

Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [60GHz-band Gigabit Transceivers and Their Applications]

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Abstract:[60GHz-band gigabit transceivers and their applications are described.]

Purpose:[Contribution for millimeter-wave interest group]

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60GHz-band Gigabit Transceivers and Their Applications

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Introduction

- **High speed interfaces available at digital equipments (not for wireless)**
 - IEEE1394a-2000 (400Mb/s) / IEEE1394b (800Mb/s, 1.6Gb/s, 3.2Gb/s)
 - USB 2.0 (480Mb/s)
 - Gigabit Ethernet (1000Base-SX, 1000Base-T, etc.)
 - Others
- **Very wide unlicensed-bands allocated in U.S. and Japan to carry such high-speed data signals**
 - 57-64GHz (US)
 - 59-66GHz (Japan)
- **Low-cost module technologies developed for:**
 - Automotive radar systems at 60 and 77GHz
 - Indoor wireless systems at 60GHz, especially in Japan, by NEC, Fujitsu Quantum Devices, SHARP, etc.

ASK Transceiver Features

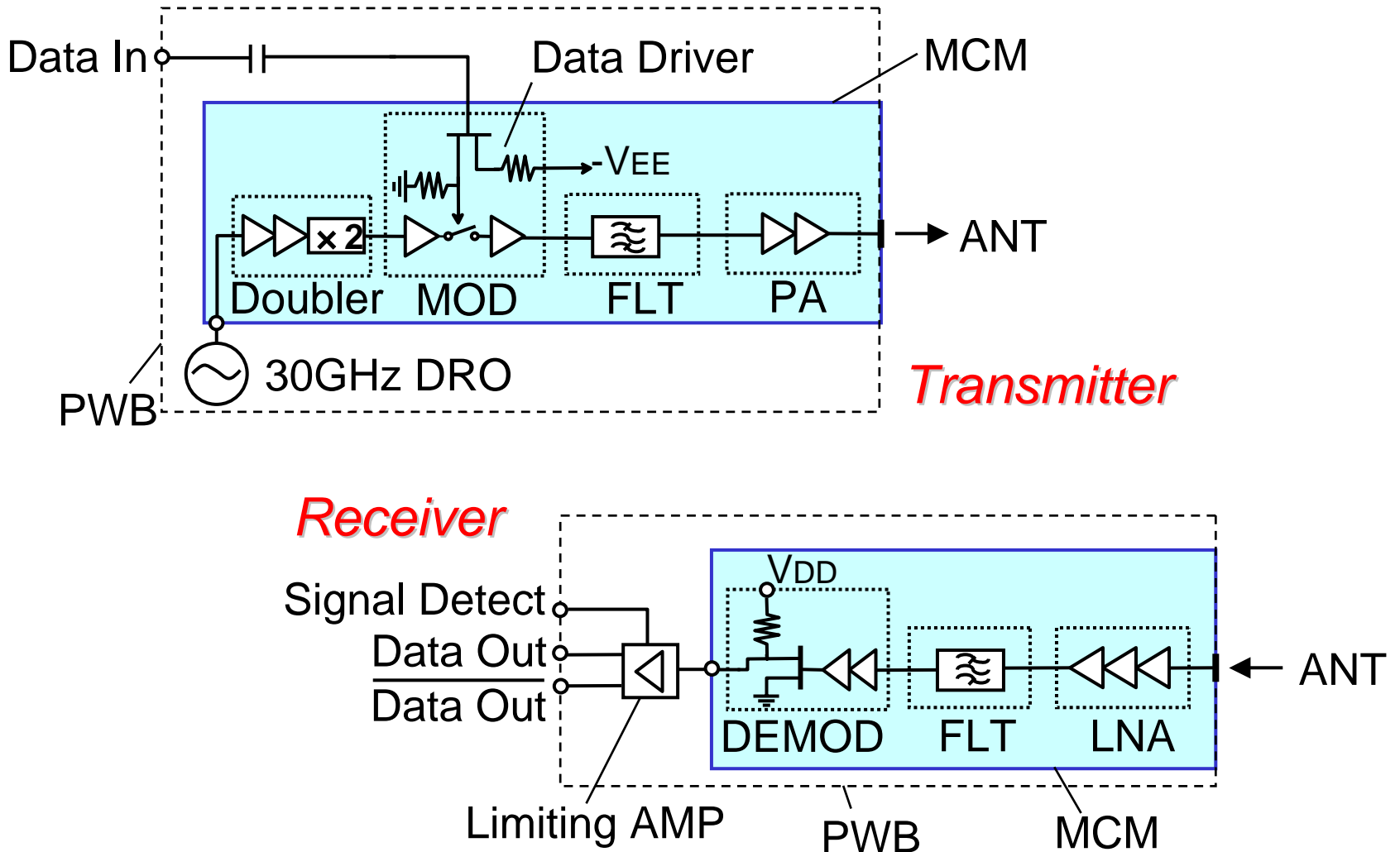
- **Promising for introducing into the market at an early stage**
 - Simple architecture
 - Feasible to transmit data at a speed of 1Gb/s and above
- **Low-cost**
 - Only one millimeter-wave oscillator
 - No need for large back-off operation (power amplifier)
 - Direct modulation/demodulation simplifying high speed circuits
- **Good connectivity with wired and fiber interfaces**
 - Handling high-speed serial data
 - Suitable for a through repeater in point-to-point communication
- **Careful design to avoid multi-path effect and obstacles**
 - Antennas and environmental situations

Japanese Technical Regulation

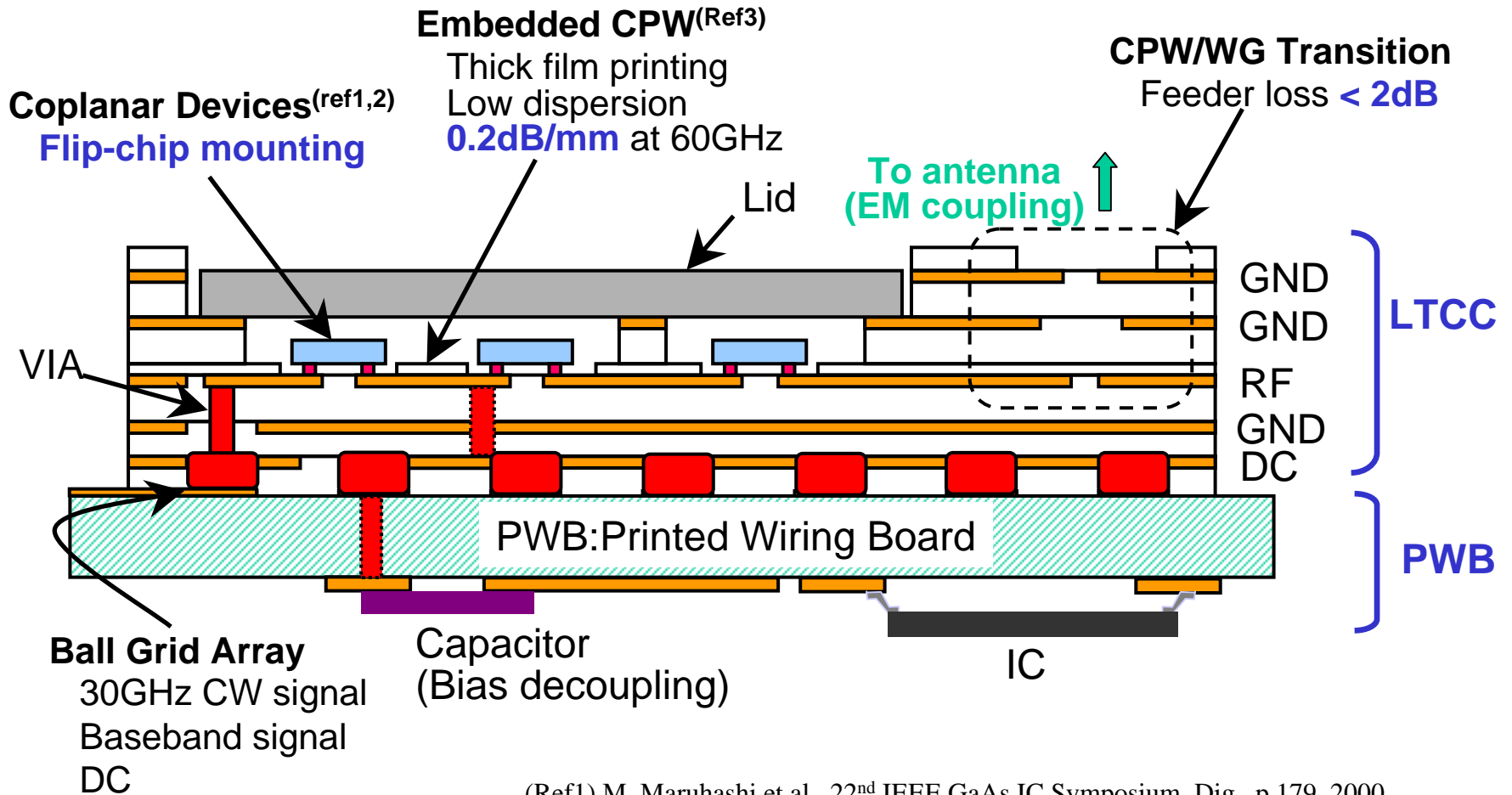
Parameter	Allowance
Unlicensed Frequency Band	59 - 66GHz
Carrier Frequency Tolerance	$\leq 500\text{ppm}$ (~30MHz)
Output Power	$\leq 10\text{mW}$ (10dBm)
Occupied Bandwidth*	$\leq 2.5\text{GHz}$
Spurious	$\leq 100\mu\text{W}$

*99% Power Occupancy

Transceiver Block Diagram

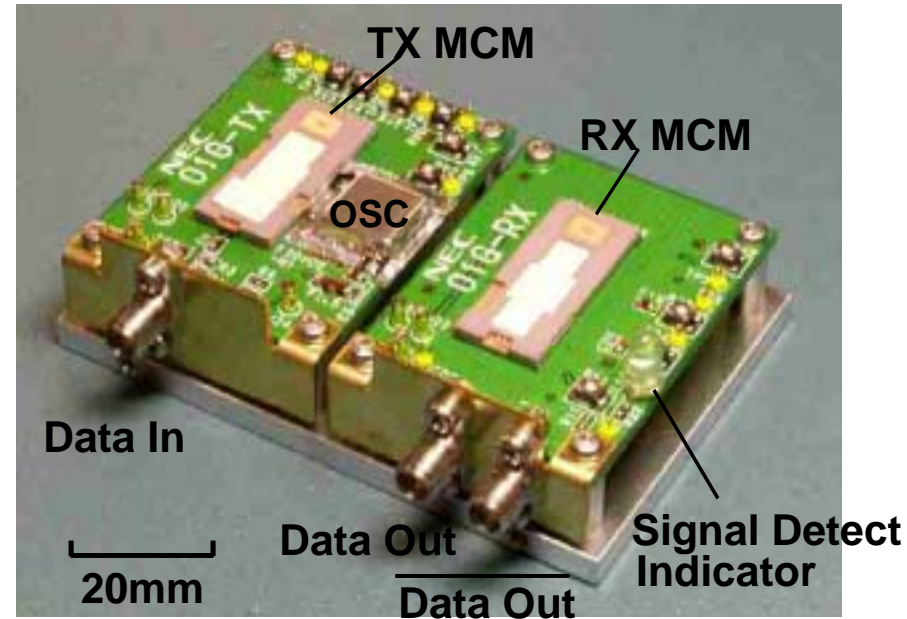
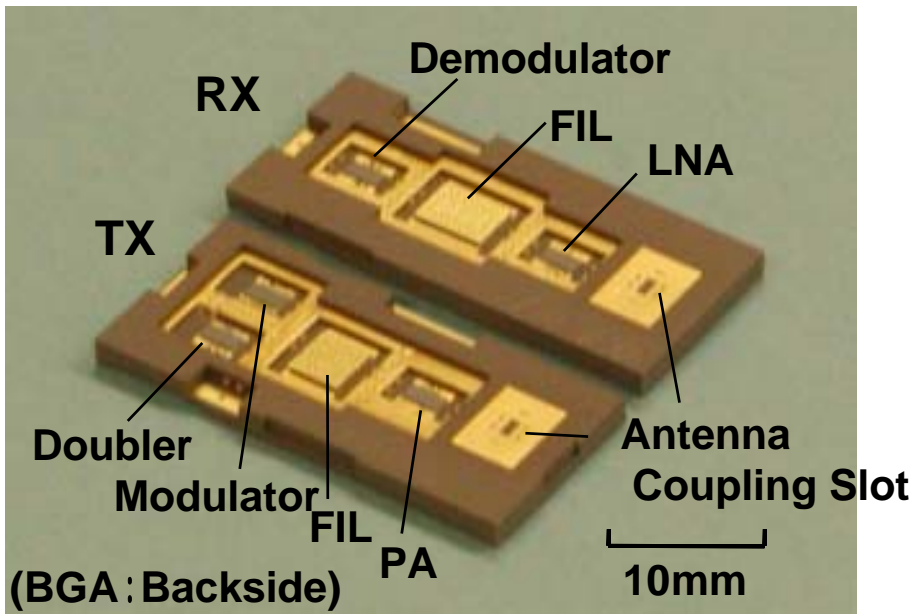


Ceramic Module



(Ref1) M. Maruhashi et al., 22nd IEEE GaAs IC Symposium, Dig., p.179, 2000
(Ref2) M. Ito et al., IEEE MTT-S Int'l Microwave Symposium, Dig., p.1789, 2002
(Ref3) K. Maruhashi et al, IEEE Int'l Solid-State Circuit Conf. Dig., p.324, 2000

Transceiver module operating up to 1.5Gb/s

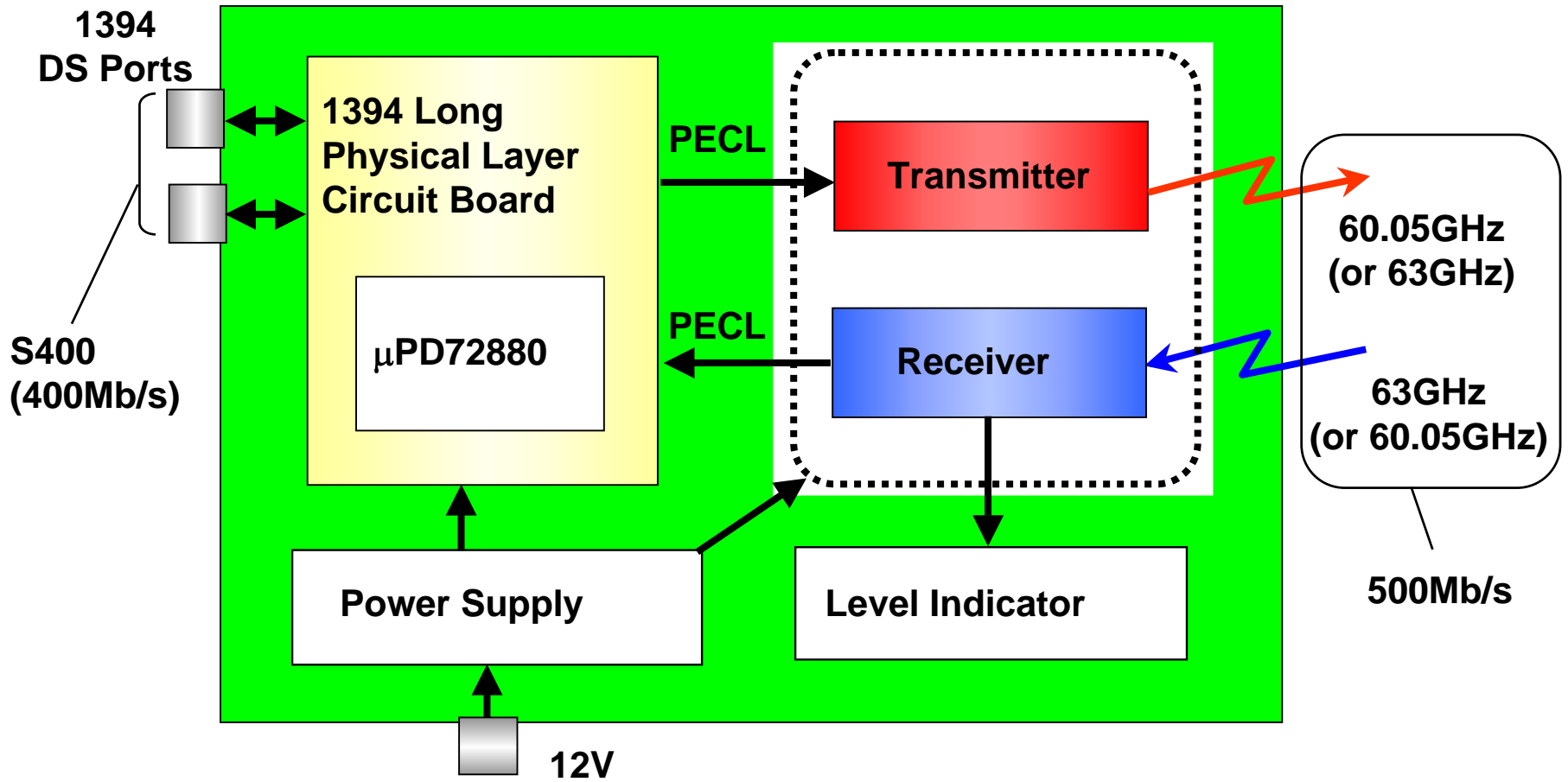


82×53×7mm³ (~30cc)
(Excluding Input/Output Connectors)

Multi-chip Modules (MCMs)

Transceiver Module

Block Diagram of Wireless 1394 Adapter (RF1394)



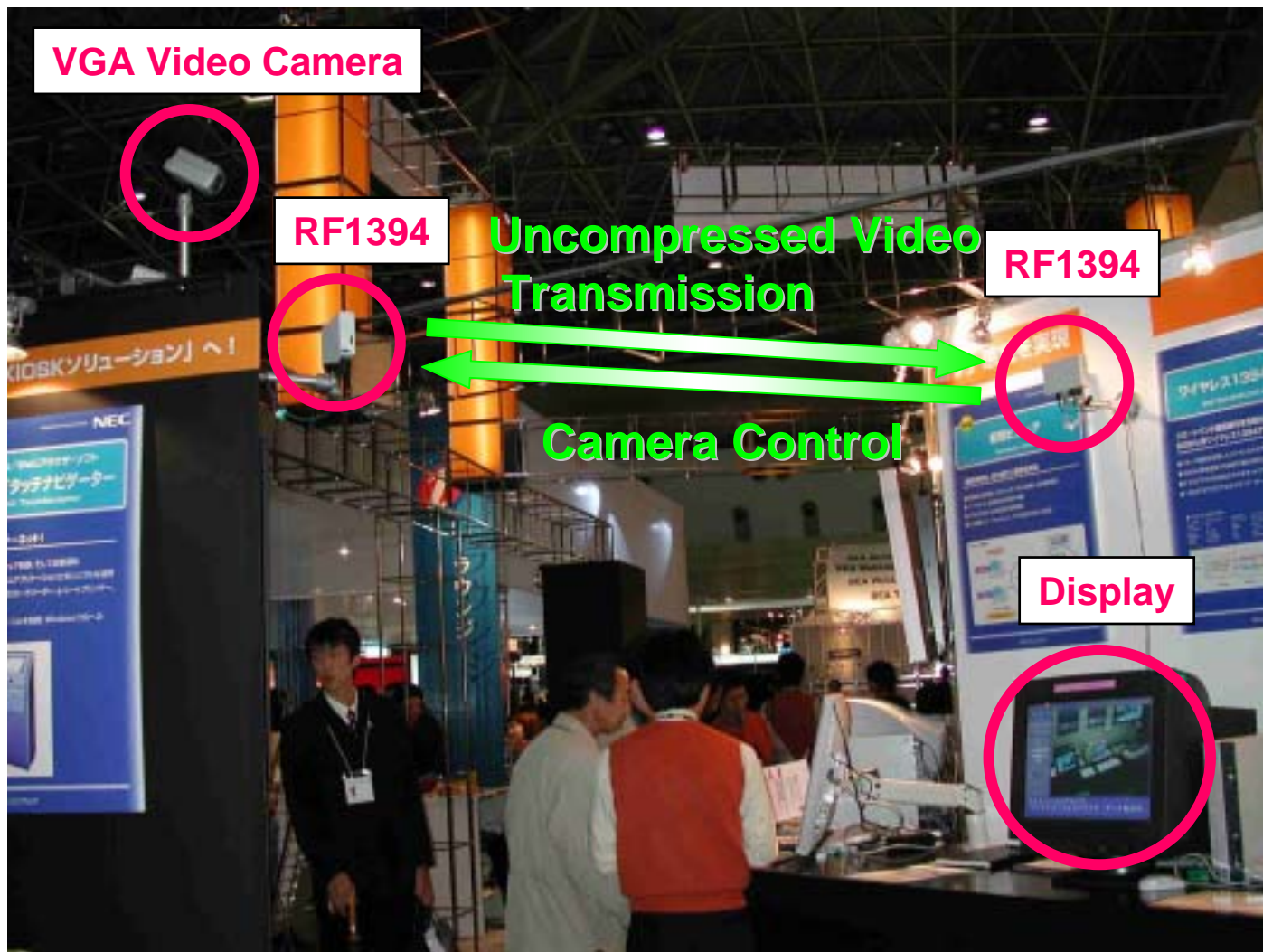
RF1394 Specification



Adapter Photograph

Carrier Freq. : 60.05GHz/63GHz
Output Power : 10mW
Occupied Bandwidth : ~1.5GHz
Antenna Beam Width : 10° (20dBi Gain)
Modulation Scheme : ASK(PCM)
Transmission Distance : 17m (Line-of-Sight)
Transmission Speed : 491.52Mbd
Transmission Link : Full Duplex
Modulation Coding : Scrambled 8B10B NRZ
Data Interface : IEEE1394a-2000 Standard
Power Supply : 12V/3.8W
Size : 141mm×91mm×32mm(~400cc)
Weight : 200g

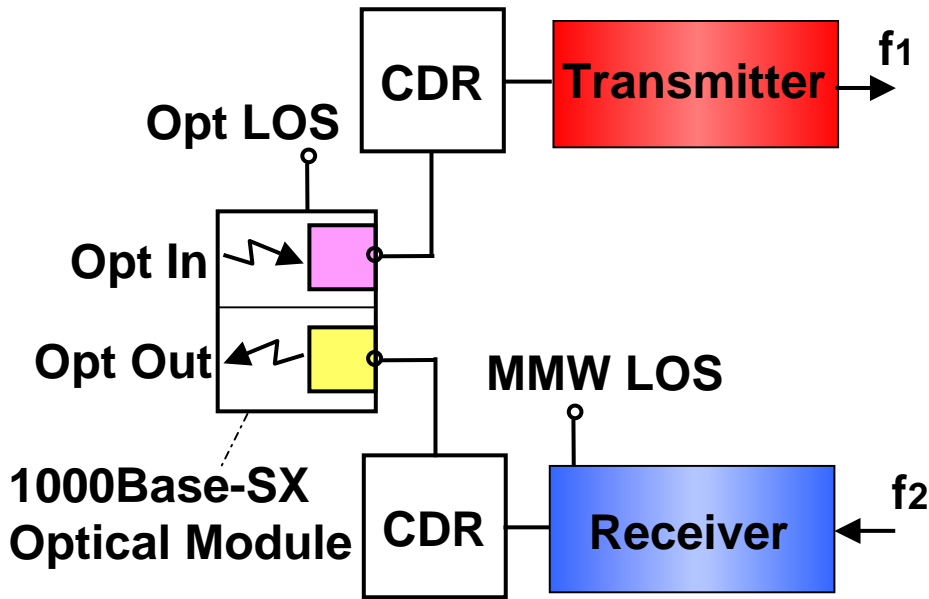
RF1394 Application Example (1)



RF1394 Application Example (2)



Wireless Gigabit Ethernet(GE) Link Transceiver



Transceiver Block Diagram



Opt. In/Out 159mm×97mm×44mm

Transceiver Photograph

Wireless Gigabit Ethernet Link Performance

Carrier Frequency	60.3 / 63.13GHz
Output Power	10.4 / 8.7dBm
Occupied Bandwidth	1.6 / 1.9GHz
Antenna Beam Width	12 ° (20dBi Gain)
Modulation	ASK (PCM)
Data Rate	1.25Gb/s Full Duplex 1.23Gb/s(TCP IP Throughput)
Transmission Distance	10m (LOS, error-free)
Data Interface	1000Base-SX (850nm Multi-Mode Fiber)
Power Supply	12V / 3W
Transceiver Size	159mm × 97mm × 44mm
Transceiver Weight	300g

Wireless GE Application Example (1)

Ultra High Speed Download System

- 1GB Download :
 <30s (Windows 2000 Server)



Contents Server



Client Server

Wireless GE Application Example (2)

Uncompressed High Definition Picture Transmission System

VGA 30fps
XGA 15fps
SXGA 7.5fps

Real Time Streaming

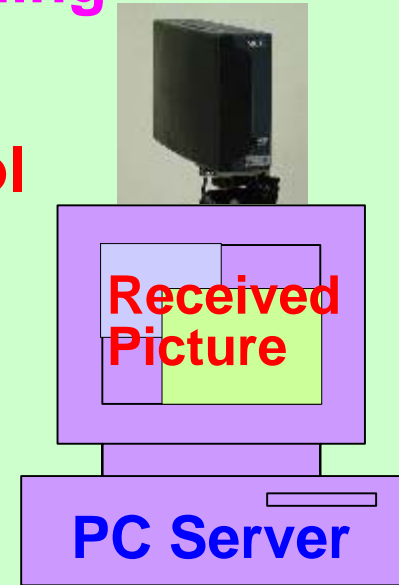
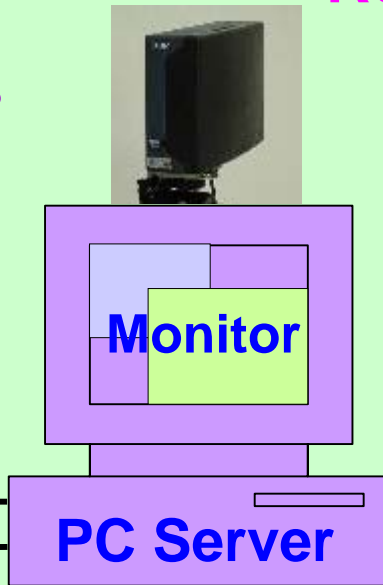
Camera Control



400Mbps



IEEE1394 Camera

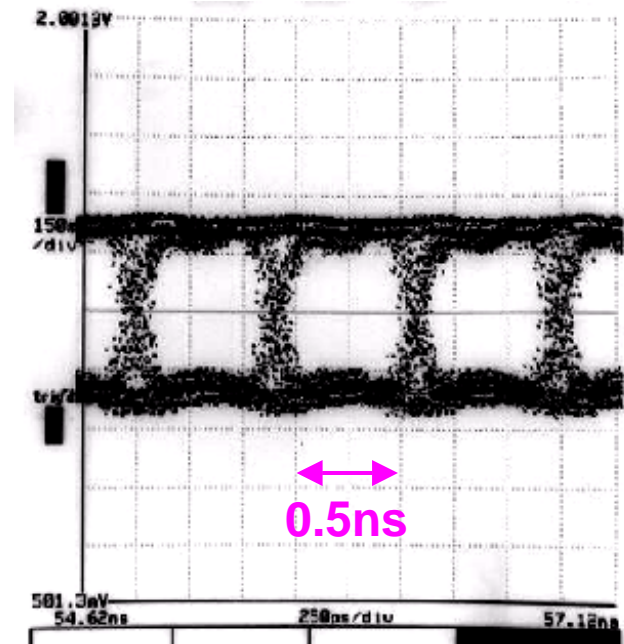


Uncompressed High Definition TV Signal Transmission

1.485Gb/s Uncompressed High Definition TV Signal Transmission based on HD SDI (Serial Digital Interface) Standard



Receiver and HD SDI Monitor



Eye Pattern of Received Signal

Conclusion

- **RF1394 and Wireless Gigabit Ethernet Link are introduced.**
- **Possible examples of wireless applications are presented.**