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IDF2011
INTEL DEVELOPER FORUM

Thunderbolt™ Technology Overview: The Fastest PC I/O Connection at 10Gbps per Channel

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HSTS001

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Agenda

- Thunderbolt™ Technology Overview
- Thunderbolt Technology Architecture
- Industry Participation

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Thunderbolt™ Technology Overview

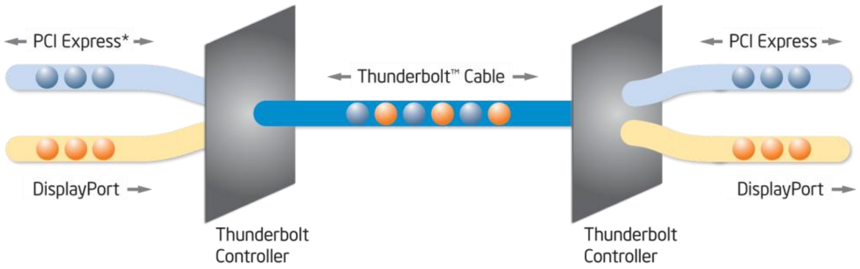
Transformational high-speed, dual-protocol, PC I/O delivering performance, simplicity, and flexibility

Leading Performance in PC I/O

- Faster speed & multi-tasking with bidirectional, dual-channel, 10Gbps per port
- Pro class A/V creation with time-synchronized low latency streaming

Simple & Flexible

- Connect to more devices with data and display on ONE cable
- Add more devices simply with daisy chaining



Fastest Connection to Your PC Experience†

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† As compared to other PC I/O connection technologies including eSATA, USB, and IEEE 1394 Firewire*. Performance will vary depending on the specific hardware and software used. For more information go to http://www.intel.com/technology/io/thunderbolt/index.htm

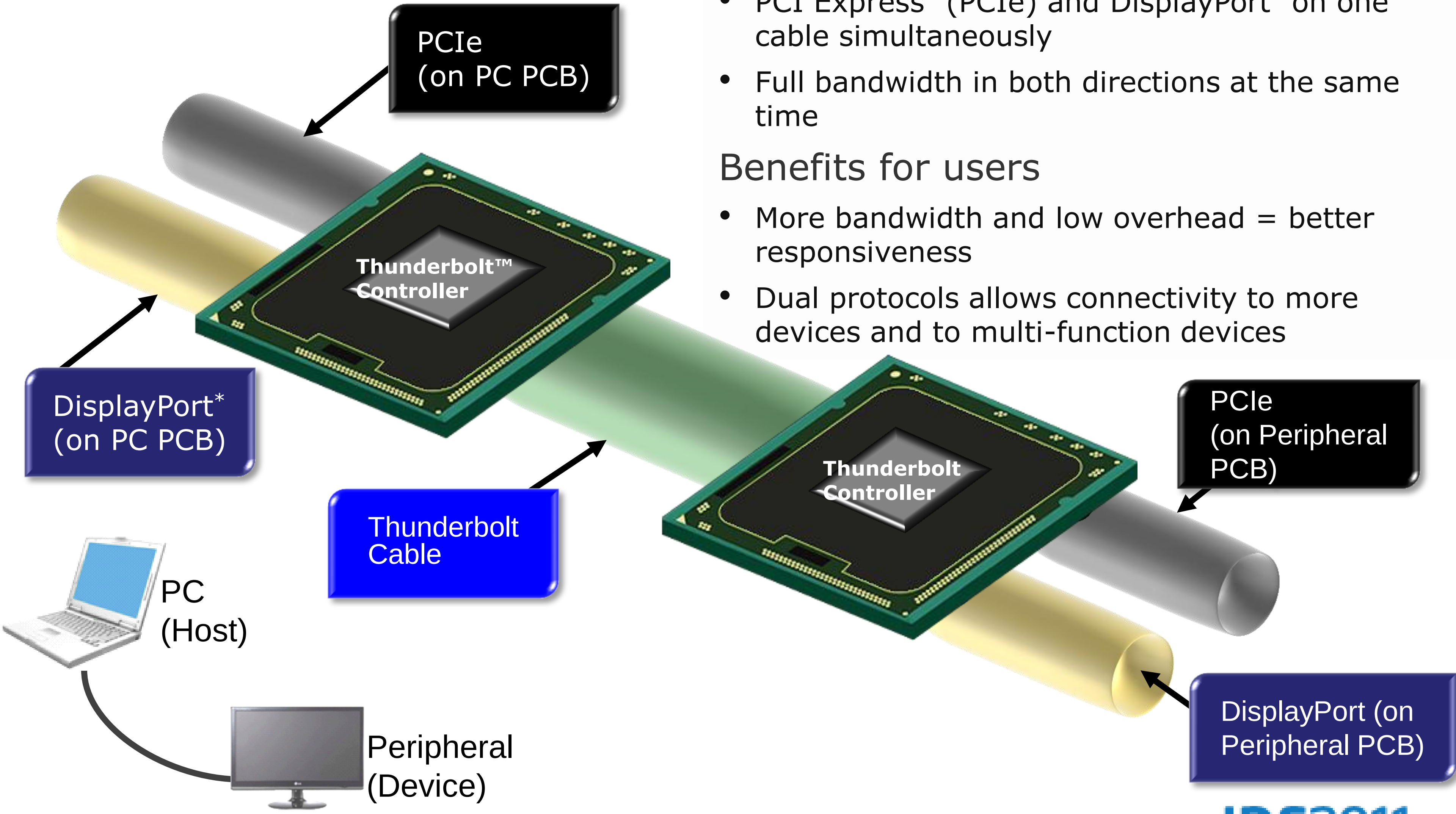
Thunderbolt™ Technology Overview

What is it?

- PCI Express* (PCIe) and DisplayPort* on one cable simultaneously
- Full bandwidth in both directions at the same time

Benefits for users

- More bandwidth and low overhead = better responsiveness
- Dual protocols allows connectivity to more devices and to multi-function devices



PCIe
(on PC PCB)

DisplayPort*
(on PC PCB)

Thunderbolt
Cable

PCIe
(on Peripheral
PCB)

DisplayPort (on
Peripheral PCB)

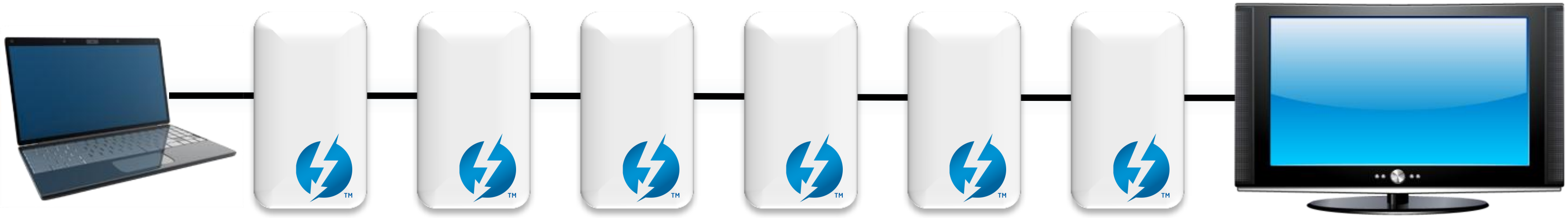
PC
(Host)

Peripheral
(Device)

The connection example shown above is one possible configuration; other configurations and data flows are possible depending on the system design.

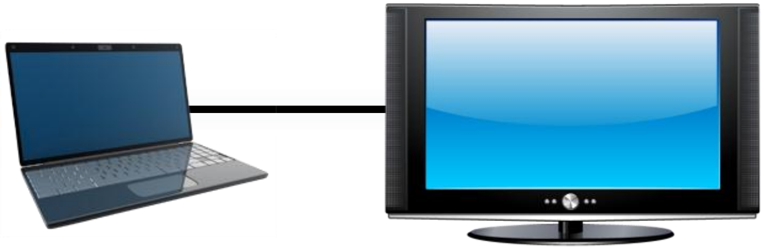
Daisy Chaining

- Up to 6 Thunderbolt devices can be connected to a single Thunderbolt connector on a PC
- And a native DisplayPort display can be connected at the end of the daisy chain*



Native Thunderbolt Products

Native
DisplayPort

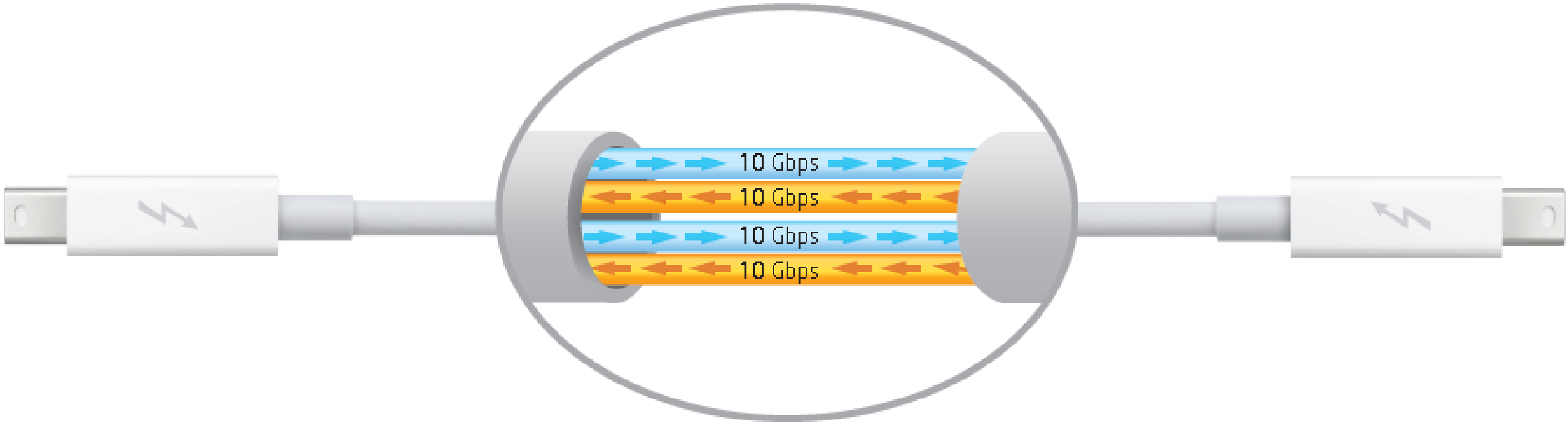


Native
DisplayPort

*The last Thunderbolt product before a native DisplayPort display cannot be a Thunderbolt display

Thunderbolt™ Cables

- 2x channels per cable – 10Gbps bidirectional per channel
- Each direction in each channel can be data and / or display
- Active cables (circuitry in cable ends) enables cable length of up to 3m
- Active Optical cables coming soon
- DisplayPort cables will NOT work as Thunderbolt cable replacement



Thunderbolt™ cable exploded view of dual channel data streams

Thunderbolt Technology and USB3.0

	Thunderbolt technology	USB3.0
Data and HD Display simultaneously	Yes	No
Connect displays or data devices to the same connector	Yes	No
Max one-way bandwidth per connector	20Gbps	5Gbps
Multiple devices	Yes – daisy chain	Yes – star, hub
Power to cable for bus powered device	10W	~5W
Max cable length	3m (electrical) Tens of meters (optical)	3m (electrical)

The data above is based upon the technology specifications, no formal benchmarking has yet been completed. Performance will vary depending on the specific hardware and software used. For more information go to http://www.intel.com/technology/io/thunderbolt/index.htm

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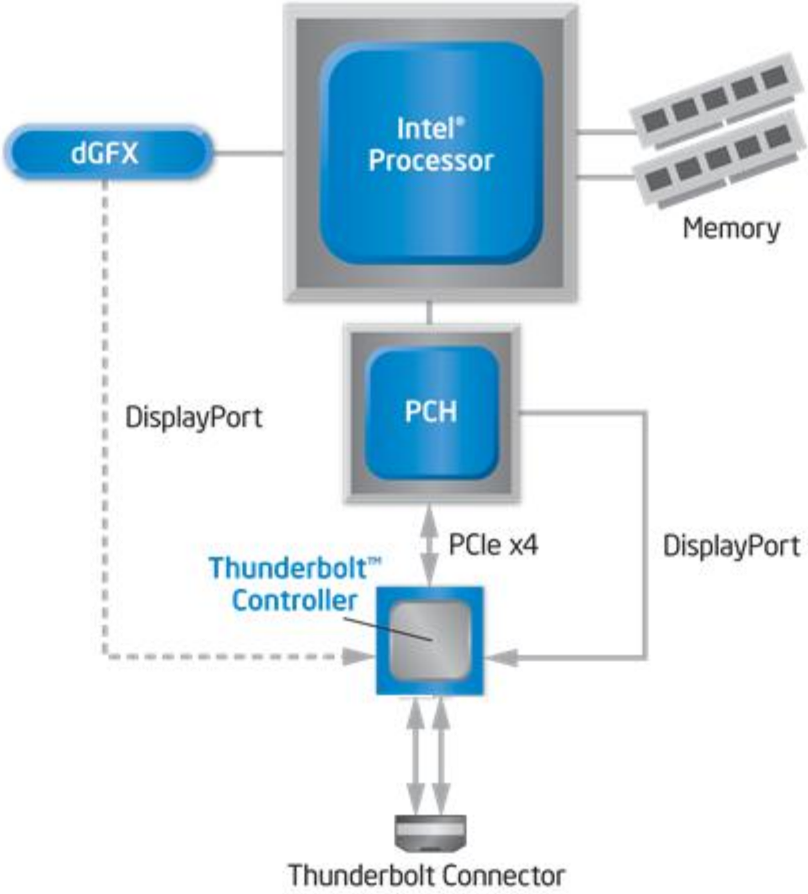
Technology Architecture

- 10Gbps per channel, bidirectional performance
  - 2 channels per cable
- Native PCIe and DisplayPort protocols
  - Uses native PCIe and DP drivers
- Compatible with standard DisplayPort
  - Thunderbolt ports can operate in native DP mode
- Small connector with cable options
  - Active electrical cable (up to 3m) w/ 10W power, or can be extended with…
  - Active optical cable (up to tens of meters)
- Daisy chain topologies
  - 6 Thunderbolt devices and 1 native DisplayPort display

Example PC System Diagram
Other system configurations possible



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Thunderbolt™ Brand

- **Brand Promise:**
  - All Thunderbolt™ branded products interoperate across all vendors
  - A single (electrical) Thunderbolt connector for all Thunderbolt branded products and cables

- **Key Requirements**
  - Signed Thunderbolt technology and trademark licenses
  - All PC's & Peripherals must pass certification testing.

- **Licensed Assets**
  - Logo for marketing – for use in product packaging, marketing, advertising, web, print
  - Icon for products – for use on bezel to identify connector(s), used on cables
  - Details of use documented in Thunderbolt technology trademark and Logo Usage Guidelines

THUNDERBOLT™

TM

Industry Device Enabling

Flexible System Designs

Multi-Function Monitors

I/O, Card Expanders

Dongles

High-Performance Storage

Desktop Storage

Mobile Storage

Card Readers

THUNDERBOLT.

Media Creation, Transfer

Cameras

Video Capture Interfaces

Audio, Video Creation Interfaces

Thunderbolt™ Technology

Industry Participation

WD Western Digital®

Canon

AJA® VIDEO SYSTEMS

AVID™

Seagate

Blackmagicdesign

SONNET™ SIMPLY FAST™

matrox®

RED DIGITAL CINEMA RED ONE

PROMISE® TECHNOLOGY, INC.

OCZ Technology

MAGMA™

Adobe

G-Technology by Hitachi

iomega®

UNIVERSAL AUDIO INC.

mLogic®

LACIE

data robotics, inc.

GRIFFIN

ATTO ATTO Technology, Inc.

elgato

BELKIN®

MOTU®

Summary

- Thunderbolt™ technology is the fastest PC I/O technology at 2 channels of 10Gbps bidirectional per cable
- PCI Express* and DisplayPort* protocols natively supported
- Innovative usage models are possible with Thunderbolt technology
- Industry support for Thunderbolt technology is growing

Q&A

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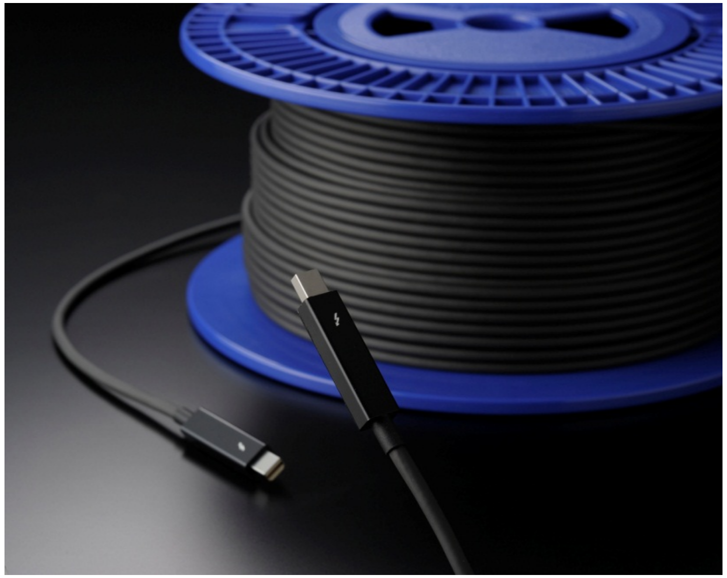
Rev. 5/9/11

Thunderbolt^{TM} Cable



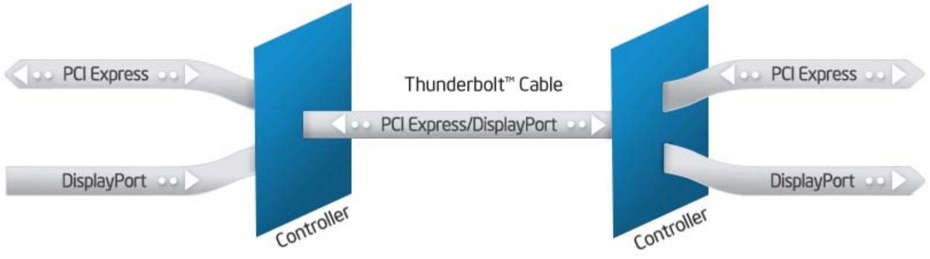
Thunderbolt$^{\mathrm{TM}}$ケーブル及びコネクタ

Thunderbolt$^{\mathrm{TM}}$ Cable

- 10Gbps双方向　2ch
- コネクタに方向性無く、データ／ディスプレイ用に接続可能
- コネクタ内にアクティブ回路を内蔵
- Thunderbolt$^{\mathrm{TM}}$機器を6台までデイジーチェーン可能

Thunderbolt$^{\mathrm{TM}}$ Connector

- 標準mDPケーブルも接続可能
- 10Gbps伝送を実現するために、標準mDPとの互換性を有するコネクタで10Gbps伝送を実現

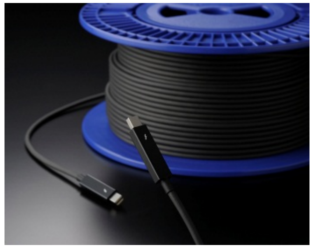
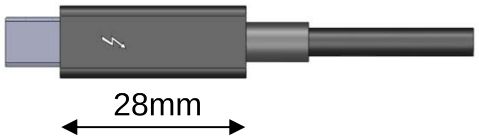
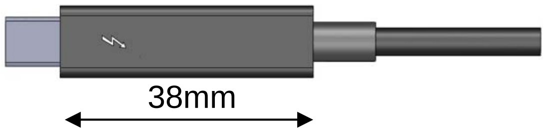


Thunderbolt^{TM}ケーブルのコンプライアンス試験

- 全てのThunderbolt^{TM}製品はコンプライアンステストを合格しなくてはいけない。
- 現在、インテルにて機能コンプライアンス試験及び電気コンプライアンス試験を実施

住友電工のThunderbolt^{TM}ケーブルは
インテルのコンプライアンステストに合格

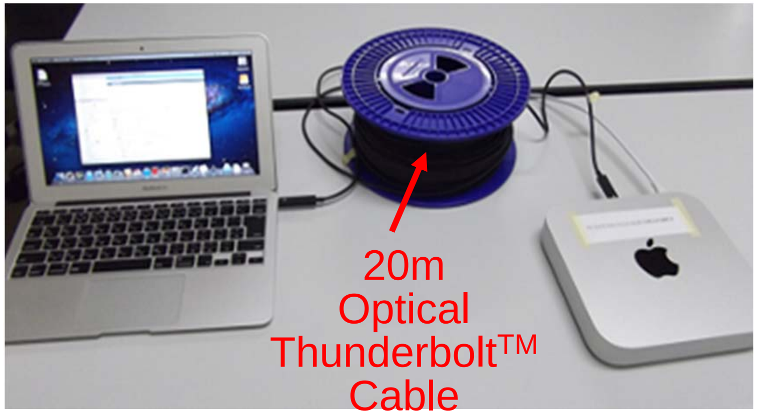
住友電工のThunderbolt™ケーブルラインナップ

	メタルケーブル 	光ケーブル 
伝送媒体	銅線	光ファイバー
ケーブルラインナップ	0.3m、0.5m、1.5m、1m、2m、3m	10m、20m
ケーブル外径	Φ4.2mm	Φ4.2mm
コネクタ寸法		
バスパワー給電	有り(10W)	無し
リリース状況	販売中(法人向け・Amazon.co.jp)	サンプル出荷中

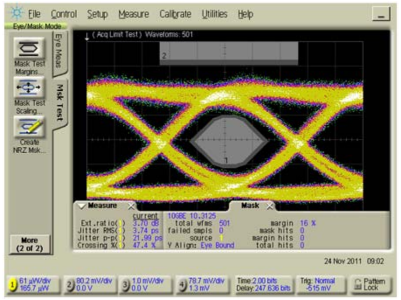
・世界初Optical Thunderbolt™ Cableのサンプル出荷開始
・メタルケーブル、光ケーブル共に同じケーブル外径、同じ使い勝手を実現
・メタル、光共に細く、しなやかで取り扱いやすいケーブル

Optical Thunderbolt^{TM} Cable

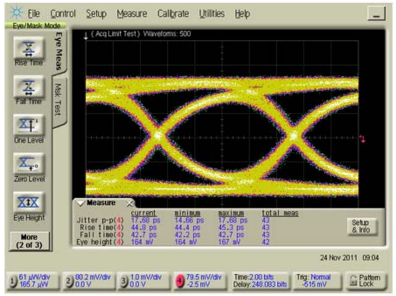
動作検証


20m Optical Thunderbolt^{TM} Cable

TX Waveform



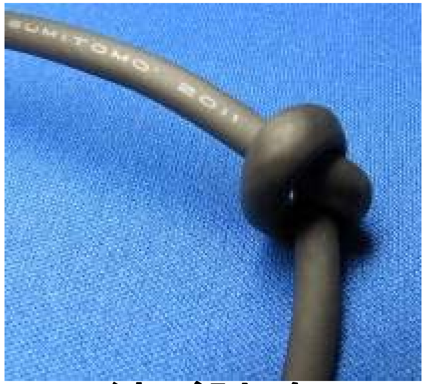
RX Waveform



20m伝送で良好な10G伝送波形

強靭性・堅牢性を追求した光ケーブル(当社独自の試験であり、Thunderbolt^{TM} 仕様ではありません)


ピンチ試験


結び試験


ステープルガン試験


引張試験

光ファイバーの断線無く、試験後のThunderbolt^{TM}の伝送を確認

Optical Thunderbolt^{TM} Cableの想定用途例

NAB2012 Blackmagic Design社ブース

Thunderbolt^{TM}デジタルシネマカメラ

ユニバーサルビデオハブ
(Thunderbolt^{TM}ルーター)

4K動画コンテンツの普及に伴い、映像機器が扱うデータ量が爆発的に増大

プロシューマー向け機器接続用Thunderbolt^{TM}ケーブルとしての需要立ち上がり

A3

テクトロニクスのThunderbolt Technology 物理層テスト・ソリューション

テクトロニクス・イノベーション・フォーラム2012

営業技術統括部　畑山　仁

www.tektronix.com/ja

Thunderbolt Technologyとコンプライアンス・テスト

- すべてのThunderbolt Technology機器（ホストおよびデバイス、ケーブル）はコンプライアンス・テストを受ける必要がある
- テクトロニクスはThunderbolt Technologyに関して唯一の民間認証会社である米国Granite River Labs Inc.（GRL）とともにテスト仕様策定、および認証測定でインテル社に協力
- 電気的特性テスト
  - トランスミッタ
  - レシーバ
  - リターン・ロス
  - HDMIおよびDisplayPortソース・テスト：ホストおよび2ポート・デバイスの場合
- SATA、PCI Expressなどのインタフェースを備えている場合には、事前に各規格のコンプライアンス・テスト相当の確認をしておくことも必要
- 必要構成・測定方法等は変更される可能性があります。ご了承ください

GRL
GRANITE RIVER LABS

必要な構成（トランスミッタ）

- 16GHz 以上のDSA70000C/Dシリーズ、あるいはMSO70000Cシリーズ
  - 最低限DSA71604C型、MSO71604C型
  - MSO70000CシリーズにはOpt.DSAUが必要
  - オプションTBT-TX TBT+自動化、デバッグ・ソリューション
- TF-TB-TPA-P Thunderboltプラグ・テスト・アダプタ
- TF-TB-TPA-UH Thunderboltポート・マイクロコントローラ
  - PC用スクリプト・ファイルはライセンス・デベロッパのみ入手可能
- PMCABLE1M型　SMA-SMAペア・ケーブル 4セット
- クロストーク・ソース：BSA125C型あるいはThunderboltデバイス
  - 前者の場合はパワー・デバイダが2組必要
  - 後者の場合にはTF-TB-TPA-P、 TF-TB-TPA-UHがもう1組必要
- その他
  - バス・パワード・デバイスの場合、電源が必要
  - PC、USBケーブル
  - マイクロソフトExcel

必要な構成（レシーバ）

- 12GHz 以上のBSAシリーズ　BERTScopeビット・エラー・レート・アナライザ
  - 最低限BSA125C-STR型
- BSA12500ISI型　汎用ISI基板
- TF-TB-TPA-P Thunderbolt プラグ・テスト・アダプタ
- TF-TB-TPA-UH Thunderbolt ポート・マイクロコントローラ
  - PC用スクリプト・ファイルはライセンス・デベロッパのみ入手可能
- PMCABLE1M型 SMA-SMAペア・ケーブル 3セット
- その他
  - バス・パワード・デバイスの場合、電源が必要
  - DCブロック 2個
  - SMA50Ωターミネーション 2個
  - PC、USBケーブル

必要な構成（その他）

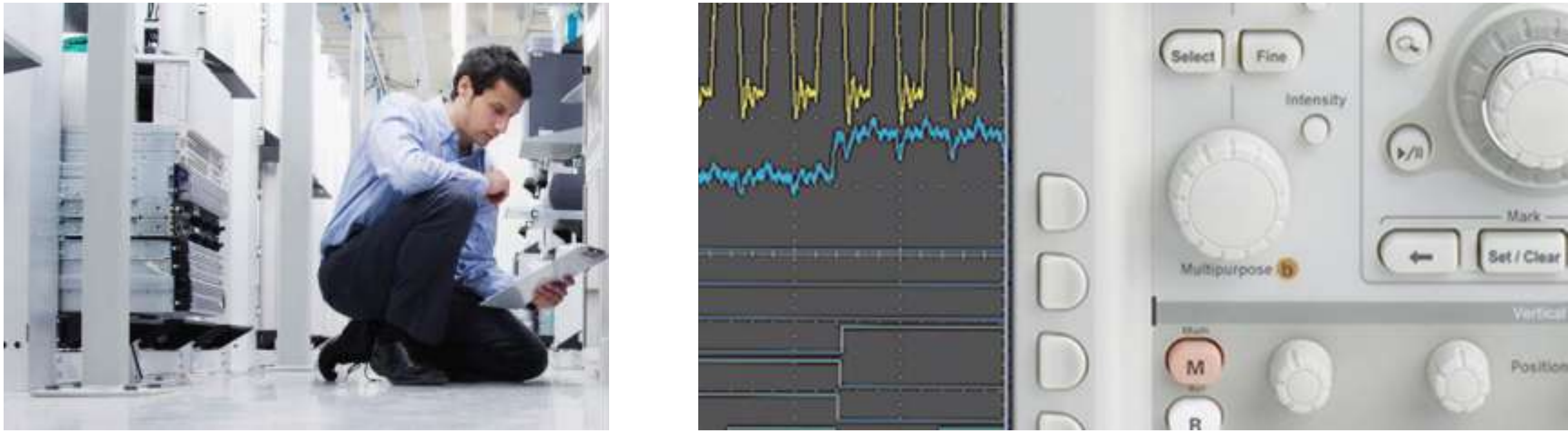
リターン・ロス ・テスト

- DSA8300型デジタル・シグナル・アナライザ本体
- 2チャンネル・サンプリング／TDRヘッド 2台推奨
  - 80E04型
- 80SSPAR IConnect Sパラメータ／Zライン・ソフトウェ

HDMIおよびDisplayPortソース・テスト（ホストおよび2ポート・デバイス）

- オプションDP12 DisplayPort自動コンプライアンス・テスト・ソリューション
- オプションHT3 HDMIコンプライアンス・ソフトウェア
- TF-MINI-DP-TPA-PT miniDisplayPortプラグ・テスト・アダプタ
- TF-HDMI-TPA-STX HDMIプラグ・テスト・アダプタ
- P7313SMA型 SMA入力差動プローブ 4本
- MiniDisplayPort⇒HDMI変換アダプタ
  - 例：Moshi MiniDisplayPort⇒HDMI変換アダプタ
- その他

ご清聴いただきありがとうございました



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