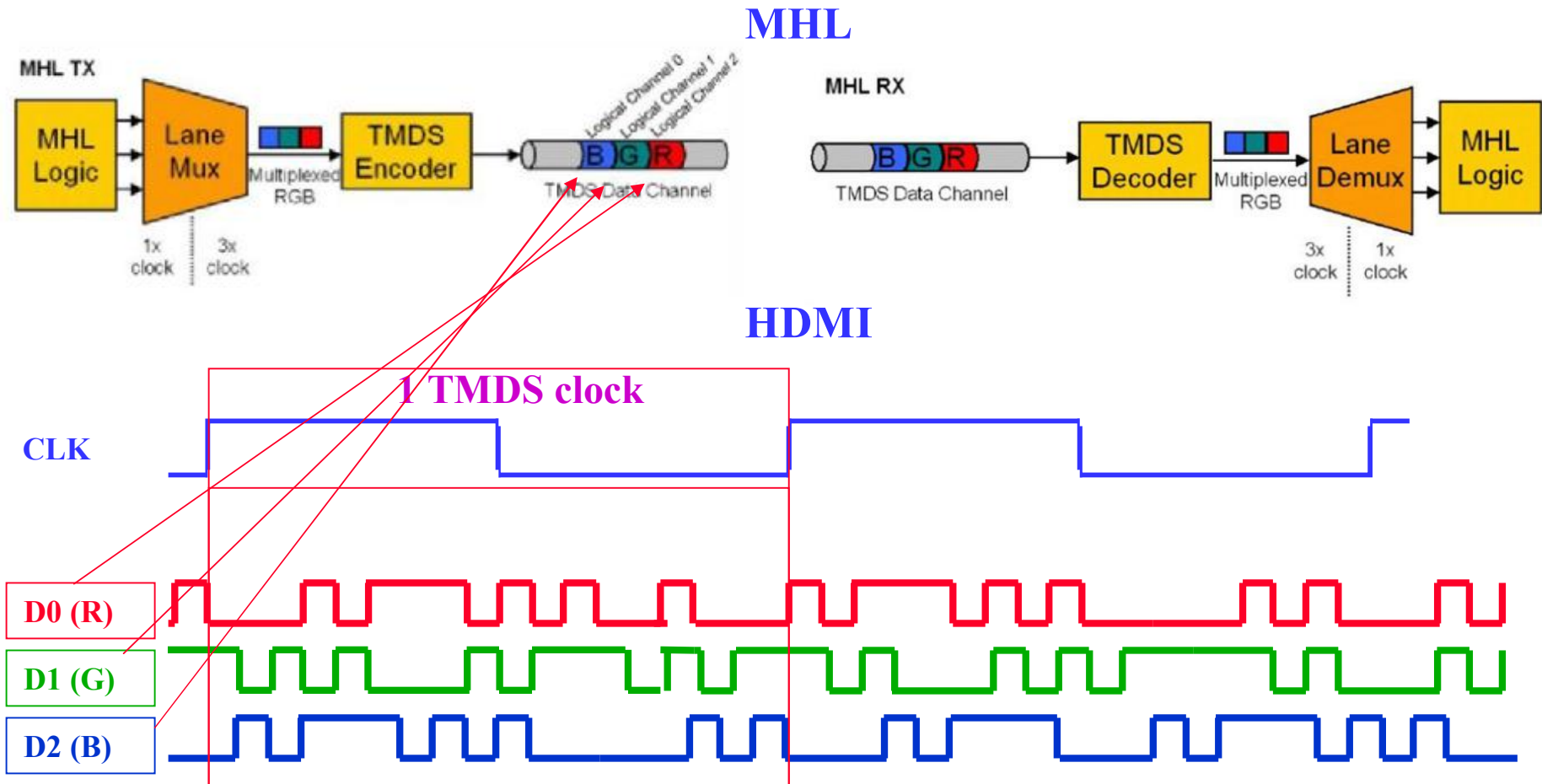


Figure 3-1. MHL Source and Sink Block Diagram

MHL 3.0的影像傳輸最大可達6Gbps，在 eCBUS上資料傳輸最大可達750 Mbps

MHL 3.0 的傳輸架構

MHL 的TMDS傳輸架構 vs. HDMI TMDS



MHL 的版本

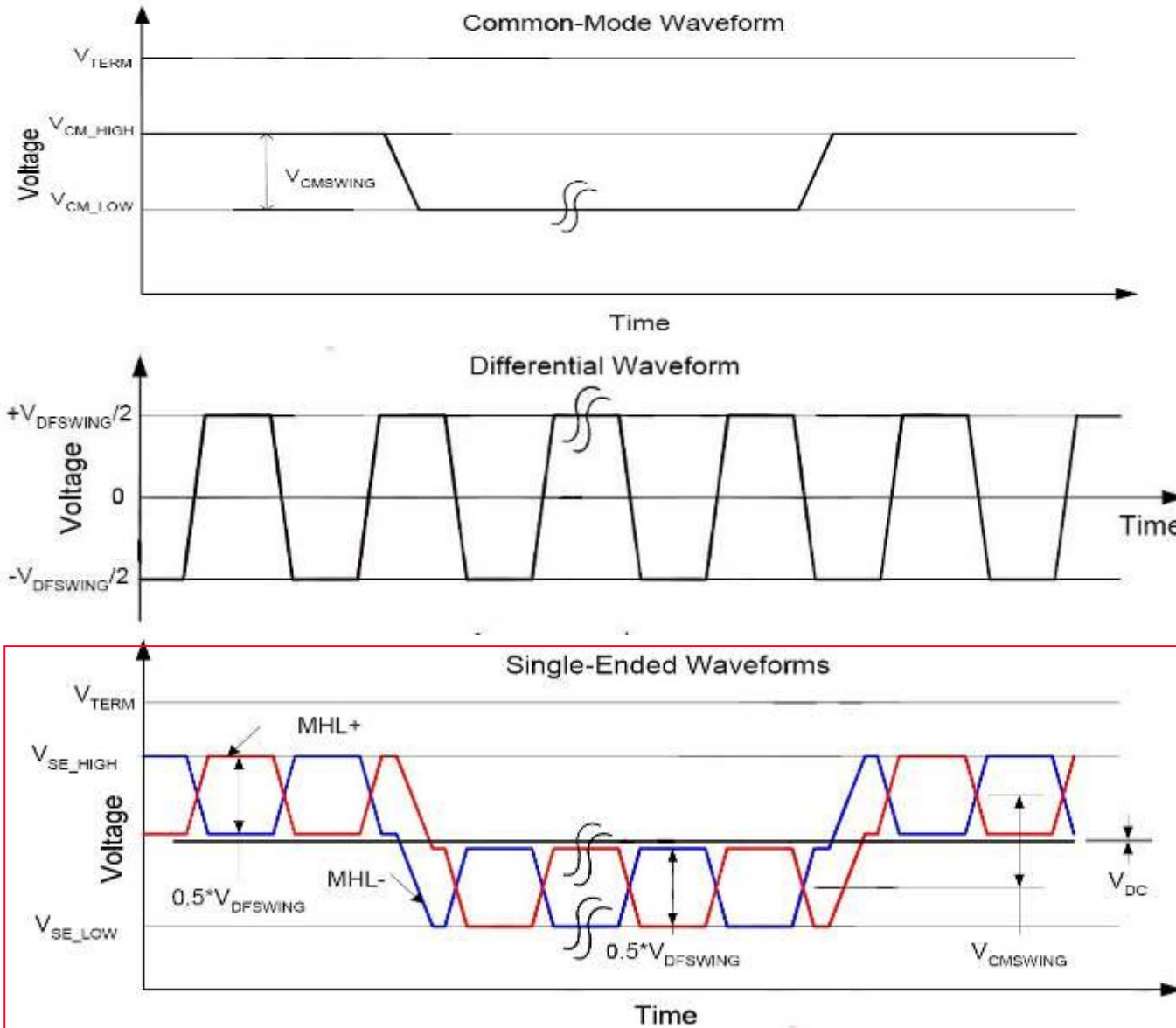
MHL 的傳輸架構--MHL 支援的最高傳輸速度及顯示條件

MHL 1.0/ MHL 1.1				
1080i	60Hz	24 bit	Bit rate Max 3 Gbps	
1080p	60Hz	16 bit		
MHL 2.0/ MHL 2.1				
1080i	60Hz	24 bit	Bit rate Max 3 Gbps	
1080p	60Hz	16 bit		
MHL 3.0				
1080i	60Hz	24 bit	Bit rate Max 6 Gbps eCBUS-S 75 Mbps eCBUS-D 750Mbps	
1080p	60Hz	16 bit		
2680p	30Hz	16 bit		

HDMI 2160p,60Hz,24bit = 4*1080p=594MHz pixel rate

MHL 2160p,30Hz,16bit =594/2*(16/24)=198MHz pixel rate→198x3(RGB)=594MHz

MHL 1 及 MHL 2 的傳輸架構



MHL Clock signal
Common Mode



MHL Data signal
Differential Mode



MHL1/2 pair signal

MHL 3.0 的傳輸架構

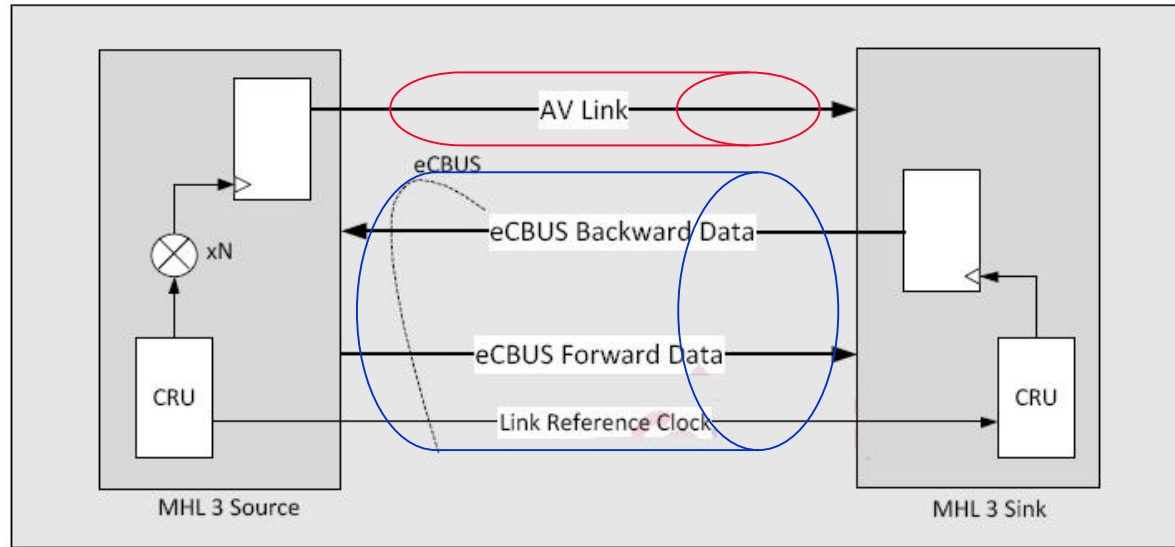


Figure 4-12. MHL 3 Link Reference Clocking Scheme

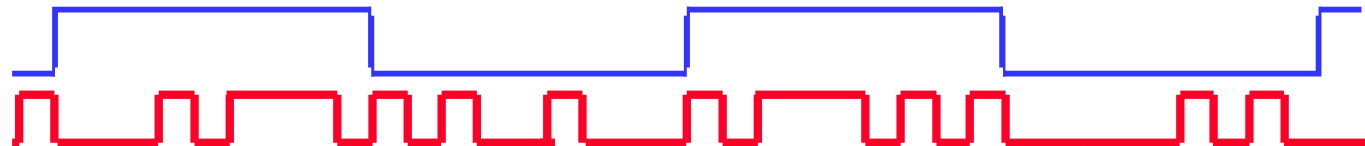
Table 4-6. eCBUS Operation Mode

Mode	Frequency of Link Reference Clock	Raw Bit Rate (One Direction)
eCBUS-S	$F_{SE_MHL_CLK}$	75 Mbps
eCBUS-D	$F_{DF_MHL_CLK}$	750 Mbps

Link Reference Clock	AV Link Speed	N
$F_{SE_MHL_CLK}$	1.5Gbps	20
	3.0Gbps	40
	6.0Gbps	80
$F_{DF_MHL_CLK}$	1.5Gbps	10
	3.0Gbps	20
	6.0Gbps	40

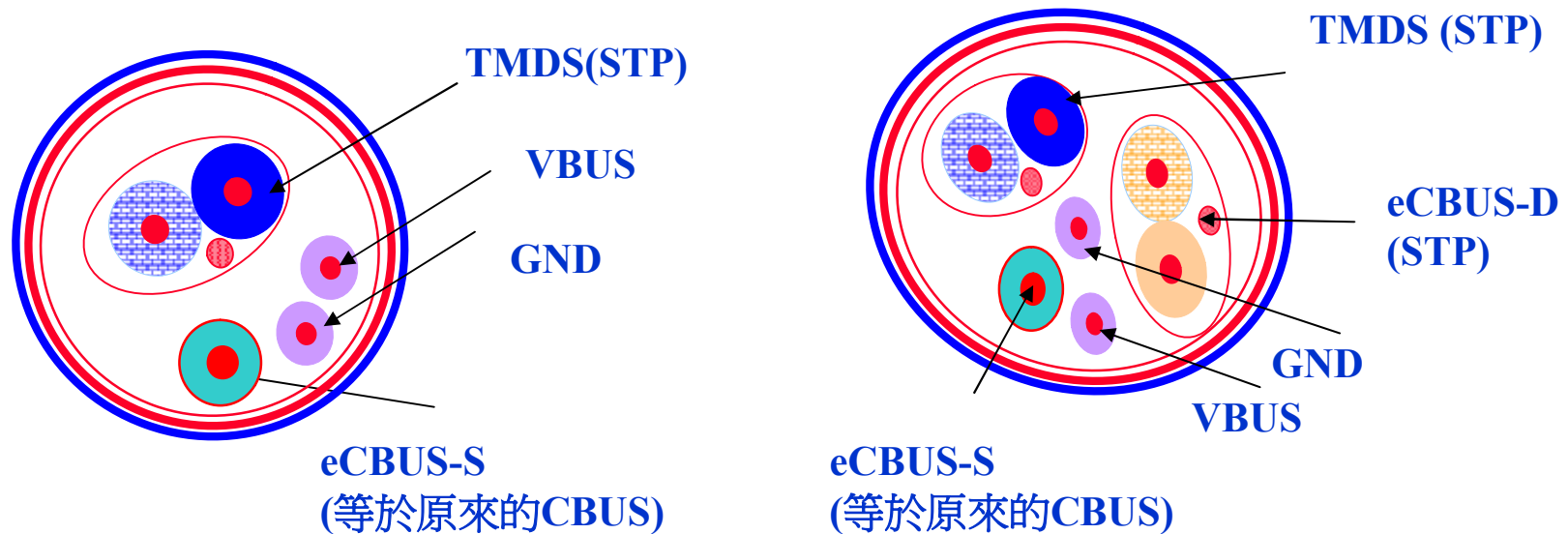
Link ref. Clock @ eCBUS

AV Link Data @ TMDS



MHL 3.0 的線材及連接器介紹

MHL3.0 裸線結構：參考結構—非規範要求



不具 eCBUS-D通道之裸線材結構：

1對遮蔽差分對

1對電源線

1條獨立遮蔽的eCBUS訊號線

具 eCBUS-D通道之裸線材結構：

2對遮蔽差分對

1對電源線

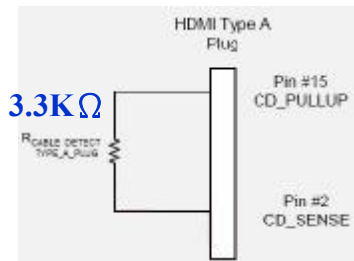
1條獨立遮蔽的eCBUS訊號線

MHL 3.0 的線材及連接器介紹

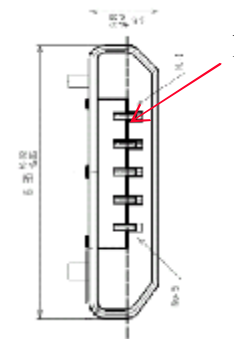
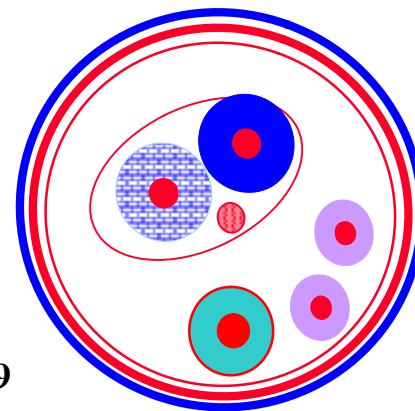
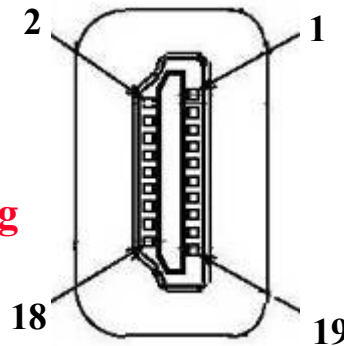
MHL連接器：micro USB B 公頭— HDMI Type A 公頭

HDMI A pin #	HDMI Name	MHL 3.0 Name
2	TMDS Data2 Shield	CD_Sense
5	TMDS Data1 Shield	TMDS_GND
7	TMDS Data0+	TMDS+
8	TMDS Data0 Shield	TMDS_Shield
9	TMDS Data0-	TMDS-
11	TMDS Clock Shield	TMDS_Shield
15	SCL	CD_Pullup
17	DDC/CEC Ground	VBUS_CBUS_GND
18	+5V Power	VBUS
19	Hot Plug Detect	CBUS/eCBUS-S
Shell	Shield	Shield

MHL 3.0 Signals	USB Name	USB 2.0 μ B pin #
VBUS	VBUS	1
TMDS-	D-	2
TMDS+	D+	3
CBUS/eCBUS-S	ID	4
GND	GND	5
Shield	shield	shield



HDMI type A Plug



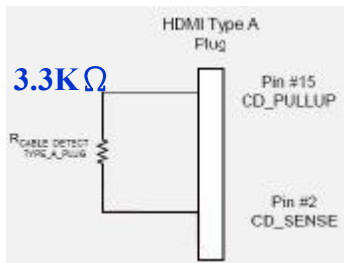
USB 2.0 μ Plug

MHL 3.0 的線材及連接器介紹

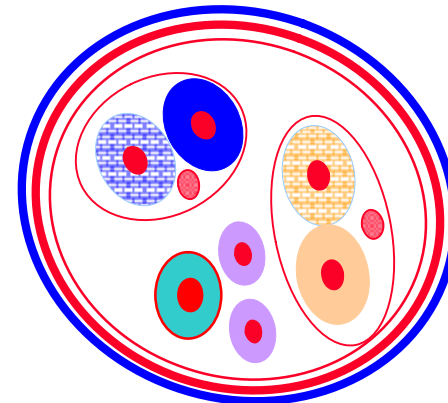
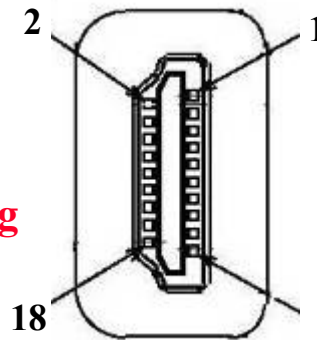
MHL連接器：micro USB B 公頭— HDMI Type A 公頭

HDMI A pin #	HDMI Name	MHL 3.0 Name
2	TMDS Data2 Shield	CD_Sense
5	TMDS Data1 Shield	TMDS_GND
7	TMDS Data0+	TMDS+
8	TMDS Data0 Shield	TMDS_Shield
9	TMDS Data0-	TMDS-
10	TMDS Clock+	eCBUS-D+
11	TMDS Clock Shield	TMDS_eCBUS_Shield
12	TMDS Clock-	eCBUS-D-
15	SCL	CD_Pullup
17	DDC/CEC Ground	VBUS_CBUS_GND
18	+5V Power	VBUS
19	Hot Plug Detect	CBUS/eCBUS-S
Shell	Shield	Shield

MHL 3.0 Name	自訂接頭	自訂接頭
TMDS+		
TMDS-		
eCBUS-D+		
eCBUS-D-		
VBUS		
CBUS/eCBUS-S		
Shield		



HDMI type A Plug



廠商自訂義
接頭

MHL的量測

線量測參數注意事項：

- MHL 2.1後針對線長不同，阻抗規格不同
- FEXT 遠端串音，為pin對pin的單端串音
- NEXT 近端串音，有pin對pin的單端串音 及 差分對單端串音



MHL 3.0 規格表 with eCBUS-D

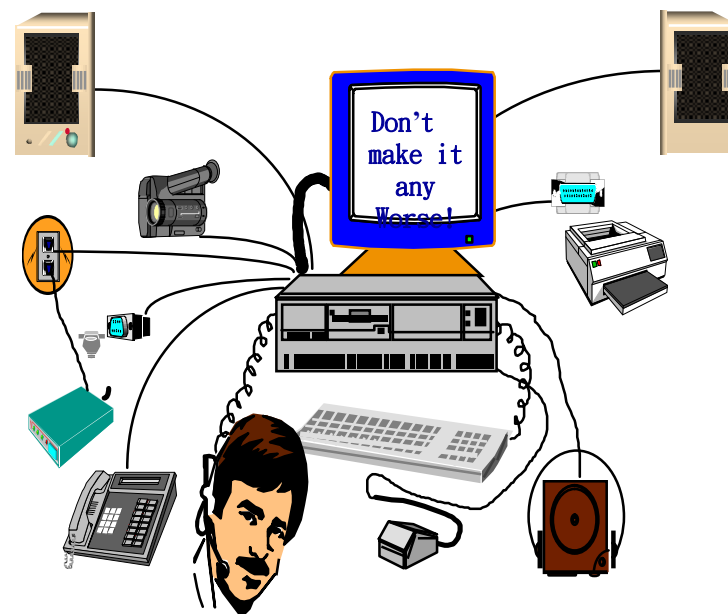
MHL 3.0 規格表 without eCBUS-D

Max test freq. for NA test **~5.1 GHz**

Min risetime for TDR test **Tr = 200ps(20 80%)**

USB3.1 線材應用與測試說明

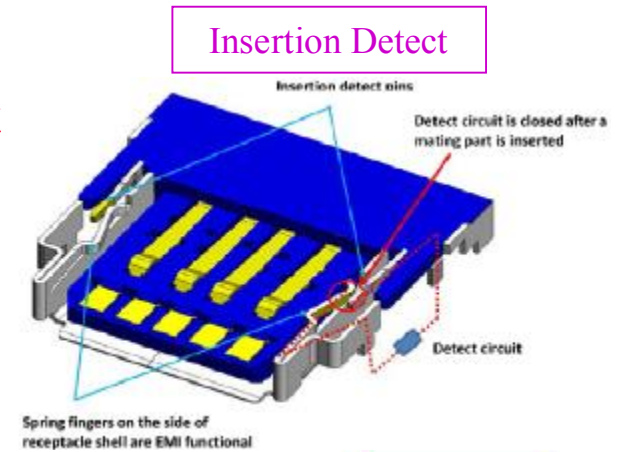
- 一、USB3.1 特性簡介
- 二、USB3.1的傳輸架構
- 三、USB3.1的線材與連接器
- 四、USB3.1線材高頻量測



USB3.1 特性簡介

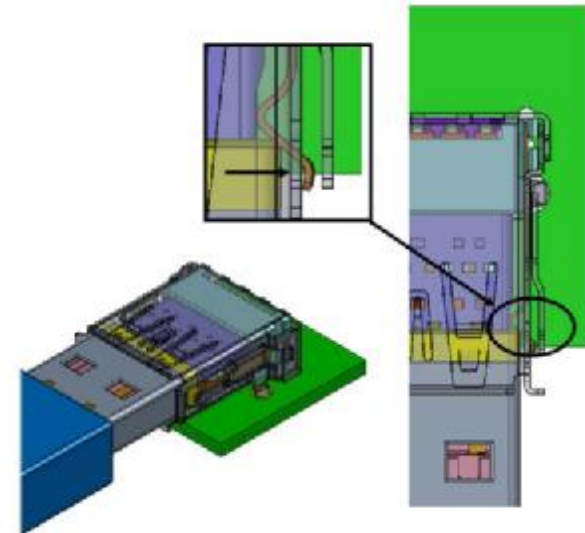
USB 3.1特色如下：

1. 新增「SuperSpeed Plus」傳輸模式，大幅提升介面傳輸速度達10 Gbps。
2. 改進編碼提高 data rate: 8bit/10bit → 128b/132bit
3. 接頭向下相容
4. 向下相容現有USB裝置的驅動及應用軟體。
5. 提高最大供電量：
10W(5V@2A) → 100W(20V@5A)



參考規範：

1. USB 3.1 Specification rev. 1.0
2. USB Power Delivery Specification



USB 的版本

USB 的傳輸架構--USB 支援的傳輸速度



USB 1.0/ USB 1.1	Low-Speed	1.5	Mbps
	Full-Speed	12	Mbps



USB 2.0	Low-Speed	1.5	Mbps
	Full-Speed	12	Mbps
	High-Speed	480	Mbps

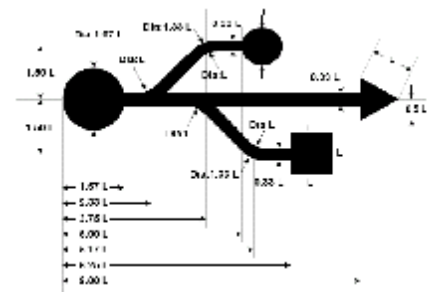


USB 3.0	Low-Speed	1.5	Mbps (LS)
	Full-Speed	12	Mbps (FS)
	High-Speed	480	Mbps (HS)
	SuperSpeed	5	Gbps (SS)

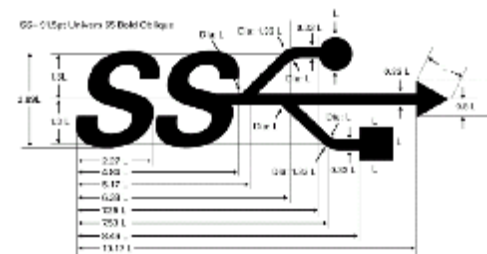


USB 3.1	Low-Speed	1.5	Mbps (LS)
	Full-Speed	12	Mbps (FS)
	High-Speed	480	Mbps (HS)
	SuperSpeed	5	Gbps (SS)
	SuperSpeed Plus	10	Gbps (SSP)

Enhanced SuperSpeed



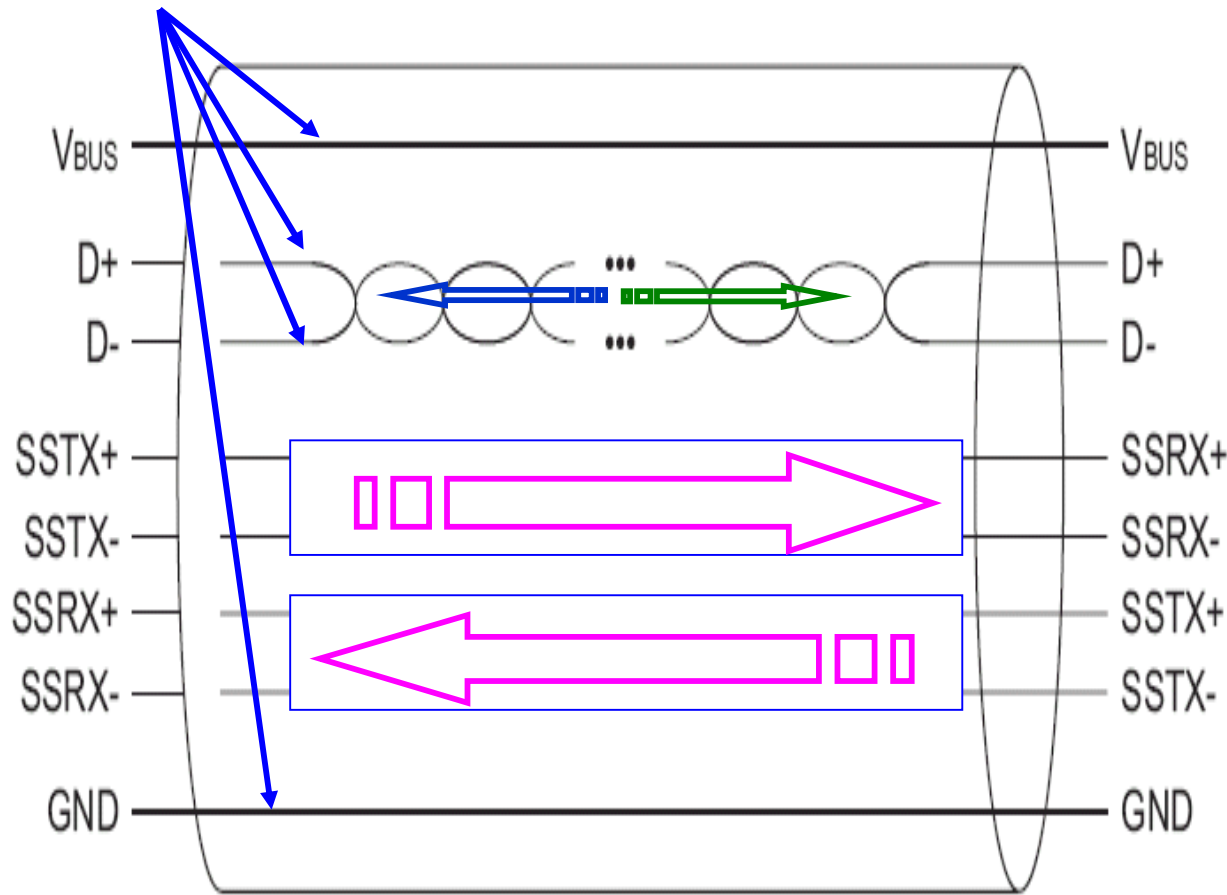
USB 1.1/2.0 LOGO



USB SuperSpeed LOGO

USB3.1 的傳輸架構

原USB 2.0線對，執行和原USB 2.0完全相同的傳輸

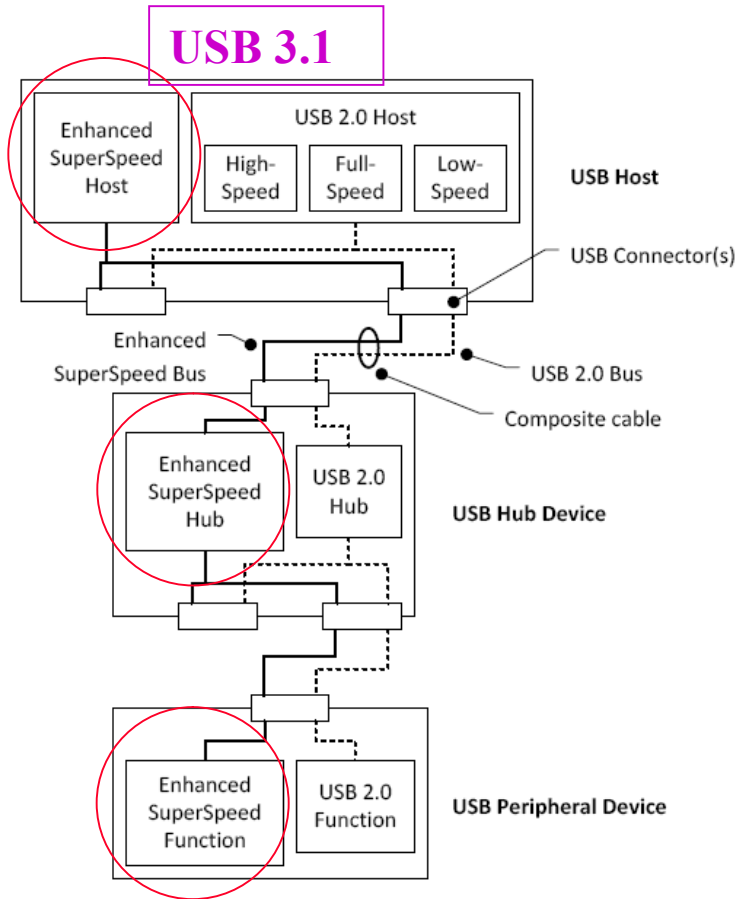


USB 2.0訊號傳輸對，
由1對UTP以半雙工傳輸
□ Low-Speed, Full-Speed,
High-Speed

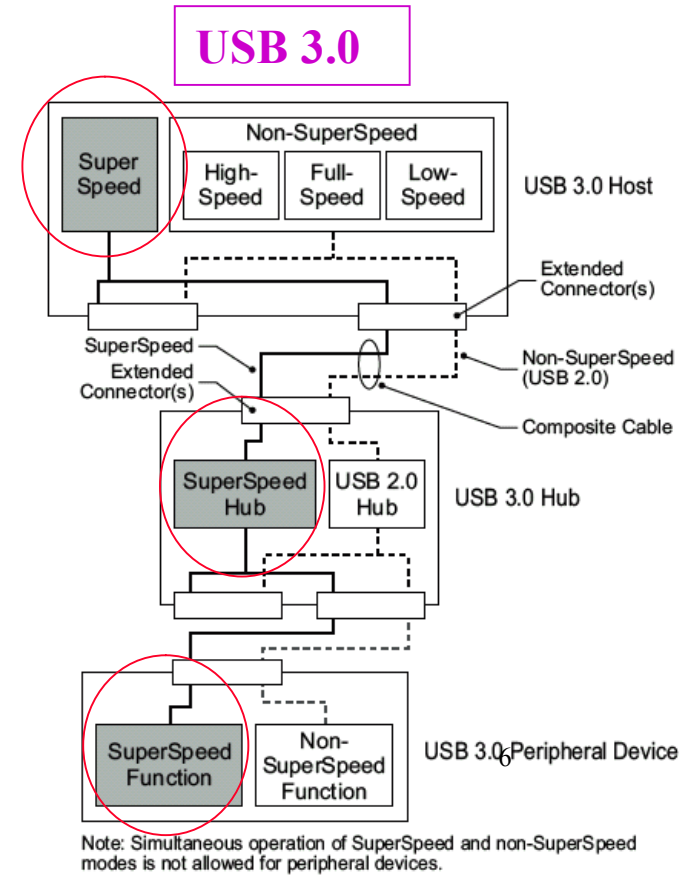
超高速傳輸對，由2對SDP
□ 各對為單工傳輸構成全雙
工傳輸
SuperSpeed, SuperSpeed Plus
(可為對絞線或同軸線)

USB3.1 的傳輸架構

傳輸架構 USB3.1 vs USB 3.0



Enhanced SuperSpeed
= SuperSpeed / SuperSpeed plus



USB 3.0裝置同時間只能傳送1種速度，主機端則可能同時傳送多種速度

USB 3.1 的線材及連接器介紹

USB3.1的線材結構:

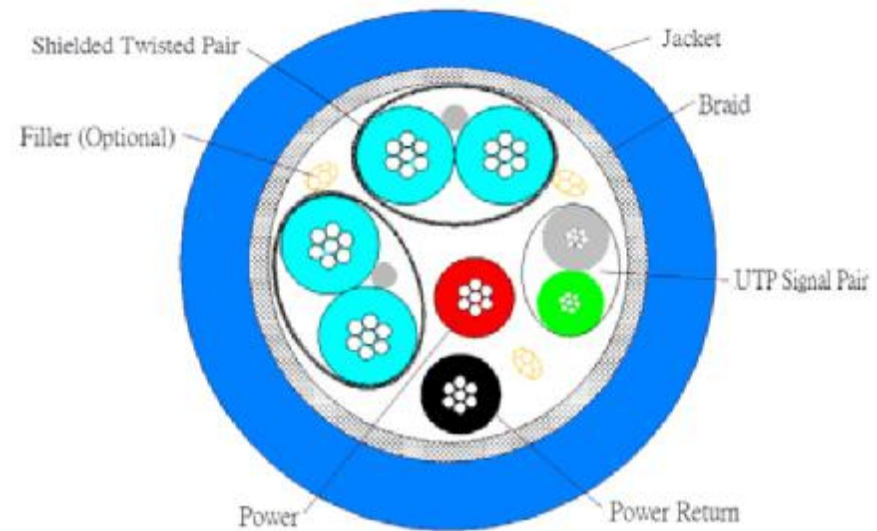
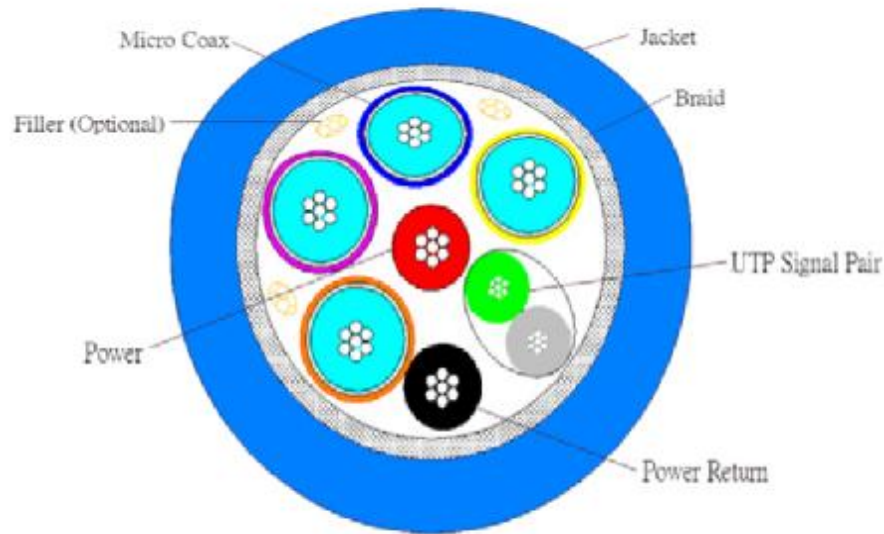


Table 5-7. Reference Wire Gauges

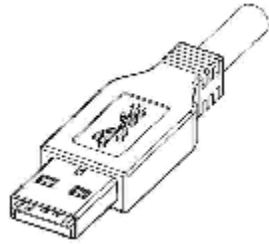
Wire Number	Signal Name	Wire Gauge (AWG)
1	PWR	20-28
2	D-	28-34
3	D+	28-34
4	GND_PWRrt	20-28
5	P1-	26-34
6	SP1+	26-34
7	P1_Drain	28-34
8	P2-	26-34
9	P2+	26-34
10	P2_Drain	28-34

Table 5-6. Cable Wire Assignments

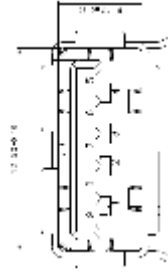
Wire Number	Signal Name	Description
1	PWR	Power
2	D-	Unshielded twist pair, negative
3	D+	Unshielded twist pair, positive
4	GND_PWRrt	Ground for power return
5	P1-	Shielded differential pair 1, negative
6	P1+	Shielded differential pair 1, positive
7	P1_Drain	Drain wire for SDP1
8	P2-	Shielded differential pair 2, negative
9	P2+	Shielded differential pair 2, positive
10	P2_Drain	Drain wire for SDP2
Braid	Shield	Cable external braid to be 360° terminated on to plug metal shell

USB 3.0 的線材及連接器介紹

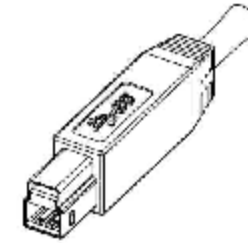
USB3.1連接器：Standard A to Standard B



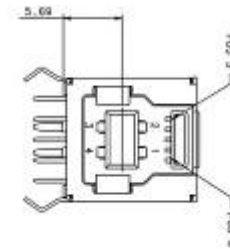
Std. A Plug



Std. A Receptacle



Std. B Plug



Std. B Receptacle

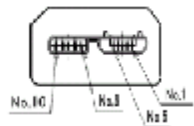
USB 3.0

USB 3.1

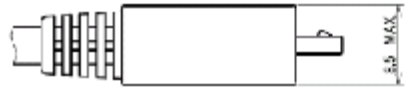
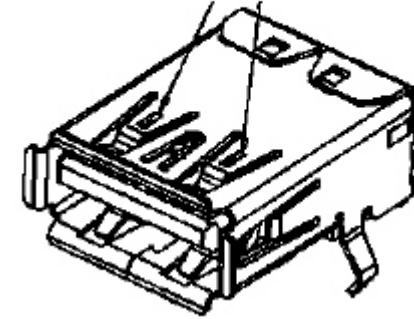
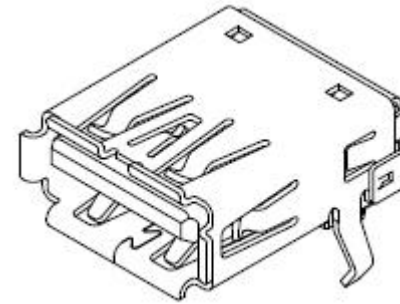
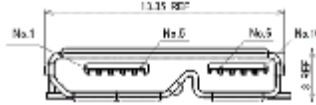
· GROUNDING SPRINGS (4X)
2 AS SHOWN - 2 ON BOTTOM



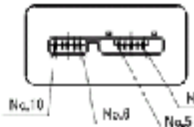
micro B Plug



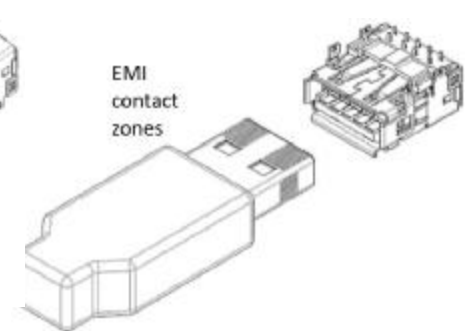
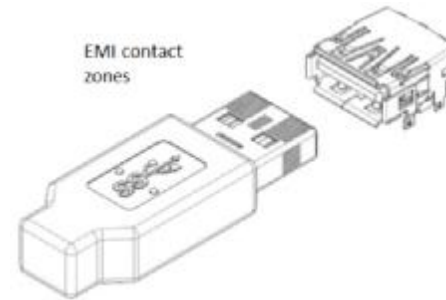
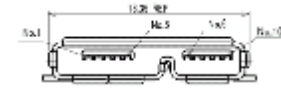
micro B Receptacle



micro A Plug

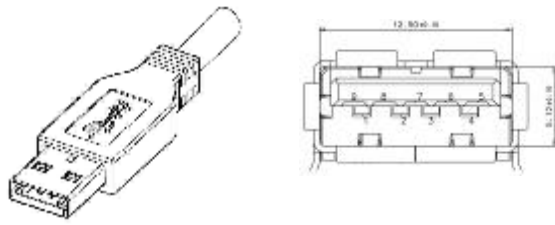


micro A/B Receptacle

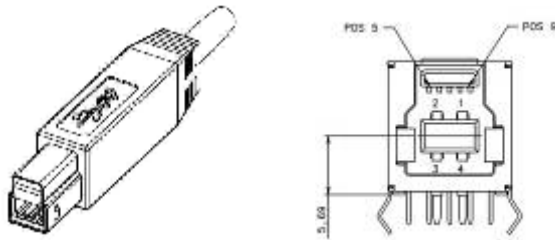


USB 3.1 的線材及連接器介紹

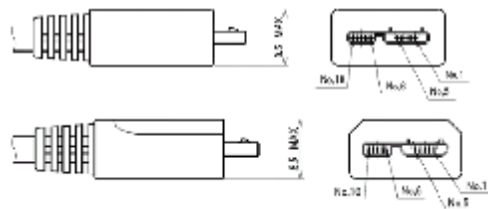
USB3.1標準成品線



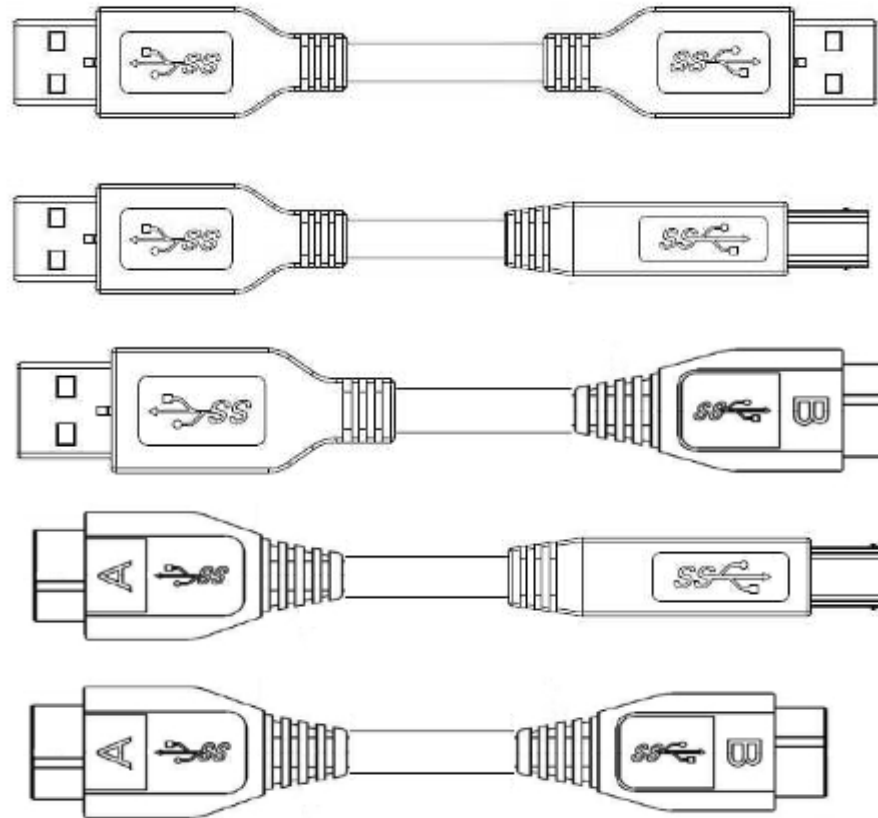
USB 3.1 A connector



USB 3.1 B connector



USB 3.1 micro connector



USB3.1 線材的高頻量測



線量測參數注意事項：

Channel Metrics 通道指標

Cable Shielding Effectiveness 線材遮蔽效應
(規格及測試方式待定)



USB 3.1 規格表



Max test freq. for NA test ~10 GHz

Min risetime for TDR test $T_r = 40\text{ps}(20-80\%)$

USB3.1 線材的高頻量測

Channel Metrics 通道指標

ILfitatNq (Insertion Loss fit at Nyquist frequency):
擬合插入損失在奈奎斯特頻率點的值，其中奈奎斯特頻率點在USB 3.1為5GHz。

$$ILfit(f) = a + b\sqrt{f} + cf + d\sqrt{f^3}$$

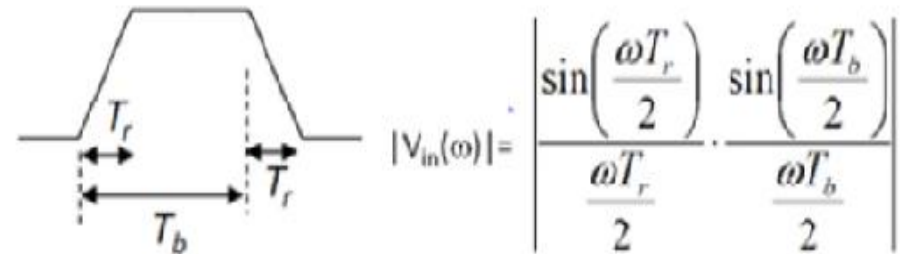
$$ILD(f) = IL(f) - ILfit(f)$$

IMR (Integrated Multi-Reflection):
整體的多重反射

$$IMR = \sqrt{\int_0^{f_{max}} |ILD(f)|^2 |V_{in}(f)|^2 df / f_{Nq}} * 1000 \text{ (in mV)},$$

IXT (Integrated XTalk):
整體的串音 (NEXT)

$$IXT = \sqrt{\int_0^{f_{max}} |NEXT(f)|^2 |V_{in}(f)|^2 df / f_{Nq}} * 1000 \text{ (in mV)},$$


$$|V_{in}(\omega)| = \left| \frac{\sin\left(\frac{\omega T_r}{2}\right)}{\frac{\omega T_r}{2}} \cdot \frac{\sin\left(\frac{\omega T_b}{2}\right)}{\frac{\omega T_b}{2}} \right|$$

$$T_b = \text{Unit Interval} = 100 \text{ ps}$$

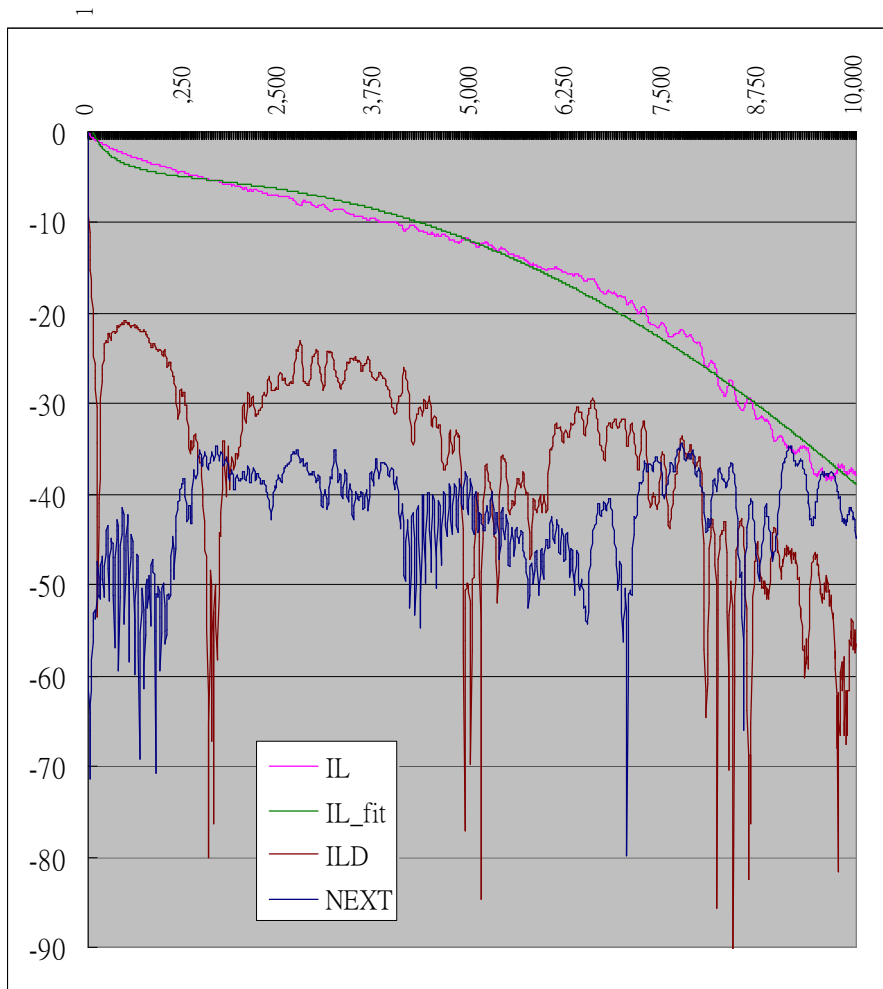
$$T_r = \text{Rise time (0-100\%)} = 0.2 T_b$$

$$\omega = 2\pi f$$

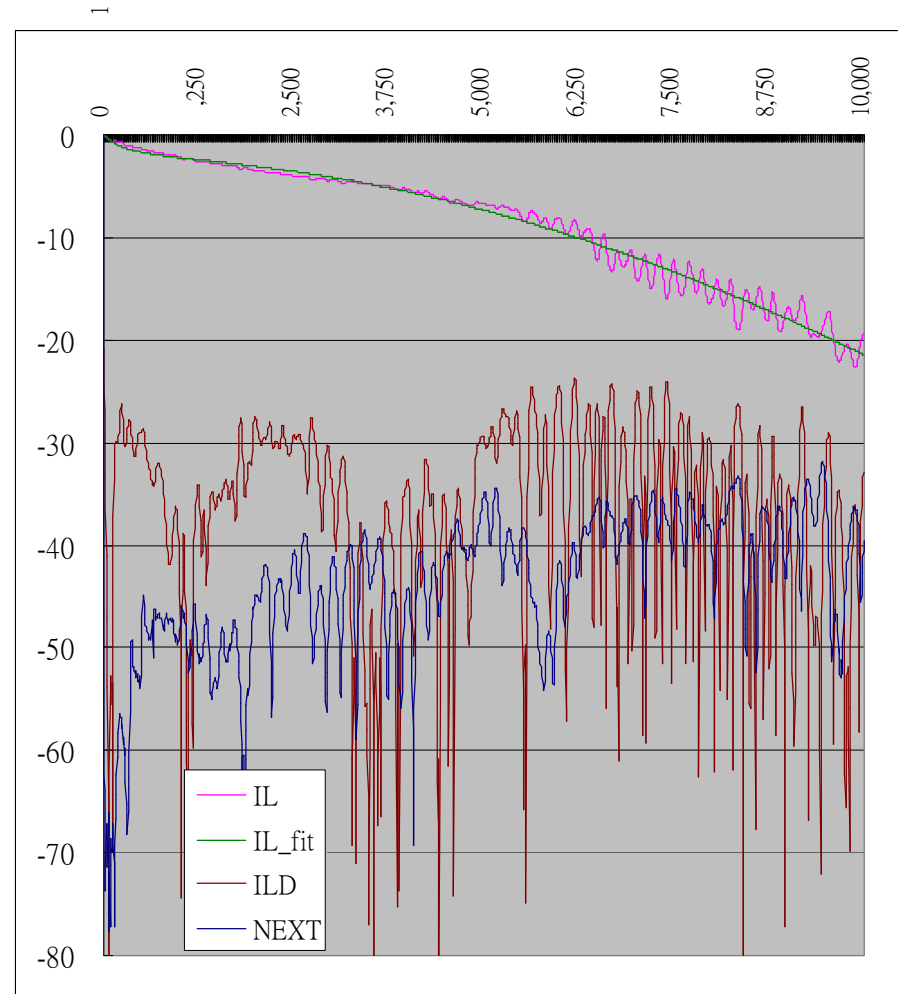
採用ILfitatNq、IMR、IXT等來評估通道特性，可以說是一種比較不會造成過嚴規格的方式。

USB3.1 線材的高頻量測

Channel Metrics 通道指標



IMR=50.99 / IXT= 9.6/ Ilfit@Nq= -12.07 dB



IMR=23.8 / IXT= 6.38 / Ilfit@Nq= -7.33 dB

USB3.1 線材的高頻量測

Cable Shielding Effectiveness 線材遮蔽效應

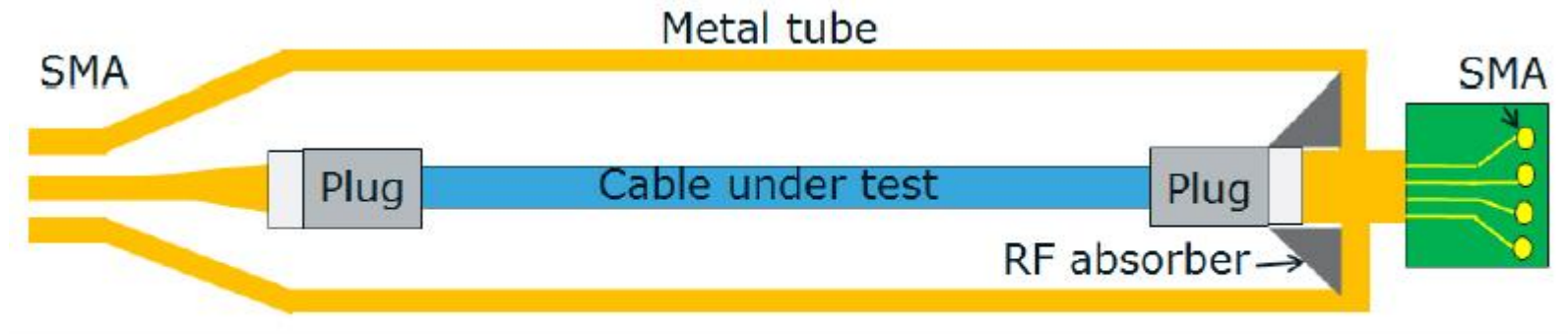


Figure 5-29. Set Up For Cable SE Measurement (subject to change)

(規格及測試方式待定)

SATA 3.2 線材應用與測試說明

- 一、SATA 3.2 特性簡介
- 二、SATA 3.2 的傳輸架構
- 三、SATA 3.2 的線材與連接器
- 四、SATA 3.2 線材高頻量測

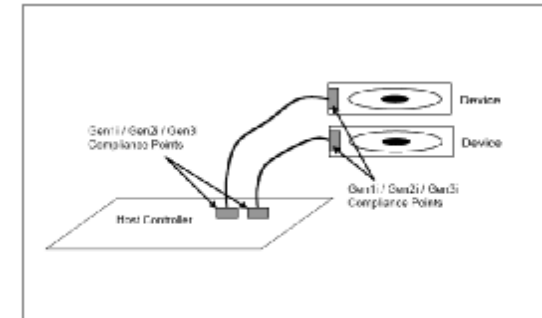


Figure 6 - Internal 1m cabled host to device application

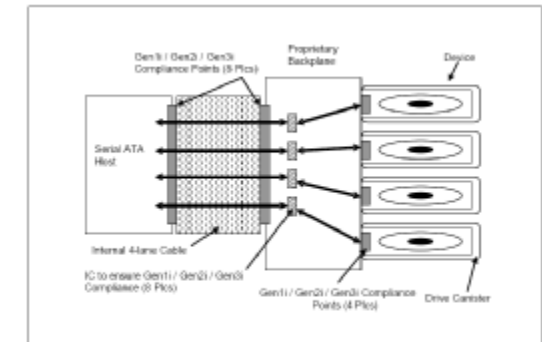


Figure 8 - Internal 4-lane cabled disk array

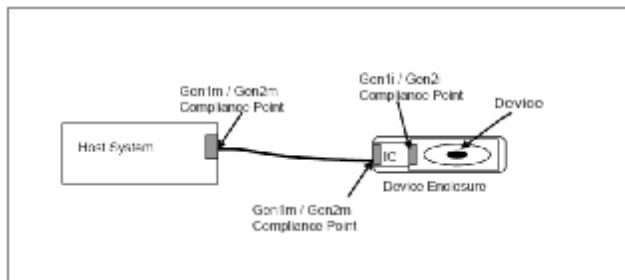


Figure 10 - External desktop application

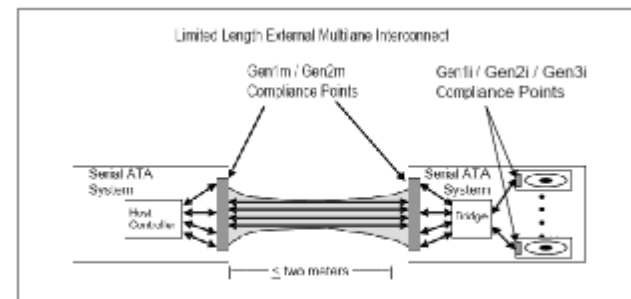


Figure 9 - System-to-system data center interconnects

SATA 3.2 特性簡介

Usage model descriptions

Characteristic	Usage model section number	Cable or backplane type	Cable length	Cable Electrical	Attenuation at 4.5 GHz	Host-side connector	Device-side connector	Hot plug support
Internal 1 m Cabled Host to Device	5.3.2	Int SL	<= 1 m	Table 36	-6 dB	6.2.5	6.2.3.1	NS
Short Backplane to Device	5.3.3	BP	-	P	P	P	6.2.3.1	R
Internal 4-lane Cabled Disk Arrays	5.3.5	Int ML	<= 1 m	Table 36	-6 dB	6.2.11 or 6.2.12	6.2.3.1	NS
System to System Interconnects – Data Center Applications xSATA	5.3.6	Ext ML	<= 2 m	Table 38	-8 dB	6.11.4 (key 7)	6.11.4 (key 7)	R
System to System Interconnects – External Desktop Applications eSATA	5.3.7	Ext SL	<= 2 m	Table 37	-8 dB	6.11	6.11	R
Proprietary Serial ATA Disk Arrays	5.3.8	BP and cable	-	Table 36	-6 dB	6.2.5 or P	6.2.3.1	R
Serial ATA and SAS	5.3.9	BP	-	P	P	SAS	6.2.3.1	R
LIF-SATA	5.3.11.6	P	P	Table 36	-6 dB	6.5.4	6.5.3	NS
mSATA	5.3.11.5	BP	-	P	P	6.6.3	6.6.4.1	NS
SATA USM	5.3.12	P	P	P	P	6.7.2	6.2.3.1	R
SATA MicroSSD	5.3.11.7	P	P	P	P	NS	NS	NS
Embedded M.2	5.3.11.8	BP	na	P	P	6.9.7	6.9.3	NS
Key: R = Required configuration requires appropriate capabilities NS = Not supported configuration is not supported by definition in specification P = Proprietary implementation is vendor specific and not defined in specification					SL = single lane ML = multi-lane Int = Internal Ext = External BP = Backplane			
NOTE - Many of the references in the table are section numbers or notations of clarification that do not require Key values.								

SATA 3.2 特性簡介

Table 2 – Usage model electrical requirements (part 1 of 2)

Characteristic	Gen1i 1.5 Gbps	Gen1m 1.5 Gbps	Gen1u 1.5 Gbps	Gen2i 3.0 Gbps	Gen2m 3.0 Gbps	Gen2u 3.0 Gbps	Gen3i 6.0 Gbps	Gen3u 6.0 Gbps
Internal 1 m cabled host to device	R	NS	NS	FS ^a	NS	NS	FS ^a	NS
Short backplane to device	D (host to provide received signal)	H	NS	D (host to provide received signal)	H	NS	NS	NS
Internal 4-lane cabled disk arrays	R	NS	NS	FS ^a	NS	NS	FS ^a	NS
System to system inter connects – data center applications xSATA	NS	R (key 7)	NS	NS	R (key 7)	NS	NS	NS
System to system inter connects – external desktop applications eSATA	NS	R	NS	NS	FS ^a	NS	NS	NS
Proprietary Serial ATA disk arrays	R	NS	NS	FS ^a	NS	NS	FS ^a	NS
Serial ATA and SAS	D	NS	NS	D	NS	NS	D	NS
LIF-SATA	R	NS	NS	FS ^a	NS	NS	FS ^a	NS
mSATA	R	NS	NS	FS ^a	NS	NS	NS	NS
SATA USM	D	NS	H	D	NS	H	D	H

Table 2 – Usage model electrical requirements (part 2 of 2)

Characteristic	Gen1i 1.5 Gbps	Gen1m 1.5 Gbps	Gen1u 1.5 Gbps	Gen2i 3.0 Gbps	Gen2m 3.0 Gbps	Gen2u 3.0 Gbps	Gen3i 6.0 Gbps	Gen3u 6.0 Gbps
SATA MicroSSD	D	NS	H	D	NS	H	D	H
Embedded M.2	D	NS	H	D	NS	H	D	H
Key: R = Required configuration requires appropriate capabilities FS = Feature specific configuration is supported by specification but may be tied to an optional capability NS = Not supported configuration is not supported by definition in specification H = Host D = Device NOTE - Many of the references in the table are section numbers or notations of clarification that do not require Key values. ^a Feature specific is intended to indicate that Gen1 is required but higher data rates are optional.								

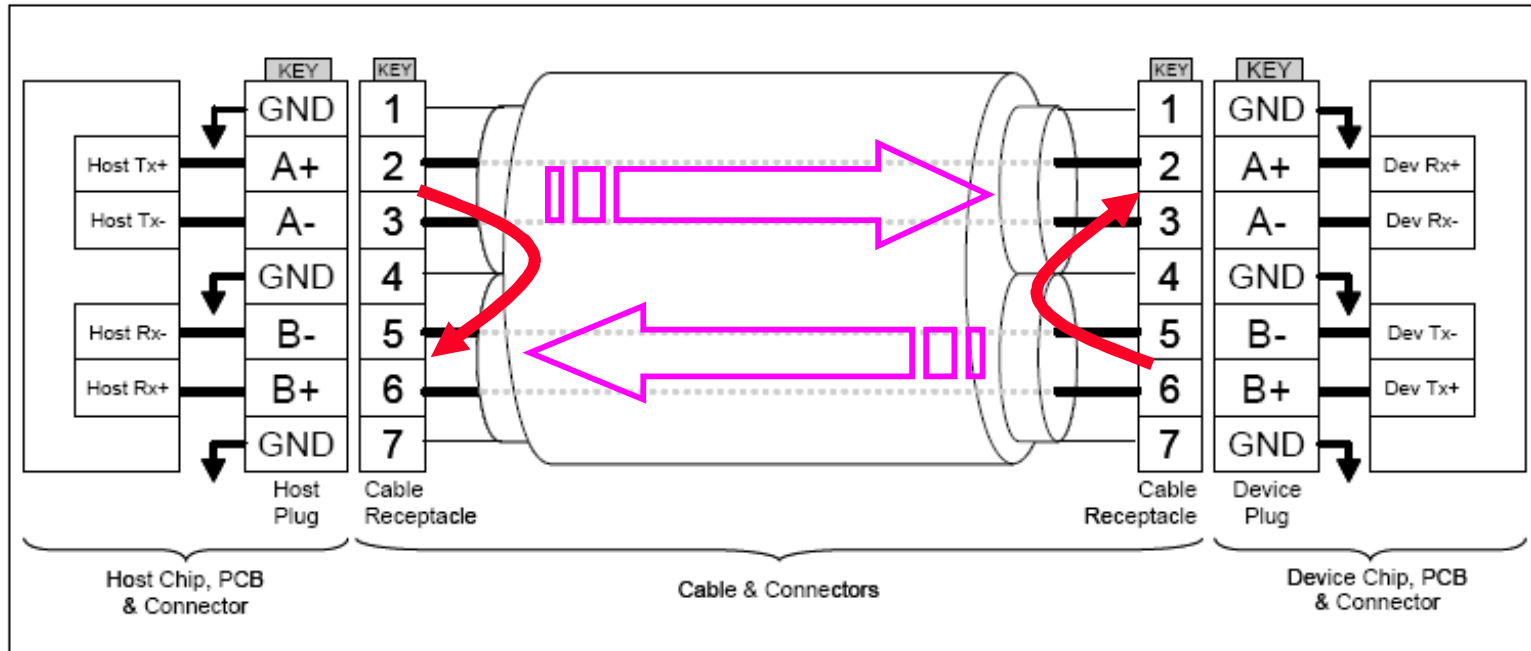
SATA 3.2 特性簡介

SATA的電氣特性要求：



SATA 3.2 的傳輸架構

SATA Single-Lane的高速傳輸架構



只有2對高速線，每對均為單工，構成整線的全雙工傳輸

SATA 3.2 的線材與連接器

SATA Internal Single-Lane 裸線結構

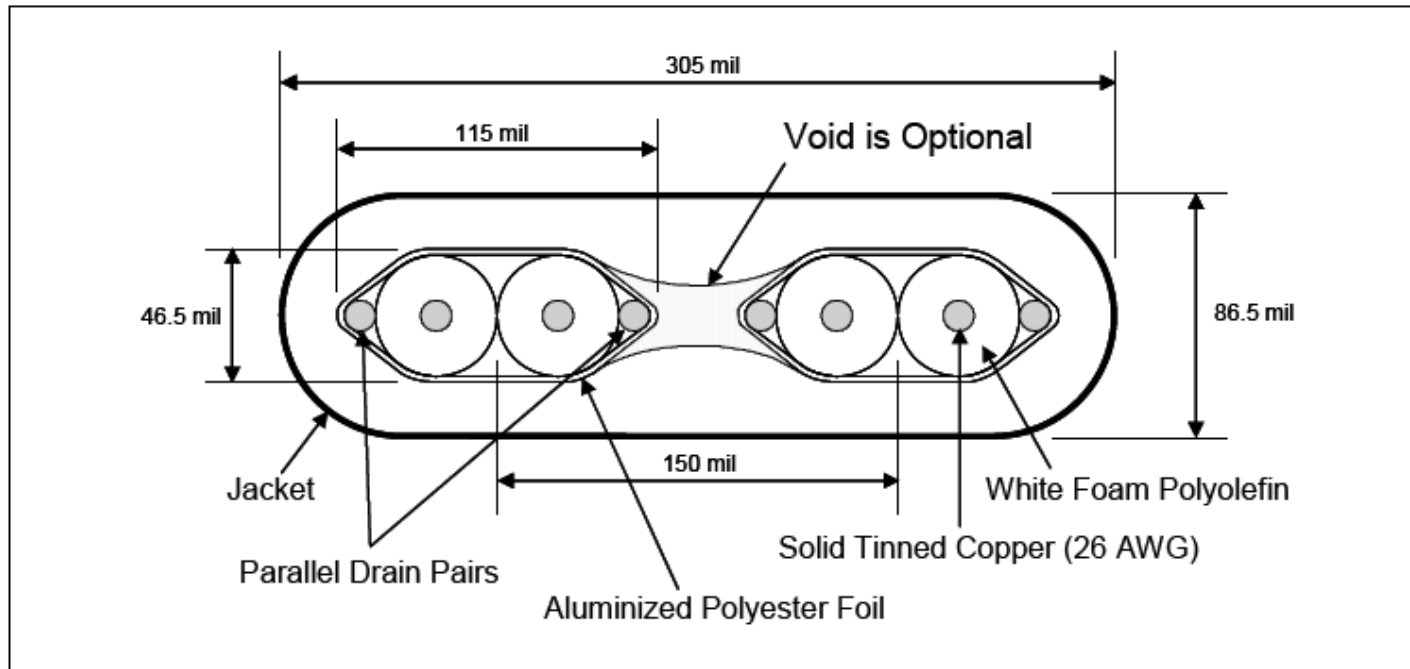


Figure 45 – Detailed cross-section of an example internal single lane cable

為2對具接地引線的雙並線構成，上圖僅為參考結構，非強制的要求。

SATA 3.2 的線材與連接器

SATA Internal 1 Lane Cabled application

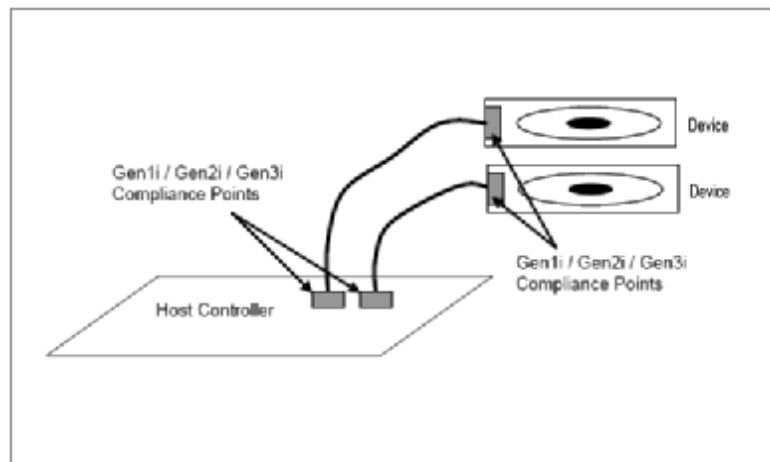


Figure 6 – Internal 1 m cabled host to device application

應用於PC內部主機板與裝置之間的連接。
其傳輸速度為1.5 Gbps / 3 Gbps / 6Gbps，
此一應用不需要支援Hot Plug電氣規格。

-SATA connector

-Slimline connector for 12.5mm, 9.5mm, 8.5mm, 7.0mm Slimline device

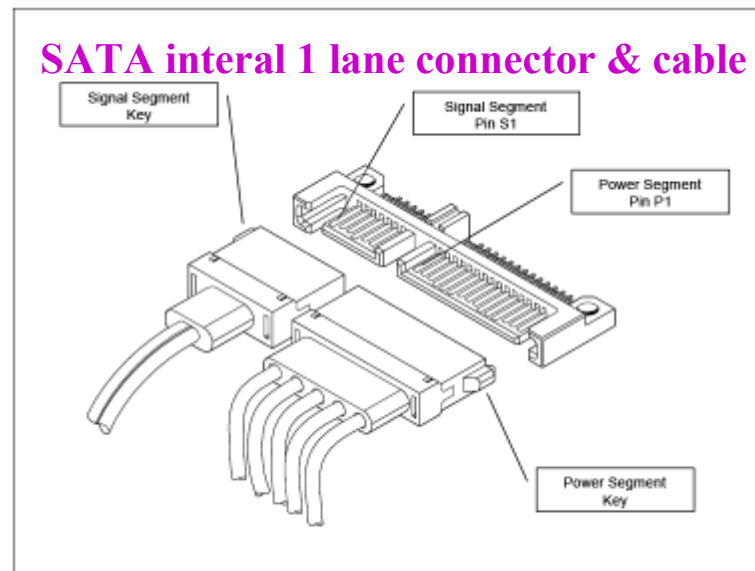


Figure 34 – Connector pin and feature locations

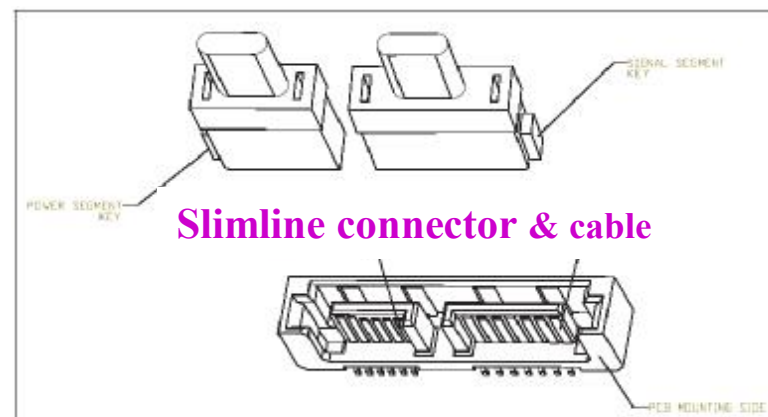


Figure 82 – Slimline connector pin and feature locations

SATA 3.2 的線材與連接器

SATA Internal MultiLane Cabled application

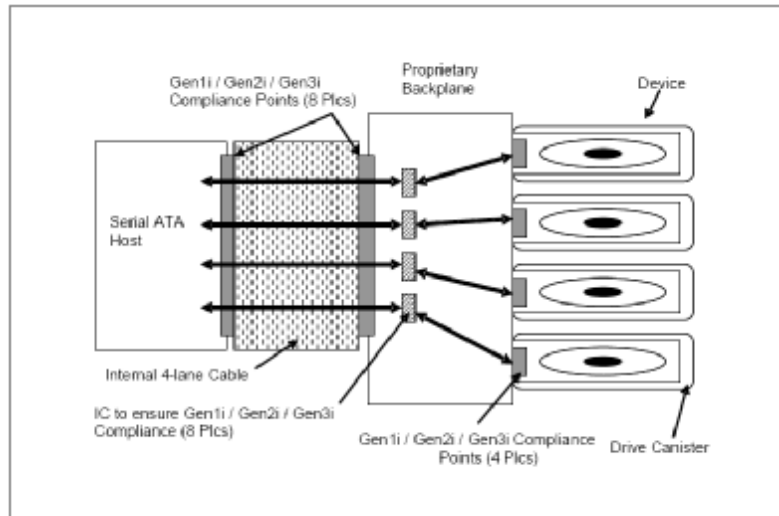


Figure 8 – Internal 4-lane cabled disk array

應用於PC內部主機板與裝置之間的連接。
其傳輸速度為1.5 Gbps / 3 Gbps / 6Gbps，
此一應用不需要支援Hot Plug電氣規格。

- SATA Internal 2 Lane connector
- SATA Internal 4 Lane connector
- Mini SATA connector

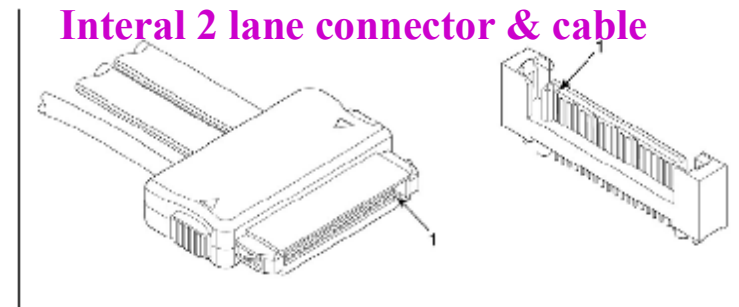


Figure 46 – Isometric drawings of the internal 2 lane cable and connector

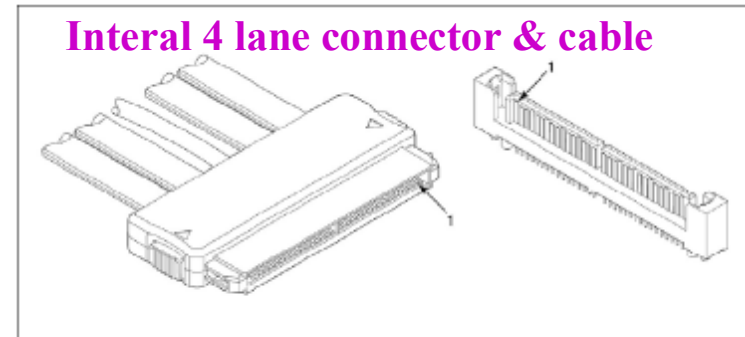


Figure 47 – Isometric drawings of the internal 4 lane cable and connector

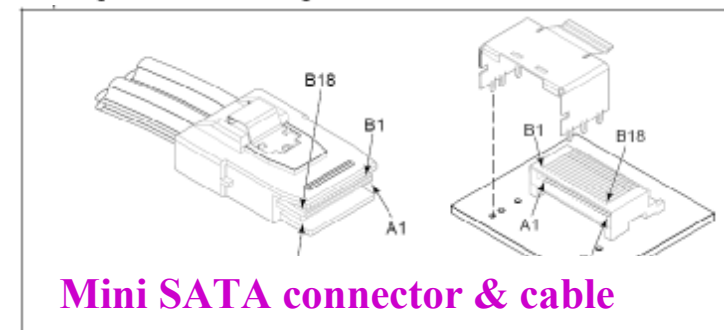


Figure 52 – Isometric drawings for Mini SATA Internal Multilane

SATA 3.2 的線材與連接器

External single lane cabled application

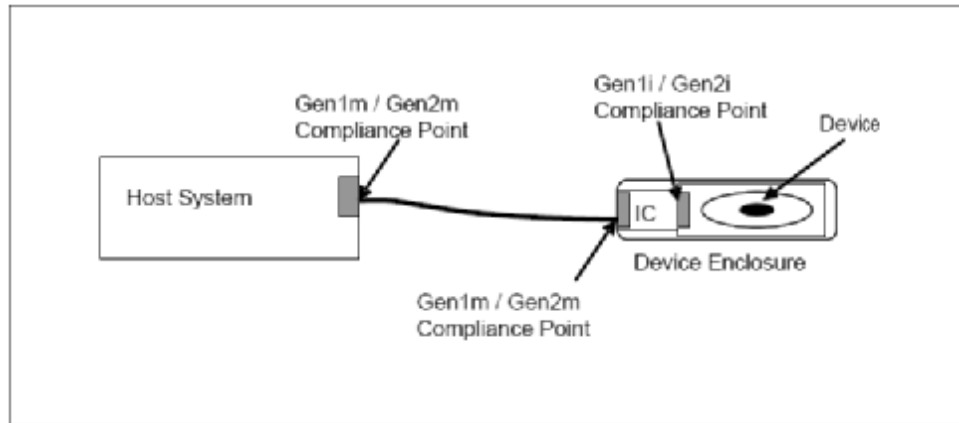


Figure 10 – External desktop application

External 1 lane connector & cable

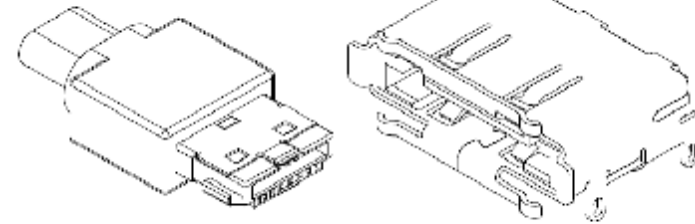


Figure 145 – Renderings of External Serial ATA cable receptacle and right angle plug

應用於PC外部機箱與裝置之間的連接。
Host System及Device Enclosure都必須支援
Hot Plug的功能。
線材及連接器須有遮蔽，以防止EMI問題
-External 1 lane connector (eSATA)



SATA 3.2 的線材與連接器

External Multi-lane cabled application

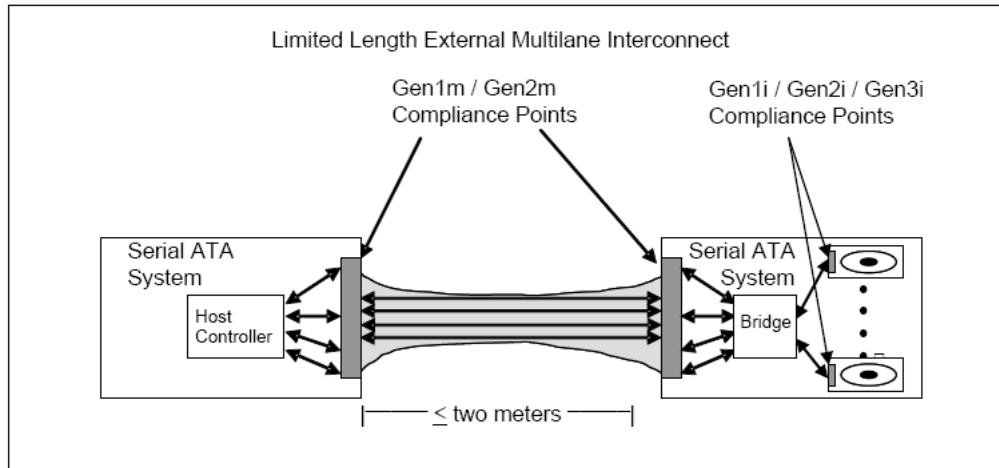


Figure 9 – System-to-system data center interconnects

System to System Interconnects - Data Center Applications(xSATA)

SATA 3針對所有外部電纜有一原則是需支援 1.5 Gbps 和 3.0 Gbps 應用且必須支援Hot plug功能。

此應用最大長度為2m

除非是不可拆除或有防止誤插key的特殊線才能只支援1.5 Gbps。

-External 4 lane connector

-Mini SATA External connector(4 Lane)

External 4 lane connector & cable

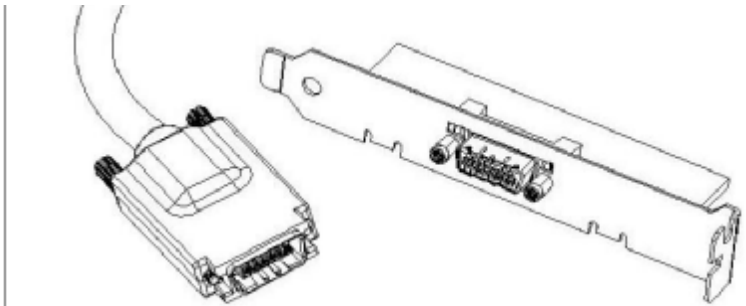


Figure 162 – External Multilane cable and connector

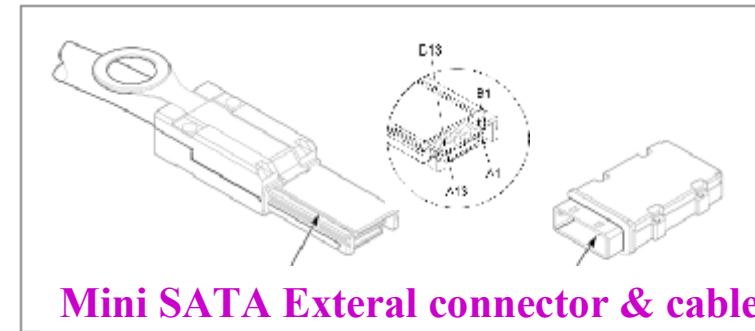
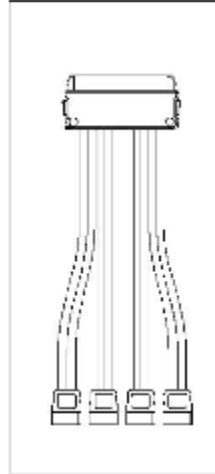


Figure 156 – Mini SATA External Multilane system, key slots 7 for m level signals

SATA 線材的高頻量測



線量測參數注意事項：

線材規格分4類：

內部單通道、內部多通道、外部單通道
及外部多通道等

特殊參數：

Risetime 上升時間

Inter-Symbol Interference 碼間串擾



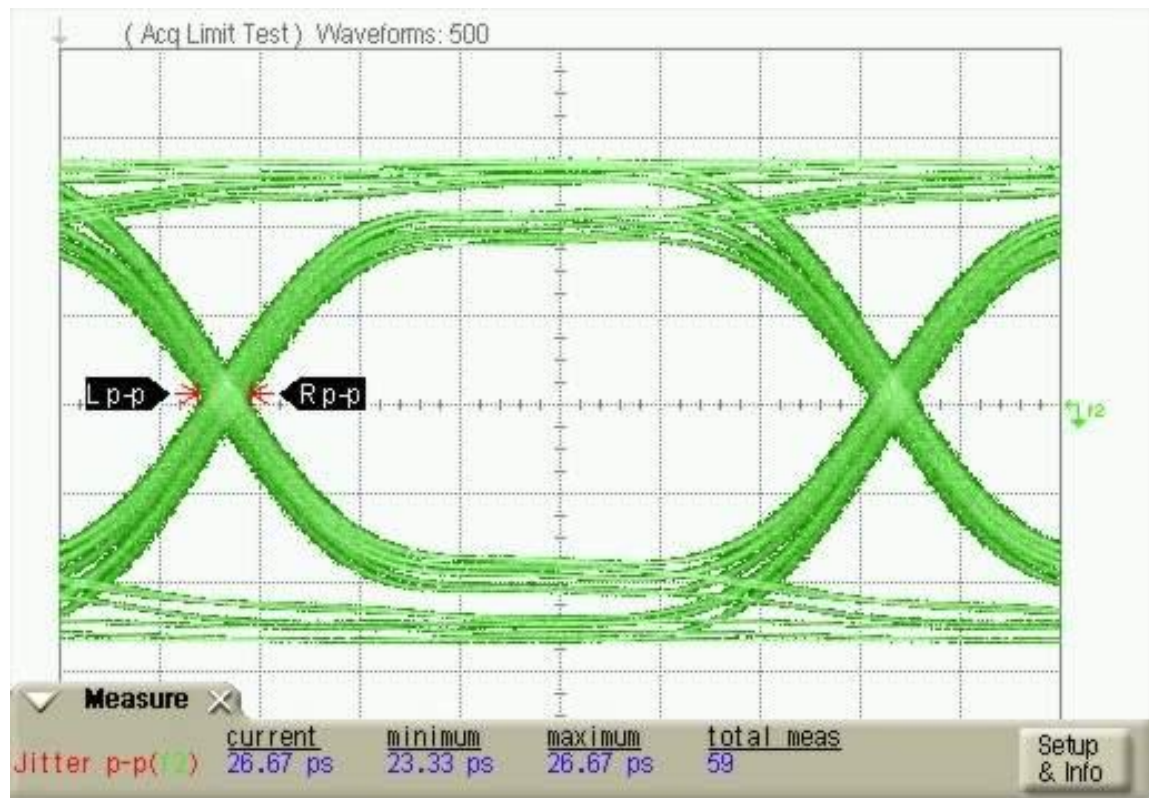
SATA 3.2 規格表

Max test freq. for NA test **~4.5 GHz**

Min risetime for TDR test **Tr = 70ps(20-80%)**

SATA 線材的高頻量測

ISI (Inter Symbol Interface) : 碼型相依性是波形受到前面的資料碼型影響時的行爲，輸入波型爲 **K28.5** 序列，以 **Jitter_{p-p}** 方式量得之抖動值。



K28.5 序列：

由K28.5+ and K28.5- 組成

→ 0011111010 1100000101

K28.5+ : 0011111010

K28.5- : 1100000101