EqcoLogic is now Microchip
Extending cable transmission distances and printed circuit board (PCB) trace lengths through better equalization

Microchip, created to be better. To be better, you have to be different.
Equalizer Principles

Equalization technology overcomes degradation of digital signals due to attenuation over an electrical conductor. The compensation applies to conductor length limitations, data rate restrictions or both.
## Products & Application

<table>
<thead>
<tr>
<th>Product</th>
<th>Function</th>
<th>Typical Applications</th>
<th>Protocol</th>
<th>Downlink speed</th>
<th>Uplink speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQCO400T</td>
<td>Unshielded Twisted Pair &quot;UTP&quot; (CAT5/6) Cable Equalizer</td>
<td>Peripherals; industrial automation; machine vision</td>
<td>1394b (FireWire) &amp; Differential Signaling</td>
<td>400Mbit/s</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100m distance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EQCO850SC</td>
<td>Symmetrical Coax Transceiver for 50-ohm Coaxial Cable and Optical Cable</td>
<td>Ethernet over coax surveillance; industrial data and video transmission</td>
<td>Differential &amp; 8b/10b Signaling Ethernet (Fast and Gigabit) 1394b (FireWire) &amp; Optical</td>
<td>Up to 1.2Gbit/s</td>
<td>Up to 1.2Gbit/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EQCO875SC</td>
<td>Symmetrical Coax Transceiver for 75-ohm Coaxial Cable and Optical Cable</td>
<td>Ethernet over coax surveillance; industrial data and video transmission</td>
<td>Differential &amp; 8b/10b Signaling Ethernet (Fast and Gigabit) 1394b (FireWire) &amp; Optical</td>
<td>Up to 1.2Gbit/s</td>
<td>Up to 1.2Gbit/s</td>
</tr>
<tr>
<td>EQCO62T20</td>
<td>CoaXPress (CXP) Transceiver pair (Transmitter and Receiver)</td>
<td>Machine Vision; vehicle traffic video surveillance</td>
<td>CoaXPress (CXP), LVDS, Differential &amp; 8b/10b Signaling</td>
<td>Up to 6.25Gbit/s</td>
<td>Up to 20Mbit/s</td>
</tr>
<tr>
<td>EQCO62R20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EQCO30T5</td>
<td>HD-SDI Transceiver pair (HDCCTV) based on SMPTE</td>
<td>Surveillance cameras, DVR &amp; Repeaters</td>
<td>SDI (290Mbps, 1.5 &amp; 3Gbps), SMPTE</td>
<td>To 3Gbit/s</td>
<td>Up to 5Mbit/s</td>
</tr>
<tr>
<td>EQCO30R5.D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
EQCO62T20 (Transmitter)
EQCO62R20 (Receiver)

Basis of new CoaXPress™ (CXP) Standard developed and promoted by JIIA
Japan Industrial Imaging Association
What is CoaXPress™? “CXP”

- An Industry Standard serial communication protocol developed to increase transmission bandwidth, distance and power over common coaxial cable for industrial machine vision and high speed inspection systems.
- High speed replacement for legacy Camera Link technology
  - Enables 4x increase in Speed
  - Enables 10x increase in cable distance
  - Enables lower standard coax cables
- Supported by 3 Industrial Industry Associations: JIIA, AIA and EMVA (also known as G3 Organization)
CoaXPress is the Principal protocol for machine vision

Gives longest range, highest speed and lowest cost solution for high end machine vision

- Invented & documented by EqcoLogic (now Microchip) plus partners
- CoaXPress won “Vision Award” 2009

- EqcoLogic (now Microchip) is the sole supplier for all transceiver chips

Early OEM Customers include:
- Matrox Imaging
- Teledyne-Dalsa
- Toshiba Teli
- Hitachi Kokusai
- Canon
- E2V
- Imperx
- Bitflow
- Adimec
- Active Silicon
- Mirtec (for Samsung)
- Sumitomo
- AvalData
Transceiver circuits in CXP Systems

Speed and Range

Performance of Equalizer core in Frame-Store side receiver determines range for given cable type

Evaluation boards available for sale
Features

- Multi-Rate adaptive equalization technology
- Supports up to 50m at 6.2Gbps with high quality coax; shorter links or lower bit rates can utilise low-priced coax. Scope also for higher speed devices.
- Separate transmitter and receiver with integrated equalizer form a bidirectional connection over a single 75Ω coax cable
- Supports Power distribution over the coax, superimposed on the data signals (> 10W power available to remote device)
- Bidirectional splitter functions on-chip for low component count and easy interfacing to FPGA’s and/or CDR chips
- High-performance link:
  - Downlink speeds from 270Mbits up to 6.2Gbps now;
  - Flexible, protocol agnostic Uplink supporting from 0 to 20Mbps
- Low Power: 150 mW for each device. Both devices have single 3.3V supply
- Both devices are packaged in 16-pin, 4mm QFN package
Video Security and Surveillance

The video security market is transitioning from analog CCTV to digital video security cameras, monitors and recorders.

- Defense Sector
- Border Security
- Retail Monitoring
- Residential Security
- Critical Infrastructure
- Transportation & Logistics
- Aviation & maritime Security
- Safe Cities & Smart Cities
- Commercial & Public Buildings
- Entertainment & Casino Security
Analog CCTV market is in Transition

Key Competing Technologies: Ethernet

Characteristics of transition from Analog to Ethernet (IP) Video

- Compressed video to enable lower bandwidth requirements (100Mbit/s max)
- Bandwidth requirement is typically <50Mbps
- HD Video quality not as good as SDI, but good enough
- Has latency concerns, but good enough
- Capable of being networked and viewed remotely via the internet
- Can be hacked via the network
- Video already compressed for storage (removes need for compression chips)
Analog CCTV market is in Transition

Key Competing Technologies: SDI

Characteristics of transition from Analog to SDI Video Transition

- SDI signal is un-compressed (extremely good video quality)
- Large bandwidth throughput requirements
- Supports Full HD Quality
- Signal has near zero latency (real-time video) (Choice for Banks & Casinos)
- Point to Point solution which can not be hacked via network
- Up to 3Gbit/s Transmission rates
- Video has to be compress for storage
- Camera Control (RS-485) over coax is a growing requirement
- Power over Cable (PoC) over coax is a growing requirement
- Must be based on SMPTE Broadcast video Standard
Ethernet (IP) over Coax Adapters

- IP is normally transmit over Cat5/6 cables
- EQCO875SC transceivers enable transmission over existing coax cables
- Cost saving
- Longer range
- Allow power transmission over cable

Part Numbers for Integrators:
- Ethernet-over-Coax Adapters: “FastECoax-7501”
- HD-SDI Repeaters: “EQCO-SDI-30-7502”

HD-SDI (HD-CCTV) Repeaters and solutions

- Uses existing coaxial cable
- EQCO-SDI-30-7502 Repeater is sold as finished Integrator product

Support:
- System solutions
- Chips
- Reference designs
HD-SDI over Coax

The video security market is transitioning from analog CCTV to digital video security cameras, monitors and recorders.

- Defense Sector
- Border Security
- Retail Monitoring
- Residential Security
- Critical Infrastructure
- Transportation & Logistics
- Aviation & maritime Security
- Safe Cities & Smart Cities
- Commercial & Public Buildings
- Entertainment & Casino Security
HD-SDI (HDCCTV)
Video Surveillance and Monitoring

HD-SDI Camera uses EQCO30T5

HD-SDI DVR uses EQCO30R5
4, 8, 16, 32 Channels

Repeater uses both EQCO30T5 and EQCO30R5

- Microchip provides chips and reference designs to camera, repeater and digital recorder manufacturers
Compatible with all SMPTE Video up to 3G-SDI data-rates

- SMPTE 259M – SDI - 143 to 360 Mbps
- SMPTE 344M – 540 Mbps
- SMPTE292M - HD-SDI – 1.485 Gbps
- SMPTE372M – dual link HD-SDI – 2.97 Gbps
- SMPTE424M– dual speed HD-SDI - 2.97 Gbps

Equalizer is pin compatible to Semtech and Texas Instruments parts
EQCO30T5 and EQC30R5 Transceivers
HD-SDI (HDCCTV)

Speed and Range

Scope for higher speed

HD-SDI Camera

EQCO30T5 on camera board

DVR Board
4.8, 16, 32 Channel

EQCO30R5 on DVR board
EQCO30T5 & EQCOR5 for HD-SDI & Broadcast Video

Can be used with low cost FPGAs

<table>
<thead>
<tr>
<th>Range using Belden 1694A (including 5 Mbps uplink and power supply transmission)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>270 Mbps</strong></td>
</tr>
<tr>
<td><strong>1.5 Gbps</strong></td>
</tr>
<tr>
<td><strong>3 Gbps</strong></td>
</tr>
</tbody>
</table>

Microchip Simultaneous Advantage:
- Power over Cable (PoC)
- Uplink for Camera Control (RS-485)
- Long Distance (up to 220m)
- Very high bandwidth (up to 3Gbit/s)
EQCO30T5 & EQCO30R5 Transceiver Circuits for HD-SDI

Features

- Operates with HD-SDI and 8b/10 coding
- Transmission at long cable distance (Belden1694A):
  - 140m @ 3.0 Gbps
  - 220m @ 1.5 Gbps
  - 500m @ 270 Mbps
- 5Mbps uplink for Camera Control
- Low Power 220 mW @ 3.3 V
- Single 3.3 V supply
- -40°C to + 85°C temperature range
- 16-pin, 0.65 mm pin pitch, 4 mm QFN package
- Pb-free and RoHS compliant
- Both devices are packaged in 16-pin, 4mm QFN package
- Can be used with low cost FPGAs
HD and 3G-SDI Repeater
EQCO-SDI-30-7502

EQCO-SDI-30-7502

- Average installed coax cable run is 300-500 meters.
- Today’s HD-SDI camera & DVRs are limited to 150m distance
- Repeaters are needed to extend transmission distance
- Up to 5 HD-SDI Microchip Repeaters can be placed in series to deliver transmission up to 1 Kilometer
- Microchip Repeater enable simultaneous video, PoC and camera control (RS-485) at 3Gbit/s
Repeater design using EQCO30T5, EQCO30R5 & Reclocker

Up to 450 meters over 5C2V cable

HDCCTV Transmit Solution
- Camera SoC

HDCCTV Receive Solution
- DVR SoC

(3G/HD)-SDI Repeater
- Video equalizer EQCO30R5
- Reclocker
- Cable driver EQCO30T5

SDI-in + 5 Mbps out (optional)
LF-in (optional)
LF-out (optional)
SDI-out + 5 Mbps out (optional)
DC power

Camera -> Repeater1 -> Repeater2 -> Monitor

SD: 450 m
HD: 200 m
3G: 140 m

Range of equalizer in monitor
Ethernet (IP) over Coax

The video security market is transitioning from analog CCTV to digital video security cameras, monitors and recorders.

- Defense Sector
- Border Security
- Retail Monitoring
- Residential Security
- Critical Infrastructure
- Transportation & Logistics
- Aviation & maritime Security
- Safe Cities & Smart Cities
- Commercial & Public Buildings
- Entertainment & Casino Security
Re-using COAX cable for IP cameras

- IP cameras are being installed all over the world, replacing analog CCTV devices
- IP cameras usually transmit images using the Ethernet standard, typically at 100Mbit/s
- Normally new cabling is installed – unshielded twisted pair (UTP) - either Cat5 or Cat6
- Microchip prevents existing coaxial cable from being wasted

EQCO875SC transceiver enable simple converters to transmit Ethernet (IP) signals over long lengths of existing coaxial cables
Ethernet (IP) Video Surveillance and Traffic Monitoring

IP Camera normally transmits over Cat5/6 cable

- Cost saving – use installed cable
- Longer range over coax; CAT5/6 cable limited to 100m
- Enables power transmission (PoC) and PoE over cable
- EQCO875SC used for IP over coax – up to 250m
- EQCO1T6 & EQCO1R6 used for IP over coax – 450m

Use installed Coax

Support:
- System solutions
- Chips
- Reference designs
Benefits of FastECoax-7501 Coax Adapters:

- Uses EQCO875SC transceiver circuit connected by UTP cable to both the NVR receiver (or Ethernet switch) and the IP camera.

- The two adaptors are connected together using the existing “already installed” coaxial cabling.
**New solution under development:**
Asymmetric Ethernet over Coax converter – up to 450m

**8 Mbps Uplink**
- Camera Control (uplink) is capable of operating up to 8Mbps, from NVR to camera.
- Buffers, up to 60kb, are used to temporarily store frames in case burst speed rises above 8Mbps.

**Coax Cable**
- Enables transmission over cable lengths up to 450m with RG-6, or up to 350m for RG-59.
- Works with lower quality cables, typically 62 Ω impedance

<table>
<thead>
<tr>
<th>Coax Cable</th>
<th>Attenuation (@100MHz)</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG-6 (Belden 1694A)</td>
<td>6.4dB/100m</td>
<td>450m/1640ft</td>
</tr>
<tr>
<td>RG-59 (Belden 543945)</td>
<td>8.5dB/100m</td>
<td>350m/1150ft</td>
</tr>
</tbody>
</table>

Table: Asymmetric Ethernet over Coax performance
EQCO875SC & EQCO850SC
for
Ethernet (Fast and Gigabit), LVDS, 8b/10b
over coaxial cable
EQCO875SC & EQCO850SC – Architecture

PHY

EQCO800SC

Receive Path

Transmit Path

Input Pre-Driver

Input wake-up Detection

Active Signal Splitter/Combiner

Equalizer Core

Remote Wake-Up Detection

Output Driver

COAX Connector

SDIp

SDIn

SDOp

SDOn

SDIO

REF

CD
EQCO875/850SC for Firewire Differential Signal Applications

- EQCO875SC & EQCO850SC transceivers are placed between PHY’s and coaxial cable connectors
- Supports many signal protocols
  - LVDS
  - 8b/10b
  - Ethernet
  - FireWire (1394b)
- Any reasonable quality coaxial cable system (50Ω or 75Ω) can be supported.
  - The EQCO850SC is used for 50Ω coax
  - The EQCO875SC is used for 75Ω coax
EQCO800SC – features summary
Includes EQCO875SC and EQCO850SC

- Multi-Rate bi-directional link technology
- Combined transmitter/receiver with integrated equalizer to form a bidirectional connection over a single 50Ω (or 75Ω) coax cable
- For 1394b, seamless connection with PHY to S800 speed
- Supports MOST network; tested at 150Mbit/s but chip supports up to 1.25Gbit/s
- Auto-mute functionality for lowest application power
- Separate mute function for transmit and receive signal paths
- Low Power - 65mA (fully active), 5μA (TX and RX mute)
- Internal LVDS termination for low external discrete count
- Allows power distribution over the coax, on top of data signals
- Single 3.3V supply
Firewire over Coax - Dongles

- Transmits up to 60 meters over coaxial cable.
- EQCO875SC (EQCO-FW7501)
- EQCO850SC (EQCO-FW5001)

Support
- Chips
- Reference designs
- Systems/Solutions
## Products & Application

<table>
<thead>
<tr>
<th>Product</th>
<th>Function</th>
<th>Typical Applications</th>
<th>Protocol</th>
<th>Downlink speed</th>
<th>Uplink speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQCO400T</td>
<td>Unshielded Twisted Pair &quot;UTP&quot; (CAT5/6) Cable Equalizer</td>
<td>Peripherals; industrial automation; machine vision</td>
<td>1394b (FireWire) &amp; Differential Signaling</td>
<td>400Mbit/s</td>
<td>N/A</td>
</tr>
<tr>
<td>EQCO850SC</td>
<td>Symmetrical Coax Transceiver for 50-ohm Coaxial Cable and Optical Cable</td>
<td>Ethernet over coax surveillance; industrial data and video transmission</td>
<td>Differential &amp; 8b/10b Signaling Ethernet (Fast and Gigabit) 1394b (FireWire) &amp; Optical</td>
<td>Up to 1.2Gbit/s</td>
<td>Up to 1.2Gbit/s</td>
</tr>
<tr>
<td>EQCO875SC</td>
<td>Symmetrical Coax Transceiver for 75-ohm Coaxial Cable and Optical Cable</td>
<td>Ethernet over coax surveillance; industrial data and video transmission</td>
<td>Differential &amp; 8b/10b Signaling Ethernet (Fast and Gigabit) 1394b (FireWire) &amp; Optical</td>
<td>Up to 1.2Gbit/s</td>
<td>Up to 1.2Gbit/s</td>
</tr>
<tr>
<td>EQCO62T20</td>
<td>CoaXPress (CXP) Transceiver pair (Transmitter and Receiver)</td>
<td>Machine Vision; vehicle traffic video surveillance</td>
<td>CoaXPress (CXP), LVDS, Differential &amp; 8b/10b Signaling</td>
<td>Up to 6.25Gbit/s</td>
<td>Up to 20Mbit/s</td>
</tr>
<tr>
<td>EQCO62R20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EQCO30T5</td>
<td>HD-SDI Transceiver pair (HDCCTV) based on SMPTE</td>
<td>Surveillance cameras, DVR &amp; Repeaters</td>
<td>SDI (290Mbps, 1.5 &amp; 3Gbps), SMPTE</td>
<td>To 3Gbit/s</td>
<td>Up to 5Mbit/s</td>
</tr>
<tr>
<td>EQCO30R5.D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>