NEW PRODUCTS

# IEEE1394 LINK LSI FOR DIGITAL AV APPLICATIONS WITH COPY PROTECTION FUNCTION

# μPD72890 / μPD72891

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**The μPD72890 and μPD72891 are IEEE1394 link-layer controllers with copy protection and DV/digital AV signal reciprocal data exchange (μPD72891 only) functions, making them ideal as IEEE1394 interfaces for set-top boxes (STB), DVHS decks and other AV devices.**

## Introduction

Spurred on by the start of digital broadcasting on the BS satellite service, devices that handle digital contents are likely to appear in Japanese homes in increasing numbers. And ahead of all others, IEEE1394, with its established copy-protection technology, is leading the field as the ideal interface for communication between these digital AV devices.

People now receive a variety of picture media into their homes, ranging from satellite broadcasting to CATV and terrestrial digital TV. Consequently, as these media have become digitized and picture quality has improved, demand is increasing for technology that would allow these high-quality images to be recorded and played back without degradation. Balancing this demand, however, is the fear expressed by video and music contents providers that the realization of "pure" digital reproduction may invite an increase in the practice of unauthorized copying.

A communication interface that is one step ahead of all the others in solving these problems is the IEEE1394. With 400 Mbps high-speed communication, this interface not only allows picture and voice data to be simultaneously transmitted along multiple channels, but also contains a contents protection mechanism to prevent illegal copying of data being transmitted. This mechanism is compliant with the DTCP (Digital Transmission Content Protection) standard jointly subscribed to by contents providers and electronics manufacturers.

The μPD72890 and μPD72891 to be introduced here have been released as part of NEC's lineup of IEEE1394 link-layer LSIs, and feature both a copy protection function and an on-chip CPU to control it. The μPD72891 also contains a DV codec function to enable conversion of images captured by a digital video camera (DVC) into audio and video (AV) signals, making it ideal for STB, DVHS deck, and DTV applications (Fig. 1).

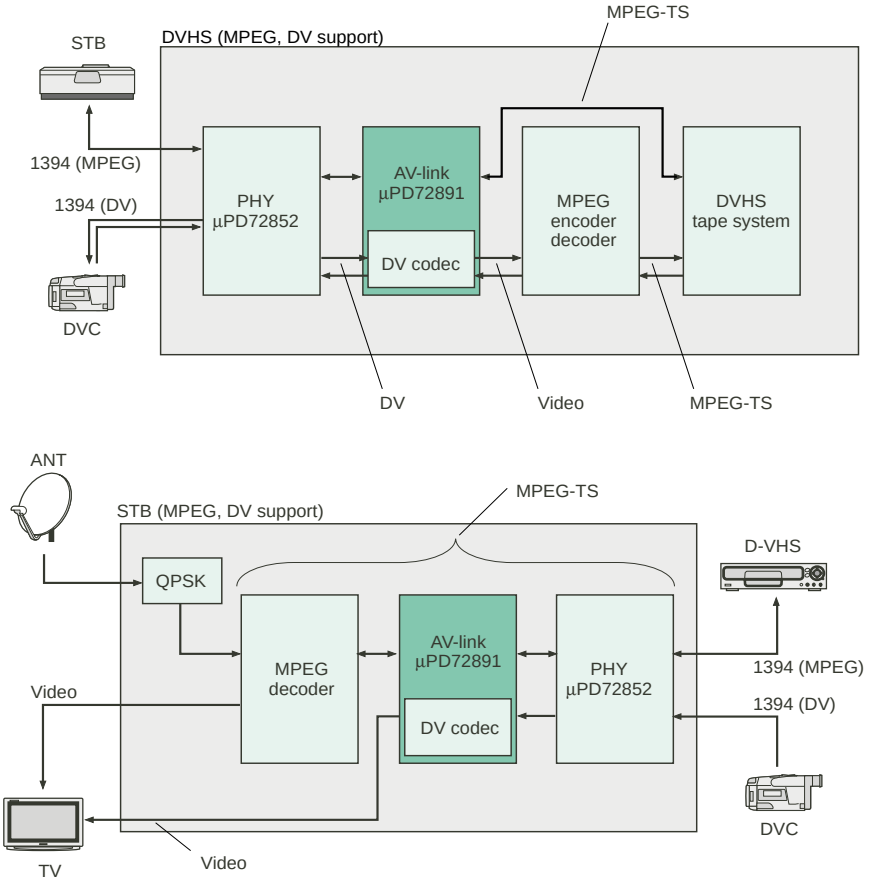


**Fig. 1 Application Example**

## Development Background

The basic technologies required of IEEE1394 products for digital AV applications include support for IEC61883 (transmission/reception of MPEG-TS and DVCR signals), copy protection, support for AV/C commands, and connection compatibility. Handling all these technologies,

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however, can cause a considerable increase in work at the system development stage, extending sometimes until after product shipment, especially in the case of system evaluation (including connection compatibility), and thus placing a continuous burden on the developer. NEC has therefore taken a number of steps to reduce this burden, such as integrating all these basic technologies on a single LSI, and supplying developers with its technological know-how.

## Features

The µPD7289x Series (Photo 1) was developed by NEC to satisfy the aforementioned demands from the digital AV device field. This series includes a lineup of four products covering a wide range of application fields (Table 1).

The main features of this series, listed below, are described in this section.

1. On-chip CPU
2. Support for DV codec (µPD72891/ µPD72893 only)
3. On-chip DTCP function (2 ch) (µPD72890/ µPD72891 only)
4. Support for IEC61883
5. On-chip IEEE1394 bus control function
6. Support for fully simultaneous 2-channel operation
7. API control method employed
8. High connection compatibility

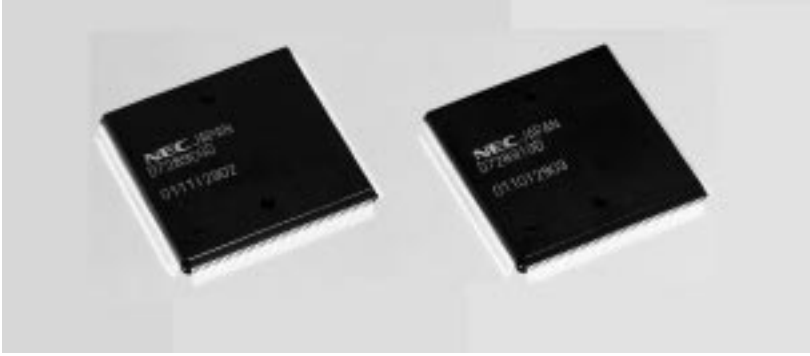

**Photo 1. µPD72980/µPD72981**

**Table 1 µPD7289x Series Lineup**

| | MPEG-TS Support | MPEG-TS, DV-Codec |
|---|---|---|
| DTCP supported Note 1 | µPD72890 Note 2<br>STB, DTV, etc. | µPD72891<br>DVHS, DVD, etc. |
| DTCP not supported | µPD72892 Note 2<br>PC peripherals | µPD72893 Note 2<br>DVC, PC peripherals |

Note 1 "DTCP supported" indicates that the DTCP function licensed by DTLA is included.
Note 2 Under development.

### 1. On-chip CPU

The most important feature of this series is the on-chip 32-bit RISC CPU (V850E), which was incorporated in order to realize the concept of a single LSI that contained all the functions required for digital AV devices. This CPU supports IEEE1394 bus control and AV/C commands, and controls DCTP processing. Moreover, because this firmware is included on the LSI, it is no longer necessary to perform program development.

### 2. Support for DV codec (µPD72891/ µPD72893 only)

STB or DVHS devices usually use signals in the MPEG-TS format, whereas DVC signals are in a DV format. It is therefore impossible to reproduce images captured by a DVC connected to an IEEE1394 pin that supports the usual MPEG-TS format. The µPD72891 and µPD72893 therefore incorporate a DV codec that enables DV signals handled by the IEEE1394 interface to be converted into AV signals, and vice versa (conversion of AV signals into DV-compressed signals). Through this on-chip DV codec device, not only MPEG-TS signals, but also those from globally popular digital video cameras can be supported.

### 3. On-chip DTCP function (2 ch) (µPD72890/ µPD72891 only)

DTCP is the only digital transfer method jointly subscribed to by the picture/music and electronics industries as a means of protecting copyrighted works. DTCP consists of a function for creating an authentication key to the works transmitted by a partner device, as well as a function for encoding and decoding real-time images, with the processing for these functions carried out inside the DTCP unit. Moreover, because the DTCP unit is on-chip, the high-speed processing required to avoid negative effects from the image wait time that occurs when devices are connected (especially in the case of the authentication function) can be achieved.

### 4. Support for IEC61883

The µPD7289x Series supports three formats: DVB, DSS (DirecTV), and DVCR, and each of the two stream ports can be set independently.

**5. On-chip IEEE1394 bus control function**

IEEE1394a 2000-compliant functions such as initialization operations after bus reset, an isochronous resource manager, and a cycle master are realized by hardware and on-chip firmware. An automatic response function for CSR access and other ASYNC transfers (transaction processing function) is also provided on the chip.

**6. Support for fully simultaneous 2-channel operation**

Each of the two stream port channels (MPEG-TS and DV signal I/O) included in the µPD7289x Series can operate independently, in accordance with the user's system. Moreover, because each channel supports the DTCP function, copy-protected signals can be simultaneously communicated to two devices (e.g. one channel receives and the other transmits).

**7. API control method employed**

Both a parallel (68000, ISA) and serial (UART) interface are incorporated in the µPD7289x Series as the host interface, enabling control of the LSI from an external CPU, and eliminating the necessity of directly accessing its registers. The LSI is controlled using the results obtained by the command functions executed from the CPU of the user's system via an API. Furthermore, as NEC supplies the API source code, users can use this code to build a system that suits their development needs.

**8. High connection compatibility**

The most important issue for communication LSIs is connection compatibility with other devices. With the µPD7289x Series, high connection compatibility has been achieved for IEEE1394 operation through the know-how built up in the development of previous NEC products for PCs (OHCI). For the copy protection function also, NEC conducted connection evaluations for existing devices from other manufacturers and used those results to produce high connection compatibility.

## Design Support Tools

NEC provides development tools for the µPD7289x Series, broadly divided into three solutions. The first solution is design reference in the form of evaluation boards and sample circuits. By using these tools at the feasibility study and early development stages, the development time can be significantly shortened. The second solution is software for evaluation tests and initialization. This software can be used for evaluation and confirmation after the board has been created. The third solution is the API source code and sample flow (application) provided by NEC to facilitate development of the control software required to control the µPD7289x Series externally. This source code and sample flow allows users to develop control firmware that satisfies the development aims of their system.

## Applications

As shown in Table 1, this series is suited to applications in the digital AV device field and PC peripherals such as media converters.

## Conclusion

In addition to the products introduced here, NEC is also promoting development of physical-layer LSIs, and a Combo-LSI, which integrates an OHCI link layer and a physical layer on one chip. Moreover, by simultaneously developing a range of development tools to aid designers, NEC is able to provide users with the ideal solution for their system architecture.

Readers are also invited to view NEC's IEEE1394 home page (http://www.ic.nec.co.jp/english/system/1394) for further information on device development and solutions.