ECN Proposal for Micro-USB Cables

- Construction -

15-Aug-2008

Fujikura Ltd.

Current USB cable construction requirements

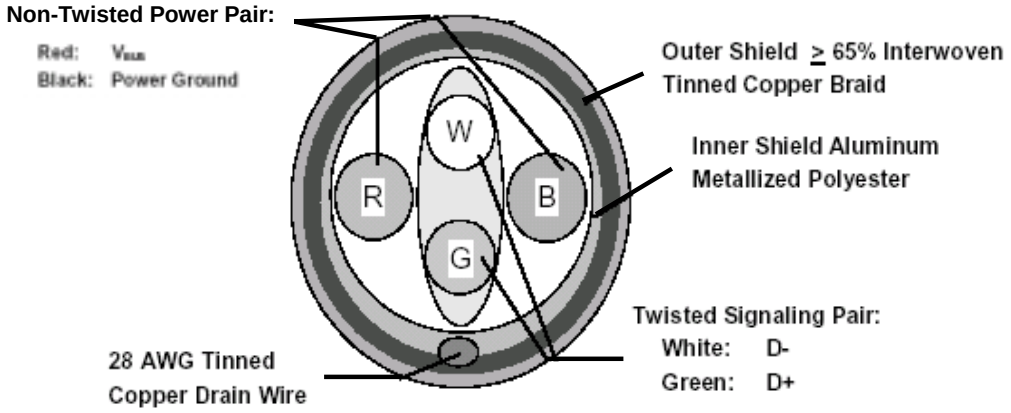
Current USB2.0 specification specifies Cable construction in Chapter 6.6

- Wiring requirement :

  Twisted data pair (28 AWG) + Non-twisted power pair (20 ~ 28 AWG)

- Shielding requirement :

  Al-tape + Drain wire 28 AWG + Braided shield (≥ 65%)



Background for ECN

When the Micro-USB Specification was released.

Mainly Mobile phone requirements were taken account for receptacle and plug connector.

Due to the existing cable construction requirements, optional data cables (size, performance, cost…) can not be done for the customers.

Requirements from Mobile phone makers and Trends of the other specification

[Requirements from Mobile phone makers]

- Typical cable diameter : < 3.5mm
- Typical cable length : 1 ~ 1.5m
- Typical cable bending performance : > 6,000cycles
- Typical cable material requirement : Halogen free
- Lowest cost
- Easy to package (Flexible)

[Trends of the other specification]

Infiniband High Speed Cable	: #30 AWG
HDMI Cable	: #36 AWG
DisplayPort	: #30 AWG

How can the cable achieve those requirements (Construction)

Example (in case of power and signal wire 28 AWG) ; *Quad type*

A. Twisted type (current USB specification)

Non-Twisted Power Pair:

Red: V_{BUS}
Black: Power Ground

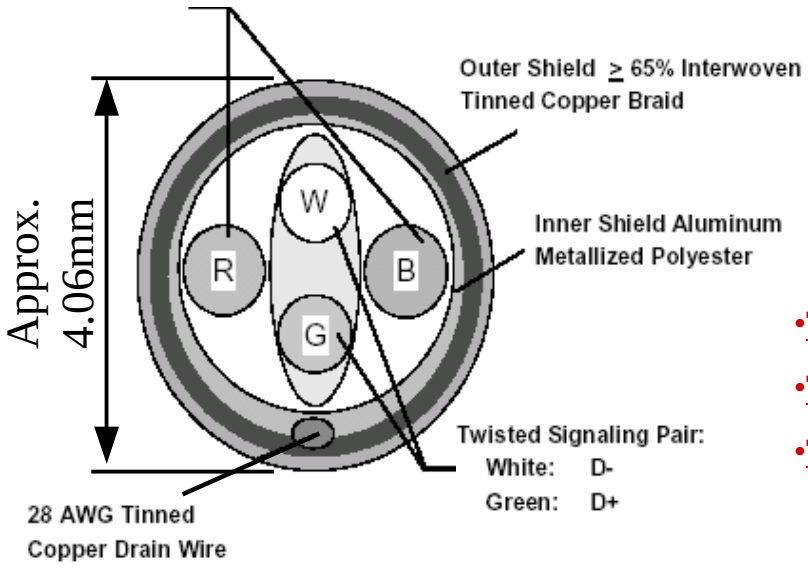
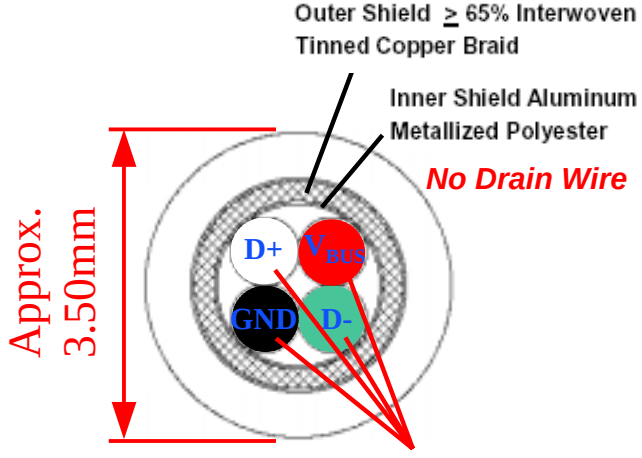


Figure 6-11. Typical High-/full-speed Cable Construction

- **To reduce diameter**
- **To get flexible**
- **To reduce cost**

B. Quad type



Twisted Power and Signaling wires

Performance of Quad type cable

[Table of evaluation of Quad type cable performance]

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Propagation Delay ---------- Page 10/23

Propagation Delay Skew ---------- Page 11/23

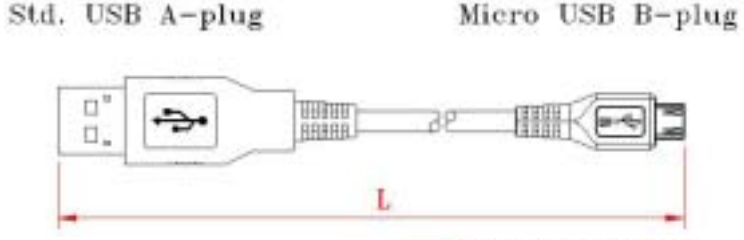
Voltage Drop Budget (28 AWG) ------- Page 12/23

Temperature Rise (28 AWG) ---------- Page 13/23 ~ 16/23

Eye Patterns and Jitter (28 AWG) ------- Page 17/23 ~ 22/23

Remark ;

These evaluation is a typical case of cable assembly with Cable of signal and power wire 28AWG and Connector Std. USB A-plug and Micro USB B-plug.



Performance of Quad type cable

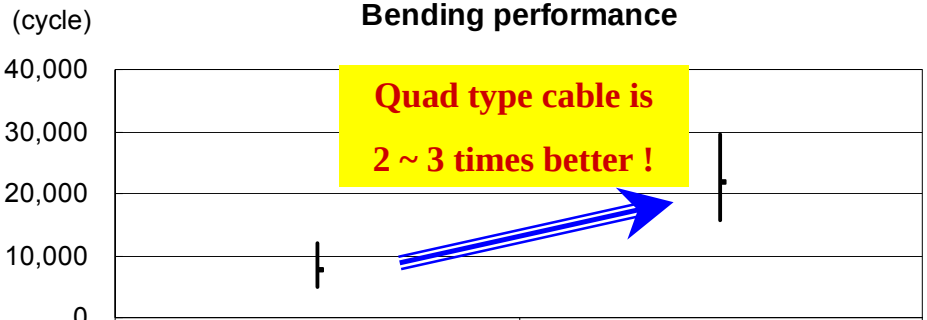
Flexibility (in case of power and signal wire 28 AWG)

- USB bending requirement :

  Min. 100 cycles (120 degree arc)

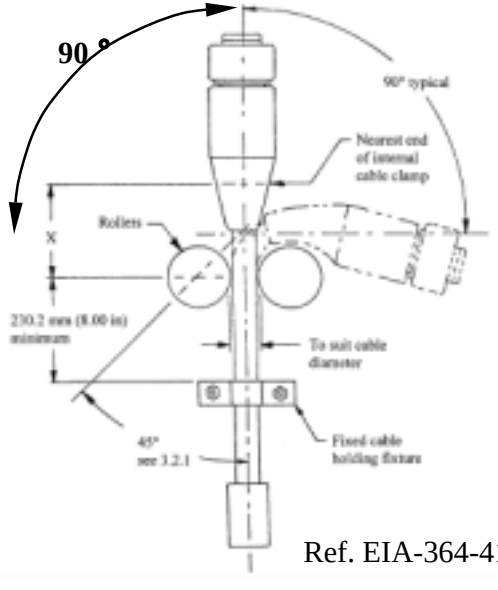
-Typical USB cable bending requirement for Mobile phone :

  Min. 6,000 cycles (180 degree arc with load)



	(A) Twisted type	(B) Quad type
Max.	12,075	29,453
Min.	4,939	15,620
Avg.	7,728	21,862

(180 degree arc with load 200g)



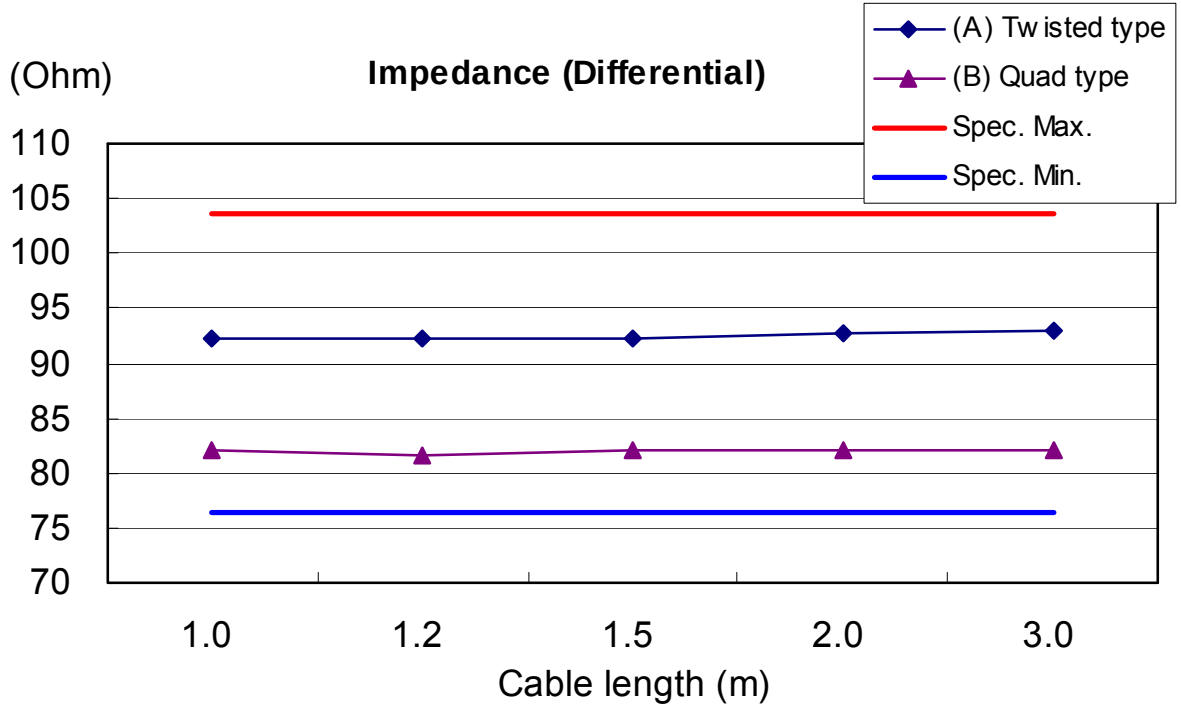
Ref. EIA-364-41C

Performance of Quad type cable

Impedance (in case of power and signal wire 28 AWG)

USB Spec. 76.5 – 103.5 Ohm

→ Quad type cable is able to meet USB Specification

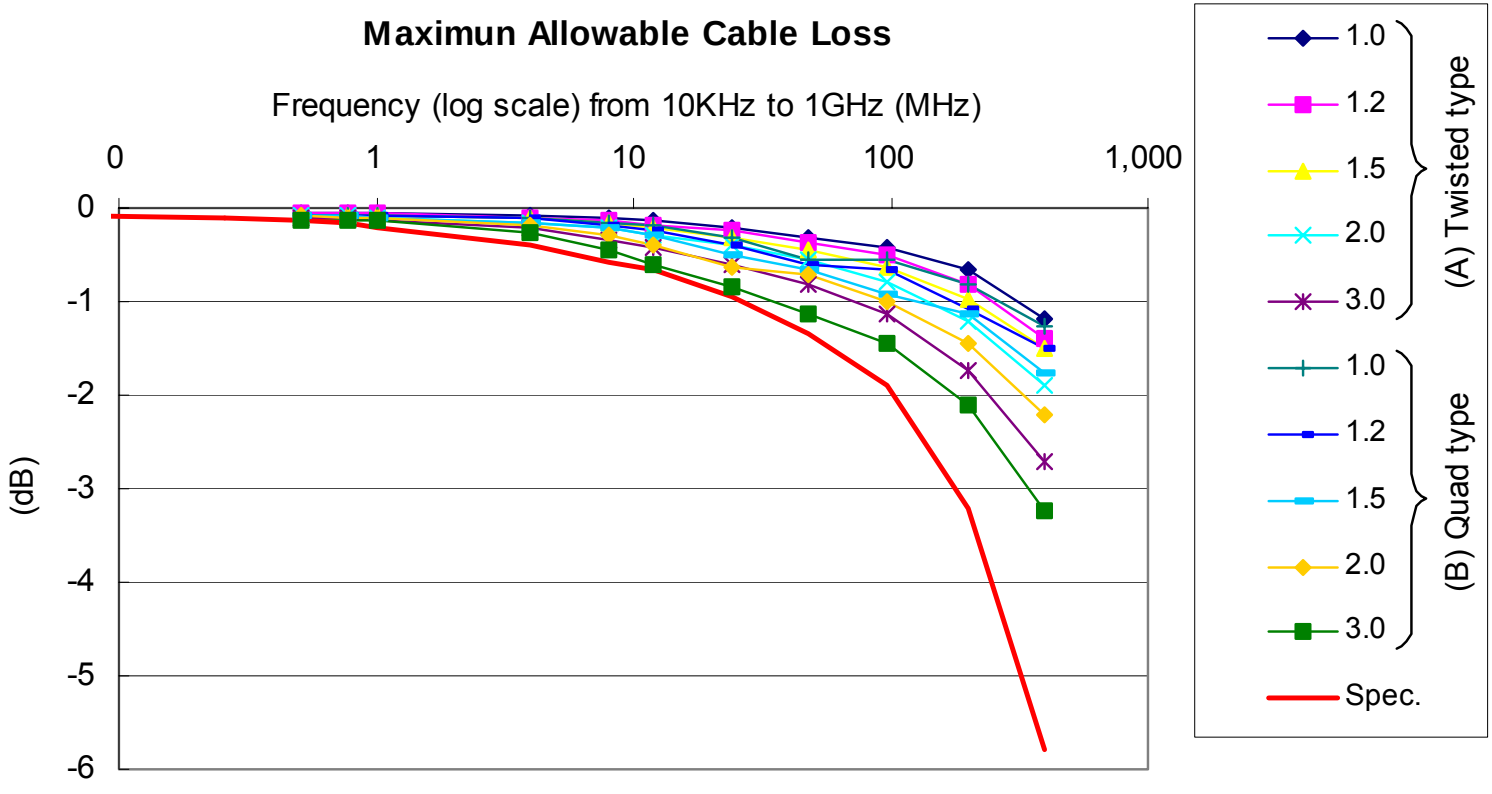


Remark ; Impedance depends on cable design and (B) is designed to get small diameter of cable.

Performance of Quad type cable

Signal Pair Attenuation

Quad type cable is able to meet USB specification



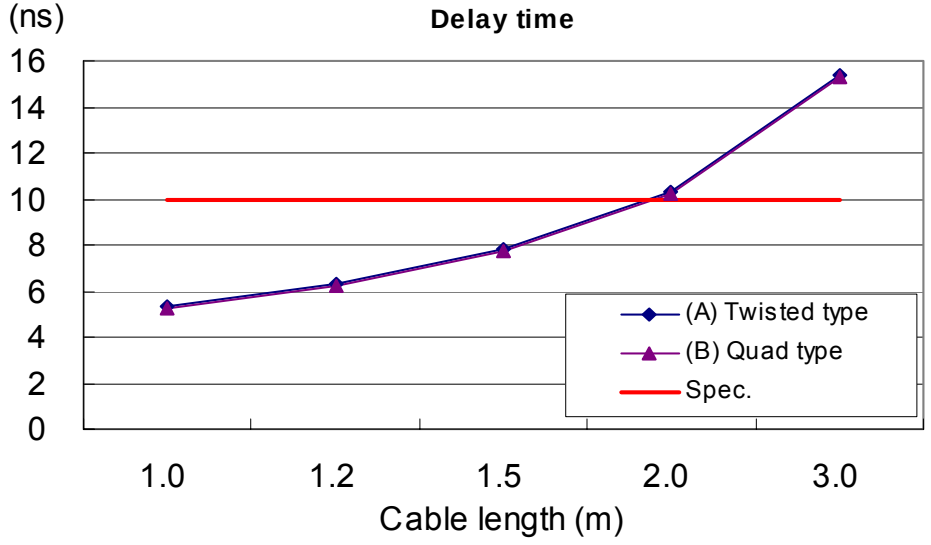
Performance of Quad type cable

Propagation Delay

USB Spec. Max.10ns

→ A typical USB cable length for Mobile phone is 1 ~ 1.5m.

Quad type cable with less than 2m length is able to meet USB specification.



Remark ; This result is based on wire 28 AWG. It can meet USB specification even though Cable assembly length 2.0m by using another wire size.

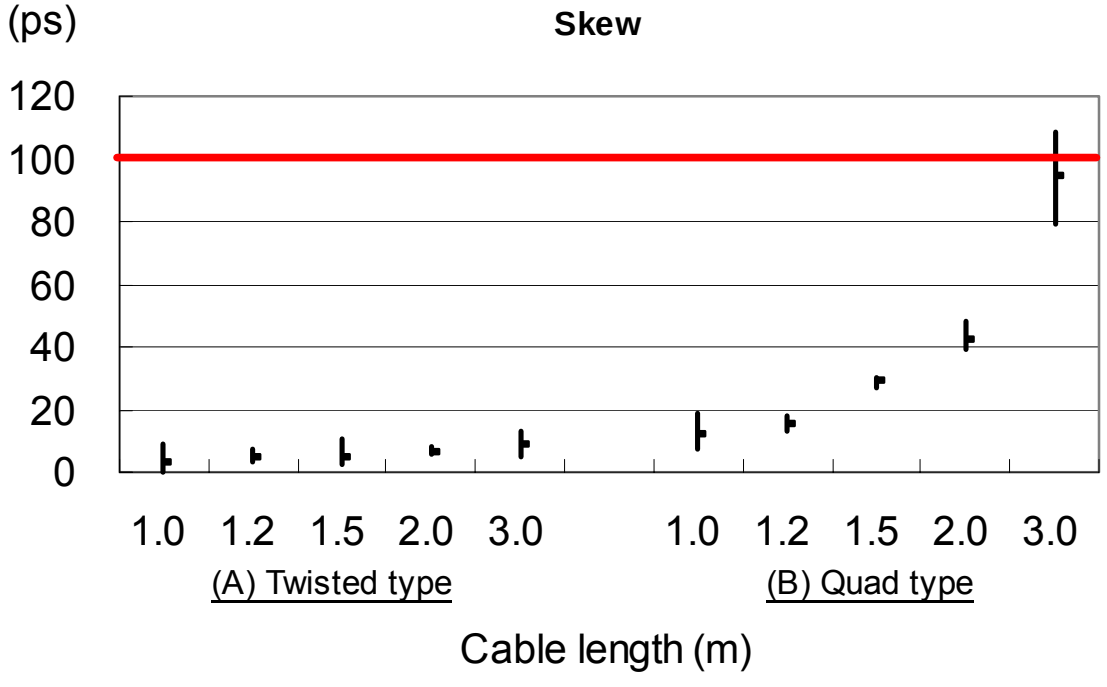
Performance of Quad type cable

Propagation Delay Skew

USB Spec. Max.100ps

→ A typical USB cable length for Mobile phone is 1 ~ 1.5m.

Quad type cable with less than 2m length is able to meet USB specification.



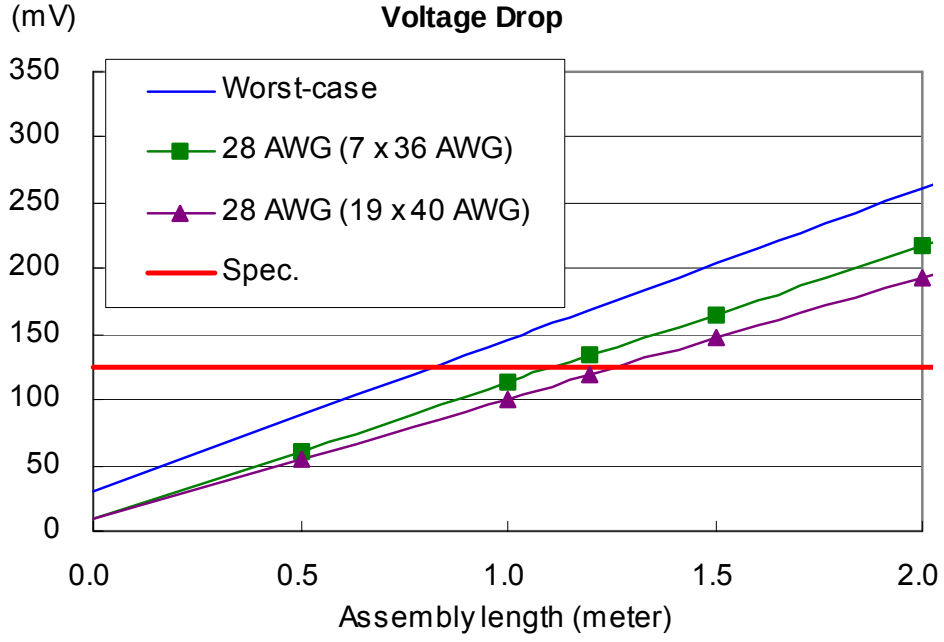
(Reference) Performance of Quad type cable

Voltage Drop Budget (28 AWG)

This performance depends on wire size.

USB Spec. Max.125mV

→ 28 AWG with less than 1.2m length is able to meet USB specification.



Remark ; Worst-case = Connector 15mV + Cable 232mOhms/MT x 0.5A + Connector 15mV

(Reference) Performance of Quad type cable

Temperature Rise (28 AWG)

This specification is for contact of connector.

But we test the cable according to this specification.

[Micro-USB Specification Rev 1.01]

5.3 Contact Current Rating

5.3.1 Signal Contacts Only (2, 3, and 4)

1A minimum when measured at an ambient temperature of 25 degrees Celsius. With power applied to the contacts, the delta temperature must not exceed +30degrees Celsius at any point in the USB connector under test.

5.3.2 With Power Applied Contacts (1 and 5)

1.8A for contacts 1 and 5 and at the same time 0.5A for contacts 2, 3 & 4, minimum when measured at an ambient temperature of 25 degrees Celsius. With power applied to the contacts, the delta temperature must not exceed +30degrees Celsius at any point in the USB connector under test.

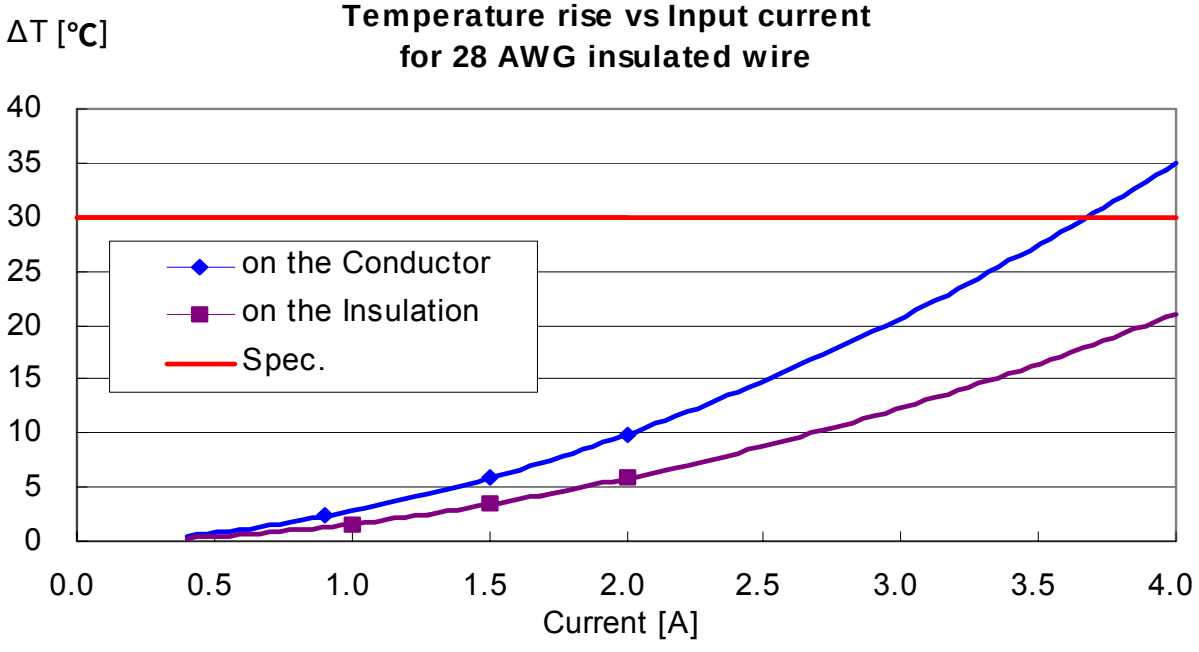
(Reference) Performance of Quad type cable

Temperature Rise (28 AWG) on the Conductor and on the Insulation

This performance depends on wire size.

Micro-USB Spec. The delta temperature must not exceed +30deg C (at connector) (Refer 5.3.1 Signal line (Contacts) only)

→ Quad type cable is able to meet USB Specification.



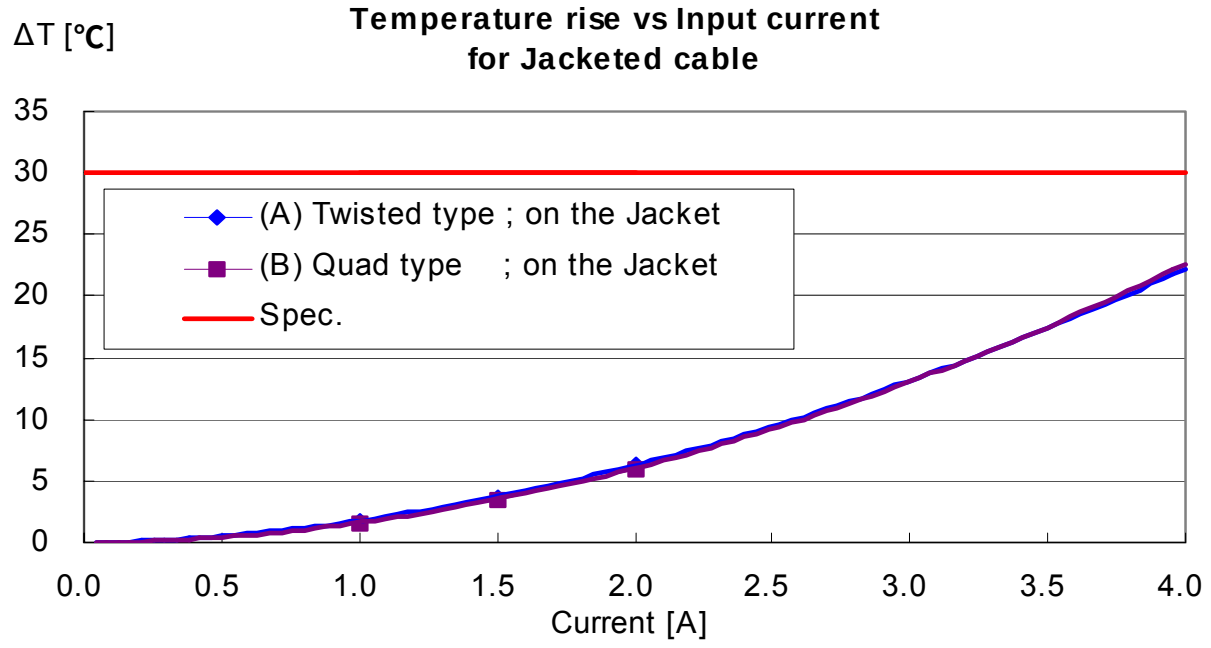
(Reference) Performance of Quad type cable

Temperature Rise (28 AWG) on the Jacket

This performance depends on wire size.

Micro-USB Spec. The delta temperature must not exceed +30deg C (at connector)
(Refer 5.3.1 Signal line (Contacts) only)

→ Quad type cable is able to meet USB Specification.



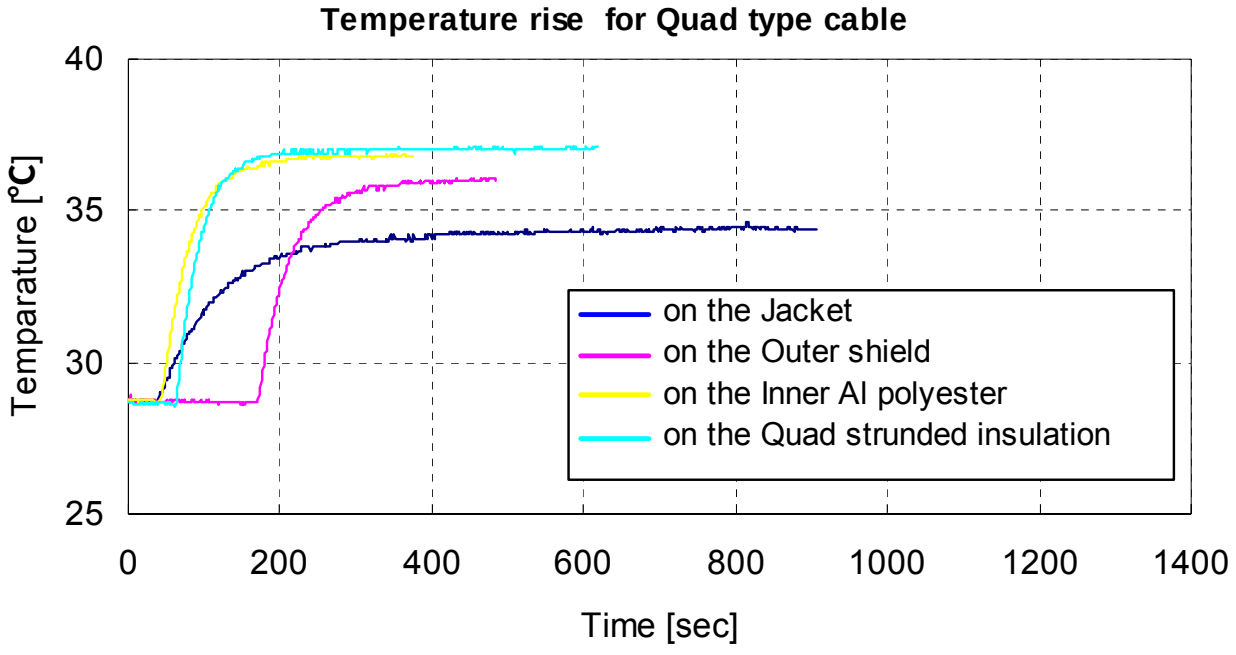
(Reference) Performance of Quad type cable

Temperature Rise (28 AWG) on each points

This performance depends on wire size.

Micro-USB Spec. The delta temperature must not exceed +30deg C (at connector) (Refer 5.3.2 with Power Applied (Contacts))

→ Quad type cable is able to meet USB Specification.



Performance of Quad type cable

Eye Patterns and Jitter (28 AWG)

USB Spec. ; refer Template 2 (Eye height 350mV, Jitter 0.3UI)

Pulse generator : Agilent technology 81134A pattern generator, Tektronix TDS8000 with 80E03 module

Signal source : Data rate : 480Mbps, PRBS 2^{7-1}, 600mV (follow Template 1)

Cable assembly length under test : 1.0m, 1.2m, 1.5m, 2.0m, 3.0m

Template 1 : Transmit waveform requirements for hub measured at TP2,
and for device (without cable) measured at TP3.

Template 2 : Transmit waveform requirements for device (with a captive cable) measured at TP .

(This test is measured at TP4.)

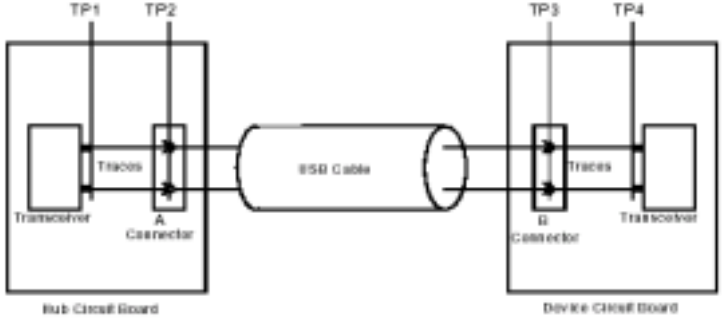
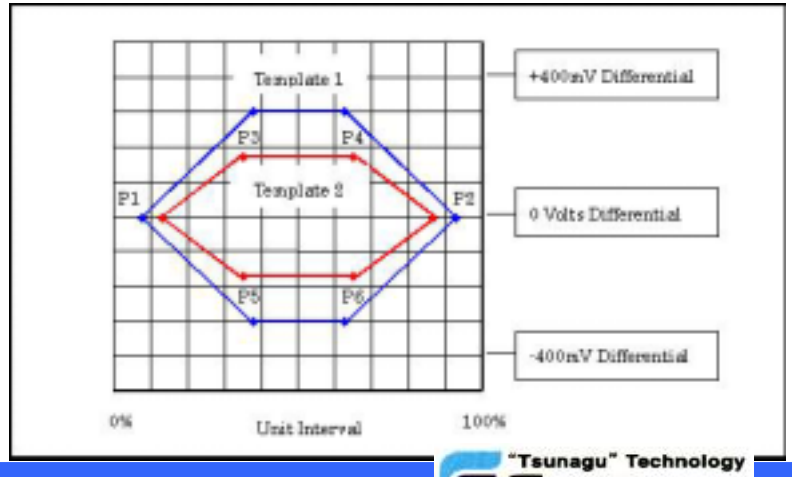


Figure 7-11. Measurement Planes

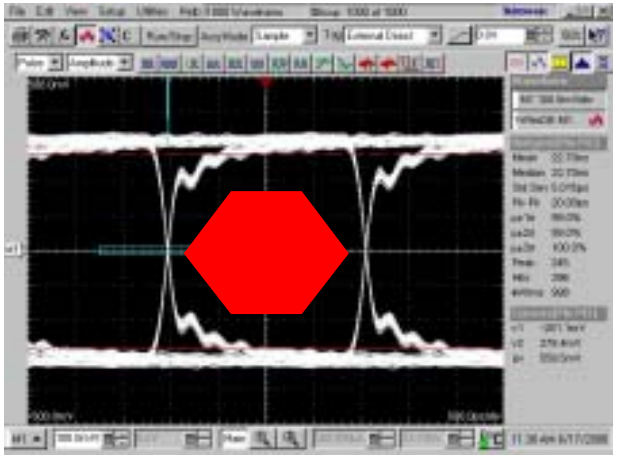


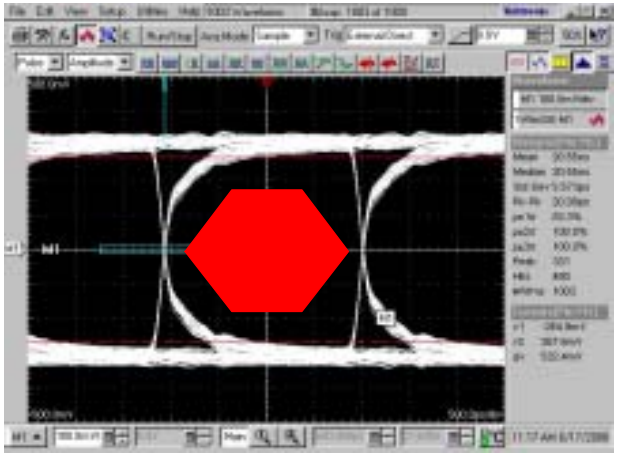
Performance of Quad type cable

Eye Patterns and Jitter (28 AWG)

- The result of Assembly length 1.0m

		(A) Twisted type ; 1.0m			(B) Quad type ; 1.0m		
USB spec.	Unit	Sample No.1	Sample No.2	Sample No.3	Sample No.1	Sample No.2	Sample No.3
Eye height > 350	mV	559.5	559.5	559.5	532.4	532.4	532.4
Jitter 30% (max)	UI	0.96%	0.48%	0.96%	0.96%	0.96%	1.44%
Result		Pass	Pass	Pass	Pass	Pass	Pass





→ Quad type cable is able to meet USB specification

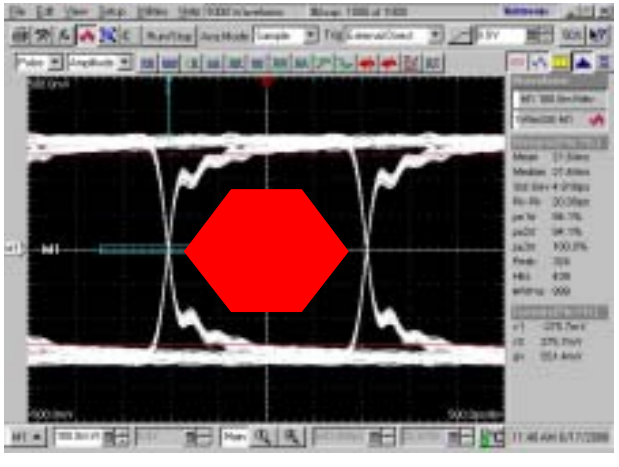
Remark ; This result is based on wire 28 AWG.

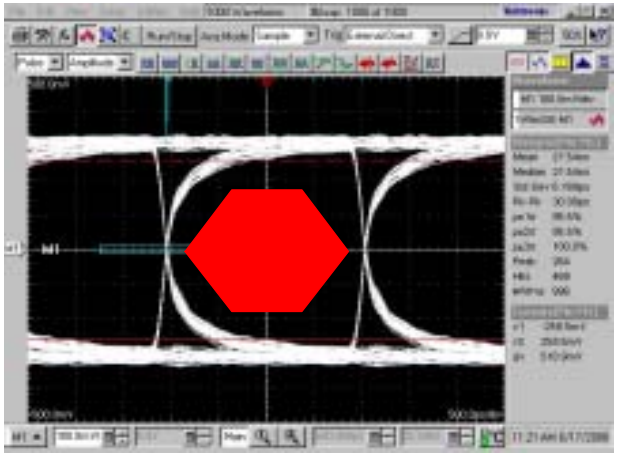
Performance of Quad type cable

Eye Patterns and Jitter (28 AWG)

- The result of Assembly length 1.2m

		(A) Twisted type ; 1.2m			(B) Quad type ; 1.2m		
USB spec.	Unit	Sample No.1	Sample No.2	Sample No.3	Sample No.1	Sample No.2	Sample No.3
Eye height > 350	mV	551.4	551.4	551.4	518.9	518.9	518.9
Jitter 30% (max)	UI	0.96%	0.96%	0.96%	1.44%	1.44%	0.96%
Result		Pass	Pass	Pass	Pass	Pass	Pass





→ Quad type cable is able to meet USB specification

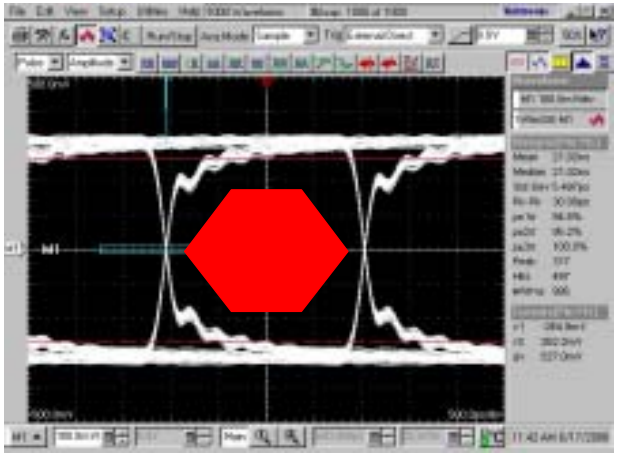
Remark ; This result is based on wire 28 AWG.

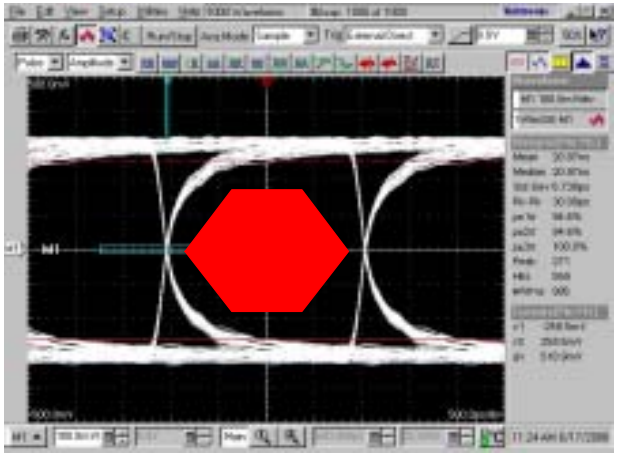
Performance of Quad type cable

Eye Patterns and Jitter (28 AWG)

- The result of Assembly length 1.5m

		(A) Twisted type ; 1.5m			(B) Quad type ; 1.5m		
USB spec.	Unit	Sample No.1	Sample No.2	Sample No.3	Sample No.1	Sample No.2	Sample No.3
Eye height > 350	mV	527.0	527.0	527.0	518.9	500.0	500.0
Jitter 30% (max)	UI	1.44%	0.96%	0.96%	1.44%	1.44%	1.44%
Result		Pass	Pass	Pass	Pass	Pass	Pass





→ Quad type cable is able to meet USB specification

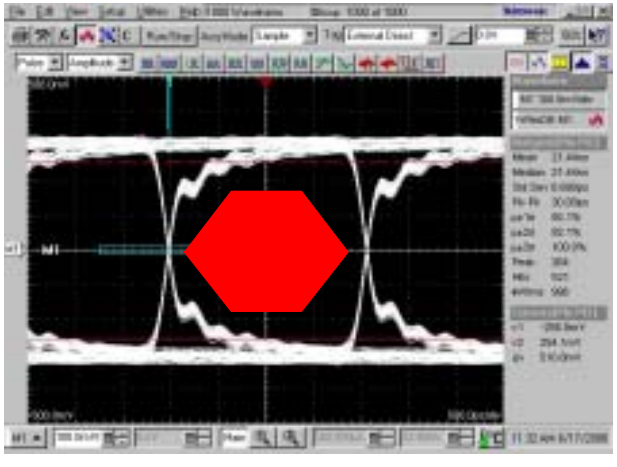
Remark ; This result is based on wire 28 AWG.

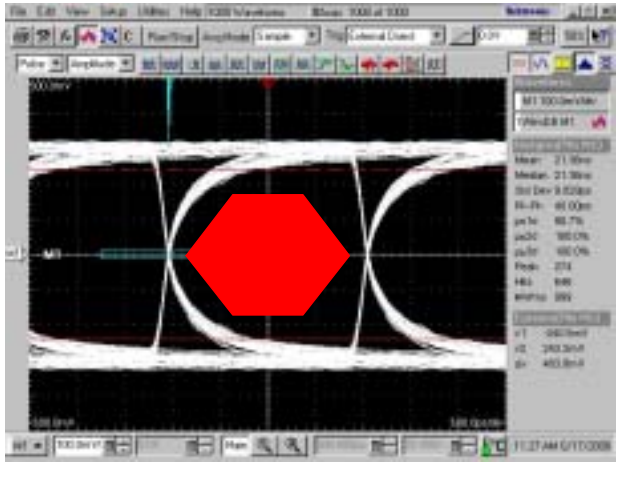
Performance of Quad type cable

Eye Patterns and Jitter (28 AWG)

- The result of Assembly length 2.0m

		(A) Twisted type ; 2.0m			(B) Quad type ; 2.0m		
USB spec.	Unit	Sample No.1	Sample No.2	Sample No.3	Sample No.1	Sample No.2	Sample No.3
Eye height > 350	mV	510.8	510.8	510.8	483.8	483.8	483.8
Jitter 30% (max)	UI	1.44%	1.44%	1.44%	1.92%	1.92%	1.92%
Result		Pass	Pass	Pass	Pass	Pass	Pass





→ Quad type cable is able to meet USB specification

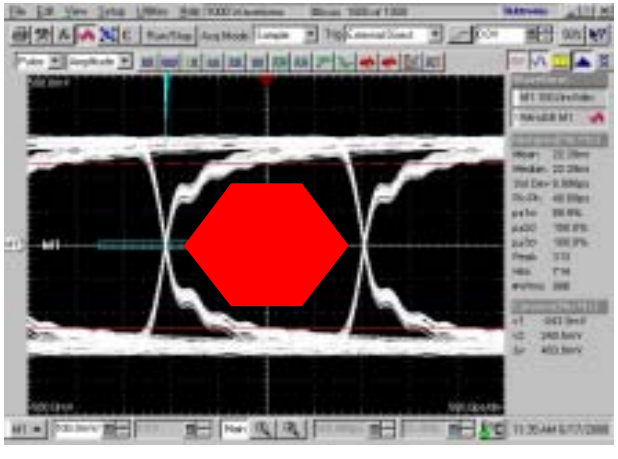
Remark ; This result is based on wire 28 AWG.

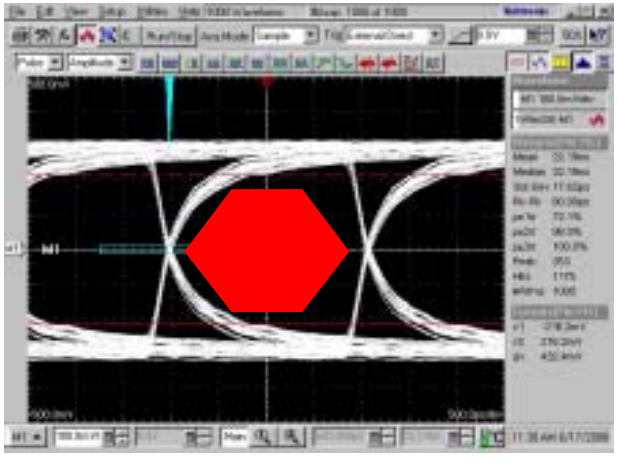
Performance of Quad type cable

Eye Patterns and Jitter (28 AWG)

- The result of Assembly length 3.0m

		(A) Twisted type ; 3.0m			(B) Quad type ; 3.0m		
USB spec.	Unit	Sample No.1	Sample No.2	Sample No.3	Sample No.1	Sample No.2	Sample No.3
Eye height > 350	mV	483.8	483.8	481.1	432.4	432.4	432.4
Jitter 30% (max)	UI	1.92%	1.92%	2.40%	3.84%	3.84%	3.84%
Result		Pass	Pass	Pass	Pass	Pass	Pass





→ Quad type cable is able to meet USB specification

Remark ; This result is based on wire 28 AWG.

Conclusion

By using Quad type cable without drain wire

- cable diameter can be made smaller
- cable bending performance can be improved
- cable cost can be reduced
- less material can be used for the cable
- less material can be used for the package
  (cable/product with smaller diameter can be packaged to smaller loop
  → more cables can be fitted to one master carton box)
- less transportation cost (more cables can be fitted to one master carton box)
- similar electrical performance can be achieved as with Twisted type cable

Due to all the benefits seen with the Quad type cable,
we would like to submit attached ECR.