Notes regarding the current version

- If using 4.5 m cables to make connections, no special knowledge is required when connecting up to 16 devices. However for larger systems, further understanding of connections is required, such as how connections can be branched.
- At present, it is not possible to create systems of 64 or more devices. In the near future, it will be possible to use devices called “bridges” to expand this to 63 x 1023 devices. However in this case as well, a certain amount of knowledge will be required.
- In the current version, even if 63 or fewer nodes are connected, there is no limitation regarding reception of realtime data such as audio and MIDI. However, the number of nodes that can transmit data is limited to approximately five devices.

  There is no limitation on the number of nodes that can transmit non-realtime data such as file transfers by IEEE 1394 devices. (The current version of mLAN does not support file transfer for mLAN devices.)

Troubleshooting

The following table provides troubleshooting hints for some common problems. Before calling for professional service, refer to the troubleshooting advice below to see if you can find and correct the cause of the problem.

Bus does not start up
- A loop connection may have been created. Check the cable connections.

Node is not displayed
- The power of an intervening node may be off, or a cable may be disconnected. If two or more CD8-mLAN cards are installed in an 02R, connections are also required between these cards.
- PC card hot plugging on the PowerBook is not supported. If you insert a new PC card, you must restart the system. If there are multiple 1394 adapters, you must specify the adapter.

mLAN plug is not displayed
- The reception plug (input plug) of a Macintosh is not visible from other nodes. Make connection settings on the Macintosh.
- For Direct mode on the CS6x/CS6R/S80, there is no reception plug (input plug).

Connection cannot be made
- A connection may have already been specified for the receiving device plug.
- The bus traffic may be approaching 100%.

Connection cannot be restored
- The connection may have been overwritten. Or, you have may performed Factory Set or mLAN Initialize. These operations will initialize the connection.
- The bus traffic may be approaching 100%.
- You may have switched devices. The connection will not be restored if you switch to a different hardware unit, even if the model is identical.

No sound
- Is a word clock being supplied? Does a word clock master node exist (if the word clock source is “ext.”).
- Is the Digital In of the mLAN8P connected? Is the Optical/Coaxial setting correct?
- Has mixer muting (channel off) been defeated on the mLAN8P/mLAN8E?
- The mLAN signals that can be received simultaneously by one Macintosh are limited to the signals transmitted from a single mLAN device. It is not possible to receive a total of two or more channels transmitted from multiple mLAN devices. Multiple channels transmitted from a single mLAN device can be received simultaneously. Even if OMS settings for multiple ports have been made, reception is limited to signals transmitted from a single mLAN device.

Can’t operate the panel
- The mLAN Mixer may be connected. It is not possible to operate the mLAN Mixer and the panel simultaneously.

Can’t receive/transmit MIDI
- In order to receive/transmit MIDI on the 03D, rear panel cable connections (TO HOST cable) and DIP switch settings are required.
- On the A4000/A5000 or CS6x/CS6R/S80, you must switch between the conventional MIDI connectors and the mLAN MIDI.
- The mLAN signals that can be received simultaneously by one Macintosh are limited to the signals transmitted from a single mLAN device. Even if OMS settings for multiple ports have been made, reception is limited to signals transmitted from a single mLAN device.

Sound is interrupted
- The cable may have been disconnected from a port whose LED is lit red, or the power of that device may have been turned off.
- A bus to which multiple devices are connected may have been joined.
- The bus may contain a node with a device of an older format (IEEE 1394 - 1995), such as an older DVCam.
- On the Macintosh, numerous applications may be running, or you may be attempting to transmit numerous channels of audio. The sound may be interrupted if a heavy processing load is being placed on the Macintosh.

Something is wrong with the sound
- Is the word clock setting correct? If the word clock is not synchronized correctly, the audio quality may be affected. Also, the A4000/A5000 and CS6x/CS6R/S80 support only 44.1 kHz.

Macintosh does not synchronize with other devices
- The Macintosh cannot be the slave of other devices.

Sound is heard when you disconnect a cable
- A “blip” sound may be heard from a device receiving mLAN audio when you disconnect the cable from the device that is transmitting that signal. If this occurs, either pause transmission/reception or lower the volume before disconnecting the cable.

YAMAHA

mLAN

Guide Book *Basic concepts of mLAN*

Leitfaden *Basiskonzepte von mLAN*

Guide *Principes de base du mLAN*

Guía *Conceptos básicos de mLAN*

English

Deutsch

Français

Español

Table of Contents

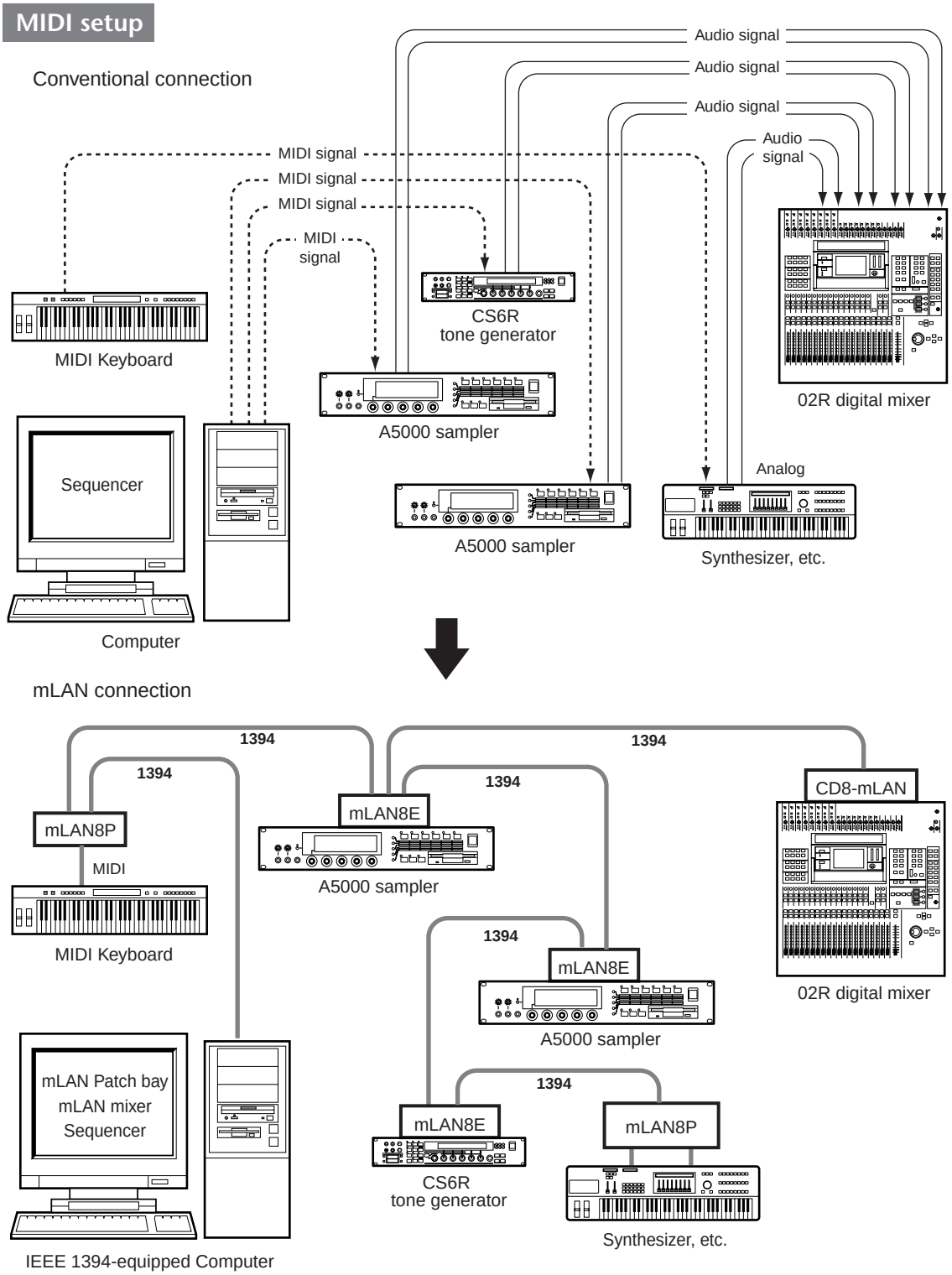
Basic Concepts of mLAN

"mLAN" is a digital network designed for musical applications. It uses and extends the industry standard "IEEE (I triple E) 1394" high performance serial bus.

In a musical environment without mLAN, dozens of various types of cables such as audio cables, phone cables, and MIDI cables are required, with different types of cable for each device and application. Also, the MIDI and audio signal flow is determined by the way in which cables are connected, meaning that cables must be reconnected if you wish to reconfigure the system.
For example if you have purchased a new synthesizer, you will need two MIDI cables plus two phone cables in the case of a stereo output instrument (or in some cases even more if the instrument has more than two audio outputs). When making connections, attention must also be paid to the input/output direction of each jack, the left/right channel, and in some cases, an understanding of impedance is also required.
As systems become larger, such factors produce more complexity and expense. Incorrect connections and other problems can increase. The time required to troubleshoot mistakes and problems also increases, resulting in wasted time. More than one reader has doubtless had the frustrating experience of tracing through an intricate web of cables one by one, just to track down a single faulty contact in one cable.

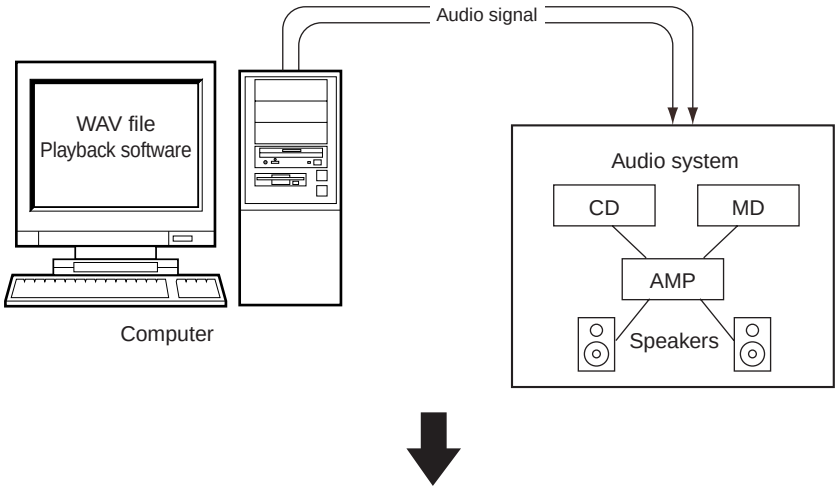
mLAN provides a dramatic simplification by allowing all such connections to be combined into a single IEEE 1394 compatible cable, and also making possible the construction of far more powerful systems.
In addition, the flow of MIDI and audio signals between mLAN devices can be freely changed without actually reconnecting any cables, and such configurations can be recorded as well.
Theoretically, the IEEE 1394 bus that mLAN uses is capable of transmitting over one hundred channels of CD-quality digital audio data (equivalent to more than 256 MIDI cables) over a single cable at one time.
Details will be given later, but if the system contains sixteen or fewer nodes (devices in the network), a system can be constructed simply by connecting devices consecutively. No special knowledge is required. Currently, a system can consist of a maximum of 63 devices, but in the future larger systems of up to 63 x 1023 devices can be constructed by observing certain simple rules.

Figure 1: Conventional connections compared to mLAN connections

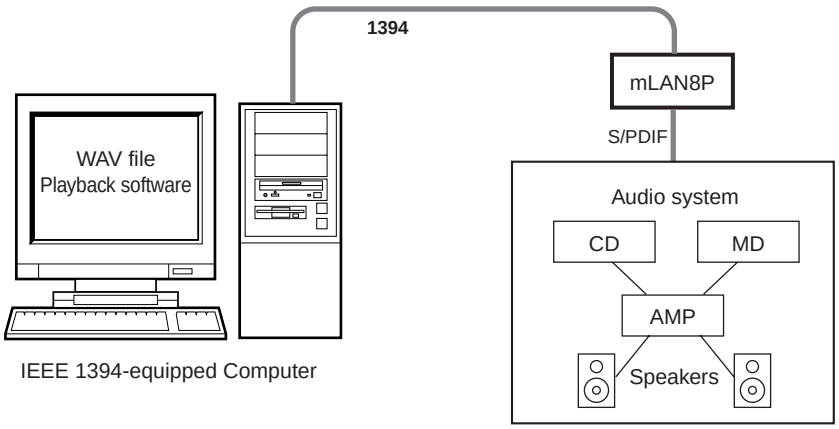


Home PC setup

Conventional connection

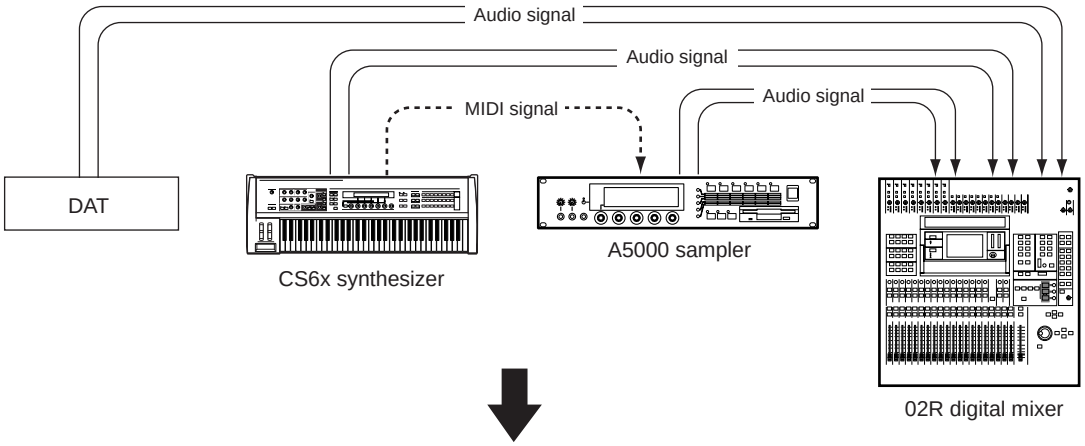


mLAN connection

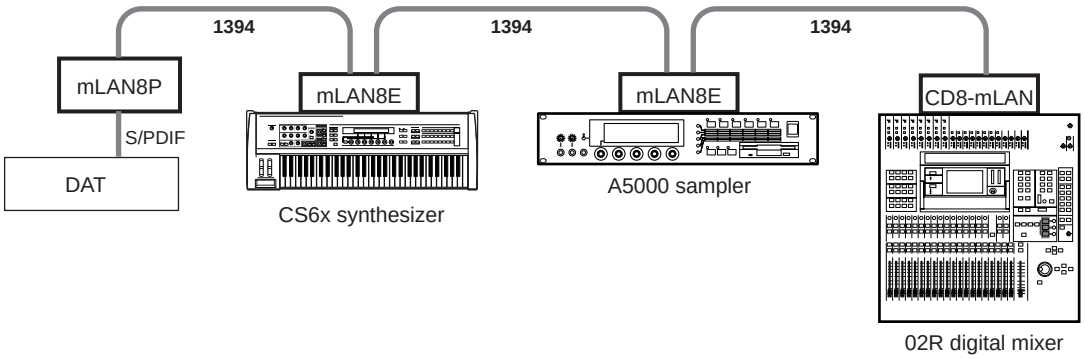


Live performance setup

Conventional connection



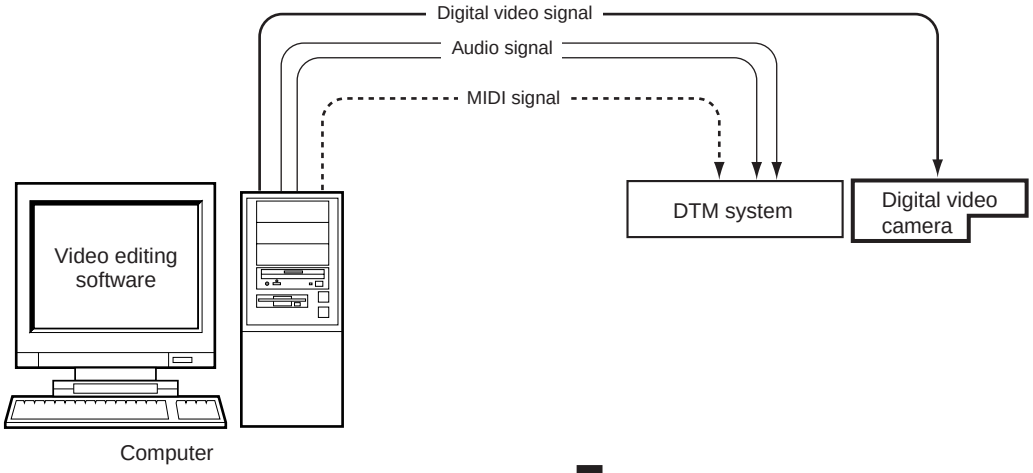
mLAN connection



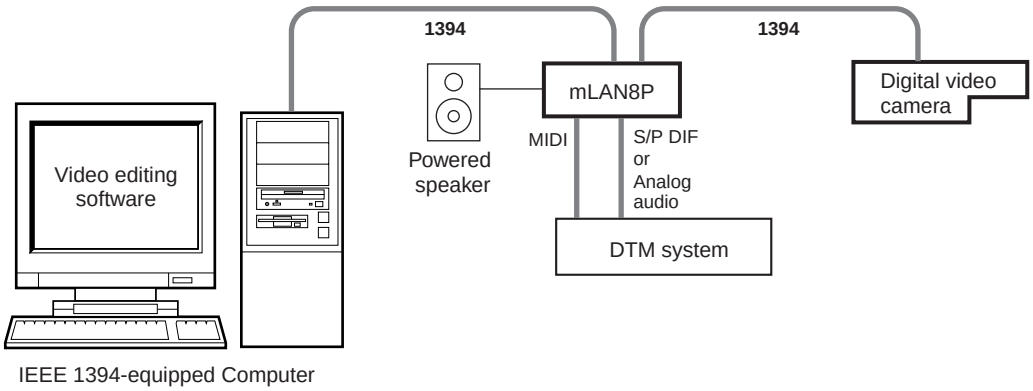
English

DV editing setup

Conventional connection



mLAN connection



NOTE The signals from the digital video camera are not recognized by mLAN8P but passed through it to the computer.

Features of mLAN

Features Inherited from IEEE 1394

- Only one type of cable is needed, in contrast to the multiple varieties required by conventional systems. In addition, jacks have no distinction of input or output, making it easy to connect a system without special knowledge.
- Data transfer rates of 100/200/400 Mbps (megabits per second) are supported. In the future, this is expected to be expanded to 800M/1.6Gbps (gigabits per second).
- Up to 63 devices can be connected. In the future, devices called “bridges” can be used to expand connections to as many as 63 x 1023 devices.
- Cables can be connected and disconnected without turning off the power (**hot pluggable**).
- Since industry-standard IEEE 1394 is used, compatibility with a variety of devices is expected into the future.
- Isochronous transfer allows data to be transferred in realtime. This is ideal for transfer of real-time data such as video and audio.

Features of mLAN Products

- The current mLAN data transfer rate is 200 Mbps.
- Electronic musical instruments and audio devices can be connected even without a computer, making it easy to construct digital network.
- MIDI and audio signal flow can be routed freely without being limited by the actual cable configuration. Signal flow between nodes can be changed without having to physically reconnect the devices, and such configurations can be recorded.
- mLAN specifications will continue to be upgraded as new products are developed. mLAN supports future expansions of its functionality, and is an specification that will “continue to evolve”.

Technical Explanations

1. About IEEE 1394

English

This is a standard defined by the IEEE (Institute of Electrical and Electronics Engineers). It is being use to implement low-cost high-speed digital networks that connect computer equipment to consumer devices (audio equipment, video equipment, electronic musical instruments) or to connect consumer devices to each other.

Although "IEEE 1394-1995" provides for a maximum of 400 Mbps (megabits per second) data transfer between computer devices, the standard is being expanded to allow data transfer at speeds of 1.6 Gbps (gigabits per second) in the future. At a speed of 200 Mbps, it is theoretically possible to handle more than one hundred channels of CD-quality digital audio data simultaneously with musical data equivalent to more than 256 MIDI cables.

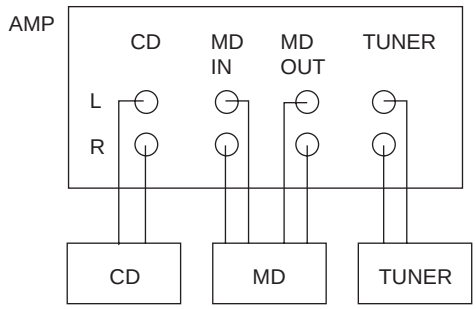
In addition, the numerous types of cables required by a conventional system to carry different types of data such as video, audio, and MIDI are no longer needed, since all data is carried over a single type of cable connected sequentially.

In the case of audio devices, conventional systems were connected in a radiating topology where connections radiated from the AV amp to the various components (CD, MD, tuner etc.). In contrast, IEEE 1394 allows a simpler method of connection in which a single type of cable is used to sequentially connect each device (amp→CD→MD→tuner). No particular knowledge is required when making connections, and new devices can be added to the system simply by connecting them sequentially.

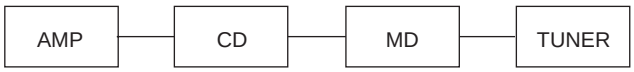
This also applies to networks connected to multimedia computers, AV devices, and electronic musical instruments, making it extremely simple to create more powerful systems than ever before.

Figure 2: Example of audio connections

Conventional connections: Attention must be paid to L/R and IN/OUT, and a limited number of devices can be connected.



IEEE 1394 connections: No particular knowledge is required, and connections may be made in any order. Up to 63 devices can be connected.



IEEE 1394 compatible cable

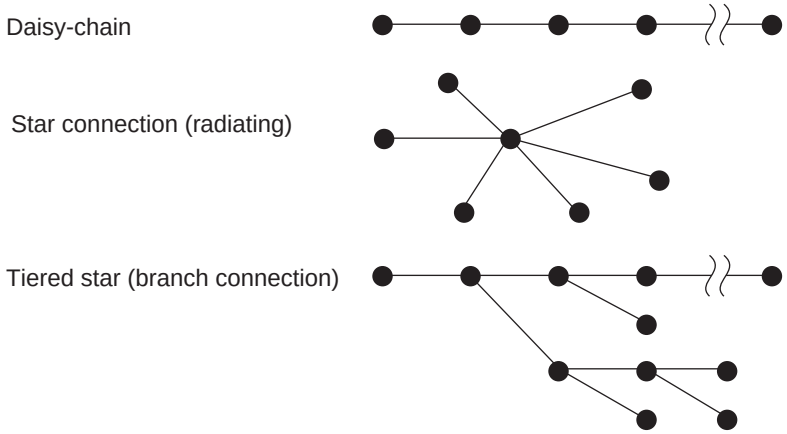
Technical points regarding IEEE 1394 are explained below.

2. Device Connections (Topology, Routes, Cycle Master)

This section provides information that will be needed by power users who wish to use IEEE 1394 with maximum efficiency. Users who are connecting 16 or fewer devices (nodes) using standard 4.5 m cables will not require this information.

"**Topology**" refers to the overall shape of the connected nodes (devices in the network). Types of topology include daisy-chain, star, and tiered star.

Figure 3: Types of topology



In these topologies, it is possible for any node to be seen from any other node as being in a "tree" structure. In this case, the single selected node is called the "**root node**." As the name suggests, the tree structure is similar to the branched form of a tree, but is normally drawn upside down from an actual tree. Thus, the "root" will be depicted at the top of the diagram. As shown in the following diagrams, any node in the topology can be the root node.

Figure 4

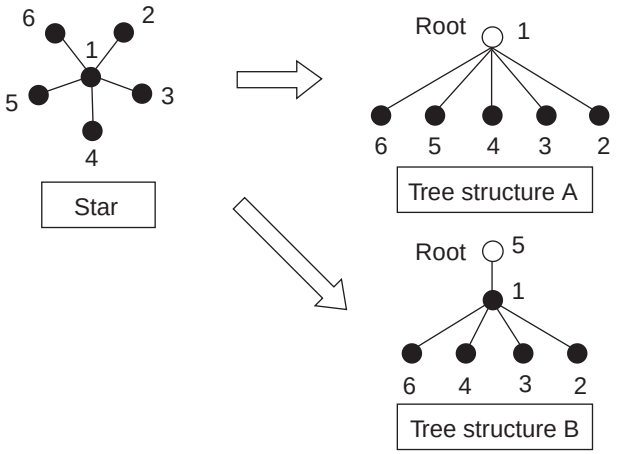
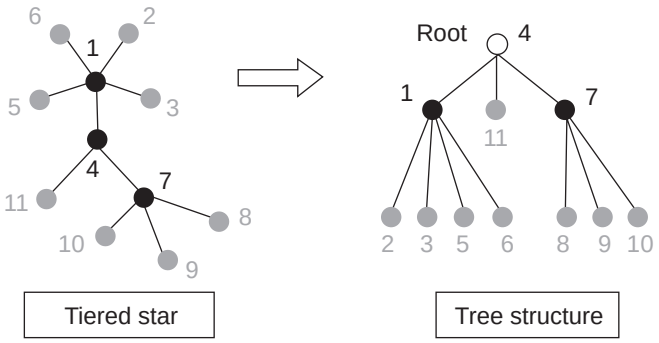


Figure 5



The above diagrams show the frequently-used tiered star (multiple stars that are connected) as a tree structure. In a tree structure, nodes that are not connected to another node in the direction away from the root are called "**leaf nodes**." In the above diagrams, these nodes are shown in gray.

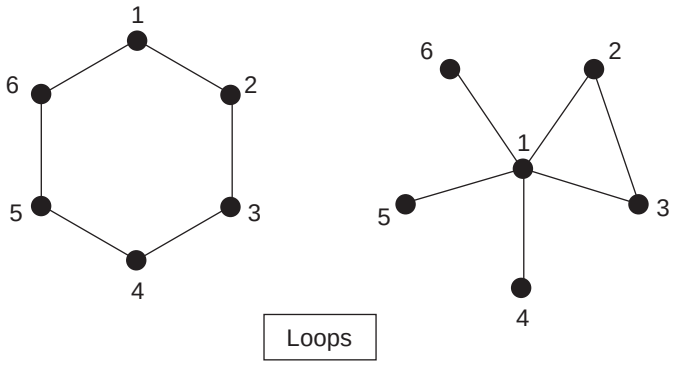
Since IEEE 1394 treats all topologies as tree structures, a specific node will automatically be selected as the root node. (It is also possible for the user to specify a specific node as the root.)

In order to transfer realtime data such as audio and MIDI, the clocks that are built into each device to measure data timing must be synchronized; i.e., the devices must be synchronized. The node containing the clock used as the master is called the "**cycle master**," and the root node fulfills this role.

The cycle master node is indispensable when transferring realtime data such as audio and MIDI. If the power of the cycle master node is turned off, or if the cable is disconnected from it, it will no longer be possible to transfer data. Consequently, the sound will be interrupted. If this occurs another node will be selected as the root node, and data transfer will resume.

By using IEEE 1394 compatible extending and relaying devices, bus connections can be branched and extended in an efficient manner. Such devices are collectively called "**repeaters**."

Of the different types of topology, "loops" cannot be interpreted as a type of tree; thus, it is not permitted to create a loop within the topology.



3. Bus Reset (Long, Short)

When a cable is connected or disconnected within a network, or when the power of a node is turned on or off, the bus* will be initialized and the network will be reconfigured. There are two types of bus reset: long bus reset and short bus reset.

* "Bus" is a technical term indicating a system by which multiple electronic devices share a single communication route to transfer data. IEEE 1394 is a "bus" specification. In the document, the term "bus" refers to the portion that is operating according to IEEE 1394.

■ Long bus reset

This will occur when the topology has been changed or broken without leaving the previous root, or if the power of the root node has been turned off. This will also occur if a device that does not support short bus reset (such as an IEEE 1394-1995 compatible DV camcorder) is connected. Since a certain amount of time is required for reconfiguration, audio data etc. will be interrupted.

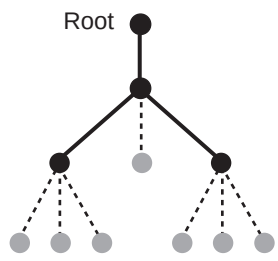
After the bus has been initialized, the following processes are performed:

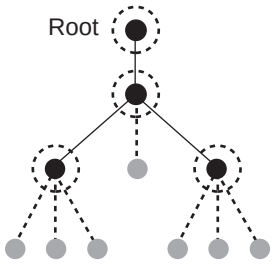
- The parent/child relationships between each node are determined, and after the root node has been decided, self-identifying packets (basic data) for each node will be transmitted. This is called "tree identification.")
- The root node will be assigned as the cycle master.

■ Short bus reset

This will occur if the change in topology does not involve the root, and since it requires less time than the long bus reset, audio data etc. will not be interrupted. This will occur when a leaf node is added or removed, or if the power of a leaf node is turned on or off.

mLAN feature
In the case of mLAN devices, the cable port LED will light green to indicate cable ports connected as leaf nodes.

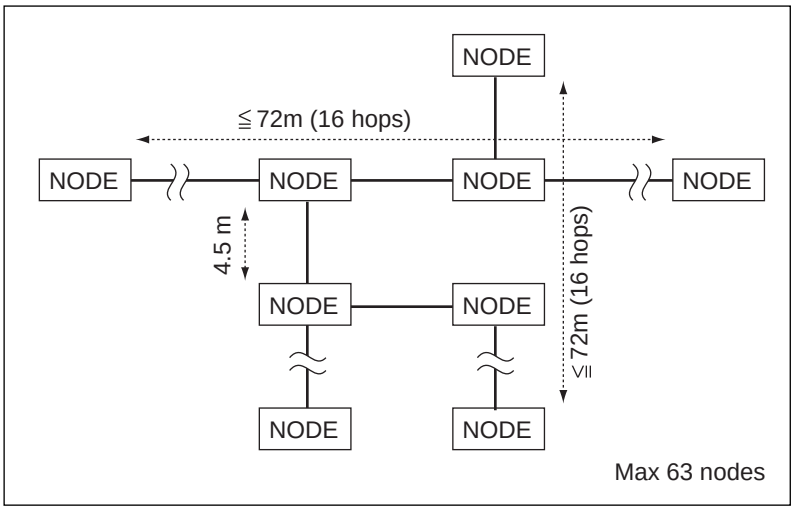




4. Calculating the Number of Hops and Cable Length

The number of hops indicates the distance between two nodes in the bus (system), and expressed by the number of cables between the two nodes.
The maximum number of hops is not the number of cables in the network; it simply means the maximum number of hops between any two nodes (not necessarily from the root). At present, the maximum is 16 hops. Even by using shorter cables such as 1 meter, it is not possible to increase the number of nodes or hops that can be used.
At present, a maximum of 63 nodes can be connected. In the future, devices called “bridges” will make it possible to connect up to 63 x 1023 devices.

Figure 6: Number of hops



5. Bandwidth Issues

■ Isochronous transfer

The **isochronous data transfer** used by IEEE 1394 is a transfer method that guarantees the right to transmit or receive data at fixed intervals (125 microseconds). This makes it possible to transmit data in realtime. It is particularly suitable for data of a realtime nature, such as video and audio. This fixed interval (125 microseconds) is managed by the cycle master node, and access rights are granted preferentially to the cycle master node.

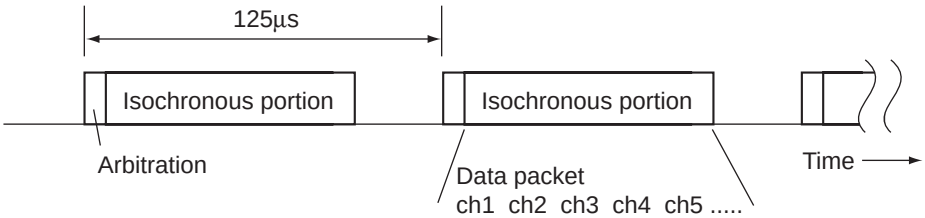
■ Arbitration

In order for a node to transmit data packets, it must obtain bus access rights. The root node **arbitrates bus access rights**, and ultimately grants access rights to a single node. It is not possible for multiple nodes to simultaneously access a single bus.

Arbitration is performed as follows:

- The node that wishes to transmit a data packet first transmits a “request” to the root node.
- Upon receiving this request, the root node transmits “permission” to the node that sent the request.
- The node that transmitted the request receives the “permission,” thereby obtaining access rights.
- The node that obtained access rights may then transmit data packets.
- The request and permission can be transmitted much faster if the node is closer to the root node (that is, fewer hops between the node and the root). Consequently, the star topology can handle the bus more efficiently than a daisy-chain topology.

Figure 7: Isochronous sub-actions



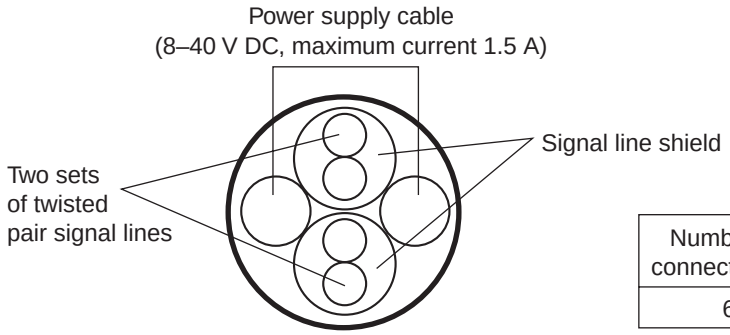
English

6. Cable Power

Nodes with multiple IEEE 1394 connectors have the important role of relaying and transmitting data between multiple connected nodes. In order for data to be transferred from one node to another, each node between these nodes must relay the data accurately. A small amount of electrical power is required for the relay functionality to operate. So that its relay functionality will continue to operate even if the power of a device is turned off, there must be a means of supplying power from other nodes. Thus, standard IEEE 1394 cables use a four-pin configuration; four pins for data and control signals, or a six-pin configuration; four pins for data and control signals and two pins for electrical power.

mLAN feature
Although DV cables that omit the power lines do exist, mLAN products use six-pin cables.

Figure 8: Cross-section of a six-pin cable

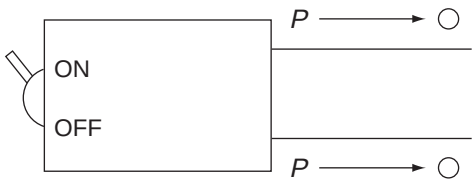


Number of connector pins	Supported speed
6	400Mbps

Since the six-pin cables are able to transmit power, power can be distributed between nodes of the network. Nodes can be classified by how they handle power.

By power supply

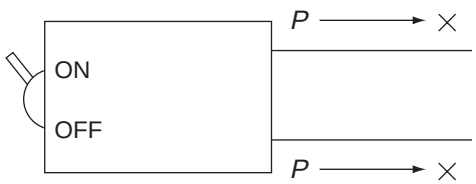
A. Nodes that are able to supply power to another node via the cable. These are called "**power nodes**."



Power can be supplied.

P : Electric power
○ : Can be supplied/relayed
× : Cannot be supplied/relayed

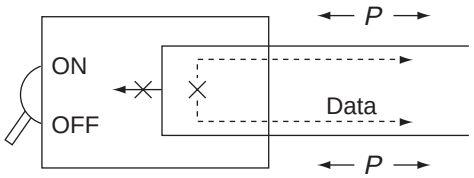
B. Nodes that are not able to supply power.



Power cannot be supplied.

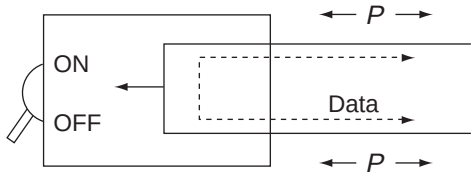
By power consumption

c. Nodes that take no power at all from the cable. When their power is turned off, they will also cease functioning as bus relays.



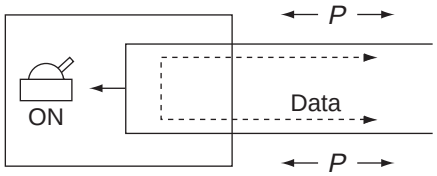
When the power is turned off, the nodes do not obtain power and cease functioning as bus relays.

d. Nodes that can obtain power from the cable and function as bus relays.



When the power is turned off, the nodes can still obtain power and function as bus relayWhen the power is turned off, the nodes can still obtain power and function as bus relay.

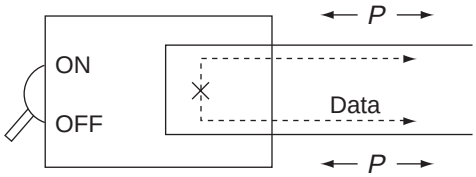
e. Nodes that can obtain power from the cable and perform all of their own functions (low power consumption portable devices etc.).



The nodes can obtain power and perform all of their own functions.

For the purpose of power, a node will have a combination of functionality from [A, B] and [c, d, e].

mLAN feature
For the current mLAN devices, this will generally be [B] and [c]. In other words, a system consisting solely of mLAN devices will function as a single system only if the power of all devices (nodes) is turned on.



7. Hot Plugging / Unplugging

IEEE 1394 allows cables to be freely plugged and unplugged even if the power is turned on. Since IDs are assigned automatically when the topology is modified, the user does not need to reset the IDs. The system can be used immediately after it has been connected.

mLAN feature
One feature of mLAN is that after nodes are connected, the MIDI and audio signal flow can be routed freely without having to actually change physical connections. No particular care need be taken regarding the order of connections.

8. Bus Status Indication (LED)

mLAN products have a two-color LED (green and red) by their connector port, a three-color (green, red and orange) LED labeled RT/ERR and a blue LED labeled ACTIVE, nearby this.
The ACTIVE LED indicates that this node is functioning as a relay. If a node is not Powered-on but its ACTIVE indicator is lit, it is receiving power from another node.

RT/ERR can be either green or red:

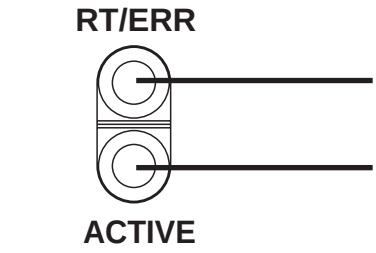
[Green] ..... Indicates that this is the root node.

[Red]/**[Orange]**..... Indicates that an error has occurred. The type of error is indicated by the way in which the connector LED is lit. For details, refer to the table in the Owner's Manual for the respective device.

If the above-mentioned RT/ERR does not indicate an error (i.e., dark or lit green), the connector LED has the following meaning:

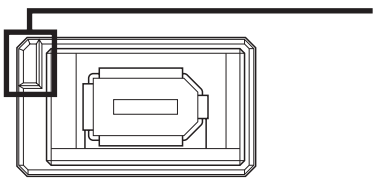
[Green] ..... The node connected to this connector is a leaf node. Even if this connector is unplugged, a major change (such as splitting the bus (system) into two) will not occur.

[Red] ..... The node connected to this connector is not a leaf node. If this connector is unplugged, the bus (system) will be split into two parts. As a result, a Long Bus Reset may occur and the sound may be interrupted.



Green : The node is a root node.
Red, Orange : An error has occurred.

Blue : The node functions as bus relay.



Green : A leaf node is connected.
Red : The connected node is not a leaf node.
(This is not an error.)

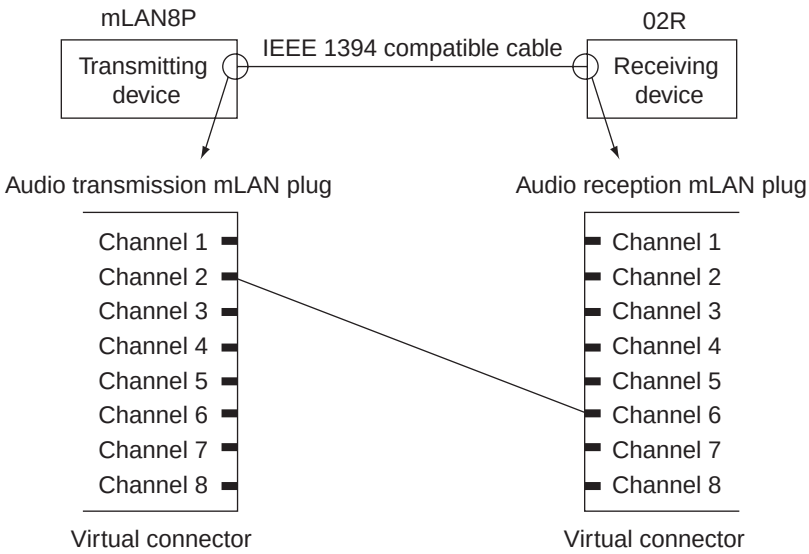
9. Other Protocols, Drivers

The IEEE 1394 specification is broadly used in DV connectors for digital video. Although DV includes an audio signal in addition to the video, it uses a different format than mLAN, and DV audio cannot be handled directly by an mLAN device. In order to handle DV audio on mLAN, a converter device and/or computer software is separately required.

10. mLAN Connection Manager

The audio/MIDI data that flows over mLAN is transferred using virtual connectors called "mLAN plugs." The logical routes that are established between these plugs are called "mLAN connections."

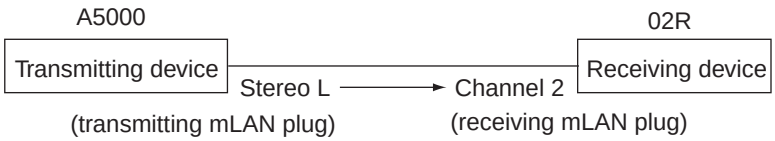
Figure 9: An example of audio signals



An mLAN connection is expressed as the combination of

- transmitting device — transmitting mLAN plug (mLAN output plug)
- receiving device — receiving mLAN plug (mLAN input plug)

Figure 10: An example of an mLAN connection



The mLAN connection manager is a function possessed by all mLAN devices, and is a module that manages the specified mLAN connections on each node.

The mLAN connection manager has the following functionalities:

- By request from another mLAN node, it creates mLAN connections in the mLAN plug of the mLAN nodes.
- In response to inquiry from another software module, it provides mLAN connection data.
- When the bus is reconfigured due to a bus reset or power-off, it is able to automatically restore mLAN connections.

The mLAN connection data is stored by the receiving device. Even when a bus reset occurs or the power is turned off, the mLAN connection data is preserved.
After a bus reset occurs or the power is turned on, a receiving device will search for the transmitting device based on its stored mLAN connection data, and will re-establish the mLAN connections.

NOTE An ID unique to each device is embedded in each node. The receiving device remembers the transmitting device by this ID. This means that even if the model of device is identical, the mLAN connection will not be restored if the ID is different.
For example in the mLAN connection example shown above, the 02R remembers that it received data from a certain A5000, but the mLAN connection will not be restored if a different A5000 is connected.

If the transmitting device is not found, the mLAN connection data will be maintained, but the mLAN connection will not be restored.

NOTE The mLAN connection will be restored when the transmitting device that could not be found is then connected. However if a different mLAN connection is established before this occurs, the mLAN connection will not be restored.
For example in the case of the above mLAN connection example, the 02R will preserve the mLAN connection data even when the A5000 is disconnected. When the A5000 is connected once again, the connection will be restored. However if, while the A5000 is disconnected, the user establishes an mLAN connection to a different instrument on channel 2 (the mLAN plug on which an mLAN connection had been established with the A5000), the mLAN connection will be overwritten. Subsequently even if the instrument is disconnected and the A5000 is reconnected, the 02R will remember the mLAN connection with the instrument. Accordingly the mLAN connection with the A5000 will not be recovered.

11. mLAN Fs Manager

mLAN Fs Manager manages the master and slave relationship between each node's word clock (WC/WCLK).
To transmit and receive digital audio data between multiple devices correctly, you need to assign one of the devices on the bus as "master" so that the rest of the devices lock to the word clock generated from the master device.
The word clock master setting provides two modes: manual mode and auto mode.
Using the group master setting makes it easy to set one device to master and the other devices to slave.

■ Manual mode

In this mode, the user assigns devices as master and slave. The user also assigns a group master.
After a Bus Reset or Power-on Reset occurs, the master/slave relationship is restored based on the stored information. If the master device no longer exists after a Bus Reset or Power-on Reset occurs, the slave devices cannot receive word clock data. Therefore, audio data on those devices will be muted.

■ Auto mode

In this mode, the master/slave relationship is automatically determined. If the user has specified group master, the remainder become slaves.
The word clock master/slave relationship specified before a Bus Reset or Power-on Reset occurs will not be stored. Instead, the word clock master/slave relationship will be re-configured based on the stored audio stream connection, so that the device that transmits audio will become master.

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