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DATA SYSTEMS

Hitachi Freedom Storage™ Lightning 9900™

Hitachi Open Remote Copy (HORC) User and Reference Guide

(Synchronous and Asynchronous for UNIX®/PC Servers)

Document Revision Level

Revision	Date	Description
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The following source documents were used to produce this 9900 user document:

- *DKC310 Disk Subsystem, Hitachi Open Remote Copy Reference Manual*, revision 9.
- MK-90RD010-S1, MK-90RD010-S2, MK-90RD010-1a-S (STR RAID400 documents).
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Changes in this Revision

- Added **sidefile overflow** suspension condition for HORC Async (Table 2.6).
- Added OPEN-E, OPEN-L, and OPEN-M devices (section 3.2.2).
- Added note on priority of HORC initial copy and update copy operations (section 2.2.2).
- Added note on offloading timer setting for HORC Async with channel extenders (sections 2.3.6, 4.4.1, 6.1).
- Added **Use Time-Saving Mode** function for creating, splitting, resyncing, and deleting pairs (sections 5.2, 5.4, 5.5, 5.6, and C.3).
- Clarified instructions for changing the HORC Asynchronous group options (section 4.4.3).
- Added port values for use in HORC scripting operation macros (section C.3).
- Removed HORC read option (SVP mode 20) (Table 2.1).
- Added note on 1-to-n HORC configurations (sections 2.1.5, 3.3.1)

Preface

The *Hitachi Open Remote Copy User's Guide* describes and provides instructions for performing Hitachi Open Remote Copy (HORC) operations on the Hitachi Lightning 9900™ subsystem. This document assumes that:

- the user has a background in data processing and understands direct-access storage device (DASD) subsystems and their basic functions,
- the user is familiar with the Hitachi Lightning 9900™ disk array subsystem,
- the user has read and understands both the *Hitachi Lightning 9900™ User and Reference Guide* and the *9900 Remote Console User's Guide*, and
- the user is familiar with the Windows operating system (e.g., opening, closing, minimizing, and restoring windows; using the keyboard and mouse to navigate on screen and select objects).

For further information on the Lightning 9900™ subsystem, please contact your Hitachi Data Systems account team, or visit Hitachi Data Systems online at http://www.hds.com.

Note: The term "9900" refers to the entire Hitachi Lightning 9900™ subsystem family, unless otherwise noted. Please refer to the *Hitachi Lightning 9900™ User and Reference Guide* (MK-90RD008) for further information on the 9900 disk array subsystems, or contact your Hitachi Data Systems account team.

Note: This document does not cover Hitachi Remote Copy (HRC) operations for S/390® data. For information and instructions on performing HRC operations for S/390 data, please refer to the *Hitachi Remote Copy (HRC) User and Reference Guide* (MK-90RD009).

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Chapter 1 Overview of Hitachi Copy Solutions

1.1 Hitachi Remote Copy (HRC) & Hitachi Open Remote Copy (HORC)

The Hitachi Remote Copy (HRC) and Hitachi Open Remote Copy (HORC) features enable you to create and maintain duplicate copies of all user data stored on the Hitachi Lightning 9900™ subsystem for data duplication, backup, and disaster recovery purposes. HRC and HORC provide synchronous and asynchronous copy modes to accommodate a wide variety of user requirements and data copy/movement scenarios. HRC is used for S/390® data, and HORC is used for UNIX®-based and PC server data. HRC/HORC is a key component of the Hitachi Data Systems CARE Copy suite solution (see section 1.2).

This document describes and provides instructions for performing HORC operations using the 9900 Remote Console PC. The licensed HORC software for the Remote Console PC displays detailed HORC information and allows you to perform all HORC operations. The Remote Console PC is attached to and communicates directly with the 9900 subsystems via the 9900-internal local-area network (LAN). In the event of a system failure or disaster at the primary (main) site, the HORC software also simplifies and expedites disaster recovery procedures.

HORC operations are nondisruptive and allow the primary (main) volume of each HORC volume pair to remain online to all hosts for both read and write I/O operations. Once established, HORC operations continue unattended to provide continuous, real-time data backup. HORC operations can be performed across distances of up to 43 km (27 miles) using standard ESCON® support. Long-distance solutions are provided, based on user requirements and workload characteristics, using approved channel extenders and communication lines.

HORC operations can be performed in conjunction with Open ShadowImage operations (see section 1.3) to provide multiple internal copies of HORC volumes. HORC also supports the LU Size Expansion (LUSE), Virtual LUN (also called Custom Volume Size, CVS), and FlashAccess (also called Dynamic Cache Residency, DCR) features of the 9900 subsystem, ensuring that all user data can be protected by remote copy operations. See section 3.6 for further information on combining HORC with these and other data management features.

HORC operations can also be performed from the UNIX®-based or PC server host using the Hitachi Command Control Interface (CCI) software product. For information and instructions on using CCI to perform HORC (or Open ShadowImage), please refer to the *Hitachi Lightning 9900™ Command Control Interface (CCI) User's Guide*.

This document does not cover HRC operations for S/390® data. For information and instructions on performing HRC operations, please refer to the *Hitachi Lightning 9900™ Hitachi Remote Copy (HRC) User and Reference Guide*.

Note: The use of the 9900 HORC remote console software and all other features and products is governed by the terms of your license agreement(s) with Hitachi Data Systems.

1.2 CARE Software Solutions

Hitachi Data Systems' CARE software solutions, which include the Copy suite, Availability suite, Resource suite, and Exchange suite, deliver enterprise-wide coverage of online data duplication and relocation, data access and protection, and storage resource management. The Copy suite components are designed for data replication, protection, and sharing and include Hitachi Remote Copy, ShadowImage, and Hitachi Online Data Migration (HODM). For further information on the CARE software solutions, please contact your Hitachi Data Systems account team, or visit Hitachi Data Systems online at http://www.hds.com/.

Note: Hitachi Remote Copy and the CARE Copy suite are available under a Hitachi Data Systems service agreement. The HORC and ShadowImage remote console software are available under license from Hitachi Data Systems.

1.3 Hitachi ShadowImage and Open ShadowImage

The Hitachi ShadowImage and Open ShadowImage data duplication features enable you to set up and maintain multiple copies of logical volumes within the same Lightning 9900™ subsystem. Open ShadowImage operations for UNIX®/PC server-based data are performed using the licensed Hitachi Open Multi-RAID Coupling Feature (HOMRCF) software on the 9900 Remote Console PC, or the Hitachi Command Control Interface (CCI) software on the UNIX®/PC server host. ShadowImage operations for S/390® data are performed using the Hitachi Multi-RAID Coupling Feature (HMRCF) remote console software, and can also be managed via TSO and/or ICKDSF commands.

The RAID-protected ShadowImage duplicates are created within the same 9900 subsystem at hardware speeds. ShadowImage can be used in conjunction with HRC/HORC to maintain multiple copies of critical data at your primary and/or secondary (remote) sites. The CARE Copy suite includes both HRC/HORC and ShadowImage for maximum flexibility in data backup and duplication activities. See section 3.6.1 for further information on combining HORC and Open ShadowImage operations.

This user's guide does not cover ShadowImage operations. For information and instructions on performing ShadowImage operations, please refer to the *Hitachi Lightning 9900™ Open ShadowImage (HOMRCF) User's Guide* or the *Hitachi Lightning 9900™ ShadowImage (HMRCF) User's Guide*, or contact your Hitachi Data Systems account team.

1.4 Hitachi Multiplatform Backup/Restore (HMBR)

The Hitachi Multiplatform Backup/Restore (HMBR) feature of the Hitachi Lightning 9900™ subsystem can also be used in conjunction with the Open ShadowImage feature to provide S/390®-based backup of Open ShadowImage volumes. HMBR operations should be configured to back up the Open ShadowImage primary volumes (P-VOLs), since the Open ShadowImage S-VOLs are not available to hosts (except when the pair has been split). If you need to perform HMBR operations on Open ShadowImage S-VOLs, you must split the pairs first to allow host access.

1.5 HARBOR File-Level Backup/Restore

The HARBOR File-Level Backup/Restore multiplatform feature of the 9900 subsystem enables users to perform mainframe-based file-level backup/restore operations on the open-system data stored on the multiplatform 9900 subsystem. HARBOR File-Level Backup/ Restore features an integrated architecture and includes:

- A host component on MVS,
- Integrated clients for desktops and servers,
- LAN-based distributed storage servers,
- High-speed HMDE file-level backup of open-system data, and
- Transparent network support.

Note: For further information on HARBOR File-Level Backup/Restore, please contact your Hitachi Data Systems account team.

1.6 HXRC and CC for S/390® Data

The HXRC feature of the 9900 subsystem is functionally compatible with the industry-standard IBM Extended Remote Copy (XRC) S/390® host software function. HXRC is also compatible with the DFSMS data mover which is common to the XRC environment. HXRC operations are performed in the same manner as XRC operations, by issuing XRC TSO commands from the host system to the 9900 subsystem. The HXRC feature must be enabled using the 9900 Remote Console PC.

The Hitachi Lightning 9900™ subsystem is also functionally compatible with the IBM 3990 Concurrent Copy (CC) function.

Please contact your Hitachi Data Systems account team for further information on these 9900 features, or visit Hitachi Data Systems online at http://www.hds.com/storage.

Note: HXRC and CC operations, as well as HRC/HORC Asynchronous, require additional cache to store the asynchronous recordsets. If you are performing HXRC and/or CC operations in addition to HRC/HORC Asynchronous on the same 9900 subsystem, you must make sure that the subsystem has adequate cache installed and available to support the asynchronous copy workloads. Please contact your Hitachi Data Systems account team to determine how much cache will be needed for your operational configuration.

Chapter 2 Overview of HORC Operations

HORC provides a storage-based hardware solution for disaster recovery which enables fast and accurate system recovery. Once HORC operations are established, duplicate copies of data are automatically maintained for backup and disaster recovery purposes. During normal HORC operations, the primary volumes remain online to all hosts and continue to process both read and write I/O operations. In the event of a disaster or system failure, the secondary copy of data can be rapidly invoked to allow recovery with a very high level of data integrity. HORC can also be used for data duplication and migration tasks.

HORC Synchronous provides volume-based real-time data backup and is ideal for high-priority data backup, duplication, and migration tasks. In the event of a disaster or system failure at the primary site, the secondary HORC Synchronous data can be rapidly invoked to allow recovery at the volume level with an extremely high level of data integrity.

HORC Asynchronous represents a unique and outstanding disaster recovery solution for large amounts of data which span multiple volumes. The HORC Asynchronous group-based update sequence consistency solution enables fast and accurate database recovery, even after a "rolling" disaster, without the need for time-consuming data recovery procedures. The HORC Asynchronous (HORCA) volume groups at the remote site can be recovered with full update sequence consistency, but the updates will be behind the primary site due to the asynchronous remote copy operations.

HORC Asynchronous provides update sequence consistency for user-defined groups of volumes (e.g., large databases) as well as protection for write-dependent applications in the event of a disaster.

This overview of HORC operations describes:

- HORC components (see section 2.1),
- HORC operations (see section 2.2),
- HORC Asynchronous recordset operations (see section 2.3),
- HORC Asynchronous consistency group operations (see section 2.4),
- HORC volume pair status and split/suspend types (see section 2.5).

2.1 HORC Components

HORC operations involve the 9900 subsystems at the primary and secondary (remote) sites, the physical communications paths between these subsystems, and the 9900 Remote Console PC. HORC copies the original online data at the primary site to the offline backup volumes at the secondary (remote) site via the dedicated ESCON remote copy connections. The 9900 Remote Console PC hosts the HORC software, which provides a user-friendly Windows-based graphical user interface (GUI) for all HORC functions and operations. Host failover software is required for effective disaster recovery with HORC.

Figure 2.1 shows the HORC components and their functions. The HORC components are:

- Hitachi Lightning 9900™ subsystems
- Main and remote control units (MCU and RCU)
- Volume pairs (P-VOLs and S-VOLs)
- HORC Asynchronous consistency groups
- Remote copy connections
- Remote control ports (RCPs)
- 9900 Remote Console PC
- Host failover software

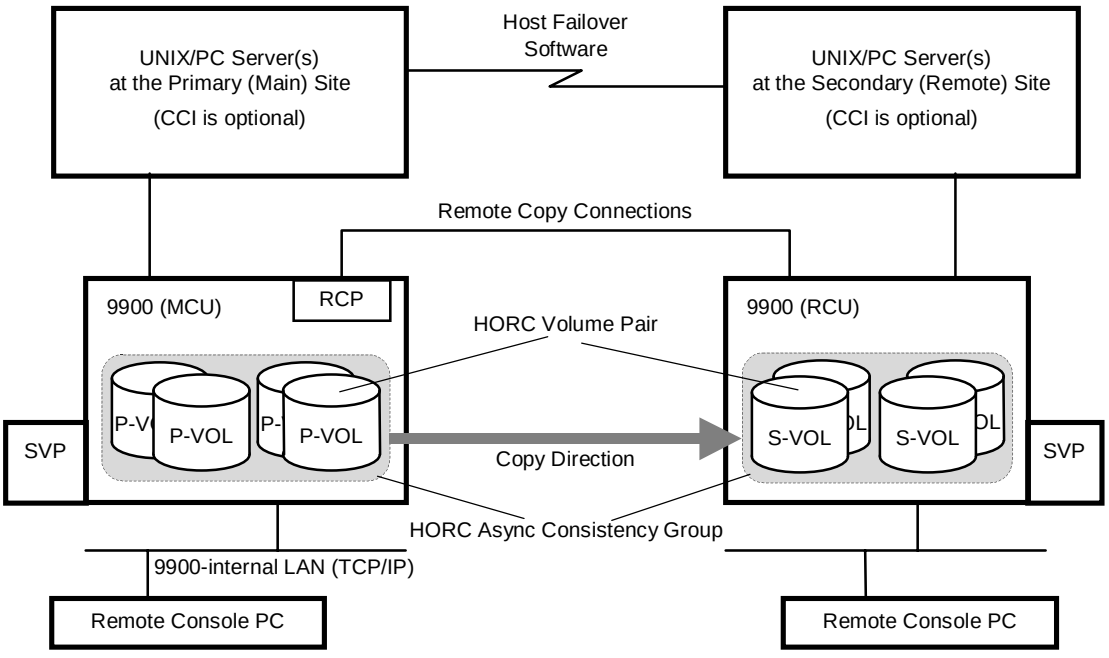


Figure 2.1 HORC Components

2.1.1 9900 RAID Storage Subsystems

HORC operations involve the primary (main) 9900 subsystems and the secondary (remote) 9900 subsystems (MCUs and RCUs). The MCUs contain the HORC primary volumes (P-VOLs), which contain the original data and are online to the host(s). The RCUs contain the HORC secondary volumes (S-VOLs), which are the synchronous or asynchronous copies of the P-VOLs. HORC supports all CU images and logical volumes of the 9900 subsystem. HORC also supports all physical hard drive options and RAID configurations for the 9900.

To provide greater flexibility and to enable the 9900 to be tailored to unique customer operating requirements, additional operational parameters, or optional modes, are available for the 9900 subsystem. At installation, the 9900 modes are set to their default values, so make sure to discuss these settings with your Hitachi Data Systems team. The 9900 modes can only be changed by your Hitachi Data Systems representative. Table 2.1 shows the 9900 modes related to HORC operations. For information on 9900 modes for HRC and HXRC, please refer to the *Hitachi Remote Copy (HRC) User and Reference Guide.*

Note: This mode information was current at the time of publication of this document, but it may change. Please contact your Hitachi Data Systems representative for the latest 9900 mode information.

Table 2.1 9900 Modes for HORC

Mode	Description
21	Required ON for MCUs and RCUs which connect to CNT channel extenders.
109	Prevents condition code 3 when using HORC with CNT channel extenders.

2.1.2 Main and Remote Control Units (MCUs and RCUs)

The main control unit (MCU) and remote control unit (RCU) control HORC operations:

- The MCU is the control unit in the primary subsystem which controls the P-VOLs of the HORC volume pairs. The Remote Console PC must be LAN-attached to the MCU of each HORC pair. The MCU communicates with the RCU via the dedicated ESCON remote copy connections. The MCU controls the host I/O operations to the HORC P-VOLs as well as the HORC initial copy and remote copy operations between the P-VOLs and S-VOLs. The MCU also manages the HORC pair status and configuration information.
- The RCU is the CU in the remote subsystem which controls the S-VOLs of the HORC volume pairs. The RCU assists in managing the HORC pair status and configuration (e.g., rejects write I/Os to HORC S-VOLs). The RCU executes the remote copy operations issued by the MCU. The secondary Remote Console PC should be LAN-attached to the RCUs at the remote site. The RCUs should also be attached to a host system to allow sense information to be reported in case of a problem with a secondary volume or remote subsystem and to provide disaster recovery capabilities.

The MCU and RCU can be defined separately for each HORC volume pair. The 9900 CU can function simultaneously as an MCU for one or more P-VOLs and as an RCU for one or more S-VOLs, provided the remote copy connections and serial interface ports are properly configured. The 9900 CU provides up to sixteen logical CU images (0-F), with each CU image controlling up to 256 logical devices (LDEVs). The HORC software allows you to select the desired CU image in the connected MCU and specify the desired CU image in the RCU. HORC operations can be performed on all logical devices except for the 9900 command device. For further information on command devices, please refer to the *Hitachi Command Control Interface (CCI) User and Reference Guide*.

2.1.3 Volume Pairs (P-VOLs and S-VOLs)

HORC performs remote copy operations for logical volume pairs created by the user. Each HORC pair consists of one primary volume (P-VOL) and one secondary volume (S-VOL) which can be located in the same subsystem or in different subsystems. The HORC P-VOLs are the primary volumes (LUs) which contain the original data, and the HORC S-VOLs are the secondary or mirrored volumes (LUs) which contain the backup or duplicate data. During normal HORC operations, the P-VOL remains available to all hosts at all times for read and write I/O operations. During normal HORC operations, the RCU rejects all host-requested write I/Os for the S-VOLs. The S-VOL write enable option allows write access to an S-VOL while the pair is split and uses the S-VOL and P-VOL cylinder maps to resynchronize the pair (see section 2.2.4).

HORC supports the logical unit (LU) types available on the 9900 subsystem (e.g., OPEN-3, OPEN-9, OPEN-K, etc.). HORC also supports the LU Size Expansion (LUSE), Virtual LUN, and FlashAccess features, ensuring that all user data can be backed up or duplicated. See section 3.2.2 for further information on HORC LU requirements and support.

HORC supports a maximum of 4,096 HORC pairs (entire RCU). When the CCI command device is defined, the maximum number of HORC pairs in the 9900 subsystem is 4,095. When HORC pairs include size-expanded LUs, the maximum number of pairs decreases.

2.1.4 HORC Asynchronous Consistency Groups

A HORCA consistency group is a user-defined set of volume pairs across which update sequence consistency is maintained and ensured at the remote site. Each HORCA volume pair must be assigned to a consistency group. HORC allows you to configure up to 64 consistency groups (0-3F) for each MCU and provides group-based operations for consistency groups (e.g., split and resync group). Consistency groups enable you to maintain update sequence consistency for databases which span multiple volumes, allowing immediate database recovery at the remote site when needed. See section 2.4 for further information on HORC Asynchronous consistency group operations.

2.1.5 Remote Copy Connections

The remote copy connections are the physical paths used by the HORC MCUs to communicate with the HORC RCUs. The number of physical paths is limited to four per logical CU image in the MCU for a maximum of 64 per 9900 subsystem (depending on the availability of serial interface ports). The MCUs and RCUs are connected via serial interface (ESCON®) cables. For distances greater than 3 km (1.9 miles), ESCON directors (ESCDs) and/or ESCON repeaters are required. HORC operations can be performed at distances of up to 43 km (27 miles) using standard ESCON support, and long-distance solutions are provided, based on user requirements and workload characteristics, using approved channel extenders and communication lines (e.g., T1/T3/ATM). See section 3.3.1 for further information on installing and configuring the remote copy connections.

The MCU-to-RCU remote copy configuration (see section 3.3.1) for HORC Asynchronous has different requirements than the HORC Synchronous remote copy configuration, as follows:

- HORC Synchronous supports 1-to-n and n-to-1 remote copy connections ($n \leq 4$). One MCU can be connected to as many as four RCUs, and one RCU can be connected to as many as four MCUs (one MCU/RCU = one physical CU, including all sixteen CU images). HORC supports the dynamic switching capability of the ESCDs which is used to share the physical interface cables between the components. The ESCDs can accommodate channel-to-MCU and channel-to-RCU connections in addition to the remote copy connections.
- HORC Asynchronous currently supports 1-to-1 remote copy connections. One MCU can be connected to only one RCU. This configuration ensures backup integrity for data which is spread across multiple volumes within one 9900 subsystem (e.g., large databases).

  Note: HORC 1-to-n configurations (one main subsystem and multiple remote subsystems) are valid for HORCA, as long as a consistency group does not span remote subsystems.

Note: Hitachi Data Systems strongly recommends that you establish at least two independent remote copy connections (one per cluster) between each MCU and RCU to provide hardware redundancy for this critical communications path.

2.1.6 Remote Control Ports (RCPs)

The remote control ports (RCPs) are the dedicated serial interface ports on the main subsystem (MCU) to which the RCUs are connected. The RCPs emulate host processor channels to enable the MCUs to send write I/O operations directly to the RCUs. The RCPs support the dynamic switching capability provided by the ESCDs. Any serial interface port of the 9900 subsystem can be configured as an RCP. The Port Change panel (see section 4.2.3) allows you to change the configuration of the 9900 serial interface ports from local control port (LCP) to RCP and from RCP to LCP as needed.

Note: Two or more RCPs must be configured before you can add the RCUs and create the HORC volume pairs. The RCPs cannot communicate with the host processor channels and are dedicated to HORC operations. The host channel interface paths must be connected to the other interface ports on the 9900 subsystem.

2.1.7 9900 Remote Console PC

The 9900 Remote Console PC hosts the remote console software products for the 9900 subsystem, including HORC and HRC. The Remote Console PC is attached to the 9900 subsystems on the 9900-internal LAN via defined TCP/IP connections. The Remote Console PC communicates with the SVP of each attached 9900 subsystem. The Remote Console PC at the primary site must be connected to the MCU of each HORC volume pair. A second Remote Console PC should also be installed at the remote site and connected to the RCUs. Having another Remote Console PC at the remote site enables you to modify the HORC Asynchronous options of the RCU (pending update data rate, offloading timer) and access the HORC S-VOLs (e.g., to perform media maintenance). If you need to perform HORC operations in the reverse direction from the remote site to the primary site (e.g., disaster recovery), the HORC remote console software simplifies and expedites this process.

Note: If the 9900 Remote Console PC is not installed, please contact your Hitachi Data Systems account team for information on HORC configuration services.

Note: If you are using Hitachi GRAPH-Track™ to monitor a HORC subsystem, you may want to disconnect GRAPH-Track from the subsystem before connecting to the subsystem from the 9900 Remote Console PC. This prevents timeouts from occurring due to heavy 9900 LAN traffic. See section 3.6.2 for instructions on performing HORC (or other) remote console operations for a subsystem which is monitored by Hitachi GRAPH-Track™.

2.1.8 Host Failover Software

Host failover software, which transfers information between host servers at the primary and remote sites, is a critical component of any disaster recovery effort. Host failover is configured using the desired host failover software product for the platform (e.g., Microsoft Cluster Server), depending on your installation requirements and standards. The 9900 remote console software products do not provide any host failover functions.

When HORC is used as a data migration tool, host failover is recommended but not required. When HORC is used as a disaster recovery tool, host failover is required to ensure effective disaster recovery operations. When a HORC pair is suspended due to an error condition, the MCU generates sense information which should be transferred to the remote site via the host failover software for effective disaster detection and recovery.

2.2 HORC Operations

Figure 2.2 illustrates the two types of HORC operations: initial copy and update copy. To reduce the overhead associated with these remote copy activities and maximize data transfer, the Lightning 9900™ subsystem utilizes a special write command which is allowed only for HORC initial and update copy operations. This command transfers the control parameters and the FBA-format data for consecutive updated records in a track using a single write operation. The special HORC write command reduces interlocks on the ESCON interface protocol as well as the overhead required for performing FBA-to-CKD and CKD-to-FBA conversions.

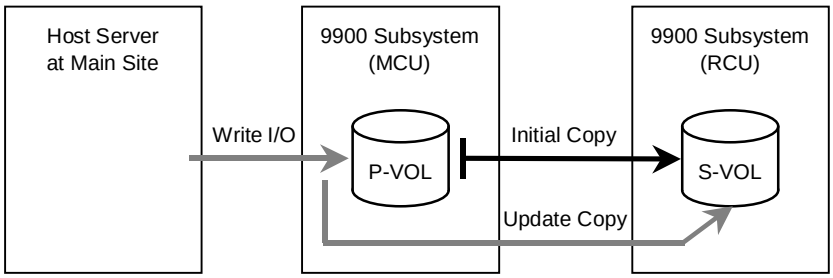


Figure 2.2 HORC Remote Copy Operations

2.2.1 Initial Copy Operation

The HORC initial copy operation synchronizes the P-VOL and S-VOL independently of host I/O processes. The initial copy operation is the same for HORC Sync and HORC Async pairs. A HORC initial copy operation takes place when you add a pair (paircreate) or resume a split/suspended pair (pairresync). When a new pair is created, the entire contents of the P-VOL are copied to the S-VOL cylinder by cylinder, except for the diagnostic and unassigned alternate tracks. You can also select **None** for the initial copy mode, which copies only cylinder #0 to the S-VOL. If **None** is selected, the user is responsible for ensuring that the P-VOL and S-VOL are already identical. The MCU cannot verify the contents of the volumes. When a split/suspended pair is resumed (pairresync), only cylinder #0 and out-of-sync cylinders (updated by write I/Os during split/suspension) are copied to the S-VOL. When the HORC S-VOL write enable function is used, the RCU keeps track of S-VOL updates and sends the S-VOL cylinder bitmap to the MCU when the split pair is resumed. In this case the MCU merges the P-VOL and S-VOL bitmaps to identify the out-of-sync cylinders.

For additional flexibility, HORC provides the following options for the initial copy operation:

- The **number of tracks** option allows you to specify how many tracks are copied simultaneously by the HORC initial copy operation when creating/resuming a HORC pair. This option can only be specified using the HORC remote console software.
- The **initial copy priority** option allows you to specify the order in which the initial copy operations are performed when creating/resuming multiple HORC pairs. This option can only be specified using the HORC remote console software.
- The **maximum initial copy activity** option allows you to specify the maximum number of concurrent initial copy operations that each MCU can perform (not pair-specific). This option can only be specified using the HORC remote console software.

2.2.2 Update Copy Operation

A HORC update copy operation occurs when the host issues a write I/O operation to the P-VOL of a HORC pair. The update copy operation duplicates the P-VOL write I/O at the S-VOL to keep the volume pair synchronized. HORC provides two modes for update copy operations: synchronous and asynchronous. The update copy mode is specified when you add a HORC pair and cannot be changed.

For synchronous update copy mode, the MCU ensures that the P-VOL and S-VOL are synchronized at all times. The MCU does not return final ending status for the P-VOL write I/O until both the P-VOL write and its associated update copy operation at the RCU are complete. For synchronous mode, the MCU starts the update copy operation when it receives:

- a write command whose data length is short enough not to pass the track-end, or
- write data to the track-end, whose total length is long enough to pass the track-end, or
- write data to the last track for the command.

Note: No matter how long the write data is, update copy is executed for each track.

For asynchronous update copy mode, the MCU stores the P-VOL updates along with additional control information in cache, and sends the updates and control information to the RCU completely independent of the host I/O processes. These updates along with their associated control information are called HORCA recordsets. The RCU stores the HORCA recordsets in cache and performs the updates to the S-VOLs in the same order as they were performed at the MCU(s) according to the HORC time-stamp and sequence information. For further information on HORCA recordset operations, see section 2.3.

Priority of initial and update copy: In both HORC Synchronous and HORC Asynchronous (HORCA), update copy has higher priority than initial copy. However, initial copy is executed based on the copy pace (3 or 15 tracks), therefore, update copy must wait this interval if initial copy is being executed. For example, if the copy pace is 15 tracks, the update copy may wait up to 15 tracks (1 cylinder). In the case of HORCA, update copy is executed asynchronously, but the same scheduling conflict can occur between the asynchronous update copy (write recordset) and initial copy.

2.2.3 Read and Write I/O Operations During HORC

When an MCU receives a read command for a HORC P-VOL, the MCU completes the read from the P-VOL. If the read fails, the redundancy provided by RAID technology recovers the failure. The MCU does not read the HORC S-VOL for recovery.

When an MCU receives a write command for a HORC Synchronous P-VOL with COPY status and the track has already been copied to the S-VOL, the MCU performs a synchronous update copy operation to complete the write at the S-VOL. When an MCU receives a write command for a HORC Asynchronous P-VOL with COPY status and the track has already been copied to the S-VOL, the MCU performs an asynchronous update copy operation.

When an MCU receives a write command for a HORC P-VOL with PAIR status, the user-selected update copy mode (synchronous or asynchronous) determines the sequence of events:

- **Synchronous Mode:** The MCU performs the write operation on the P-VOL, starts the update copy operation for the S-VOL, and then reports final ending status to the host only after the update copy operation is complete. If the P-VOL write or S-VOL update copy operation fails, the MCU reports a unit check, and the host system and application program will regard that write operation to the P-VOL as failed. If a failure occurs at the P-VOL or the S-VOL, the corresponding volume of the HORC pair will decommit the update to maintain exact synchronization of the volumes.

- **Asynchronous Mode:** The MCU completes P-VOL write operations independently of the associated update copy operations at the S-VOL. The RCU manages the S-VOL updates according to the HORCA recordset information and maintains time-based data consistency for the S-VOLs. If the P-VOL write operation fails, the MCU reports a unit check and does not create the HORCA recordset for this operation. If the update copy operation fails, the RCU suspends either the affected pair or all HORCA pairs in the consistency group, depending on the type of failure. When the suspended HORC pair or group is resumed (pairresync), the MCU and RCU negotiate the resynchronization of the pair(s). See section 2.5.2 for further information on suspended HORC Asynchronous pairs.

The RCU does not allow a HORC S-VOL to be online (mounted) during normal HORC operations and rejects all host-requested write I/O operations for an S-VOL. The special HORC S-VOL write enable option enables write access to an S-VOL while the pair is split (see section 2.2.4). The S-VOL write option can only be enabled when you split the pair from the MCU.

Note: To reduce the overhead associated with HORC remote copy operations, the 9900 uses a special write command which is allowed only for HORC initial and update copy operations. This HORC command transfers the control parameters and the FBA-format data, which includes consecutive updated records in each track, using a single write operation. This capability reduces interlocks on the ESCON interface protocol and eliminates the overhead required for performing FBA-to-CKD and CKD-to-FBA conversions.

2.2.4 S-VOL Write Option

HORC provides an S-VOL write option which enables write access to the S-VOL of a split HORC pair. The S-VOL write option can be selected by the user during the pairsplit-R operation and applies only to the selected pair(s). The S-VOL write option can be accessed only when you are connected to the MCU. When you resync a split HORC pair which has the S-VOL write option enabled, the RCU sends the S-VOL cylinder bitmap to the MCU, and the MCU merges the P-VOL and S-VOL bitmaps to determine which cylinders are out-of sync. This ensures proper resynchronization of the pair.

2.3 HORC Asynchronous Recordset Operations

The HORCA recordsets contain the P-VOL updates and the associated control information, including the time-stamp of the P-VOL update, which enables the RCU to maintain update consistency of the HORC S-VOLs. HORC recordset operations include:

- Creating and storing recordsets at the MCU,
- Sending recordsets to the RCU,
- Storing recordsets at the RCU,
- Selecting and settling recordsets at the RCU,
- Types of recordsets, and
- Inflow control for sidefiles.

2.3.1 Creating and Storing Recordsets at the MCU

When an MCU performs an update (host-requested write I/O) on a HORC P-VOL, the MCU creates a HORCA recordset which contains: the updated record, time-stamp information, sequence number, record location (device, cylinder, track, record number), and record length. The HORCA recordsets are queued in the cache storage of the MCU and sent to the RCU independent of host I/O processes. The RCU utilizes the time-stamp and sequence number information in the recordsets to update the S-VOL(s) in the same order as the P-VOL(s).

The HORC time-stamp information is acquired from the 9900 SVP. This time-stamp provides a protective measure for write-dependent applications and minimizes recovery time in the event of a disaster. The sequence number indicates the number of recordsets that the MCU has created for each consistency group. The recordset information, except for the updated records, is stored and queued in an area of cache known as sidefile cache (see section 2.3.6 for further information on sidefile cache). ***Note:*** HORC Asynchronous operations continue uninterrupted if the SVP reboots or even if the SVP fails (in this case the time-stamps may not be correct).

2.3.2 Sending Recordsets to the RCU

The MCU sends the HORCA recordsets to the RCU in a similar manner as the HORC synchronous updates. The MCU's RCP ports act as host processor channels and issue special I/O operations, called remote I/Os (RIOs), to the RCU. The RIO transfers the recordsets in FBA format (not CKD) using a single channel command, eliminating the overhead associated with FBA-CKD conversion and thus providing more efficient transfer of data. The MCU can send several recordsets using a single RIO, even if their sequence numbers are not contiguous. Therefore, HORCA recordsets are usually sent to the RCU in a different order than the arrivals at the MCU. The RCU ensures that records are applied to the S-VOLs in the correct sequence. This method of remote I/O provides the most efficient use of MCU-to-RCU link resources.

Note: The parameter length and detailed specification of the HORC Asynchronous channel command are different than for HORC Synchronous RIOs. You must make sure that your channel extenders are capable of supporting this command. For further details, please contact your Hitachi Data Systems account team.

2.3.3 Storing Recordsets at the RCU

The RCU maintains queues to control the storing of recordsets in the sidefile and commitment of updating records in the S-VOLs. The RCU queuing mechanism uses time-stamping to control the sequence in which S-VOL updates are applied, and uses sequence numbers provided by the MCU to check for any missing updates.

Note: The MCU does not remove the sidefile entry for a recordset from its cache until it receives an I/O completion signal (device end) from the RCU. This is true even if the MCU and RCU are connected via a channel extender product. If a recordset is lost in transmission from the MCU to the RCU, the MCU's cylinder bitmap ensures that the missing recordset is identified and resent to the RCU.

2.3.4 Selecting and Settling Recordsets at the RCU

The RCU selects the recordset to be promoted to formal data (or "settled") as follows:

1. The RCU checks for a valid entry at the top of each queue in the consistency group. If the top of any queue is empty (i.e., recordset not yet received), the RCU waits for that entry.
2. When the top of each queue contains a valid entry (recordset), the RCU selects the entry which has the earliest time-stamp value, and then settles this recordset.
3. The RCU repeats steps (1) and (2) to select and settle HORCA recordsets.

Figure 2.3 (next page) illustrates recordset selection and settling at the RCU. In this example, the top of the queue contains a valid entry: S1/T1. The RCU selects recordset S1/T1 to be settled, because T1 is the earliest time-stamp. When S1/T1 is removed from the MCU queue, recordset S2 becomes the top entry, but it is empty. When recordset S2 arrives (and its time-stamp is later than T1 and earlier than T3), the RCU selects S2/T2 as the next recordset to be settled. The recordset selected by the RCU is marked as "host-dirty" and treated as formal data. The time-stamp value of that recordset is promoted to the consistency time (C/T) of the group. The RCU settles the updated records in the recordset as follows:

- If the corresponding track is in cache (track-hit), the updated records in the recordset are copied to the existing cached track, and the cache space for the sidefile is released.
- If the corresponding track is not in cache (track-miss), the RCU changes the cache designation of the sidefile to formal data. The data is not physically moved.

2.3.5 Types of Recordsets

In addition to host update recordsets, the MCU passes control information to the RCU in special non-update recordsets. These special recordsets indicate when volume pair status changes and when an MCU power-off sequence is initiated, and also maintain sequence numbers in periods of low host activities.

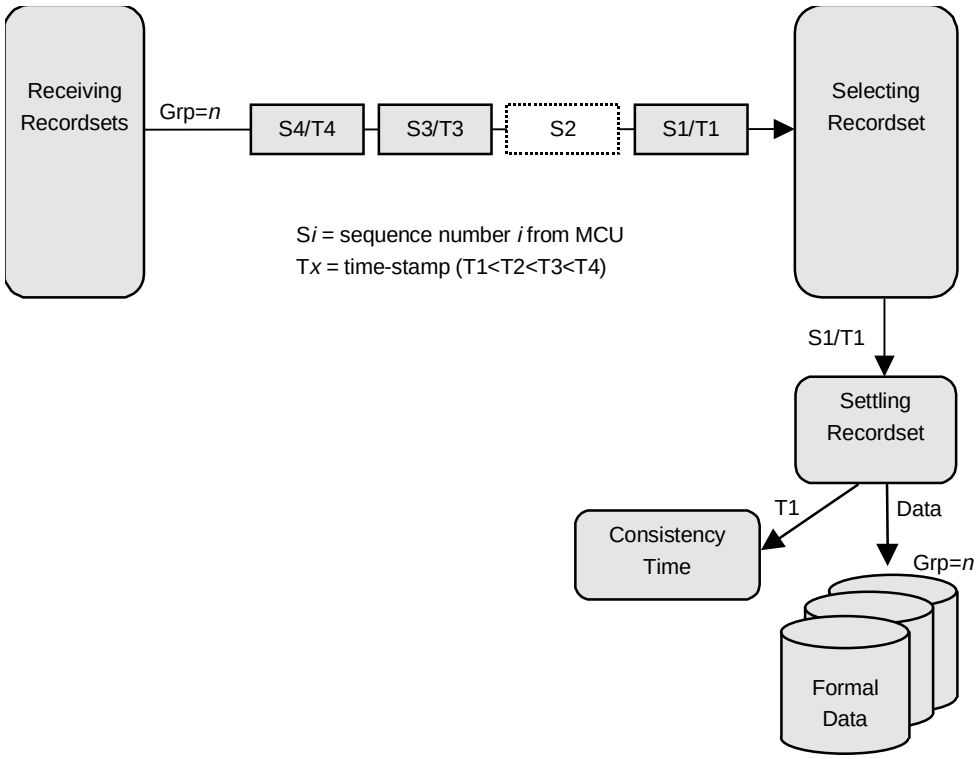


Figure 2.3 Selecting and Settling HORC Asynchronous Recordsets at the RCU

2.3.6 Inflow Control of Recordsets

As described in the previous sections, both the MCU and RCU create sidefiles for storing HORC (and HRC) Asynchronous recordsets. Since the sidefiles occupy exclusive space in cache, both the MCU and RCU perform inflow control to prevent an overload of the subsystem's cache resources. The 9900 subsystems use the following parameters for HORC Asynchronous cache inflow control, and the HORC Async Option panel (see section 4.4.1) allows you to modify these parameters:

- Sidefile (HORC) threshold = maximum cache % available for use by HORC sidefiles.
- Offloading timer = maximum time between HORC Async recordset transfers.

Inflow Control by MCU. When the amount of MCU sidefile cache reaches the user-specified threshold, the subsystem's I/O response is delayed. If the MCU is not able to send a recordset to the RCU within the user-specified offloading timer value, the MCU suspends all affected HORC Async volume pairs and resets the SCP condition to avoid hanging up the system.

Note: When channel-extenders are used for HORC Async, the offloading timer should be set to 35 seconds or less to avoid affecting host I/O performance.

Inflow Control by RCU. When the amount of RCU sidefile cache reaches the user-specified threshold, the RCU responds with channel-command-retry requests to the RIO commands which transfer the recordsets from the MCU. The only recordset accepted by the RCU is the recordset with the sequence number required to continue settling the pending recordsets. If the RCU is not able to settle a recordset within the user-specified offloading timer value, the RCU suspends all HORC Asynchronous volume pairs and resets the channel-command-retry condition to avoid hanging up the MCU.

Table 2.2 shows the sidefile threshold values for HORC Asynchronous operations and write pending operations and describes the actions that occur when each threshold is reached.

Table 2.2 Sidefile Thresholds

Operation	Threshold(s)	Action(s)
HORC Asynchronous	Sidefile threshold = 50%. HORC threshold can be adjusted using the HORC remote console software (30, 40, 50, 60, 70%).	MCU reaches threshold: I/O delay. RCU reaches threshold: command retry to MCU.
Write Pending	[write pending] / [avail cache - sidefile] = 70%	Command retry.

Note: FlashAccess operations may decrease the total amount of cache available for HORC Asynchronous operations but do not directly affect sidefile cache usage. Available cache is defined as the amount of physical cache memory installed on the subsystem minus any cache reserved for the FlashAccess feature.

For information on HXRC and Concurrent Copy (CC) cache sidefile operations, please refer to the *Hitachi Remote Copy (HRC) User and Reference Guide*. Subsystems performing HORC Asynchronous in combination with HXRC and/or CC must have sufficient cache installed to handle the increased sidefile activity.

2.4 HORC Asynchronous Consistency Group Operations

HORC Asynchronous consistency groups enable update sequence consistency to be maintained across a group of volumes. The P-VOLs and S-VOLs of the pairs in a consistency group must be located within one physical MCU and one physical RCU (1-to-1 requirement). The HORC consistency group operations include:

- Group options,
- Group consistency time, and
- Group operations.

2.4.1 Group Options

HORC provides the following options for each consistency group: **copy pending timeout**, and **RCU ready** timeout. These options are selected when you add a group, and can only be modified when the group does not contain any P-VOLs in the MCU.

Copy pending timeout. This group option specifies the maximum delay allowed for HORC Asynchronous copy operations. The RCU will suspend all S-VOLs in the group when:

- The RCU has not had any communication from the MCU within the specified time. This situation could indicate a disaster or failure at the primary site.
- The RCU has been receiving recordsets from the MCU(s) but has not been able to settle a recordset within the specified time. This situation may indicate that the RCU does not have enough resources to handle the remote copy and I/O workloads.

RCU ready timeout. This group option specifies the maximum delay allowed for re-establishing MCU-RCU communications following MCU power-off. During MCU power-on, the MCU re-establishes communication with all registered RCUs. If the MCU is not able to re-establish communication with an RCU within the specified time, the MCU suspends all affected HORC Asynchronous volume pairs.

2.4.2 Group Consistency Time

During normal HORC operations, the consistency time (C/T) of a group corresponds to the time-stamp value of the most recently settled recordset at the RCU. The consistency time for the group is indicated as part of the HORC S-VOL pair status. As the primary system continues to update the P-VOLs, the difference between the current system time and the group consistency time indicates the amount of time that the S-VOLs are behind the P-VOLs. The P-VOL updates which take place during this time may be lost when a disaster occurs.

When a HORCA pair is split or suspended, the C/T of the S-VOL is frozen. If the RCU can ensure the update sequence consistency between the split/suspended S-VOL and the other S-VOLs in the consistency group, the S-VOL C/T is frozen at the latest consistency time of the group. Otherwise, the S-VOL C/T is frozen at the time-stamp value of the most recent update that was successfully copied to the S-VOL. The C/T of a split/suspended S-VOL may be older than the C/T of other S-VOLs in the group, and if the entire group was not also split or suspended, the consistency time of the group is still ticking. For split/suspended HORC S-VOLs, the Pairdisplay panel displays whether the C/T was frozen to the group or S-VOL time.

Once HORC Asynchronous operations are established, you should monitor the consistency time of each group at the RCU(s). If the average delay is longer than your disaster recovery design can accept, you should consider adding remote copy resources (e.g., paths, cache) and/or reducing the I/O workload to improve subsystem performance. If the delay between the P-VOL update and the corresponding S-VOL update reaches the time specified by the **Copy Pending Timeout** group option, the MCU will suspend all affected volume pair(s) due to the heavy I/O workload (at MCU or RCU). To prevent timeout errors, you can increase the **Copy Pending Timeout** value, reduce I/O workload, and/or add remote copy resources.

2.4.3 Group Operations

HORC Asynchronous provides the following group-based operations to simplify and expedite disaster/failure recovery procedures:

- Group operations at the MCU:
  - Split (pairsplit-R) all pairs in a consistency group. See section 5.4 for a description of the **Suspend Range-Group** pairsplit-R option.
  - Resume (pairresync) all split or suspended pairs in a group. See section 5.5 for a description of the HORC **Resume Range-Group** pairresync option.
  - Delete (pairsplit-S) all pairs in a group. See section 5.6 for a description of the **Delete Range-Group** pairsplit-S option.
- Group operations at the RCU:
  - Split (pairsplit-R) all pairs in a consistency group. See section 5.4 for a description of the **Suspend Range-Group** pairsplit-R option.
  - Delete (pairsplit-S) all split/suspended pairs in a consistency group except for any inconsistent pairs. See section 5.6 for a description of the **Delete Range-C/T** pairsplit-S option.
  - Delete (pairsplit-S) all pairs in a group regardless of their consistency status. See section 5.6 for a description of the **Delete Range-Group** pairsplit-S option.

HORC also provides the **Error level** pair option (see section 5.2.2) which is used to trigger automatic suspension of an entire consistency group. When a HORCA pair is suspended due to failure (not user-requested), this HORC pair option determines whether all pairs in the same consistency group will also be suspended. If you selected the **Group** error level for the HORC pair, all pairs in the same group will be suspended. If you selected the **LU** error level, only the affected HORC pair will be suspended.

Note: The **Error level** pair option is very important for managing HORC Asynchronous groups and planning for disaster recovery. The **Group** error level should be selected for all HORCA volumes which are essential to disaster recovery. Suspended HORC S-VOLs which have the **LU** error level should not be used for disaster recovery.

2.5 HORC Volume Pair Status

HORC displays the pair status for each volume in the selected logical CU image (CUI) of the connected 9900 subsystem. Table 2.3 lists and describes the HORC pair status descriptions. The MCU maintains the status of the P-VOL and can change the pair status of the P-VOL and S-VOL. The RCU maintains the status of the S-VOL and can change the pair status of the S-VOL but not the P-VOL. The MCU will detect when the RCU changes the S-VOL status (if the path status is normal) and will change the P-VOL status accordingly. You can display the detailed pair status information at the Remote Console PC (HORC Pairdisplay panel) or at the UNIX®/PC server host (CCI Pairdisplay command).

A volume which is not assigned to a HORC pair has the status **SMPL**. When a HORC pair is started, the MCU changes the status of the P-VOL and S-VOL to **COPY**. When the initial copy operation is complete, the MCU changes the status of both volumes to **PAIR**. When a HORC pair is split by the user (pairsplit-R), the MCU/RCU changes the status of the P-VOL and S-VOL to **PSUS** (if the path status is normal). When a pair is suspended due to an error condition, the MCU/RCU changes the P-VOL and S-VOL status to **PSUE** (if the path status is normal). When a pair is deleted by the user from the MCU (pairsplit-S), the MCU changes the status of the P-VOL and S-VOL to **SMPL** (if path status is normal). When a pair is deleted from the RCU, the RCU changes the S-VOL status to **SMPL**, and the MCU detects the pair deletion (if path status is normal) and changes the P-VOL status to **PSUS**.

When a HORC pair is split or suspended, the MCU generates a service information message (SIM) to notify the host(s). If SNMP is installed and operational for the 9900, this SIM results in an SNMP trap which indicates the reason for suspension.

HORC LUSE Pair Status

For HORC LUSE pairs only, the **PDUB** status indicates that the status of the HORC LUSE volume pair is **COPY** or **PAIR**, but the status of one or more individual LDEV pairs within the HORC LUSE pair is **SMPL** or **PSUE** (due to some error condition).

HORC Asynchronous Pair Status

The HORC **Suspending** and **Deleting** transitional states occur when a request to change HORCA pair status has been accepted, but the change to the requested status (**PSUS**, **PSUE**, or **SMPL**) is not yet complete. These states are not reported to the host. In the case of **Suspending**, both the user and the MCU can request the status change. In the case of **Deleting**, only the user can request the status change. If the user requested the status change, the final status is reported at the end of the transition. If an error caused the status to change to **PSUE**, the suspended status is reported at the beginning of the transition.

Table 2.3 HORC Volume Pair Status

Pair Status	Description	P-VOL Access	S-VOL Access
SMPL (simplex)	This volume is not currently assigned to a HORC volume pair. When this volume is added to a HORC pair, its status will change to COPY.	Read/write	Read/write
COPY	The initial copy operation for this pair is in progress. This pair is not yet synchronized. When the initial copy is complete, the status changes to PAIR.	Read/write	Read only
PAIR	This pair is synchronized. Updates to the P-VOL are duplicated on the S-VOL.	Read/write	Read only
PSUS (pair suspended-split) (see Table 2.4 for split types)	This pair is not synchronized, because the user has split this pair (pairsplit-R), or because the user has deleted this pair from the RCU (pairsplit-S). For HORCA pairs, the MCU and RCU keep track of any recordsets that were discarded during the pairsplit-R operation. While a pair is split, the MCU and RCU keep track of the P-VOL and S-VOL cylinders which are updated. – When you split a pair from the MCU, the MCU changes the status of the P-VOL and S-VOL to PSUS. When you split a pair from the RCU, the RCU changes the status of the S-VOL to PSUS. The MCU detects this (if path status is normal) and changes P-VOL status to PSUS. – When you delete a pair from the RCU, the RCU changes the S-VOL status to SMPL. The MCU detects this (if the path status is normal) and changes the P-VOL status to PSUS. You must delete the pair from the MCU in order to change the P-VOL status to SMPL.	Read/write	Read only; Read and write, if write enable split option is selected.
PSUE (pair suspended-error) (see Table 2.6 for suspend types)	This pair is not synchronized, because the MCU or RCU has suspended the pair due to an error condition. For HORCA pairs the MCU and RCU keep track of any recordsets that were discarded during the suspension operation. The MCU keeps track of the P-VOL cylinders which are updated while the pair is suspended. – For HORC Synchronous pairs, if the MCU cannot keep the pair synchronized for any reason, the MCU changes the status of the P-VOL and S-VOL (if possible) to PSUE. – For HORC Asynchronous pairs, if the MCU detects a HORCA suspension condition (see section 2.5.3), the MCU changes the P-VOL and S-VOL status (if possible) to PSUE. – For HORC Asynchronous pairs, if the RCU detects a HORCA suspension condition (see section 2.5.3), the RCU changes the S-VOL status to PSUE, and the MCU detects this (if the path status is normal) and changes the P-VOL status to PSUE.	Read/write; Read only if fenced.	Read only
Pair Status for HORC LUSE volumes only:			
PDUB	This HORC pair consists of LUSE volumes (e.g., OPEN3*n), and an individual LDEV within this HORC LUSE pair has failed due to some error condition. The status of the HORC LUSE volume is PAIR or COPY, and the status of one or more LDEV pairs is PSUE or SMPL.	Read/write	Read only
Pair Status for HORC Asynchronous only:			
Suspending	This pair is not synchronized. This pair is in transition from PAIR or COPY to PSUS/PSUE. When the split/suspend pair operation is requested, the status of all affected pairs changes to **Suspending**. When the split/suspend operation is complete, the status changes to PSUS/PSUE.	Read/write	Read only
Deleting	This pair is not synchronized. This pair is in transition from PAIR, COPY, or PSUS/PSUE to SMPL. When the pairsplit-S operation is requested, the status of all affected pairs changes to **Deleting**. When the pairsplit-S operation is complete, the status changes to SMPL.	Read/write	Read only

2.5.1 HORC Split Types (PSUS)

Table 2.4 lists and describes the HORC split types. A HORC pair can be split by the user at any time after the initial copy operation is complete. The user must split a HORC pair in order to perform media maintenance on the P-VOL or to access the S-VOL (S-VOL write enable).

When a HORC Synchronous pair is split by the user, the MCU ensures synchronization by completing any pending update copy operation before changing the status to PSUS. After the pair status changes to PSUS, the MCU stops performing update copy operations to the S-VOL and may or may not continue accepting write I/Os for the P-VOL, depending on the P-VOL fence level and pairsplit-R options. If the P-VOL accepts write operations while the pair is split, the MCU keeps track of the P-VOL cylinders which are updated. If you enabled the S-VOL write option when you split the pair, the RCU keeps track of the S-VOL cylinders which are updated while the pair is split. When the pair is resumed (pairresync), the RCU sends the S-VOL cylinder bitmap to the MCU, and the MCU merges the P-VOL and S-VOL bitmaps to determine which cylinders are out-of-sync.

When a HORC Asynchronous pair is split by the user, the MCU and RCU ensure synchronization by either completing or discarding any pending update copy operations according to the user-specified drain/purge pairsplit option. The MCU and RCU keep track of any recordsets that were discarded during the pairsplit operation. After the pair status changes to PSUS, the MCU stops performing recordset operations for the pair, continues accepting write I/Os for the split HORCA P-VOL, and keeps track of the P-VOL cylinders which are updated while the pair is split. If you enabled the S-VOL write option when you split the pair, the RCU also keeps track of the S-VOL cylinders which are updated while the pair is split. When the pair is resumed, the RCU sends the S-VOL cylinder bitmap to the MCU, and the MCU merges the P-VOL and S-VOL bitmaps to determine which cylinders are out-of-sync.

A split (or suspended) HORCA S-VOL has an additional status called the consistency status. The consistency status is displayed only at the RCU and indicates the S-VOL's update sequence consistency with respect to the other S-VOLs in the same group. Table 2.5 lists and describes the consistency status descriptions for split (or suspended) HORCA S-VOLs.

Table 2.4 Split Types (PSUS)

Type	Applies to	Description
PSUS, P-VOL by Operator	P-VOL (HORC Sync only)	The user split the pair from the MCU using the **P-VOL Failure** option. The S-VOL split type is **PSUS-by MCU**.
PSUS, S-VOL by Operator	P-VOL, S-VOL	The user split the pair from the MCU or RCU using the **S-VOL** option.
PSUS, by MCU	S-VOL	The RCU received a request from the MCU to split the pair. The P-VOL split type is **PSUS-P-VOL by Operator** or **PSUS-S-VOL by Operator**.
PSUS, Delete pair to RCU	P-VOL	The MCU detected that the S-VOL status changed to **SMPL** because the user deleted the pair (pairsplit-S) from the RCU. The pair cannot be resumed because the S-VOL does not have the **PSUS/PSUE** status.

Table 2.5 Consistency Status for Split/Suspended HORC Async S-VOLs

Consistency Status	Description
Volume	This HORC Asynchronous volume pair was probably split or suspended alone. Update sequence consistency between this S-VOL and other S-VOLs in this consistency group is not ensured. This S-VOL cannot be used for disaster recovery at the secondary site. This status is indicated when: – This pair was split by the user using the **Suspend Range-LU** pairsplit-R option. – This pair was suspended due to a failure that did not affect the entire consistency group, and the **Error Level** pair option for this pair is set to **LU**.
Group	This HORC Asynchronous volume pair was split or suspended along with the other pairs in its consistency group. Update sequence consistency between this S-VOL and other S-VOLs in this consistency group is ensured. This S-VOL can be used for disaster recovery at the secondary (remote) system (after deleting the HORC pair from the RCU). This status is indicated when: – This pair was split by the user using the **Suspend Range-Group** pairsplit-R option. – All pairs in this consistency group were suspended due to a failure that affected the entire consistency group (not just one pair) (e.g., MCU-RCU communication failure). – One pair in the group was suspended due to a failure that did not affect the entire group, and the **Error Level** pair option for this pair is set to **Group**.

2.5.2 HORC Suspend Types

Table 2.6 lists and describes the HORC suspend types, which indicate the reason for the suspension. HORC Synchronous pairs can only be suspended by the MCU. HORC Asynchronous pairs can be suspended by the MCU or by the RCU. For further information on HORCA suspension conditions, please see section 2.5.3.

The MCU suspends a HORC pair when it detects any of the following suspension conditions:

- When the MCU detects that the user has deleted the volume pair from the RCU,
- When the MCU detects an error condition related to the RCU, S-VOL, or a HORC update copy operation,
- When the MCU is unable to communicate with the RCU, or
- When the MCU detects a HORC Asynchronous suspension condition.

When a HORC Sync pair is suspended, the MCU stops performing update copy operations to the S-VOL and may or may not continue accepting write I/Os for the P-VOL, depending on the P-VOL fence level pair option. If a HORC synchronous update copy operation fails, the MCU maintains exact synchronization by reporting a unit check and decommitting the P-VOL update, so that the host system and application program regard that write operation to the P-VOL as failed. If the MCU accepts write I/Os for a suspended P-VOL, the MCU keeps track of the P-VOL cylinders which are updated while the pair is suspended. When a suspended HORC Sync pair is resumed, the MCU copies the out-of-sync P-VOL cylinders to the S-VOL. HORC does not allow access to an S-VOL while the pair is suspended (only when split).

When a HORC Asynchronous (HORCA) pair is suspended, the MCU stops performing HORC Async recordset operations for the pair. The MCU continues accepting write I/Os for the suspended P-VOL and keeps track of the P-VOL cylinders which are updated while the pair is suspended. The MCU and RCU also keep track of any recordsets that were discarded during the pair suspension. When a suspended HORCA pair is resumed, the RCU sends the S-VOL cylinder bitmap to the MCU, and the MCU merges the P-VOL and S-VOL bitmaps to determine which cylinders are out-of-sync. This method ensures that all cylinders which contain recordsets that were discarded at the RCU are resynchronized at this time.

A suspended (or split) HORCA S-VOL has an additional status called the consistency status. The consistency status is displayed only at the RCU and indicates the S-VOL's update sequence consistency with respect to the other S-VOLs in the same group. Refer to Table 2.5 (above) for a description of the consistency status for suspended/split HORCA S-VOLs.

Table 2.6 Suspend Types (PSUE)

Type	Applies to	Description
PSUE, by RCU	P-VOL, S-VOL	The MCU detected an error condition at the RCU which caused the MCU to suspend the HORC volume pair. The S-VOL suspend type is **PSUE-S-VOL Failure**.
PSUE, S-VOL Failure	P-VOL, S-VOL	The MCU detected an error during RCU communication or an error during update copy. In this case, the S-VOL suspend type is usually **PSUE-S-VOL Failure**. This suspend type is also used when the number of paths falls below the minimum number of paths setting on the RCU Option panel.
PSUE, MCU IMPL	P-VOL, S-VOL	The MCU could not find valid control information in its nonvolatile memory during IMPL. This condition occurs only if the MCU is without power for more than 48 hours (i.e., power failure and fully discharged backup batteries).
PSUE, Initial Copy Failed	P-VOL, S-VOL	The HORC pair was suspended before the initial copy operation was complete. The data on the S-VOL is not identical to the data on the P-VOL.
PSUE, MCU P/S OFF	S-VOL (HORC Async only)	The RCU received a request from the MCU to suspend the S-VOL due to MCU power-off. The RCU stops expecting recordsets from that MCU. The P-VOL status does not change due to MCU power-off.
PSUS, Sidefile overflow (HORCA only)	P-VOL, S-VOL	The amount of sidefile exceeds the specified "current pending update data rate", and the RCU data is not transferred within the specified "offloading timer".

2.5.3 HORC Asynchronous Suspension Conditions

HORC Asynchronous operations involve additional suspension conditions related to the recordset operations. Both the MCU and RCU can detect HORCA suspension conditions and suspend HORCA pairs. When a HORCA pair is suspended, the cylinders which contain the following records are marked in the cylinder bitmap as modified (to be copied during the pairresync operation):

- The recordsets that were created by the MCU but not yet sent to the RCU. After marking these P-VOL cylinders as modified, the MCU discards these recordsets.
- The recordsets that were sent to the RCU but not acknowledged by the RCU. The MCU marks these P-VOL cylinders as modified and discards these recordsets. This ensures that recordsets which are lost during transmission to the RCU are identified and marked.
- The recordsets that reached the RCU but have not yet been settled. After marking these S-VOL cylinders as modified, the RCU discards these recordsets.
- The P-VOL records updated by host-requested write I/Os after the pair was suspended (same function as for HORC Synchronous pairs).

If a recordset is lost in transmission from the MCU to the RCU, the MCU's cylinder bitmap ensures that the missing recordset is marked. After the MCU sends the recordset to the RCU, the MCU does not remove the sidefile entry for the recordset from its cache until it receives an I/O completion signal (device end) from the RCU.

Table 2.7 describes the HORC Asynchronous suspension conditions and indicates which CU detects the condition and which pairs are suspended. The HORC offloading timer option (see section 4.4.1) and timeout group options (see section 4.4.3) are used to control the HORC Asynchronous suspension conditions. See Table 7.4 in section 7.1 for troubleshooting information for HORC Asynchronous suspension conditions.

Table 2.7 HORC Asynchronous Suspension Conditions

Suspension Condition	Detected by:	HORCA Pairs to be Suspended
The MCU could not send a pending recordset to the RCU before the **offloading timer** async option expired.	MCU	All HORCA pairs with P-VOLs in the MCU.
During MCU power-on, the MCU could not establish communication with the RCU before the **RCU ready timeout** group option expired.	MCU	All HORCA pairs with P-VOLs in the MCU.
The RCU could not settle a pending recordset before the **copy pending timeout** group option expired.	RCU	All HORCA S-VOLs in the consistency group.
The RCU could not communicate with the MCU before the **copy pending timeout** group option expired (see section 4.4.3).	RCU	All HORCA S-VOLs in the consistency group.
The RCU could not receive the recordset successfully due to a hardware failure.	RCU	Only the affected S-VOL.
The RCU detected a logical error while selecting the recordset to be settled.	RCU	All HORCA S-VOLs in the consistency group, or only the affected S-VOL, depending on the type of failure and the **error level** HORCA pair option.
The RCU could not settle the recordset due to a hardware failure, track condition, or logical error.	RCU	

Chapter 3 Preparing for HORC Operations

3.1 System Requirements

HORC operations involve the 9900 MCUs and RCUs containing the primary and secondary volumes, the remote copy connections between the MCUs and RCUs, the UNIX® and/or PC server host(s) at the primary and remote sites, and the HORC remote console software. The HORC system requirements are:

- **MCU:** Hitachi Lightning 9900™ subsystem with HORC installed.
- **RCU:** Hitachi Lightning 9900™ subsystem with HORC installed.

Note: HORC can coexist with HRC (all copy modes) in the same 9900 subsystem.

Note: The 9900 subsystems may have additional installation requirements (e.g., SVP modes). For further information on 9900 SVP modes for HORC, refer to Table 2.1.

- **Remote copy connections** (see section 3.3.1 for further information):
  - Multimode serial interface (ESCON®) cables are required at both the MCU and RCU.
  - For distances from 3 km to 43 km, single-mode serial interface cables with IBM 9032 or 9033 ESCON directors (ESCDs) and/or 9036 ESCON repeaters are required.
  - For distances greater than 9 km, the extended distance facility (XDF) provided by the ESCDs and/or ESCON repeaters is required.
  - For distances greater than 43 km, approved third-party channel extender products and telecommunications lines are required. Long-distance HORC solutions are provided based on user requirements and workload characteristics. ***Note:*** Usage of channel extenders may require additional 9900 configuration (e.g., SVP mode 21).

    Note: All remote copy activities between two 9900 subsystems (i.e., HORC Sync and HORCA, HRC Sync and HRCA) can share the same remote copy connections.
- **UNIX®-based and PC server platforms:** The 9900 subsystem supports HORC operations for a variety of UNIX®-based and PC server platforms, including Sun® Solaris®, IBM® AIX®, HP-UX®, Windows NT®, Novell® NetWare®. Please contact your Hitachi Data Systems account team for the latest information on 9900 platform support.
- **9900 Remote Console PC:** The RMCMAIN and DKCMAIN HORC license key codes are required. If you are using HORC for disaster recovery, install a second Remote Console PC at the remote site. Please refer to the *9900 Remote Console User's Guide* for instructions on installing and using the 9900 Remote Console PC.

  Note: Administrator access to RMCMAIN or custom HORC access is required to perform HORC operations. Users without administrator or HORC access privileges can only view HORC information.

3.2 HORC Requirements and Restrictions

HORC has the following requirements and restrictions:

- One-to-one volume copy operations
- Logical unit (LU) type (also called device emulation or type)
- Consistency groups
- Accessing HORC P-VOLs and S-VOLs
- Cache and NVS
- Host failover software
- Duplicate volume
- Host system crash

3.2.1 One-to-One Volume Copy Operations

HORC requires a one-to-one relationship between the logical volumes of the volume pairs. A volume (LU) can only be assigned to one HORC pair at a time. HORC does not support operations in which one P-VOL is copied to more than one S-VOL, or more than one P-VOL is copied to one S-VOL. Because HORC operates on logical volumes rather than on files, multivolume files require special attention. For complete duplication and recovery of a multivolume file (e.g., a large database file which spans several volumes), make sure that all volumes of the file are copied to HORC S-VOLs, and use HORC Asynchronous to ensure update sequence consistency across this group of S-VOLs.

3.2.2 Logical Unit (LU) Types

HORC supports the OPEN-x LU types which can be configured on the 9900 subsystem (OPEN-3, OPEN-8, OPEN-9, OPEN-K, OPEN-E, OPEN-L, OPEN-M). (OPEN-L and -M are used only for Windows® 2000 systems.) The HORC remote console software displays the LU type of the P-VOLs and S-VOLs. A HORC pair must consist of LUs of the same type and capacity (e.g., OPEN-3 to OPEN-3). The 9900 multiplatform volumes (e.g., 3390-3A/B/C, 3380-KA/B/C) cannot be assigned to HORC pairs. ***Note:*** Please contact your Hitachi Data Systems account team for the latest information on supported devices.

HORC supports the LU Size Expansion (LUSE) feature of the 9900, which allows you to configure expanded LUs using two or more contiguous LDEVs (up to 36). When LUSE volumes are assigned to a HORC pair, the P-VOL and S-VOL must contain the same type and number of LDEVs (e.g., OPEN-3*6 to OPEN-3*6). The number of LDEV pairs in a HORC LUSE pair equals the number of LDEVs in each LUSE volume. When the status of all LDEV pairs within one HORC LUSE pair is not the same (e.g., one LDEV pair is suspended), the pair status of the HORC LUSE pair changes to PDUB.

HORC also supports the Virtual LUN feature of the 9900 subsystem (also called custom volume size or CVS), which allows you to configure custom-size LUs which are smaller than standard-size LUs. When custom-size LUs are assigned to a HORC pair, the S-VOL must have the same capacity as the P-VOL.

3.2.3 Consistency Groups

The HORC Asynchronous consistency groups have the following requirements:

- Each HORCA pair must be assigned to one and only one consistency group.
- The maximum number of volume pairs in one consistency group is 4,096 (entire RCU) (4,095 when the CCI command device is defined).
- The maximum number of consistency groups established for one MCU-RCU pair is 64 (00-3F). The RCU supports a maximum of 64 groups. This limit of 64 groups includes both HORCA groups and HRC Asynchronous groups (e.g., 32 HORCA + 32 HRCA).
- A HORC consistency group must consist only of HORCA pairs (no HRC pairs).

3.2.4 Accessing HORC P-VOLs and S-VOLs

To ensure maximum data integrity during normal HORC operations, the RCU rejects all write operations issued by a host to a HORC S-VOL. If you need write access to a HORC S-VOL, you must split the pair using the S-VOL write option (see section 2.2.4). When you resume (resync) the split pair, the RCU will send the S-VOL cylinder bitmap to the MCU to ensure proper resynchronization of the pair.

3.2.5 Cache and Nonvolatile Storage (NVS)

Cache and nonvolatile storage (NVS) must be operable for both the MCU and RCU of a HORC volume pair. If not, the HORC paircreate operation will fail. The remote subsystem cache should be configured to adequately support the HORC remote copy workloads as well as any local workload activity.

3.2.6 Host Failover Software

The 9900 remote console software products do not provide any host failover functions for disaster recovery. Host failover software is a critical component of any disaster recovery effort. When an MCU fails to maintain synchronization of a HORC pair, the MCU generates sense information. It is very important that this information be transferred to the remote site via the host failover software for effective disaster recovery.

3.2.7 Duplicate Volumes

Since the contents of the P-VOL and S-VOL of a HORC pair are identical, the S-VOL can be considered a duplicate of the P-VOL. Since the host operating system does not allow duplicate volumes, the host system administrator must take precautions to prevent system problems related to duplicate volumes. You must define the HORC S-VOLs so they do not auto-mount or come online to the same host at the same time as the P-VOLs (see **WARNING** below).

HORC does not allow the S-VOL to be online (except when the pair is split). If the S-VOL is online, the HORC paircreate operation will fail.

WARNING: If the HORC S-VOLs are physically attached to the same host server(s) as the HORC P-VOLs, the following problem can occur:

- When a HORC pair is deleted, the old S-VOL is usually offline. If the host is then restarted, the system administrator may be offered both volumes and asked which volume should be left offline. This can be confusing and is prone to error.

If the HORC S-VOLs and P-VOLs are connected to the same host(s), Hitachi Data Systems strongly recommends that the S-VOLs are defined to remain offline to avoid this problem.

3.2.8 Host System Crash

The contents of the P-VOL and S-VOL of a HORC pair may become inconsistent if the host system hangs (crashes) while a write operation is being performed on the HORC P-VOL, and the write operation cannot be retried because of the following reasons:

- A check condition is reported to the host due to a failure in the subsystem when the write command for the HORC pair is issued.
- A reset command is issued from the host and the write operation is stopped (the write operation is incomplete).

If these conditions occur, you must retry the job to complete the write operation.

3.3 Installing the Hardware

Initial installation of the HORC hardware is performed by the user and the Hitachi Data Systems representative. The hardware configuration for HORC Synchronous and HORC Asynchronous is the same.

To install the hardware required for HORC operations:

1. **User:** Identify the locations of the HORC P-VOLs and S-VOLs (primary and secondary volumes), so that the HORC hardware can be installed and configured properly.
2. **User and Hitachi Data Systems Representative:** Install the 9900 Remote Console PC near the HORC MCU(s), and connect the Remote Console PC to the HORC MCU(s) via the 9900-internal LAN. Hitachi Data Systems recommends that you also install a Remote Console PC connected to the RCUs at the remote site. Refer to the *9900 Remote Console User's Guide* for instructions on installing the 9900 Remote Console PC.
3. **Hitachi Data Systems Representative:** Make sure that the MCUs and RCUs are properly configured for HORC operations (e.g., cache, NVS) (see section 3.2.5). Make sure that adequate cache is installed and available for asynchronous operations (HRC/HORC, XRC, CC). You must also consider the amount of FlashAccess data to be stored in cache when determining the required amount of cache. Set the SVP clock to local time so that the HORC time-stamps will be correct. Also make sure that the desired SVP modes are enabled (see Table 2.1).
4. **Hitachi Data Systems Representative:** Make sure the MCUs are configured to report sense information to the host(s). The RCUs should also be attached to a host server to enable reporting of sense information in case of a problem with an S-VOL or RCU. If the remote site is unattended, the RCUs should be attached to a host server at the primary site, so that the system administrator can monitor the operational condition of the RCUs.
5. **Hitachi Data Systems Representative:** If power sequence control cables are used, set the power select switch for the cluster to LOCAL to prevent the MCU from being powered off by the host. Also make sure the RCU will not be powered off during HORC operations. See section 5.8 for further information on powering off/on the HORC MCUs and RCUs.
6. **Hitachi Data Systems Representative:** Install the Serial Port Adapter features (e.g., the DKC-F410I-8S serial 8-port adapter (pair of 4-port CHE cards, 1 card per cluster) provides eight ESCON links). If the MCU and RCU are multiplatform subsystems, there may be available serial interfaces, and additional Serial Port Adapter features may not be required.
7. **Hitachi Data Systems Representative:** Install the HORC remote copy connections between the MCU(s) and RCU(s). This hardware (ESCON cables, ESCON directors, etc.) is supplied by the user. See section 3.3.1 for remote copy configurations. Distribute the paths between different storage clusters and ESCDs to provide maximum flexibility and availability. The logical paths between the MCU and RCU must be separate from the logical paths between the host and RCU. All remote copy activities between two 9900 subsystems (i.e., HORC Sync and HORCA, HRC Sync and HRCA) can share the same remote copy connections.

3.3.1 HORC Remote Copy Connections

Figure 3.1 shows the HORC remote copy connection configurations. The MCU and RCU of each HORC pair must be connected via multimode ESCON® cables. For distances greater than 3 km, single-mode cables up to 20 km in length and IBM 9032/9033 ESCDs and/or 9036 ESCON repeaters are required. The IBM 9032/9033 ESCD supports the extended distance facility (XDF), which uses single-mode ESCON cables up to 20 km. The IBM 9036 ESCON repeater supports single-mode-to-single-mode connection or single-mode-to-multimode connection. When HORC subsystems are more than 9 km apart, the XDF connections provided by the ESCDs or ESCON repeaters are required. HORC operations can be performed at distances of up to 43 km (27 miles) using standard ESCON support. Long-distance solutions are provided using approved channel extenders and communication lines.

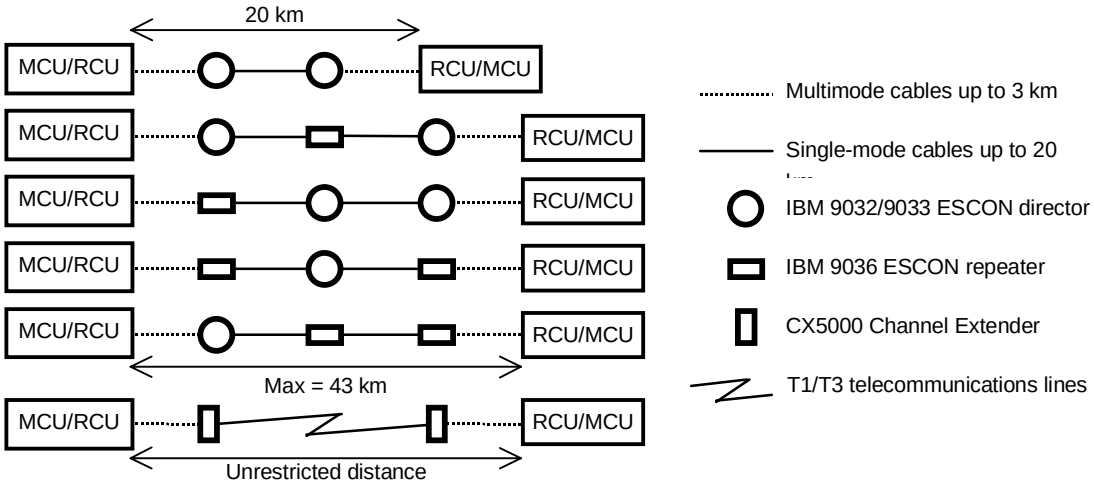


Figure 3.1 HORC Remote Copy Connection Configurations

Dedicated ESCON channels may be installed, or existing ESCON channels connected by ESCDs may be used. The logical paths between the MCU and RCU must be separate from the logical paths between the host and RCU. ***Note:*** All remote copy activities between two 9900 subsystems (i.e., HORC and HRC) can share the same remote copy connections.

The ESCDs can accommodate multiple MCU-RCU remote copy connections (see Figure 3.2). N-to-1 or 1-to-n remote copy connections (n≤4) can also be configured by using the dynamic switching capability of the ESCDs to share the physical interface cables between the components (see Figure 3.3). In addition, the ESCDs can accommodate channel-to-MCU and channel-to-RCU connections in addition to the remote copy connections (see Figure 3.4).

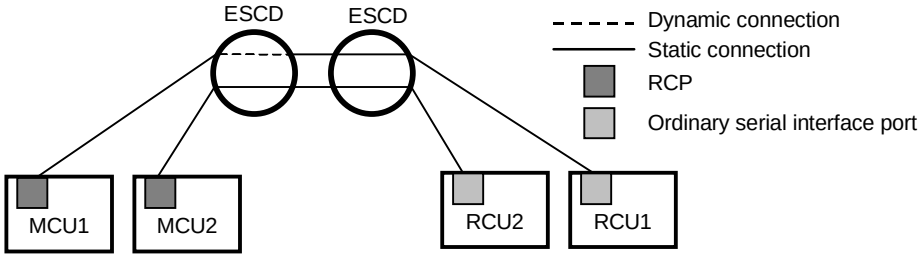


Figure 3.2 N Pairs of Remote Copy Connections

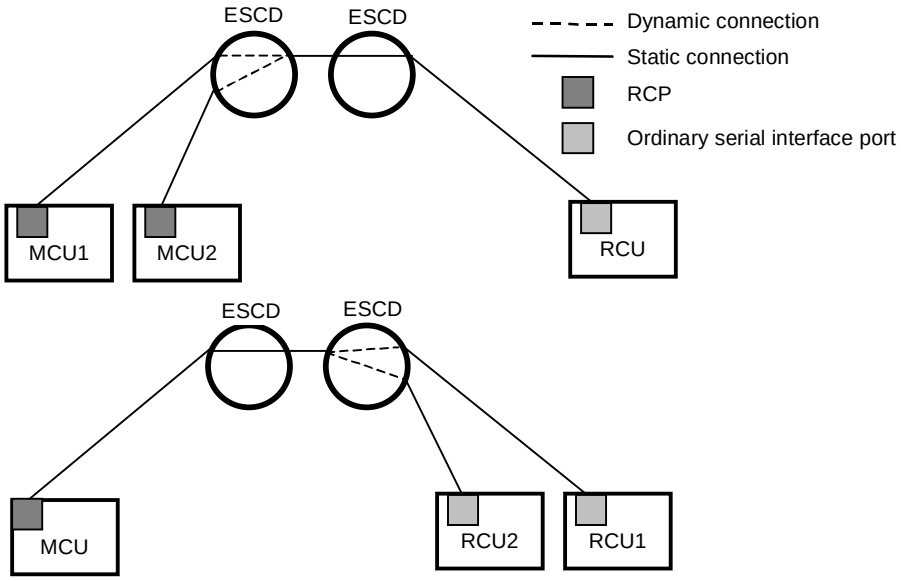


Figure 3.3 N-to-1 and 1-to-N Remote Copy Connections (N≤4)

Note: 1-to-n configurations (one main subsystem and multiple remote subsystems) are valid for HORC Asynchronous, as long as a consistency group does not span remote subsystems.

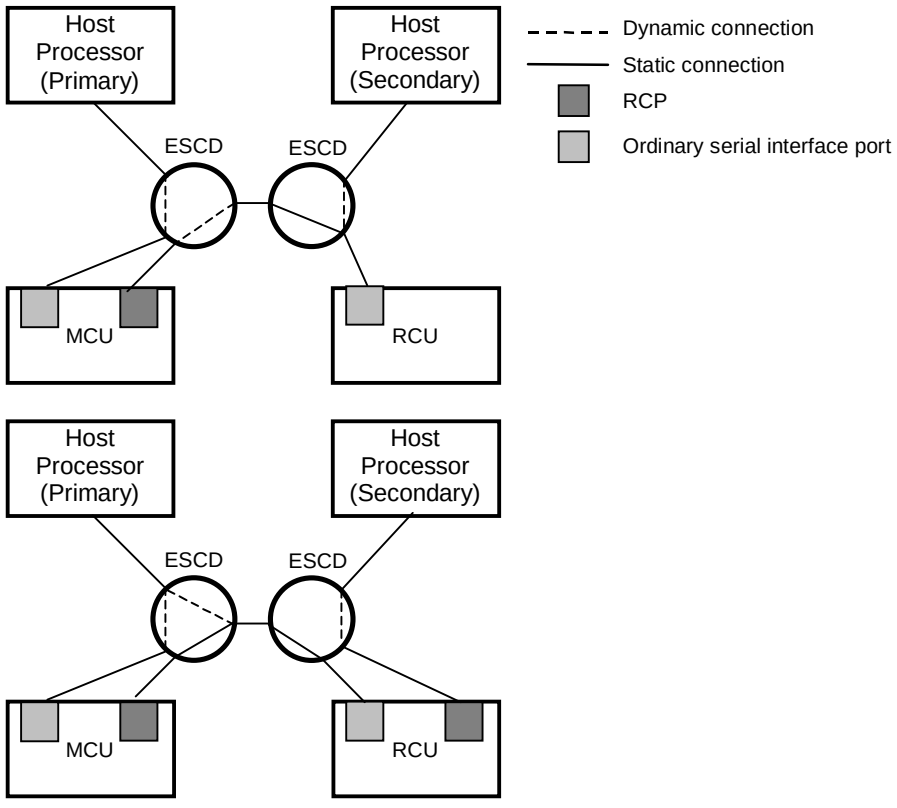
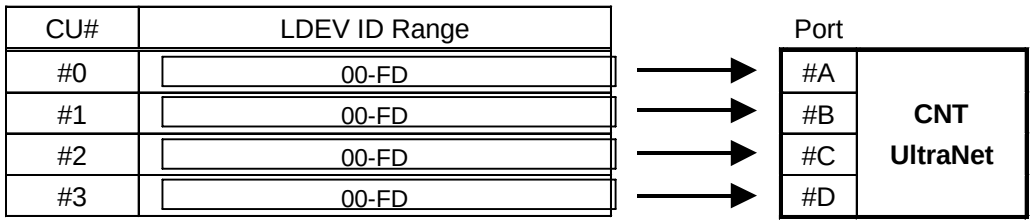


Figure 3.4 Remote Copy Connections Shared With Channel-to-RCU Connections

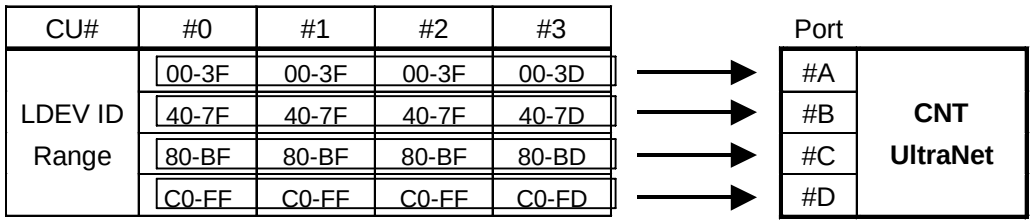
3.3.2 Using Channel Extenders

HORC Asynchronous can be integrated with third-party channel extender products to provide remote data backup for distances greater than 43 km. The following information was current at the time of publication of this document, but may change. Please contact your Hitachi Data Systems account team for the latest information on channel extender support for HORC.

- HORC has been tested with the CNT UltraNet Storage Director:
  - UltraNet supports T3 and ATM (asynchronous transfer mode) communication lines.
  - UltraNet supports ATM OC-3 (optical carrier) levels. The transfer speed of OC-3 is a maximum of 155 Mb/s.
  - The transfer speed of T3 is a maximum of 44 Mb/s.
- The 9900 subsystems' serial numbers must be set on the channel extenders as follows. If the serial numbers are not set correctly, the HORC paircreate operation will terminate with an error. For CNT UltraNet, this operation must be performed by the CNT representative.
  - Set the RCU serial number to the MCU-side extender.
  - Set the MCU serial number to the RCU-side extender.
  - Set the serial number on each CNT UltraNet port.
- Make sure that your channel extenders are capable of supporting the HORC Asynchronous channel command. The parameter length and detailed specification of the HORC Asynchronous channel command are different than for HORC Synchronous RIOs.
- The LDEV IDs of the S-VOLs must be assigned on each port of the MCU-side extender. The maximum number of LDEVs which can be assigned on each port is 254. Figure 3.5 shows the required LDEV assignment on each extender port. If the LDEV IDs are not assigned properly, the HORC paircreate operation will terminate with an error. For CNT UltraNet, this operation must also be performed by the CNT representative.



Example 1: Assigning the same LDEV IDs of a specific CU number to each port.



Example 2: Assigning specific LDEV IDs on each CU number to each port.

Figure 3.5 Assigning S-VOL LDEV IDs to the Channel Extender Ports

3.4 Enabling the HORC Feature

The user enables the remote HORC option on the Remote Console PC and the HORC copy options on each 9900 subsystem using the RMCMAIN and DKCMAIN license key codes for HORC. ***Note:*** You must have separate DKCMAIN license key codes for each 9900 subsystem. You may not re-use the same DKCMAIN key code for multiple 9900 subsystems.

To enable the HORC feature:

1. Check with your Hitachi Data Systems representative to verify that the correct microcode and SVP software are installed and enabled on the 9900 subsystems which will perform HORC operations. Also make sure that your RMCMAIN software version is correct.
2. Make sure that the 9900 Remote Console PC and RMCMAIN software are installed and functioning properly. Refer to the *9900 Remote Console User's Guide* for instructions on installing the Remote Console PC and RMCMAIN software.
3. Enable the remote HORC option(s) on the Remote Console PC as follows:
   a) Start up and log in to the 9900 RMCMAIN software with administrator access.
   b) Select **Option…** to open the RMCMAIN Option Product panel (see Figure 3.6).
   c) On the Option Product panel, select **Remote HORC**, and then select **Install…** to open the Input Key Code panel (see Figure 3.7).
   d) Enter the license key code in the **Key Code** text box, and then select **OK**.
   e) If the key code is accepted, the Program Product (P.P.) Confirmation panel opens (see Figure 3.8). Confirm the information displayed on this panel, and select **Install**. The Option Product panel now displays **[Install]** for the **Remote HORC** option.
   f) If you are also enabling HORC Asynchronous, repeat steps (c)-(e) for the **Remote HORC Asynchronous** option listed on the RMCMAIN Option Product panel. Select **Close** on the Option Product panel to return to the Remote Console Main panel.
4. If not already done, add the attached 9900 subsystems to the Remote Console PC. Select **Controller…**, select **Add…**, enter the subsystem name, S/N, and IP address, and select **OK**. Then select the subsystem you just added on the Connection Control panel, and select **Entry**. Refer to the *9900 Remote Console User's Guide* for more detailed instructions.
5. Enable the HORC copy option(s) on each subsystem (MCUs and RCUs) as follows:
   a) On the Connection Control panel, select the desired 9900 subsystem, and then select **Install…** to open the DKCMAIN Option Product panel (see Figure 3.9).
   b) Select **HORC** (must be enabled first), select **Install…**, enter the license key code for the selected subsystem on the Input Key Code panel, and select **OK**.
   c) Confirm the information displayed on the P.P. Confirmation panel, and select **Install** to enable the selected HORC option on the selected subsystem. The DKCMAIN Option Product panel now displays **[Install]** for the selected HORC copy option.
   d) If you are also enabling HORC Asynchronous, repeat steps (a) through (c) for the **HORC Asynchronous** copy option listed on the DKCMAIN Option Product panel.
6. After enabling the HORC options on all 9900 subsystems, you are now ready to configure the 9900 subsystems as MCUs and RCUs for HORC operations (see the next section).

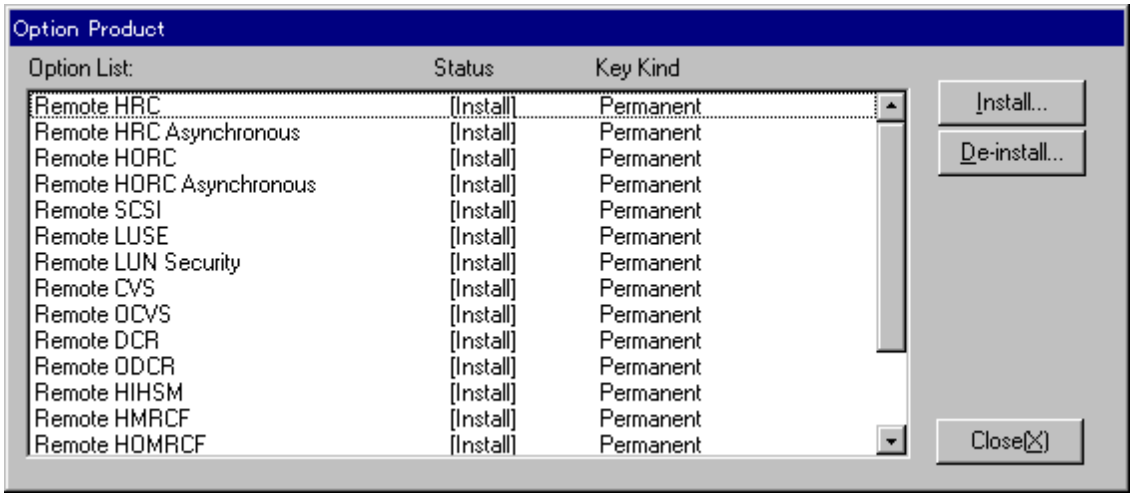


Figure 3.6 Enabling the Remote HORC Option

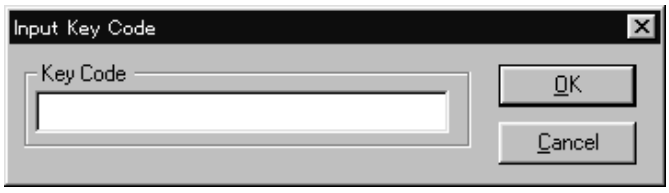


Figure 3.7 Entering the HORC License Key Code

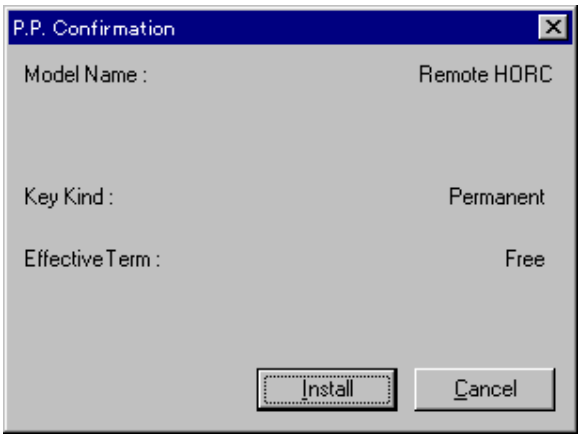


Figure 3.8 Confirming the HORC Key Code

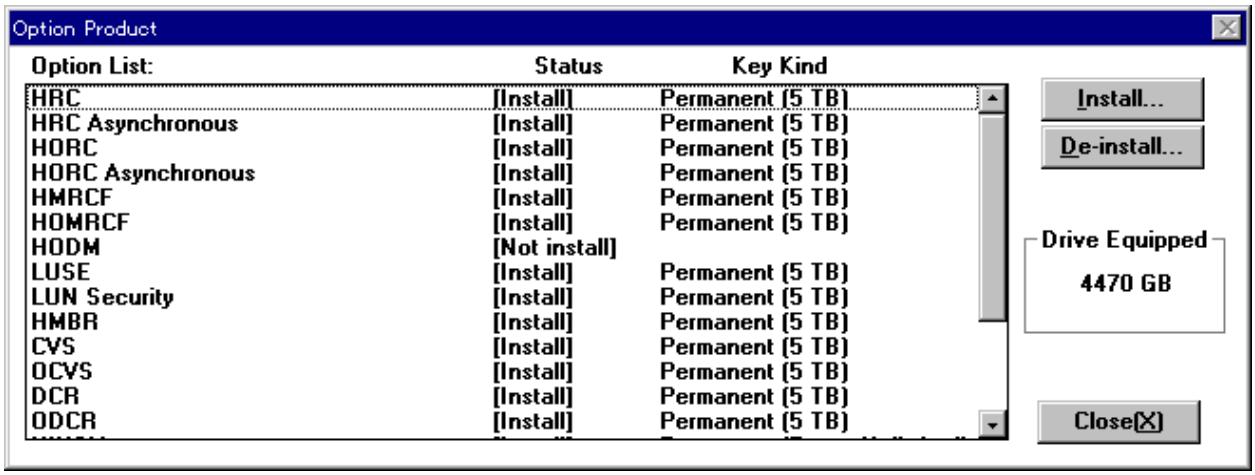


Figure 3.9 Enabling the HORC Copy Options on Each Subsystem

3.5 Configuring the MCUs and RCUs for HORC Operations

After you have added the subsystems to the Remote Console, installed the HORC hardware and software, you can configure the MCUs and RCUs for HORC operations as follows:

1. Identify the volumes that will become the HORC P-VOLs and S-VOLs. You need to know the subsystem S/N, SSID, and CU image of each HORC volume, so that you can configure the MCUs and RCUs correctly for your desired HORC pairs and HORCA groups. When you create the HORC pairs, you will need to know the port ID, target ID, and LUN of each HORC volume.
2. If Hitachi GRAPH-Track™ (GT) is connected to the subsystem to be configured as a HORC MCU, you may want to disconnect GT to avoid contention on the internal 9900 LAN (see section 3.6.2 for further information).
3. Start up and log in to RMCMAIN with administrator access.
4. Select **Connect…** to open the Connection Control panel, select the subsystem that you want to configure as a HORC MCU, and then select **Connect**.
5. Select **HORC** to start the HORC software. The HORC Main Control panel displays the S/N of the connected subsystem and the selected CU image (CU 0 is displayed first).
6. Configure the serial interface ports which are connected to the RCUs as RCPs using the Port Change panel (see Figure 3.10) (see section 4.2.3 for instructions).
7. Add the desired RCU(s) to the current MCU CU image using the Add RCU panel (see Figure 3.11) and Path Parameter panel (see Figure 3.12) (see section 4.3.1 for instructions):
   SSID = maximum of four SSIDs per CU, 64 LDEVs per SSID.
   Number of path = maximum of four ESCON links (RCPs) per CU image.
   Physical port number = port A-H at CL-1 or CL2.
   Link address = destination port address on the ESCD (00 for static link to RCU).
   Logical address = RCU CU image number (00-0F)
8. Repeat step (7) for each CU image of the MCU. After adding all RCUs to each MCU CU image, verify the RCU options, and select **OK** to close the RCU Option panel (see Figure 3.13) (see section 4.3.2 for instructions).
9. If you plan to create HORCA pairs with P-VOLs in this MCU, configure the MCU async options (Figure 3.14) (see section 4.4.1 for instructions), and then add the desired consistency group(s) to the MCU (see Figure 3.15) (see section 0 for instructions).
10. When you are finished configuring this MCU, exit HORC, and disconnect RMCMAIN from the subsystem. If desired, you can reconnect GRAPH-Track to this subsystem now.
11. Repeat steps (4)–(10) for each subsystem which will function as a HORC MCU. After you have configured the MCUs, added the RCUs, and configured the HORC async options and consistency groups, you are ready to begin HORC volume pair operations.

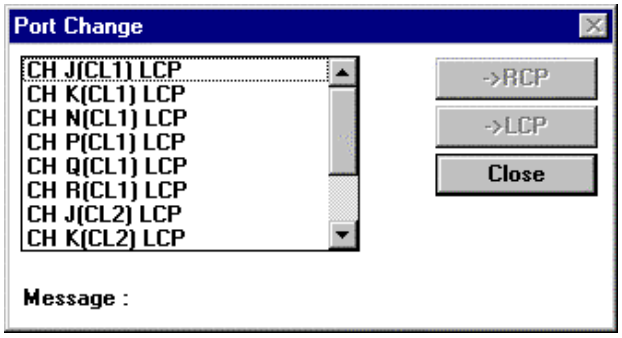


Figure 3.10 Configuring the RCPs

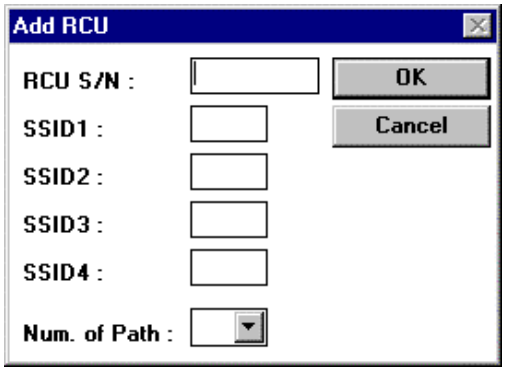


Figure 3.11 Adding the RCUs

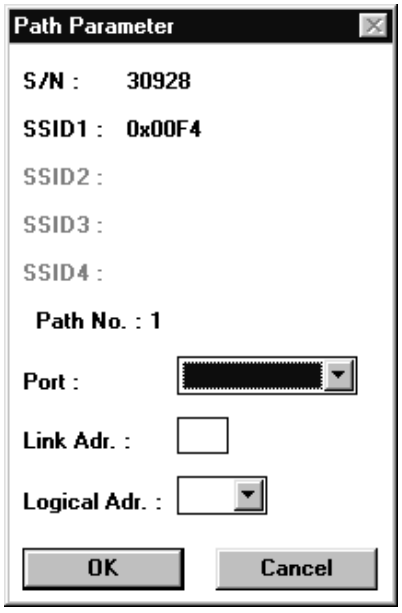


Figure 3.12 Entering the RCU Path Parameters

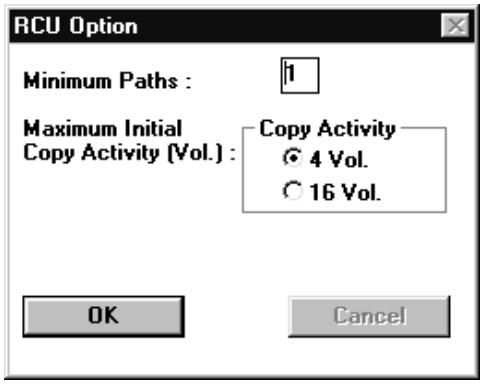


Figure 3.13 Configuring the RCU Options

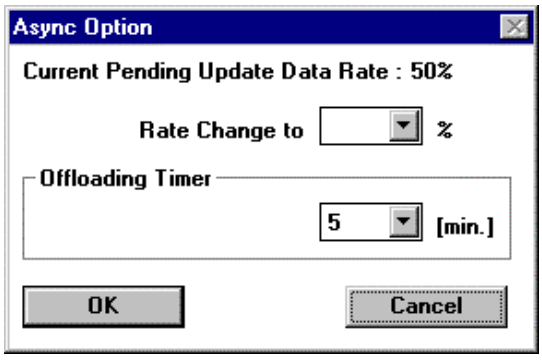


Figure 3.14 Setting the HORC Asynchronous Options

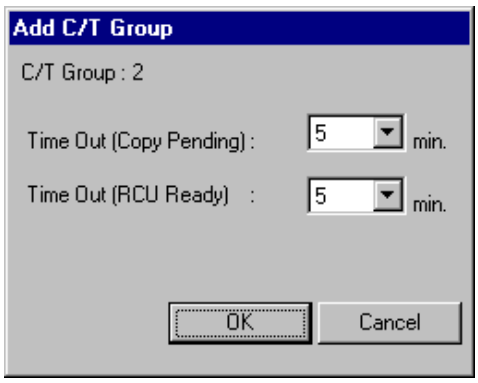


Figure 3.15 Adding the Consistency Groups

3.6 Combining HORC with Other Data Management Operations

HORC supports concurrent operations with the following data management functions:

- **LU Size Expansion (LUSE).** LUSE volumes can be assigned to HORC pairs, provided that the P-VOL and S-VOL have the same LU type and the same number of LDEVs. If you need to perform LUSE operations on an existing HORC P-VOL or S-VOL, you must delete the pair first to return the volume to SMPL status.
- **Virtual LUN**. Virtual LUN (CVS) volumes can be assigned to HORC pairs, provided that the S-VOL has the same capacity than the P-VOL. If you need to perform Virtual LUN operations on an existing HORC P-VOL or S-VOL, you must delete the pair first to return the volume to SMPL status.
- **FlashAccess**. FlashAccess volumes can be assigned to HORC pairs, and FlashAccess operations can be performed on HORC P-VOLs and S-VOLs.
- **LUN Security**. LUN Security operations do not affect HORC operations. Volumes which are under secure ports and/or which are assigned to World Wide Name (WWN) groups and/or LUN groups can also be assigned to HORC pairs. Volumes which are assigned to HORC pairs can also be assigned to secure ports, WWN groups, and/or LUN groups for LUN Security. ***Note:*** HORC S-VOLs cannot be accessed by any UNIX®/PC server host except when the pair is split.
- **ShadowImage**. ShadowImage (HOMRCF) volumes can be assigned to HORC pairs, and HORC volumes can be assigned to ShadowImage pairs. See section 3.6.1 for information on HORC and ShadowImage shared volume configurations.

  Note: ShadowImage is recommended for intra-subsystem copy operations. If ShadowImage is not installed, HORC (Synchronous only) can be used to copy within the same 9900 subsystem. This configuration requires at least one external ESCON cable loop.
- **HODM**. Hitachi Online Data Migration (HODM) volumes cannot be assigned to HORC pairs, and HORC volumes cannot be assigned to HODM pairs. HORC and HODM operations can be performed concurrently in the same 9900 subsystem, but volumes cannot be shared between HORC and HODM. For further information on HODM, please contact your Hitachi Data Systems account team.

Note: When HORC and HRC coexist in the same 9900 subsystem, each consistency group must contain either HORCA pairs or HRCA pairs (not both), and HORCA and HRCA share the same cache sidefile area.

3.6.1 Combining HORC and ShadowImage

HORC and ShadowImage (also called HOMRCF) can be used together in the same subsystem and on the same volumes to provide multiple copies of data at the primary and/or remote sites. Table 3.1 describes the host pair status reporting for HORC volumes, ShadowImage volumes, and HORC/ShadowImage shared volumes. Table 3.2 shows the currency of the data on a shared HORC/ShadowImage volume based on HORC and ShadowImage pair status.

- For shared HORC/ShadowImage volumes, the HORC pair status is reported to the host if you query the HORC P-VOL or S-VOL. To obtain the ShadowImage pair status, query the P-VOL of the ShadowImage pair.
- ShadowImage supports multiple S-VOLs for each P-VOL. If you issue a pair status query to a ShadowImage P-VOL (e.g., pairdisplay), the status for only one ShadowImage pair is reported (the pair with the S-VOL with the lowest LDEV ID). To obtain the pair status for the ShadowImage pair(s) with the other S-VOL(s), you must direct the host query to the specific S-VOL using the S-VOL's LDEV ID in the host command. The ShadowImage remote console software displays the LDEV ID and ShadowImage pair status of all S-VOLs associated with a P-VOL.

Table 3.1 Host Pair Status Reporting for HORC/ShadowImage Shared Volumes

Number of HORC Pairs	Number of ShadowImage S-VOLs	Pair Status Reported by 9900
0	0	Simplex
0	1	ShadowImage pair status
0	2 or more	ShadowImage pair status for the pair whose S-VOL has the lowest LDEV ID
1	0	HORC pair status
1	1	HORC pair status
1	2 or more	HORC pair status

Table 3.2 Data Currency of a Shared HORC/ShadowImage Volume

	ShadowImage (HOMRCF) Pair Status					
HORC Pair Status	COPY (PD)	PAIR	COPY(SP)	PSUS	COPY(RS/RS-R)	PSUE
COPY	Not current	Not current	Not current	CURRENT	Not current	Not current
PAIR	Not current	Not current	Not current	CURRENT	Not current	Not current
PSUS/PSUE	Not current	CURRENT	CURRENT	CURRENT	CURRENT	Not current

Figures 3.13 through 3.16 show the various HORC/ShadowImage (HOMRCF) configurations which share volumes. HORC supports synchronous and asynchronous operations for shared HORC/HOMRCF volumes.

- Figure 3.16 shows an example of a HORC P-VOL which is also functioning as a ShadowImage (HOMRCF) P-VOL. This configuration allows you to use ShadowImage for on-site data backup in case of a HORC failure, and to use HORC to provide remote backup of the ShadowImage P-VOL in case of a ShadowImage failure.
- Figure 3.17 shows an example of a HORC S-VOL which is also functioning as a ShadowImage (HOMRCF) P-VOL. This configuration allows you to use ShadowImage to provide multiple backup copies of a single HORC P-VOL.
- Figure 3.18 combines the configurations shown in Figure 3.16 and Figure 3.17. Within a single HORC pair, the P-VOL and S-VOL are both functioning as ShadowImage P-VOLs, providing multiple copies at the primary and remote sites.
- Figure 3.19 shows an example of a ShadowImage S-VOL which is also used as a HORC P-VOL. *Caution:* This configuration requires that the ShadowImage pair be established in duplex mode (PAIR) and then split (PSUS) before the HORC pair is created.

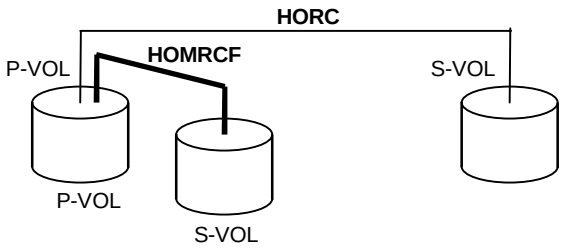


Figure 3.16 Shared HORC P-VOL/HOMRCF P-VOL

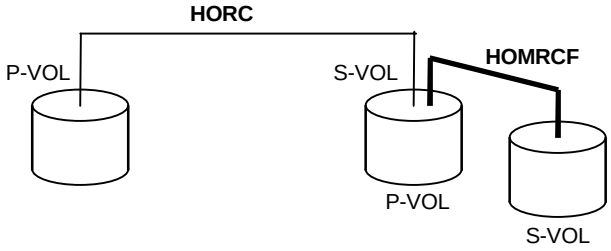


Figure 3.17 Shared HORC S-VOL/HOMRCF P-VOL

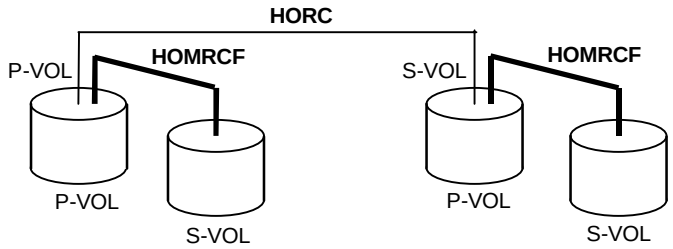


Figure 3.18 Shared HORC P-VOL/HOMRCF P-VOL with Shared HORC S-VOL/HOMRCF P-VOL

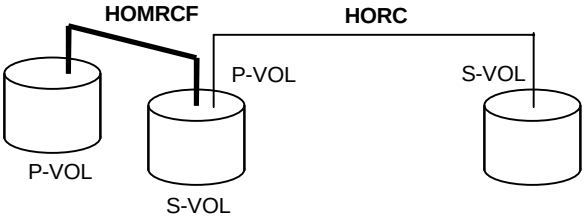


Figure 3.19 Shared HOMRCF S-VOL/HORC P-VOL

3.6.2 Combining HORC and Hitachi GRAPH-Track

The Hitachi GRAPH-Track software product provides detailed information on the I/O activity and hardware performance of the 9900 (and 7700) subsystems and allows you to tune the subsystem's duplex write (DW) cache setting. GRAPH-Track can be used to monitor the 9900 subsystems which will be (or already are) performing HORC operations. The subsystem usage and performance data displayed by GRAPH-Track enables you to:

- Identify the best times to perform HORC data duplexing operations (e.g., during periods of light system I/O activity),
- Adjust the cache settings of the subsystems to accommodate HORC operations (e.g., increase DW cache during HORC initial copy operations), and
- Determine the best locations for the HORC S-VOLs (e.g., in array groups with less frequently accessed volumes to avoid bottlenecks of backend activity),
- Monitor subsystem performance during HORC operations and during testing activities.

GRAPH-Track data collection does not affect subsystem operations in any way. However, GRAPH-Track data collection can cause a significant amount of traffic on the 9900-internal LAN, especially when GRAPH-Track is collecting lots of LDEV data. To prevent timeouts from occurring while you are performing HORC (or other) operations on the Remote Console PC, you may want to decrease GRAPH-Track data collection activities before using the 9900 RMCMAIN software. This reduces 9900-internal LAN traffic, so that inquiries and commands issued by the Remote Console PC can be processed more quickly.

To perform HORC (or other) remote console operations while GRAPH-Track is collecting data for one or more subsystems on the same 9900-internal LAN:

1. If GRAPH-Track is collecting lots of LDEV data, consider disabling GRAPH-Track LDEV data collection for one or more subsystems before using the remote console software. Please refer to the GRAPH-Track online help for instructions on disabling LDEV data collection.
2. If GRAPH-Track is collecting data for more than three subsystems on the 9900-internal LAN, consider disconnecting GRAPH-Track from one or more subsystems before using the remote console software. Refer to the GRAPH-Track online help for instructions on disconnecting GRAPH-Track.
3. After you have disabled LDEV data collection and/or disconnected GRAPH-Track, you can connect to the subsystem using RMCMAIN, launch the HORC remote console software, and perform HORC operations (e.g., create pairs, view pair status).
4. When you are finished performing HORC operations, exit the HORC software, and then exit the Function Select panel to disconnect RMCMAIN from the subsystem.
5. After you have disconnected the Remote Console PC from the subsystem, you can re-enable GRAPH-Track data collection.

Chapter 4 Performing HORC Configuration Operations

The HORC configuration operations include the MCU operations, RCU operations, HORC Asynchronous control operations, discontinuing HORC operations, and scripting. The HORC Main Control panel (see section 4.1) provides access to all HORC configuration operations.

The MCU operations (see section 4.2) configure the MCUs for HORC operations and include:

- Adding the MCUs,
- Changing the CU image,
- Configuring the MCU serial interface ports, and
- Monitoring the MCU volume usage statistics.

The RCU operations (see section 4.3) configure the RCUs for HORC operations and include:

- Adding the RCUs,
- Setting the RCU options,
- Adding/deleting logical paths to an RCU,
- Adding/deleting SSIDs for an RCU,
- Viewing RCU status, and
- Deleting RCUs.

The HORC Asynchronous control operations (see section 4.4) configure the HORC Asynchronous groups and options and include:

- Setting the MCU async options,
- Adding consistency groups,
- Setting the consistency group options,
- Viewing consistency group status, and
- Deleting consistency groups.

You can optimize HORC operations and 9900 subsystem performance by selecting the appropriate HORC settings and options for your operational environment and also by addressing conditions which can affect subsystem performance (see section 4.5).

When you want to discontinue HORC operations (see section 4.6), you must perform the required HORC operations (e.g., pair deletion, RCU deletion, port reconfiguration, etc.) in a specific order to ensure smooth operations and avoid command rejects and error conditions.

The HORC scripting function (see section 4.7) allows you to specify and execute a series of HORC operations from the Remote Console PC without having to issue commands separately.

The HORC Main Control panel also provides access to all HORC volume pair operations: creating pairs, splitting and resyncing pairs, and viewing pair status. Chapter 5 describes and provides instructions for performing the HORC volume pair operations.

4.1 HORC Main Control Panel

The HORC Main Control panel (see Figure 4.1) displays the HORC information for the selected CU image of the connected subsystem and provides access to all HORC functions. The HORC Main Control panel is accessed from the RMCMAIN Option Select panel.

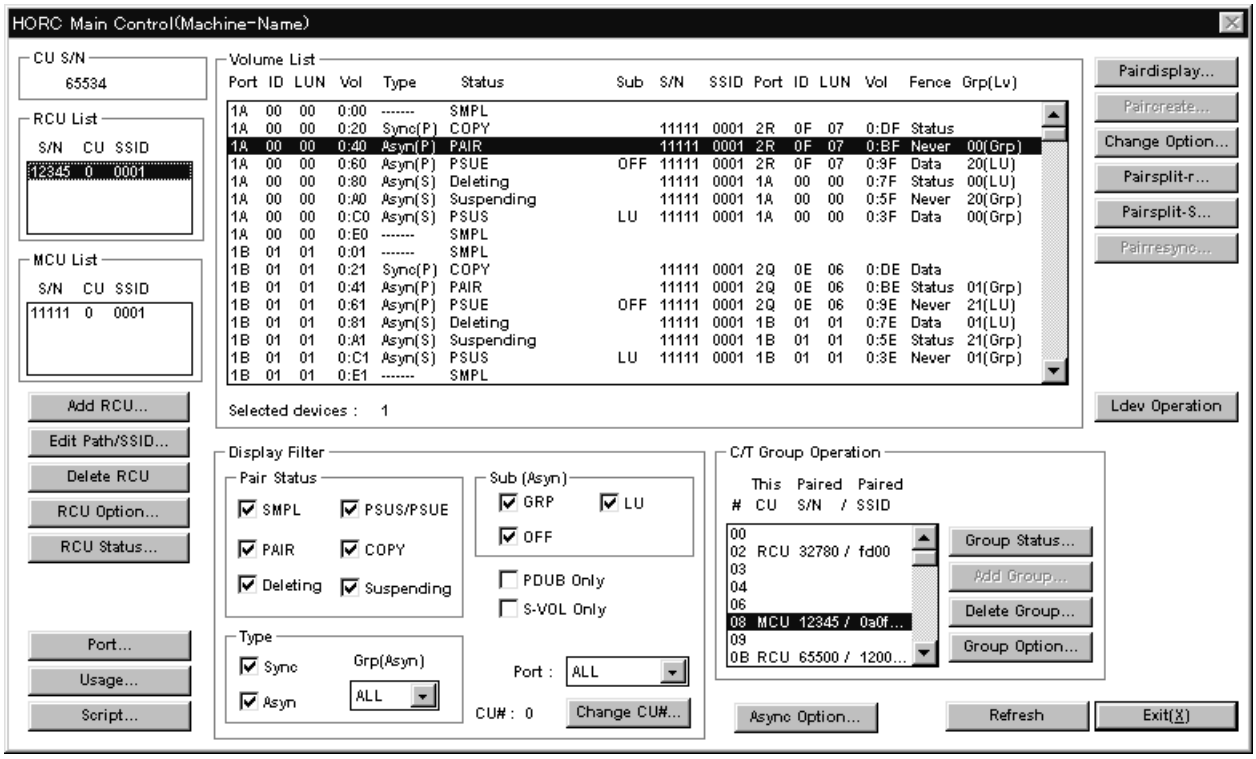


Figure 4.1 HORC Main Control Panel

To open the HORC Main Control panel:

1. Start up and log in to RMCMAIN. If you want to perform HORC operations, log in with administrator access. You do not need administrator access to view HORC information.
2. Connect to the desired 9900 subsystem using the Connection Control panel.
3. When the Function Select panel opens, select the **HORC** button to open the HORC Main Control panel.
4. The HORC Main Control panel displays the HORC pair information for the most recently selected CU image of the connected subsystem (CU 0 is the default CU image) and allows you to perform HORC operations. The HORC Main Control panel is described below.

The **CU S/N** field displays the serial number of the connected subsystem. The **RCU List** box displays the RCUs which have been added to the current CU image. The **MCU List** box displays the MCUs for the S-VOLs in the current CU image. The buttons below the **MCU List** box provide access to the RCU operations (see section 4.3): add RCU, edit path/SSID, delete RCU, RCU options, and RCU status.

The **Port…** button opens the Port Change panel (see section 4.2.3), which allows you to configure the serial ports of the connected subsystem. The **Usage…** button opens the Remote Copy Monitoring panel (see section 4.2.4), which displays volume usage statistics for the specified CU on the connected subsystem. The **Script…** button opens the Script Monitor panel, which allows you to run a HORC script (see section 4.7).

The **Volume List** box (see section 4.1.1) displays the volumes (LUs) in the selected CU image and port and displays the HORC pair information for each volume. The **Display Filter** box (see section 4.1.2) allows you to control which volumes are displayed by pair status, pair type, HORCA group number, port, and CU image. You must change CU images to access all LDEVs in the 9900 subsystem.

The **C/T Group Operation** box displays the consistency group information for the connected subsystem: group number, CU type of the connected subsystem (MCU and/or RCU), serial number and SSID of the other CU in the group. The buttons next to the group list box provide access to the HORC Asynchronous control operations (see section 4.4): group status, add group, delete group, and group options. The **Async Option…** button provides access to the HORC async options for the connected MCU (see section 4.4.1).

The **Pairdisplay…**, **Paircreate…**, **Change Option…, Pairsplit-R…**, **Pairsplit-S…**, and **Pairresync…** buttons allow you to perform HORC volume pair operations (see Chapter 5). The **Ldev Operation** button (below the pair operation buttons) provides access to LDEV-specific HORC pair information (e.g., for HORC LUSE pairs) (see section 4.1.3).

The **Refresh** button refreshes the information displayed on the HORC Main Control panel. The **Exit** button closes the HORC Main Control panel, exits the HORC software, and returns you to the RMCMAIN Function Select panel. Exiting the HORC software does not affect the HORC activities in progress.

4.1.1 Volume List Box

The **Volume List** box on the HORC Main Control panel displays the following information for each volume (LU) of the connected disk subsystem:

- **Port**, **ID**, **LUN:** Port number, SCSI target ID (TID), and LU number (LUN).
- **Vol:** CU image:LDEV ID. The CU images are numbered 0-F. The LDEV ID is hexadecimal (00-FF). For a LUSE volume, the first LDEV (lowest LDEV ID) is listed.
- **Type:** Pair type: **Sync** or **Async**. **(P)** = HORC primary volume; **(S)** = HORC secondary volume. "-----" indicates a simplex volume. ***Note:*** Volumes which are currently assigned to ShadowImage pairs are displayed in the **Volume List** box as simplex volumes.
- **Status:** (see section 2.5 for further information on HORC pair status)
  - **SMPL**. The volume is not currently assigned to a HORC pair. When the initial copy is started by a paircreate operation, the volume status changes to **COPY**.
  - **COPY**. The HORC initial copy operation is in progress. Data on the HORC pair is not fully identical. When the initial copy is complete, the status will change to **PAIR**.
  - **PAIR**. The volume is currently assigned to a HORC pair, and the HORC pair is 100% synchronized. All updates from the host to the P-VOL are duplicated at the S-VOL.
  - **PSUE**. The pair has been suspended by the MCU or RCU due to an error condition. The volumes in this pair are not synchronized.
  - **PSUS**. The pair has been split by the user (pairsplit-R), or the pair has been deleted by the user from the RCU (pairsplit-S). The volumes in this pair are not synchronized.
  - **PDUB**. This HORC LUSE pair is in the **COPY** or **PAIR** state, but at least one LDEV pair within the HORC LUSE pair is in the **SMPL** or **PSUE** state.
  - **Suspending**. HORC Asynchronous only. This pair is not synchronized. This pair is in transition from the **PAIR** or **COPY** state to the **PSUS/PSUE** state.
  - **Deleting**. HORC Asynchronous only. This pair is not synchronized. This pair is in transition from the **PAIR**, **COPY**, or **PSUS/PSUE** state to the **SMPL** state.
- **Sub:** This volume substatus is displayed for HORC Asynchronous pairs only:
  - **GRP**. The consistency time (C/T) of the volume corresponds to the C/T of its group.
  - **LU**. The consistency time of the volume does not correspond to the C/T of its group.
  - **OFF**. The volume is suspended by MCU power-off.
- **S/N** and **SSID** of the other subsystem (MCU or RCU) of the volume pair.
- **Port**, **ID**, **LUN:** Port number, TID, and LUN of the other volume of the volume pair.
- **Vol:** CU image:LDEV ID of the other volume of the volume pair. For a LUSE volume, the first LDEV (lowest LDEV ID) is listed.
- **Fence:** The P-VOL fence level of the HORC volume pair: data, status, or never. See section 6.1.1 for a complete description of the HORC P-VOL fence-level parameter.
- **Grp(Lv):** The HORCA group number (0-3F hex) and async error-level option (group or LU) for this pair. See section 5.2.2 for a description of the error-level pair option.

4.1.2 Display Filter

The **Display Filter** box on the HORC Main Control panel (see Figure 4.2) allows you to control which volumes are displayed in the **Volume List** box by CU image, and within each logical CU image by port, pair status, pair type (synchronous or asynchronous), group number (HORC Asynchronous only), and consistency status (HORC Asynchronous only).

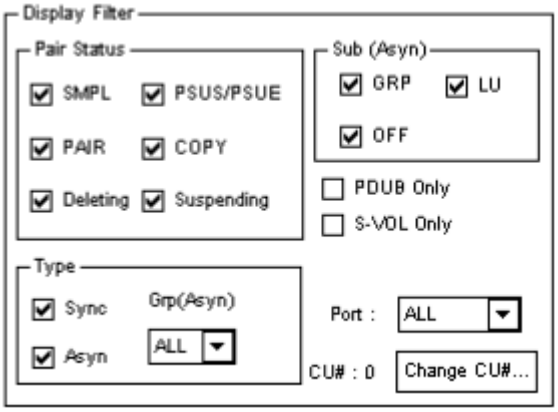


Figure 4.2 Display Filter on the HORC Main Control Panel

The **Status** box allows you to display only HORC volumes which have the selected pair status: **SMPL**, **PAIR**, **PSUS/PSUE**, **COPY**, **Deleting** (Async only), and/or **Suspending** (Async only). Simplex volumes are always displayed (except when the **PDUB Only** or **S-VOL Only** box is selected).

The **Type** box allows you to select the types of HORC volumes to be displayed: **Sync** and/or **Asyn**. The **Grp(Asyn)** drop-down list box allows you to select the group(s) to be displayed.

The **Sub(Asyn)** box allows you to display only volumes with the selected consistency status: **GRP**, **LU**, and/or **OFF**.

The **PDUB Only** checkbox allows you to display only HORC LUSE volumes with the **PDUB** status. When this box is selected, simplex volumes are not displayed.

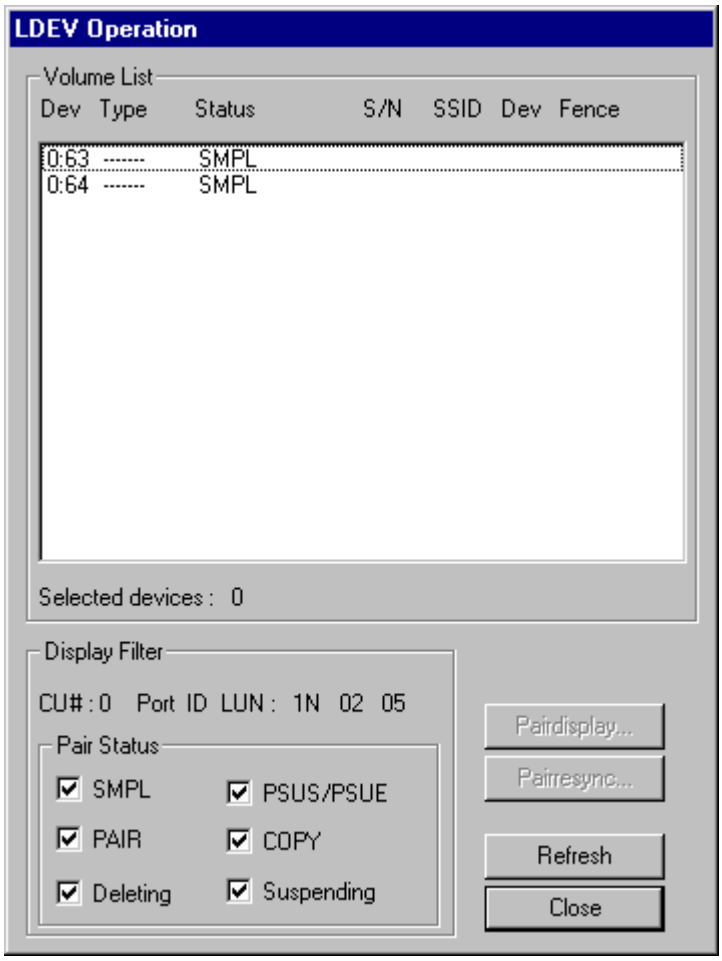
The **S-VOL Only** checkbox allows you to display only HORC S-VOLs. When this box is selected, simplex volumes are not displayed.

The **Port** drop-down list box allows you to select the desired 9900 port or all ports. The **Volume List** box will display only the volumes behind the selected port(s).

The **CU#** field displays the current CU image. The **Change CU#…** button allows you to select a different CU image (0, 1, 2, …F) in the connected subsystem. The **Volume List** box will display only the volumes behind the selected CU image, and HORC operations such as add RCU and paircreate will apply only to the volumes in the selected CU image. ***Note:*** When performing HORC operations, always make sure to select the appropriate CU image, so that you can access the desired volumes and MCU-RCU paths.

4.1.3 LDEV Operation Panel

The LDEV Operation panel (see Figure 4.3) displays HORC information for individual LDEV pairs within HORC LUSE pairs. The LDEV Operation panel also provides access to the pairdisplay and pairresync operations for individual LDEV pairs. The LDEV Operation panel is accessed from the HORC Main Control panel (select one LU, and select **Ldev Operation**) and from the Pairdisplay panel (select **Ldev Operation**).



The **Volume List** box displays the following information for each LDEV in the selected LU:

- **Dev:** CU image:LDEV ID.
- **Type:** Pair type (Sync or Async, primary or secondary).
- **Status:** Pair status (SMPL, COPY, PAIR, PSUS/PSUE, Suspending, or Deleting).
- **S/N, SSID, Dev:** Subsystem S/N, SSID, and LDEV ID of the other LDEV in the pair.
- **Fence:** Fence level of the pair (data, status, or never).

Figure 4.3 LDEV Operation Panel

The **Display Filter** box displays the selected LU (CU image, port, SCSI TID, LUN) and allows you to filter the LDEVs displayed in the **Volume List** box by pair status (same as on the HORC Main Control panel).

The **Pairdisplay…** button opens the Pairdisplay panel (see section 5.3.2), which displays the detailed HORC status information for the selected LDEV. The **Pairresync…** button opens the Pair List (Pairresync) panel (see section 5.5), which allows you to restart the selected split or suspended LDEV pair. The **Refresh** button refreshes the information displayed on the panel.

4.2 MCU Operations

The MCUs are the disk control units which control the P-VOLs of the HORC volume pairs. Each subsystem which is attached to the Remote Console PC on the 9900-internal LAN can function as an MCU. The MCUs receive and process user-requested HORC commands from the Remote Console PC, and send the HORC copy operations to the RCUs. The MCUs can also function as RCUs, provided the remote copy connections are properly configured.

The MCU operations are:

- Adding MCUs (*using RMCMAIN software, not within HORC*),
- Changing the CU image,
- Configuring the MCU serial interface ports, and
- Monitoring the MCU volume usage statistics.

4.2.1 Adding MCUs

Each 9900 subsystem which has been added to the 9900 Remote Console PC can function as an MCU for HORC operations, provided that the remote copy connections are properly configured. For instructions on adding subsystems to the Remote Console PC, please refer to the *9900 Remote Console User's Guide*.

4.2.2 Changing the CU Image

The Change CU# panel (see Figure 4.4) allows you to select the CU image to be displayed on the HORC Main Control panel. The Change CU# panel is accessed from the HORC Main Control panel (**Change CU#…** button). The HORC Main Control panel displays only the LUs in the selected CU image.

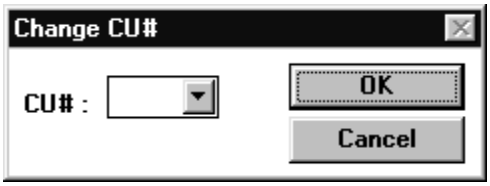


Figure 4.4 Change CU# Panel

The 9900 subsystem provides sixteen logical CU images, one for each set of 256 LDEVs. You must remember to select the correct CU image before performing HORC pair operations. The following HORC general operations apply to all CU images of the connected subsystem:

- Adding MCUs,
- Configuring MCU ports, and
- Setting RCU options (minimum paths, and maximum initial copy activities).

4.2.3 Configuring the MCU Ports

All serial interface ports on the 9900 subsystem have a default setting of local control port (LCP). LCP mode is used for host processor channel interface. The 9900 serial interface ports which will be used for HORC communications to the RCUs must be configured as remote control ports (RCPs). RCP mode emulates a host channel to enable the MCU to send write I/O operations directly to the RCU. The HORC remote console software allows you to change the configuration of the 9900 ports as needed to accommodate the desired host and HORC communications paths. Two or more RCPs must be configured before you can add the RCUs and create the HORC pairs. For further information on the RCPs, see section 2.1.6.

The Port Change panel (see Figure 4.5) displays the serial ports of the connected subsystem and allows you to change the mode (local or remote) of each port. The Port Change panel is accessed from the HORC Main Control panel (**Port…** button).

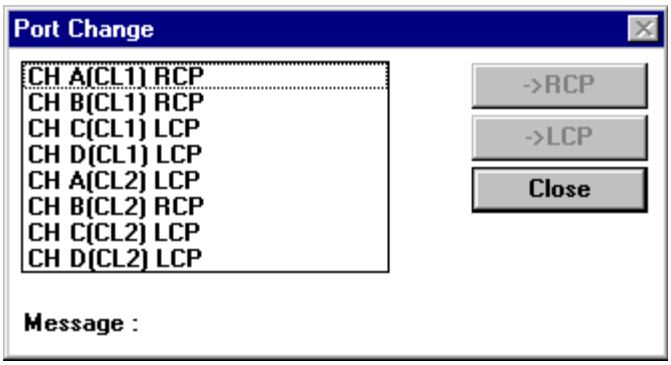


Figure 4.5 Port Change Panel

The Port Change panel displays the current mode of each serial interface port of the connected subsystem. For example, **CH C(CL2) LCP** indicates that the port for channel C in cluster 2 is configured as an LCP. The **→RCP** button changes the selected port(s) from an LCP to a RCP. The **→LCP** button changes the selected port(s) from an RCP to an LCP. The **Message** area displays the status of the port configuration operation.

Before changing the operation mode of a serial port from LCP to RCP, remove all channel paths to the specified port using S/390® host system console or ESCD commands.

LCP→RCP. To change one or more LCPs to RCPs:

1. Start RMCMAIN, connect to the desired subsystem, and start the HORC software.
2. On the HORC Main Control panel, select **Port…** to open the Port Change panel.
3. On the Port Change panel, select the LCP(s) you want to reconfigure, and then select **→RCP**. ***Note:*** Make sure that the port being reconfigured is disconnected from the host.
4. The Remote Console PC displays a message asking you to vary the selected channel paths offline. Make sure that the selected paths are offline from the host(s), and then select **OK**.
5. The **Message** area displays the status of the port change operation. The 9900 makes sure that the channels are offline, and then blocks the channels and reconfigures the port.

6. When the port change operation is complete, the Remote Console PC displays a message asking you to exchange the channel cable connections. Make sure that the channel cable connections have been exchanged, and then select **OK**.
7. The **Message** area now displays the status of the port recovery operation. When the port recovery operation is complete, you may close the Port Change panel or reconfigure additional ports as needed.

Before changing the operation mode of a port from RCP to LCP, delete all affected HORC pairs, delete all paths to the RCU from that RCP, and then delete the RCU from the MCU.

RCP→LCP. To change one or more RCPs to LCPs:

1. Start RMCMAIN, connect to the desired subsystem, and start the HORC software.
2. On the HORC Main Control panel, select **Port…** to open the Port Change panel.
3. On the Port Change panel, select the RCP(s) you want to reconfigure, and select **→LCP**.
4. The Remote Console PC displays a message asking you to vary the selected channel paths offline. Make sure that the selected paths are offline from the host(s), and then select **OK**.
5. The **Message** area displays the status of the port change operation. The 9900 makes sure that the channels are offline, and then blocks the channels and reconfigures the port.
6. When the port change operation is complete, the Remote Console PC displays a message asking you to exchange the channel cable connections. Make sure that the channel cable connections have been exchanged, and then select **OK**.
7. The **Message** area now displays the status of the port recovery operation. When the port recovery operation is complete, you may close the Port Change panel or reconfigure additional ports as needed.

4.2.4 Monitoring Remote Copy Activities

The Remote Copy Monitoring panel (see Figure 4.6) displays the user-selected remote copy I/O statistics for either all LDEVs or the selected LDEVs in the connected 9900 subsystem. The Remote Copy Monitoring panel is accessed from the HORC Main Control panel (**Usage...** button). Remote copy monitoring is available to all Remote Console users.

Table 4.1 lists and describes the remote I/O (RIO) statistics that can be displayed on the Remote Copy Monitoring panel. The RIO is a special I/O operation which transfers data to the RCU in FBA format (not CKD) using a single channel command, eliminating the overhead associated with FBA-CKD conversion and thus providing more efficient transfer of user data.

Note: The RIO statistics include both HORC and HRC remote copy operations (e.g., total RIO count = HORC RIOs + HRC RIOs), unless otherwise specified (e.g., restore copy IO counts apply to HODM only).

Figure 4.6 Remote Copy Monitoring Panel

The Monitoring panel plots the user-selected I/O statistics on an x-y graph. The x-axis displays time, and the y-axis displays the number of I/Os during the last sampling period. The user-selected data sampling rate is displayed to the right of the graph area, and the graph is updated at each sampling time. The user-selected data legend is located below the graph, providing a color coded key to identify the charted information. The **Monitor** pull-down menu allows you to begin monitoring another volume or exit the Monitoring panel. The **Window** menu lists the active monitoring panels and allows you to arrange the panels (cascade, tile or icon). The **Display** menu allows you to display the graph with or without the graphical legend.

To view the HORC I/O statistics for one or more volumes of the selected CU image on the connected subsystem:

1. Start RMCMAIN, connect to the desired subsystem, and start the HORC software.
2. On the HORC Main Control panel, select the **Usage…** button to open the Remote Copy Monitoring panel (refer to Figure 4.6).
3. On the Remote Copy Monitoring panel, select the **Monitor** menu, and then select **Start**. The Monitoring Parameter panel opens (see Figure 4.7).
4. On the Monitoring Parameter panel, enter the desired subsystem data sampling rate (from one minute to 546 minutes in one-minute increments), and then select **OK**. The Select Logical Device panel now opens (see Figure 4.8).
5. On the Select Logical Device panel, select **Subsystem Total Count** to display I/O statistics for all LDEVs in the connected subsystem, or select **Logical Device Count** and then select the desired CU image and LDEV(s). When you are finished selecting LDEVs, select **OK**. The Select Monitoring Data panel now opens (see Figure 4.9).
6. On the Select Monitoring Data panel, select the I/O statistics you want to view, and then select **OK**. Refer to Table 4.1 for a description of the I/O statistics.
7. The Remote Copy Monitoring panel now opens and displays the selected I/O statistics for the selected LDEV(s). To open another monitoring panel for another set of LDEVs, repeat steps (3) through (6). You can open several monitoring displays at the same time and use the Window menu commands to arrange the panels on screen.

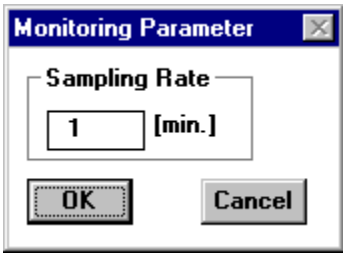


Figure 4.7 Monitoring Parameter Panel

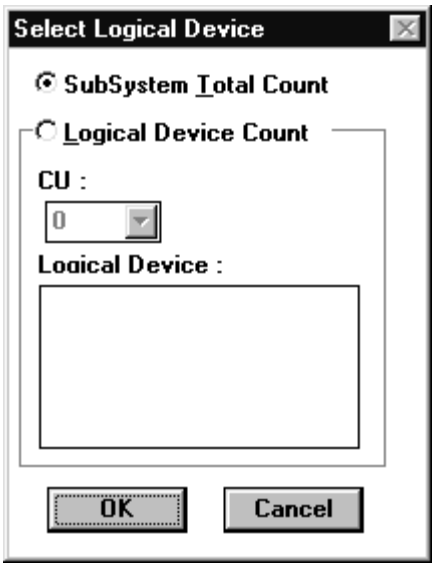
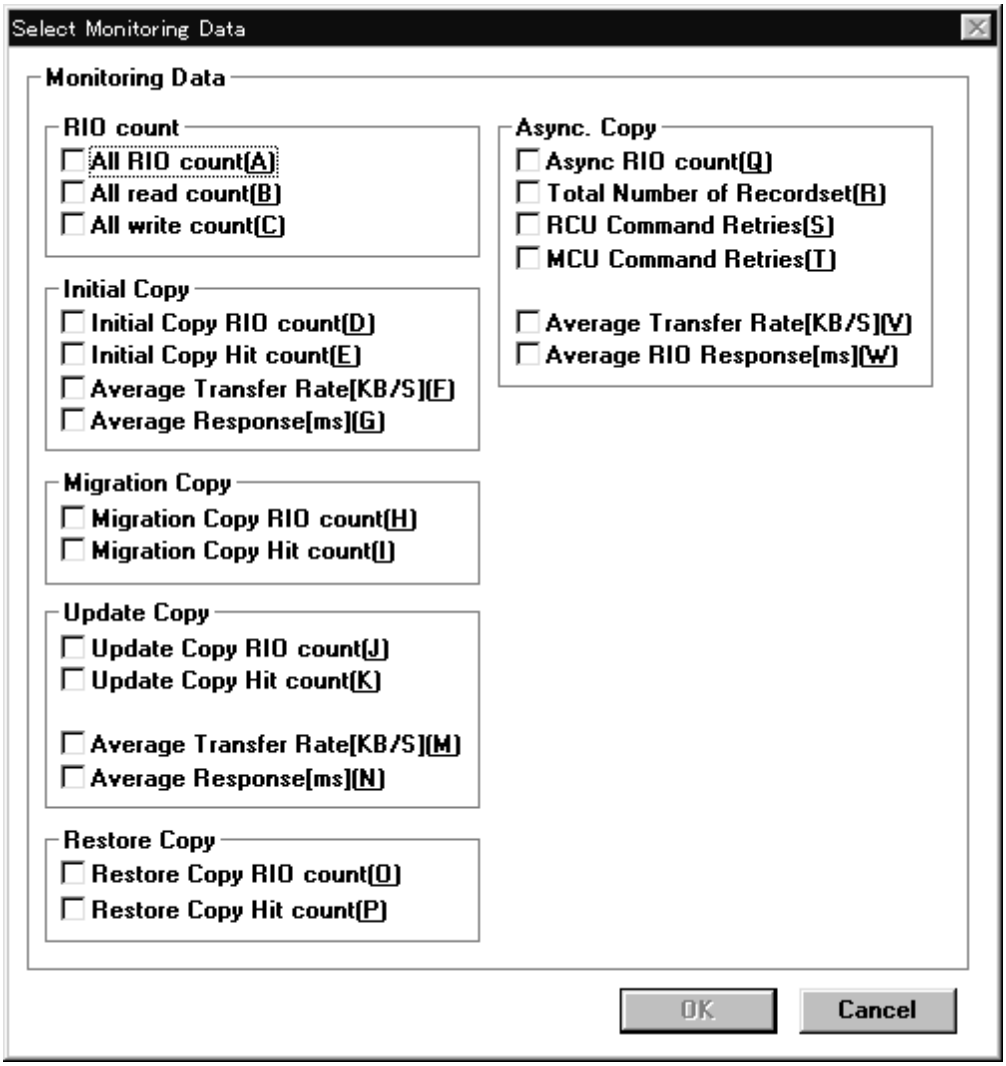


Figure 4.8 Select Logical Device Panel



Note: Migration Copy and Restore Copy apply only to HODM.

Figure 4.9 Select Monitoring Data Panel

Table 4.1 Monitoring Panel I/O Statistics

Statistic	Description
RIO count	
All RIO count	Total number of remote I/Os.
All read count	Total number of remote read I/Os.
All write count	Total number of remote write I/Os.
Initial copy	
Initial copy RIO count	Number of initial copy remote I/Os.
Initial copy hit count	Number of initial copy hits.
Migration Copy (HODM only)	
Migration copy RIO count	Number of HODM migration copy remote I/Os.
Migration copy hit count	Number of HODM migration copy hits.
Update copy	
Update copy RIO count	Number of update copy remote I/Os.
Update copy hit count	Number of update copy hits.
Restore Copy (HODM only)	
Restore copy RIO count	Number of HODM restore copy remote I/Os.
Restore copy hit count	Number of HODM restore copy hits.
Asynchronous copy	
Asynchronous RIO count	Number of asynchronous update copy remote I/Os.
Total number of recordsets	Number of asynchronous recordsets.
RCU command retries	Number of command retries due to RCU channel-command-retry messages.
MCU command retries	Number of command retries due to MCU state-change-pending (SCP) messages.
Average transfer rate (kB/s)	Average transfer rate (kB/sec) for HORC/HRC Async update copy remote I/Os.
Average RIO response (ms)	(Total RIO process time on a subsystem or selected volume for a certain interval period) / (Asynchronous RIO count); where RIO process time = time between the async data transfer request and the actual transfer of the recordset(s) to the RCU.

Note: **Migration Copy** and **Restore Copy** apply only to HODM. All other RIO statistics include both HORC and HRC remote copy operations (e.g., async RIO count = HORCA RIOs + HRCA RIOs).

4.3 RCU Operations

The RCUs are the control units which control the S-VOLs of the volume pairs. The RCUs are connected to the MCUs via the remote copy connections and receive and process commands from the MCUs. For HORC operations, the secondary Remote Console PC at the remote site should be connected to the RCUs to allow HORC commands to be issued directly to the RCU (e.g., in case of disaster or failure at the primary site).

The RCU operations are performed separately for each CU image of each MCU and RCU to provide maximum flexibility in HORC configurations. The RCU operations are:

- Adding RCUs (see section 4.3.1),
- Setting the RCU options (see section 4.3.2) (***Note:*** The RCU options apply to all CU images of the MCU),
- Determining the RCU path parameters (see section 4.3.3),
- Adding and deleting logical paths to an RCU (see section 4.3.4),
- Adding and deleting SSIDs for an RCU (see section 4.3.5),
- Viewing RCU status (see section 4.3.6), and
- Deleting RCUs (see section 4.3.7).

4.3.1 Adding an RCU

You can add up to four RCUs to each MCU, and you can establish up to four paths to each RCU. You must add each CU image as a separate RCU. The logical paths are established for the CU images of the MCU and RCU separately. The maximum number of logical paths for each MCU is 64 (4 paths per CU image × 16 CU images). The remote copy connections and MCU ports must be properly installed and configured before you can add an RCU. When you add an RCU, the current CU image of the MCU registers the specified CU image as a HORC RCU and establishes the specified number of logical paths to the RCU. After you have added an RCU (and path status is normal), you can create HORC pairs which have S-VOLs in the newly added RCU.

The Add RCU panel (see Figure 4.10) allows you to add an RCU to the current CU image of the connected MCU. The Add RCU panel is accessed from the HORC Main Control panel (**Add RCU…** button).

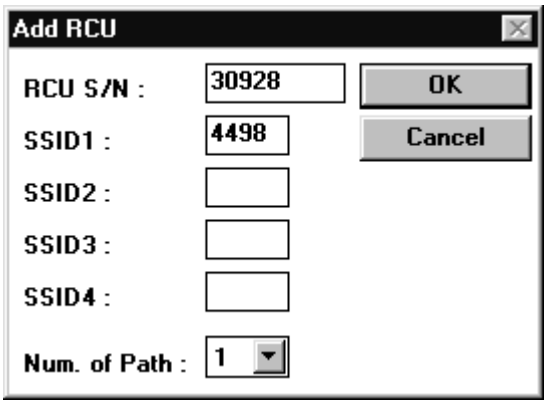


Figure 4.10 Add RCU Panel

The **RCU S/N** and **SSID** fields allow you to enter the serial number and SSID(s) of the RCU being added. The 9900 uses one SSID for each set of 256 volumes and four SSIDs per CU image. The **Num. of Path** box allows you to select the number of paths (up to four) to be established between the MCU and RCU. When you select **OK**, the RCU Option panel opens automatically (see section 4.3.2), followed by the Path Parameter panel (see section 4.3.3).

To add an RCU to the connected MCU:

1. Make sure the remote copy connections and MCU ports are properly configured. Get the S/N of the RCU and the SSID(s) for the desired CU image in the RCU. The add RCU operation will fail without this information. The 9900 subsystem should have a label or tag indicating its S/N and SSIDs. The Hitachi Data Systems representative can also get the RCU S/N and SSIDs using the RCU's SVP (i.e., at the remote site).
2. On the HORC Main Control panel, make sure the correct CU image (0-F) is selected. Use the **Change CU#** button to change CU images. You must add the RCUs to each CU image separately.
3. On the HORC Main Control panel, select **Add RCU…** to open the Add RCU panel.
4. On the Add RCU panel, enter the S/N of the RCU and the SSID(s) for the desired CU image. The MCU verifies the S/N when the paths are established, and verifies the SSIDs when the volume pairs are created. If desired, you can add and delete SSIDs later using the Edit SSID panel (see section 4.3.5).
5. Select the number of paths to be established to the RCU in the **Num. of Path** list box (1 through 4). The MCU will not allow you to establish less than the minimum number of paths as specified on the RCU Option panel (see section 4.3.2). If desired, you can add and delete paths later using the Edit Path panel (see section 4.3.4).
6. After entering the S/N, SSID(s), and number of paths, select **OK** to open the RCU Option panel.
7. On the RCU Option panel, enter the desired **Minimum Paths** setting, and select the desired **Maximum Initial Copy Activity** setting. For multiplatform 9900 configurations with both HORC and HRC paths, set the **Maximum Initial Copy Activity** to **4 Vol**. Make sure to select **OK** on the RCU Option panel (even if you made no changes). The Path Parameter panel (see section 4.3.3) now opens.
8. On the Path Parameter panel, enter the parameters for the first path (**Port**, **Link Adr**., and **Logical Adr**.), and then select **OK**. See section 4.3.3 for further information on the RCU path parameters. If you selected more than one path in step (5), the Path Parameter panel will reset to allow you to enter the information for the next path. When you have entered the parameters for all paths, the Path Parameter panel will close when you select **OK**.
9. The new RCU is displayed in the **RCU List** box on the HORC Main Control panel. To check the path status for this RCU, select the RCU, and then select **RCU Status…**. Refer to Table 7.2 for detailed information on the path status.

4.3.2 RCU Options

The RCU Option panel (see Figure 4.11) allows you to set the RCU options for the connected subsystem. The RCU options apply to all CU images of the current MCU and to all RCUs connected to the MCU. The RCU Option panel opens automatically when you add an RCU, and can also be accessed from the HORC Main Control panel (**RCU Option…** button).

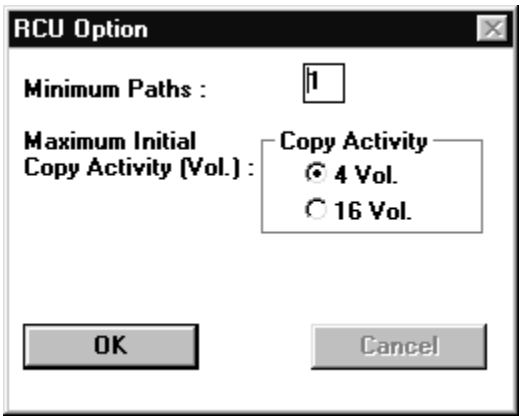


Figure 4.11 RCU Option Panel

The **Minimum Paths** option allows you to specify the minimum number of paths required for each RCU connected to the current MCU. If the number of paths falls below this number (e.g., failed path), the MCU suspends all affected HORC (and HRC) pairs to prevent remote copy operations from adversely affecting performance due to the inadequate number of paths. If the MCU contains HORC pairs which contain critical data for disaster recovery, set the minimum number of paths to one, so that HORC operations continue even if there is only one path to an RCU. If you need high performance at the MCU, set the minimum number of paths to two or more (up to four per CU image), depending on the number of pairs managed by the MCU.

CAUTION: If HORC volume pairs are suspended because the number of paths has dropped below this setting, the P-VOL fence-level pair option (see section 5.2.2) determines whether the HORC Synchronous P-VOLs are fenced (i.e., reject all write operations).

The **Maximum Initial Copy Activity** setting specifies the number of concurrent initial copy operations: **4 Vol** or **16 Vol**. HORC initial copy activities can impact the performance of the main subsystem, depending on the amount of I/O activity and the number of pairs being added at the same time. The maximum initial copy activity setting of **4 Vol** allows you to limit the impact of initial copy activities on subsystem performance. For example, if you set the maximum initial copy activity to **4 Vol** and then add five HORC pairs at the same time, the MCU starts the first four pairs and will not start the fifth pair until one of the first four pairs is synchronized (PAIR status). When you change the maximum initial copy activity setting, the new setting applies to HORC pairs created after the setting was changed, not to existing pairs.

Note: The RCU options are common to both HORC and HRC operations. For multiplatform 9900 configurations with both HORC and HRC paths, the **Maximum Initial Copy Activity** must be set to **4 Vol**, and the most recently entered **Minimum Paths** value (entered on HORC or HRC RCU Option panel) will be applied to both HORC and HRC operations.

4.3.3 RCU Path Parameters

The RCU path parameters are similar to the channel path definitions in the I/O configuration dataset (IOCDS). In the IOCDS, a logical path is specified with a subchannel number, link destination address, and logical address for the CU. HORC uses the "port" parameter instead of the subchannel number to specify the MCU's serial interface port. For the 9900 subsystem, the logical address must correspond to the CU image number. Figure 4.12 shows a typical HORC remote copy configuration with two paths. Figure 4.13 shows a configuration with serial connections going through two ESCON® storage directors and the HORC remote console panels used for this configuration.

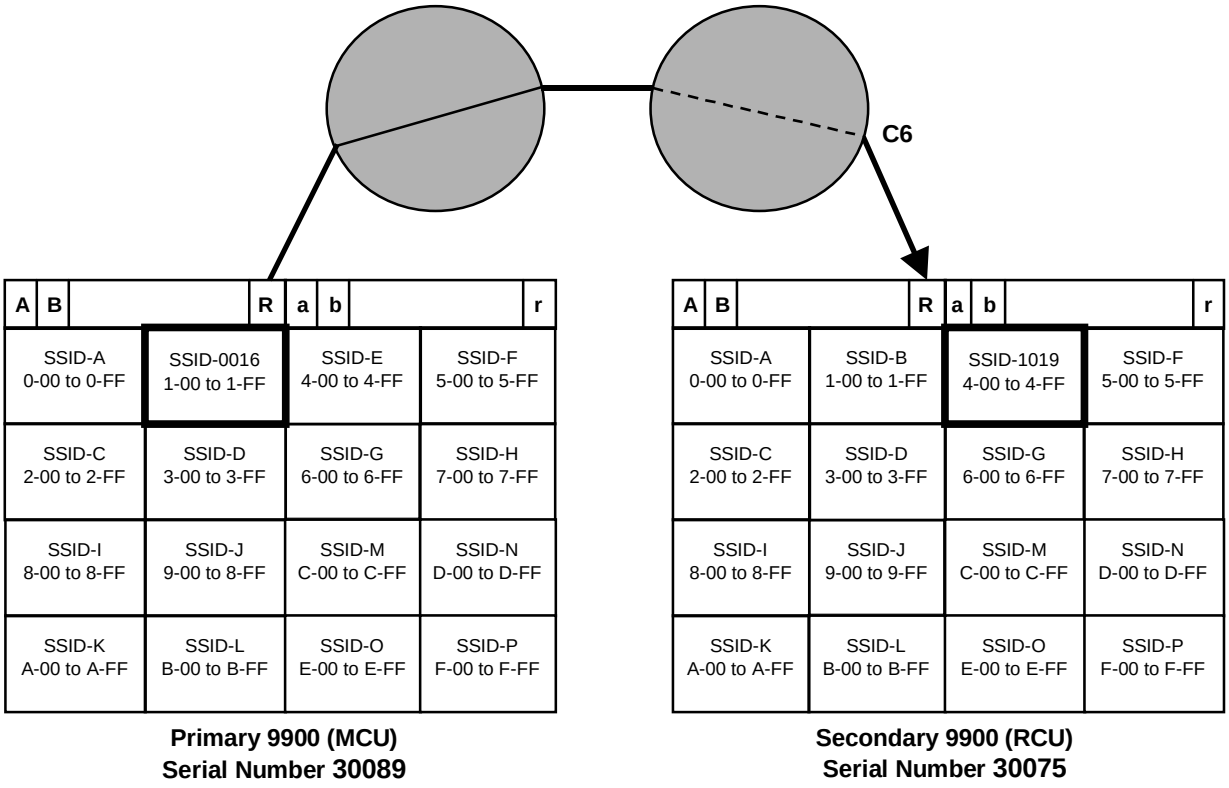


Figure 4.12 Add RCU Operation – Example 1

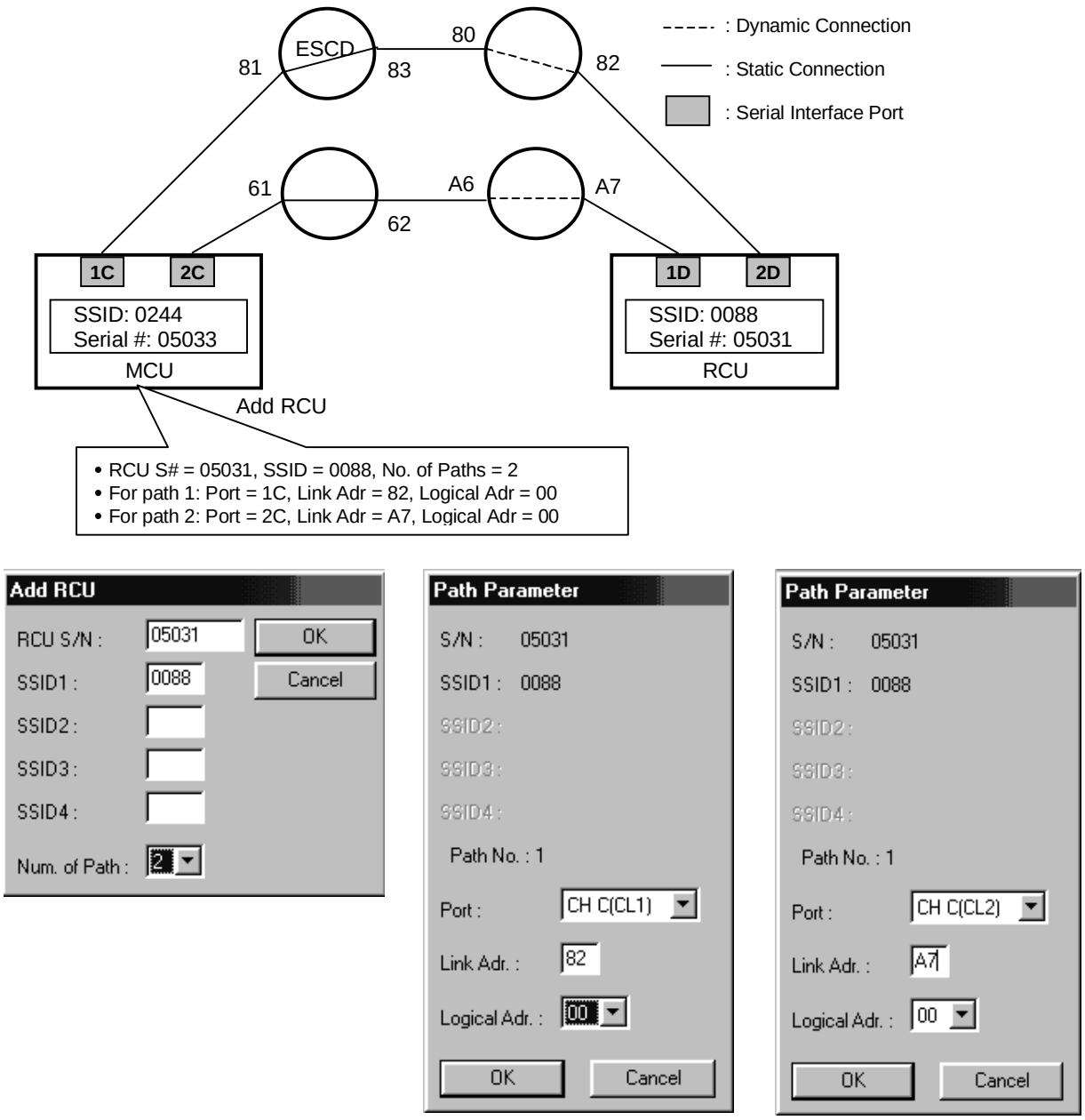


Figure 4.13 Add RCU Operation – Example 2

The Path Parameter panel (see Figure 4.14) allows you to enter the parameters for a new logical path from the connected MCU to the specified RCU. The Path Parameter panel opens automatically when you add an RCU or add a path to an existing RCU.

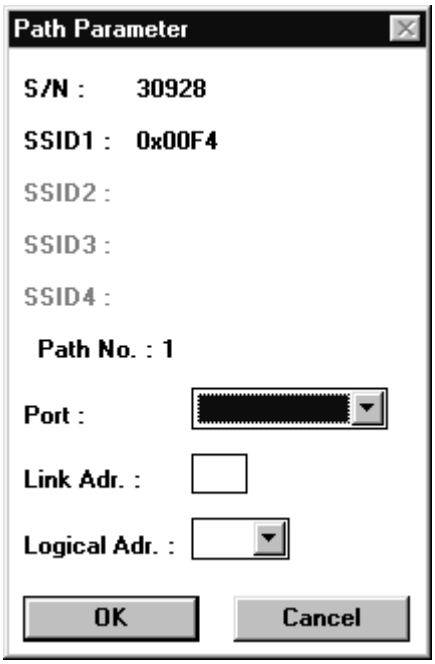


Figure 4.14 Path Parameter Panel

The Path Parameter panel displays the S/N and SSID(s) of the RCU to which the path is being established and allows you to enter the parameters for the new path. The **OK** button notifies the MCU to establish the specified path.

The RCU path parameters are:

- **Port**. The **Port** drop-down list box displays the remote control ports (RCPs) of the connected 9900. Only the ports which are already configured as RCPs are displayed.
- **Link Adr**. The **Link Adr**. field allows you to enter the link destination address for the new path. If the remote copy connection to the RCU is a dynamic link, the link address is the destination port address on the ESCD. If the remote copy connection to the RCU is a static link, the link address is 00.
- **Logical Adr**. The **Logical Adr**. drop-down list box allows you to select the logical CU address (CU image number) of the RCU: 00-0F.

4.3.4 Adding and Deleting Logical Paths for an RCU

The Path/SSID Edit panel (see Figure 4.15) provides access to the Edit Path panel and Edit SSID panel. The Edit Path panel (see Figure 4.16 and section 4.3.4) allows you to add and delete logical paths from the MCU to an existing RCU. The Path/SSID Edit panel is accessed from the HORC Main Control panel.

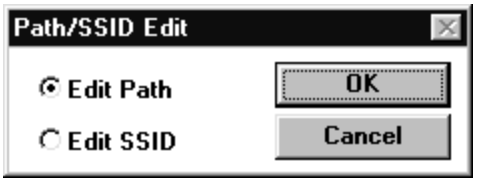


Figure 4.15 Path/SSID Edit Panel

Select the **Edit Path** button and click **OK** to add or delete paths to the selected RCU. Select the **Edit SSID** button and click **OK** to edit the SSIDs of the connected subsystem. See section 4.3.5 for information and instructions on editing SSIDs.

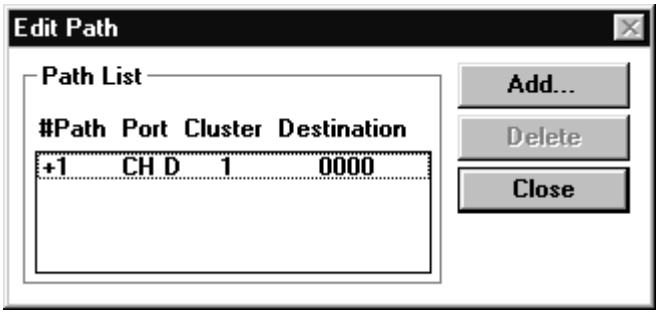


Figure 4.16 Edit Path Panel

The **Path List** box lists the existing paths between the MCU and the selected RCU by path number, displays the port, cluster, and link address for each path, and indicates the status of each path (+ normal, - not normal). Refer to Table 7.2 for further information on the path status. The **Add…** button opens the Path Parameter panel, which allows you to enter the path parameters. The **Delete** button allows you to delete the selected path(s).

Before adding a path to an RCU, make sure that the remote copy connection is properly installed, that the appropriate MCU ports are configured as RCPs, and that the appropriate MCU CU image is selected. You can add up to four RCUs to each MCU CU image and establish up to four paths to each RCU. When you add a path to an RCU, HORC will automatically start using the new path to perform HORC copy activities.

To add a new logical path from the connected MCU to an existing RCU:

1. On the HORC Main Control panel, select the appropriate CU image, select the desired RCU in the **RCU List** box, and then select **Edit Path/SSID…** to open the Path/SSID Edit panel (refer to Figure 4.15).
2. On the Path/SSID Edit panel, select **Edit Path** and click **OK** to open the Edit Path panel (refer to Figure 4.16).
3. On the Edit Path panel, select **Add…** to open the Path Parameter panel.
4. On the Path Parameter panel, enter the parameters for the new path (refer to section 4.3.3), and then select **OK**. The Edit Path panel now displays the new path information.
5. Verify that the new path appears in the **Path List** box, and then close the Edit Path panel. The MCU will automatically begin using the new logical path for HORC activities.

Before deleting a path to an RCU, make sure that the remaining number of paths will be equal to or greater than the minimum number of paths setting (selected on the RCU Option panel). The delete path operation will fail if the number of remaining paths is less than the minimum number of paths.

To delete a path from the connected MCU to an existing RCU:

1. Open the RCU Option panel, and check the minimum number of paths setting. If the remaining number of paths will be less than this value, the delete path operation will fail. If needed, change the minimum number of paths so that you can delete the desired path.
2. On the HORC Main Control panel, select the appropriate CU image, select the desired RCU in the **RCU List** box, and then select **Edit Path/SSID…** to open the Path/SSID Edit panel.
3. On the Path/SSID Edit panel, select **Edit Path**, then select **OK** to open the Edit Path panel.
4. On the Edit Path panel, select the path to be deleted, and then select **Delete**. The Edit Path panel updates itself to reflect the new path information.
5. Verify that the specified path has been removed from the **Path List** box, and then close the Edit Path panel.

4.3.5 Adding and Deleting SSIDs for an RCU

The Edit SSID panel (see Figure 4.17) allows you to add and delete SSIDs for an existing RCU and provides access to the Add SSID panel (see Figure 4.18). The Edit SSID panel is accessed from the Path/SSID Edit panel (refer to Figure 4.15).

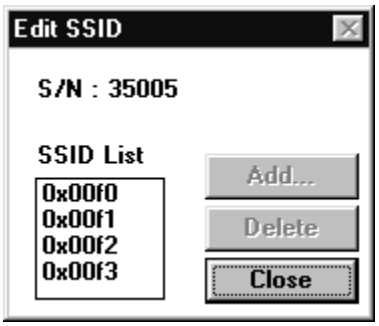


Figure 4.17 Edit SSID Panel

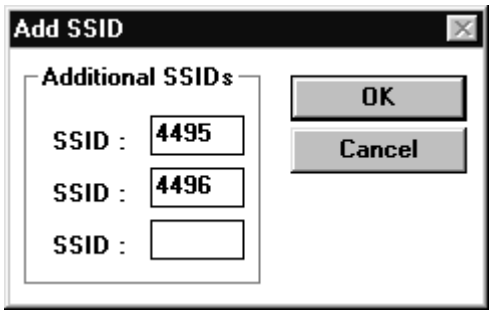


Figure 4.18 Add SSID Panel

The Edit SSID panel displays the S/N and current SSID(s) for the selected RCU. The **Add…** button opens the Add SSID panel, which allows you to add up to three SSIDs to the selected RCU CU image. The **Delete** button allows you to delete selected SSID(s). Before adding an SSID, make sure that the remote copy connection is properly installed. You can add up to three SSIDs to each RCU. Before deleting an SSID, make sure the remaining SSIDs are still valid, or the connection between the MCU and RCU may be lost.

To add or delete an SSID for an existing RCU:

1. On the HORC Main Control panel, select the appropriate CU image, select the RCU whose SSIDs you want to change, and then select the **Edit Path/SSID…** button to open the Path/SSID Edit panel (refer to Figure 4.15).
2. On the Path/SSID Edit panel, select **Edit SSID**, and then select **OK** to open the Edit SSID panel (refer to Figure 4.17).
3. To add an SSID:
   a) On the Edit SSID panel, select the **Add…** button to open the Add SSID panel (refer to Figure 4.18).
   b) On the Add SSID panel, enter the new SSID(s) in the SSID fields, and select **OK**.
   c) After the subsystem's SSIDs are reconfigured, the **SSID List** on the Edit SSID panel will reflect the additional SSID(s). When you are finished adding SSIDs, close the Edit SSID panel.
4. To delete an SSID:
   a) On the Edit SSID panel, select the SSID you want to delete, and select **Delete**. When the confirmation panel appears, select **Yes** to delete the selected SSID.
   b) After the subsystem's SSIDs are reconfigured, the **SSID List** on the Edit SSID panel will reflect the SSID deletion. Repeat step (a) for each SSID you wish to delete. When you are finished deleting SSIDs, close the Edit SSID panel.

4.3.6 Viewing RCU Status

The RCU Status panel (see Figure 4.19) displays the RCU options and the status of each logical path from the MCU to the selected RCU. Table 4.2 describes the RCU path status descriptions. To open the RCU Status panel, select the desired CU image on the HORC Main Control panel, select the desired RCU, and then select the **RCU Status…** button.

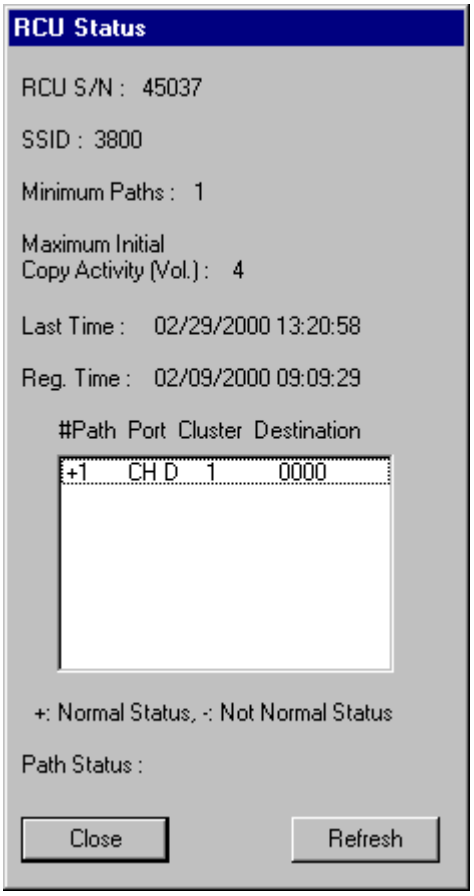


Figure 4.19 RCU Status Panel

The RCU Status panel displays the following information for the selected RCU:

- **S/N** and **SSID**(s) of the selected RCU.
- **RCU options:** minimum paths and maximum initial copy activity (see section 4.3.2).
- **Last Time:** Date and time of the last RCU path status update.
- **Reg. Time:** Date and time that the RCU was added to the MCU (registered).
- **Paths:** The paths are listed by path number, port, cluster, and destination link address. A plus sign (+) indicates normal status, and a minus sign (-) indicates not normal status. To display the detailed path status, select the path. See section 7.1 for troubleshooting information for MCU-RCU paths.

Table 4.2 Logical Path Status

Status Description	Condition
Normal	This logical path has been successfully established and can be used for HORC copy activities.
Initialization Failed	The link initialization procedure with the RCU has failed because either the physical path connection between the MCU and the RCU or the connection between the MCU and the host was missing.
Communication Timeout	A timeout error has occurred between the MCU and RCU.
Resource Shortage	The establish logical path link function has been rejected by the RCU. All logical path resources in the RCU might be used for other connections.
Serial Number Mismatch	The serial number of the control unit which is connected to this logical path does not match the serial number specified by the **RCU S#** parameter.
Invalid Port	The serial interface port specified by the **Port** parameter is not in the RCP mode.

4.3.7 Deleting an RCU

You can delete an RCU from an MCU only after all HORC volume pairs between the MCU CU image and RCU CU image have been deleted. When you delete an RCU from an MCU, the MCU deletes all logical paths from the current MCU CU image to the selected RCU CU image. Deleting an RCU does not affect the HORC operations between the other MCU CU images and that RCU. After an RCU has been deleted, you can reconfigure the remote copy connections to add another RCU to the MCU, or you can remove the remote copy connections and change the MCU RCP(s) back to LCP(s) to provide additional host channels for the MCU.

The **Delete RCU** button on the HORC Main Control panel allows you to delete the selected RCU from the current MCU CU image. If all affected HORC pairs have not been deleted, the MCU will reject the delete RCU operation to prevent accidental deletion of HORC pairs.

To delete an RCU from an MCU:

1. Start RMCMAIN, connect to the desired MCU, and start the HORC software.
2. On the HORC Main Control panel, select the desired CU image using the **Change CU#** button.
3. Make sure that all affected HORC volume pairs have been deleted. The volume pairs which consist of a P-VOL in the connected MCU and CU image and an S-VOL in the selected RCU must be deleted.
4. On the HORC Main Control panel, select the RCU to be deleted in the **RCU List** box, and then select **Delete RCU**.
5. When the confirmation panel appears, select **OK** to delete the selected RCU.

4.4 HORC Asynchronous Control Operations

The HORC Asynchronous control operations include:

- Configuring the HORC async options (see section 4.4.1),
- Adding consistency groups (see section 4.4.2),
- Setting the consistency group options (see section 4.4.3),
- Viewing consistency group status (see section 4.4.4), and
- Deleting consistency groups (see section 4.4.5).

4.4.1 Configuring the HORC Asynchronous Options

The Async Option panel (see Figure 4.20) allows you to select the HORC async options for the connected subsystem. The async options apply to the entire physical control unit, including all HORC P-VOLs and S-VOLs behind the control unit. The async options can only be modified when no HORCA pairs or groups exist in the connected CU (P-VOLs or S-VOLs). The Async Option panel is accessed from the HORC Main Control panel (**Async Option…**).

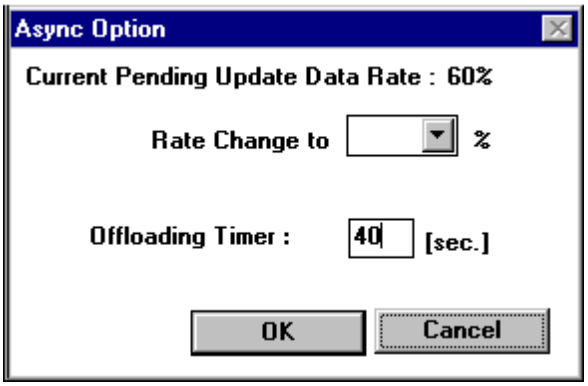


Figure 4.20 Async Option Panel

Description continues on the next page.

The HORC async options are:

- **Current Pending Update Data Rate:** This option specifies the HORC (and HRC) Asynchronous sidefile threshold, which is the maximum amount of cache that can be used for storing HORC (and HRC) Async recordsets (sidefiles). You can select any value between 30% and 70% (10% increments). ***Note:*** The current pending update data rate is common to both HORCA and HRCA operations. The most recently entered value (using the Async Option panel) will be applied to both HORCA and HRCA operations.

  When the amount of cache being used for HORC (and HRC) Async recordsets reaches the specified threshold value, the MCU/RCU performs cache inflow control as follows:

  – The MCU's I/O response is delayed.

  – The RCU accepts only the one specific recordset that will enable it to settle the pending recordsets in the queue(s). For all other recordsets the RCU responds to the MCU with the channel-command-retry request.

  Note: If one or more C/T groups exist (HORC or HRC), this setting cannot be changed. This setting can only be changed when no HORC or HRC consistency groups are assigned.

- **Offloading timer:** This option specifies the amount of time, 0-255 seconds, that the MCU will wait to send a HORCA recordset to the RCU. The MCU will suspend all affected HORCA volume pairs, if it has not been able to offload a recordset to the RCU within the specified time (e.g., the RCU is still responding channel-command-retry).

  Note: When channel-extenders are used for HORC Async, the offloading timer should be set to 35 seconds or less to avoid affecting host I/O performance.

4.4.2 Adding Consistency Groups

The Add C/T Group panel (see Figure 4.21) allows you to add a consistency group to the connected MCU and select the group options for the group. The Add C/T Group panel is accessed from the HORC Main Control panel (**Add Group…** button).

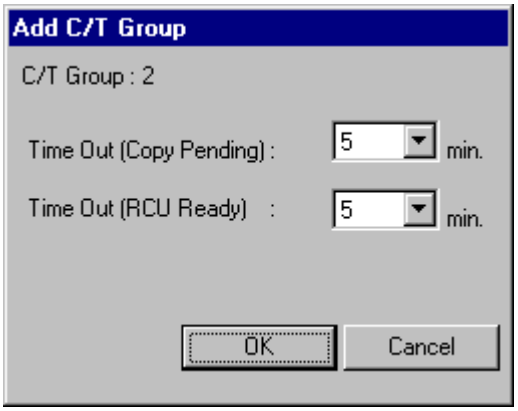


Figure 4.21 Add C/T Group Panel

The **C/T Group** field displays the group number.

The **Time Out (Copy Pending)** field allows you to select the maximum delay allowed for HORCA copy (none = no timeout for HORCA copy pending). If the delay between the HORCA P-VOL update and the corresponding S-VOL update reaches the specified time, the RCU will suspend all S-VOLs in the group. A timeout occurs when the RCU was not able to settle a recordset within the specified time, or when the RCU has not had any communication from one of the MCUs in the group within the specified time. *Important:* The copy pending timeout value should be less than the I/O timeout value of the host system.

The **Time Out (RCU Ready)** field allows you to select the maximum delay allowed for re-establishing MCU-RCU communications following MCU power-off (none = no timeout for HORCA RCU ready). If the MCU is not able to re-establish communication with the RCU within the specified time, the MCU suspends all P-VOLs in the group.

To add a consistency group:

1. Start RMCMAIN, connect to the desired MCU, and start the HORC software.
2. Make sure that the async options are configured as desired (refer to section 4.4.1).
3. On the HORC Main Control panel, select the desired (unassigned) group, and then select the **Add Group…** button to open the Add C/T Group panel. The Add C/T Group panel displays the selected group number (0-F).
4. On the Add C/T Group panel, select the desired group options: copy pending timeout, and RCU ready timeout. Remember that you will not be able to modify the group options once you assign a pair to the group.
5. After selecting the desired group options, select **OK** to add the specified group to the MCU. The group is now assigned on the HORC Main Control panel.

4.4.3 Consistency Group Options

The C/T Group Option panel (see Figure 4.22) allows you to modify the group options, and is accessed from the HORC Main Control panel (**Group Option…** button).

Note: If you want to change the group options, you must split all pairs in the group first.

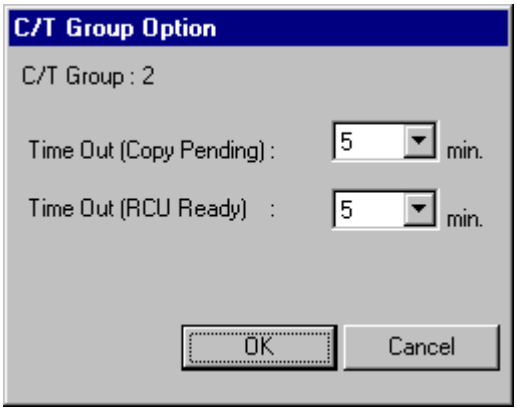


Figure 4.22 C/T Group Option Panel

The **C/T Group** field displays the group number.

The **Time Out (Copy Pending)** field allows you to select the maximum delay allowed for HORCA copy (none = no timeout). If the RCU was not able to settle a recordset within the specified time, or the RCU has not had any communication from one of the MCUs in the group within the specified time, the RCU will suspend all S-VOLs in the group.

Important: The copy pending timeout value should be less than the I/O timeout value of the host system.

The **Time Out (RCU Ready)** field allows you to select the maximum delay allowed for re-establishing MCU-RCU communications following MCU power-off (none = no timeout). If the MCU is not able to re-establish communication with the RCU within the specified time, the MCU will suspend all P-VOLs in the group.

To change the group options:

1. Start RMCMAIN, connect to the desired MCU, and start the HORC software.
2. Split all pairs in the group (pairsplit-R), so that you can change the group options.
3. On the HORC Main Control panel, select the desired group, and then select the **Group Option…** button to open the C/T Group Option panel. If the **Group Option…** button is not enabled, you need to split the remaining pairs in this consistency group.
4. Change the group options as desired, and then select **OK** to save your changes.
5. When you are finished changing group options, resync all pairs in the group (pairresync).

4.4.4 Viewing Consistency Group Status

The Group Status panel (see Figure 4.23) displays the detailed status information for the selected consistency group. The group status can be displayed at both the MCU and RCU. Table 4.3 describes the information displayed on the Group Status panel. The Group Status panel is accessed from the HORC Main Control panel (**Group Status…** button).

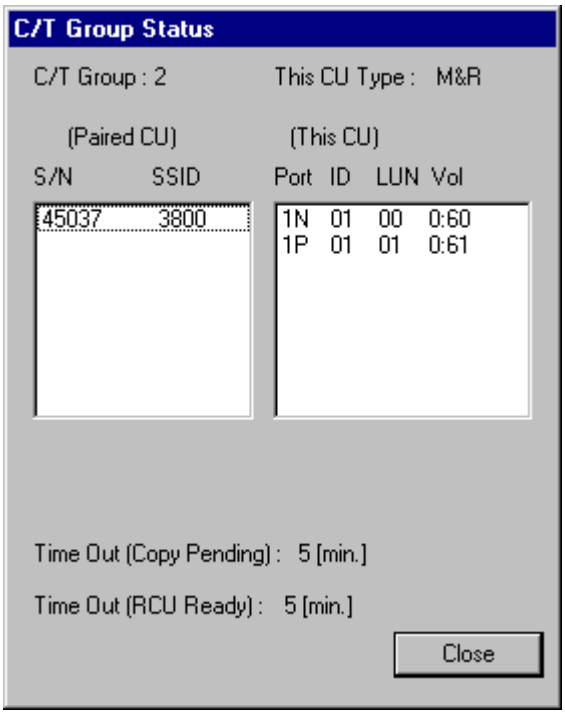


Figure 4.23 Group Status Panel

Table 4.3 Consistency Group Status

Item	Description	Displayed by: MCU	RCU
C/T Group	Consistency group number (0-F, hexadecimal).	Yes	Yes
This CU Type	CU type (MCU, RCU, M&R) of connected subsystem.	Yes	Yes
Paired CU	S/N and SSID(s) of the other CU for this group.	Yes	No
This CU	Volumes in the connected subsystem which belong to this group (port, TID, LUN, CU:LDEV).	Yes	Yes
Time Out (Copy Pending)	Specified copy pending timeout group option.	Yes	Yes
Time Out (RCU Ready)	Specified RCU ready timeout group option.	Yes	No

4.4.5 Deleting Consistency Groups

A consistency group can be deleted only from the MCU and only if the MCU does not contain any P-VOLs still assigned to the group. Deleting a consistency group from an MCU does not affect the consistency groups registered at other MCUs. The RCU will automatically delete a consistency group when the last volume pair in the group is deleted.

The **Delete Group** button on the HORC Main Control panel allows you to delete the selected group from the current MCU. The MCU will not allow you to delete a group which still has P-VOLs in the current MCU.

To delete a consistency group from an MCU:

1. Start RMCMAIN, connect to the desired MCU, and start the HORC software.
2. On the HORC Main Control panel, select the group to be deleted, and then select the **Delete Group** button. If the **Delete Group** button is not enabled, the selected group still contains P-VOLs in this MCU.
3. When the confirmation panel appears, select **OK** to delete the selected group. The MCU clears the group assignment information for the selected group.

4.5 Optimizing HORC Operations and Subsystem Performance

HORC operations result in increased utilization of the 9900 subsystem's channel resources because of the additional write (remote copy) operations to the secondary volumes. The HORC update copy mode (synchronous or asynchronous) determines exactly how the remote copy operations will impact subsystem performance as follows:

- **Synchronous** copy mode has an additional effect on subsystem performance: increased service and disconnect time for write I/Os to HORC P-VOLs due to the delay between channel-end and device-end. The length of this delay increases as the distance between the P-VOL and S-VOL increases, so that the longest delay occurs when the primary and secondary volumes are the maximum distance apart.
- **Asynchronous** copy mode (HORC Asynchronous) eliminates all delays associated with HORC Synchronous operations while providing increased protections for write-dependent applications in the event of a disaster. Write I/Os for HORCA P-VOLs are processed in the same way as writes for simplex volumes, without any increase in service or disconnect time. The asynchronous S-VOL updates are performed completely independent of all host I/O processes at the P-VOLs, and there are no restrictions on subsequent read/write operations to HORCA P-VOLs. The only performance concerns for HORC Asynchronous are (1) ensuring that adequate cache resources are available for sidefiles which are used to store the recordsets at both the MCUs and RCUs, and (2) ensuring that sufficient ESCON paths are defined for copy operations.

In addition to the HORC update copy mode, several other factors can also affect 9900 subsystem performance. You can optimize both the HORC operations and the I/O performance of the subsystems by analyzing workloads and addressing system-level conditions (e.g., number of ESCON paths) which can affect subsystem performance. You can also control the impact of HORC operations on subsystem performance by selecting the appropriate RCU options for each MCU (see section 4.3.2) and the appropriate update copy mode (synchronous or asynchronous) and pair options (see section 5.2.2) for each HORC pair. In addition, you can upgrade the HORC hardware components and/or adjust the configuration of the components to improve subsystem performance under a wide range of operating conditions.

Table 4.4 lists some of the conditions which affect subsystem performance and provides recommendations for addressing these conditions.

Table 4.4 Optimizing HORC Operations and 9900 Subsystem Performance

Condition	Description	Recommendation(s)
Write-intensive workloads	Write-intensive workloads, such as database logging volumes, can have a significant impact on subsystem I/O response times.	Spread write-intensive data across several volumes to minimize queuing. Also consider increasing the duplex write line (DWL) of the subsystem using the Hitachi GRAPH-Track software product.
Large block size	Workloads with large write block sizes, such as DB deferred writes, can impact performance.	Spread workloads with large write block sizes across several volumes.
High host channel demand	The demand on the MCU's host channels can affect performance.	Spread the workload across several disk subsystems to utilize additional channels.
Sequential write operations	HORC operations can have a negative impact on workloads with a high percentage of sequential write operations, such as batch processing operations (e.g., dump/restore, sort operations).	Avoid performing restore operations to volumes which belong to HORC pairs. Instead, restore data to a scratch volume and then create the HORC volume pair.
Cache size	Large cache size improves read hit performance, which allows more subsystem resources to be devoted to write operations. The resulting performance improvement can offset some or all of the performance loss due to the HORC remote copy operations. HORC Asynchronous (and HXRC and Concurrent Copy) require additional cache for sidefile data. Insufficient cache resources can result in command retries, state-change-pending (SCP) notifications, and puncture conditions.	Consider increasing the cache size of the HORC subsystems to handle cache sidefile operations and to improve overall subsystem performance. For best results, the cache and NVS capacity of the primary and secondary subsystems should be the same (for HORC Asynchronous the RCU sidefile requirements are twice that of the MCU) to enable the remote site to function adequately during disaster recovery.
RCU capacity	The performance of the RCUs directly affects the performance of the MCUs. If an RCU becomes overloaded with heavy update activity, MCU and system performance can also be degraded.	Distribute HORC remote copy operations among several remote subsystems to avoid overloading any one RCU.
ESCON paths	An inadequate number of ESCON paths may decrease subsystem performance. Performing HORC Synchronous operations over long distances can also degrade performance. HORC Asynchronous is recommended for long distances.	Make sure to install an adequate number of ESCON paths between the primary and secondary subsystems. This is especially important for subsystems which contain both P-VOLs and S-VOLs.

4.6 Discontinuing HORC Operations

If you plan to use HORC for nondisruptive data migration or duplication (see section 5.7), you will configure and establish HORC operations, allow HORC to synchronize the volumes, redirect application I/Os (if migrating), and then discontinue HORC operations. When you are ready to discontinue HORC operations, you will need to perform HORC operations in the correct order to avoid generating error messages. For example, HORC will not allow you to delete an RCU path until you have deleted all HORC pairs still using that path, and you cannot delete a group until you have deleted all HORC Asynchronous pairs in that group.

To discontinue all HORC operations, perform the following actions in the following order:

1. First delete all HORC pairs from the MCU(s) (pairsplit-S, see section 5.6). For HORCA pairs, you can use the **Delete Range-Group** option to delete all pairs in a group using just one operation. Verify that the pair status has changed to SIMPL for all HORC volumes before continuing.
2. Delete the HORCA group(s) from the MCU(s) (see section 4.4.5). The RCU will automatically delete a group when all pairs in the group have been deleted.
3. Delete the RCUs (see section 4.3.7). Check each CU image of each MCU to make sure that all RCUs have been deleted before continuing.
4. Remove the remote copy connections (physical paths). If you are not familiar with the operation of the remote copy hardware components (e.g., ESCON directors and repeaters), please call the Hitachi Data Systems Support Center for assistance.
5. Reset the RCP(s) to LCP(s) at the MCU(s) (see section 4.2.3).

4.7 Scripting

The HORC remote console software supports scripting for managing pre-defined HORC operations. The HORC scripting function enables you to define multiple HORC operations in a text file that the HORC remote console software reads and executes as a batch file. Scripting allows you to perform a series of HORC operations without having to issue the commands separately. Using HORC scripting, you can set up and execute a large number of HORC commands within a short period of time. The HORC scripting function enables you to:

- save time by executing multiple HORC operations with a single command,
- run a series of predefined and tested HORC operations after business hours or overnight, and/or
- allow a non-resident system administrator to set up and start an entire day's worth of HORC operations in the limited time that the administrator is on-site.

This section describes the selection and execution of an existing HORC script file. Appendix C describes and specifies the requirements for the HORC script files.

The Script Monitor panel (Figure 4.25) displays detailed information for the script being executed. To open the Script Monitor panel, select the **Script…** button on the HORC Main Control panel (see section 4.1).

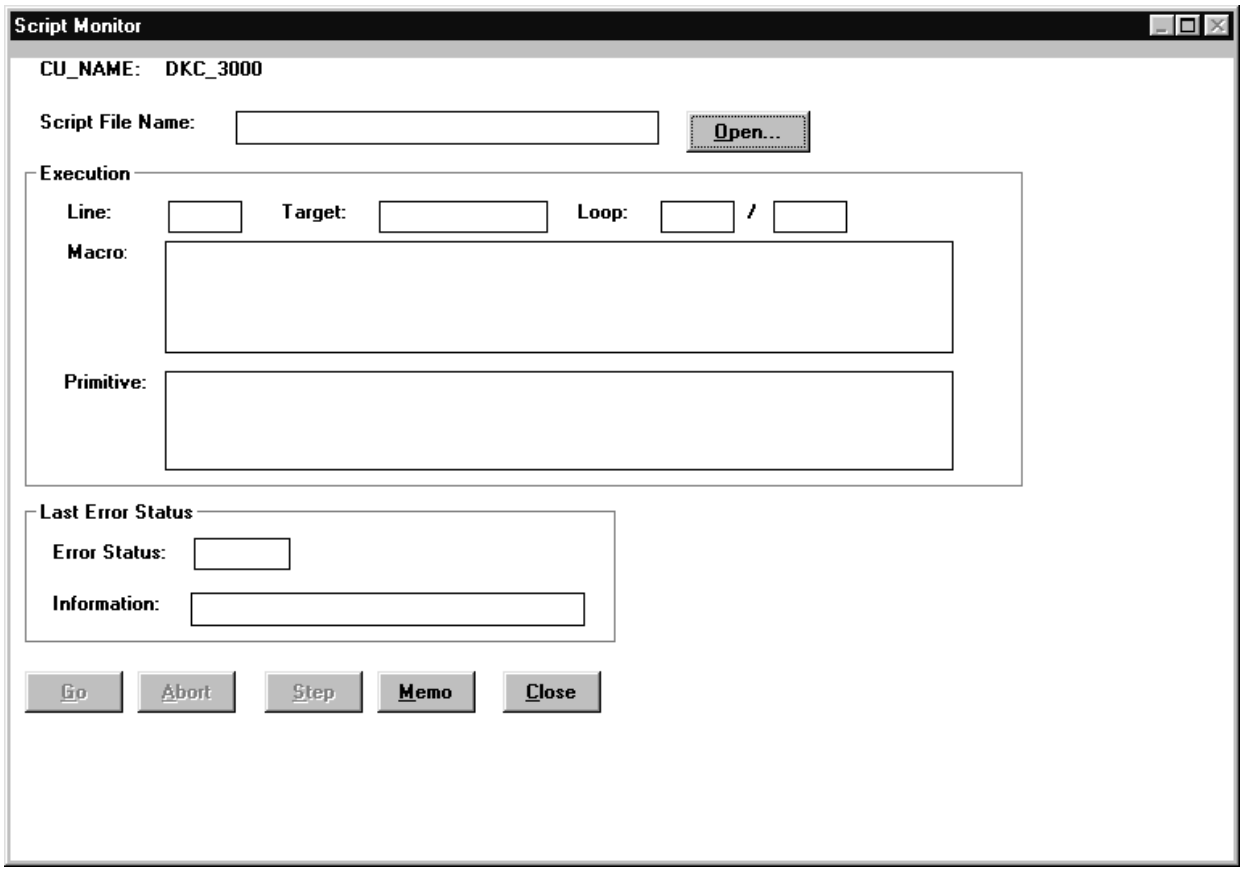


Figure 4.25 Script Monitor Panel

The **CU_NAME** field displays the name of the connected 9900 subsystem. The **Script File Name** field displays the name of the selected HORC script file. The script file name can have up to eight characters, and the file extension must be **.spt**. The **Open...** button opens the Open panel (see Figure 4.26), which allows you to select and open an existing HORC script file.

While a HORC script file is open, the **Execution** and **Last Error Status** boxes display the following detailed information (see Figure 4.27). All completed and attempted macros are logged in the macro trace file. All errors are logged in the error trace file.

Line The script file line number being executed.

Target The target device ID (LDEV ID) for the current operation.

Loop The current/total repetition count for a looped command (e.g., 150/300).

Macro The macro being executed. Macros which execute a process for a device are listed: Create-, Change-, Suspend-, Resume-, and DeleteHorcPair.

Primitive The specified (or default) parameters for the current macro. For example:

If macro = `ResumeHorcPair $Port=0x10, $Id=0x0F,$Lun=0x77`

Then primitive = `ResumeHorcPair $Port=0x0010, $Id=0x0077, $Fence=0x0000, $Sync=0x0003`

Error Status The most recent macro error (**None** = no errors).

Information The time and script line location of the error in the **Error Status** box.

The **Go** button executes the selected script file. The **Abort** button stops the active script (after the current macro completes and before the next macro starts). The **Step** button executes the selected script file one macro at a time. The **Close** button exits the Script Monitor panel.

The **Memo** button opens the WordPad panel (see Figure 4.28), which allows you to open the current script file, macro trace file, or error trace file in Microsoft® WordPad.

- The **Script File** option has two functions. If a script file is open, this option opens the current script file. If a script file is not open (**Script File Name** is blank), this option opens a new WordPad document to allow you to create a new script file.
- The **Macro Trace File** option opens the text file (**macro.trc**) that traces the macros used (see Figure 4.29). Table 4.4 describes the contents of the macro trace file.
- The **Error Trace File** option opens the text file (**error.trc**) that details the errors that occurred while running scripts (see Figure 4.30). Table 4.5 describes the error trace file.

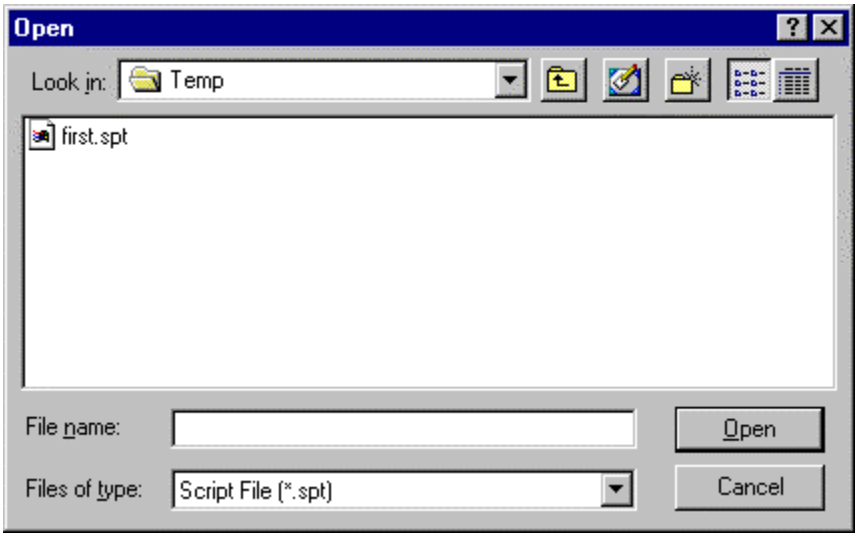


Figure 4.26 Open Panel

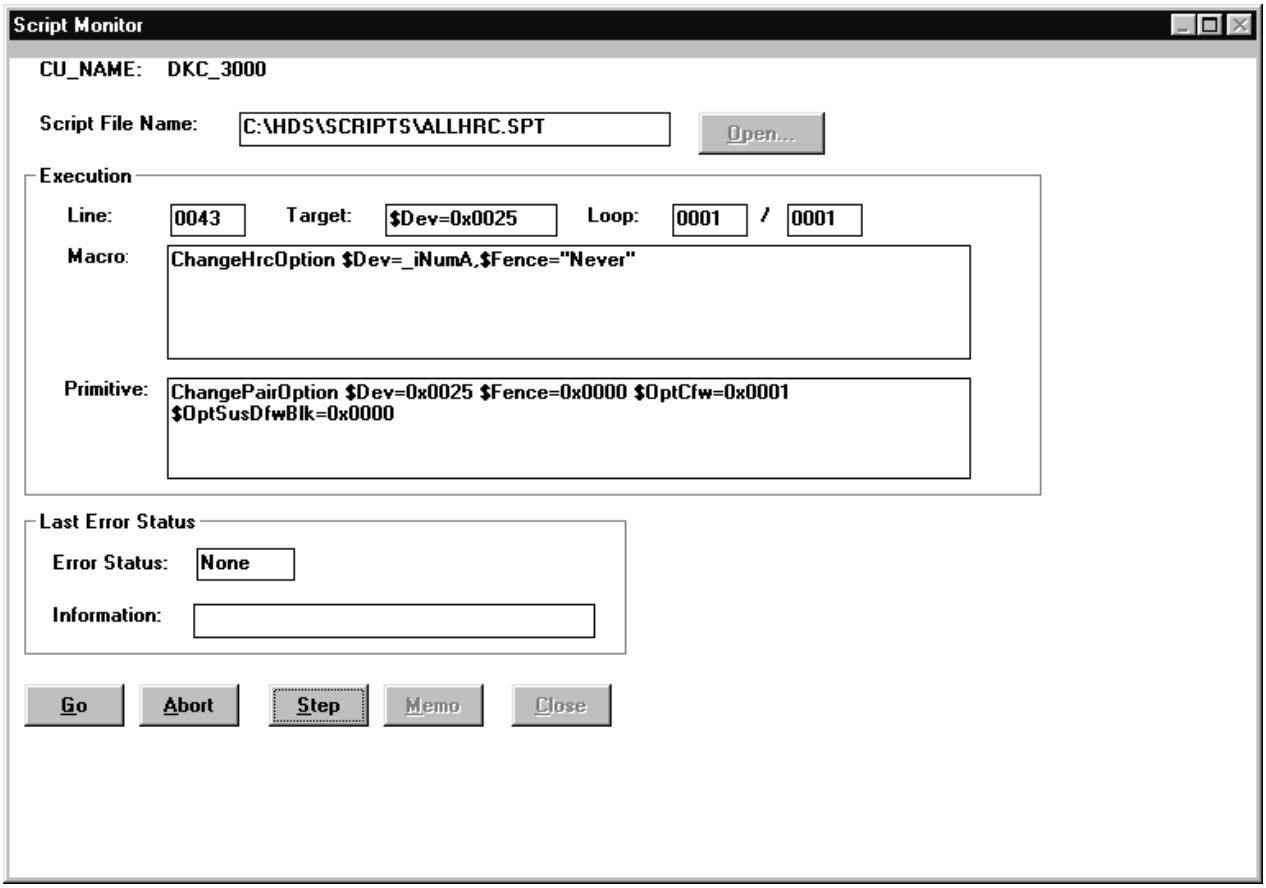


Figure 4.27 Script Monitor Panel During Execution of a HORC Script File

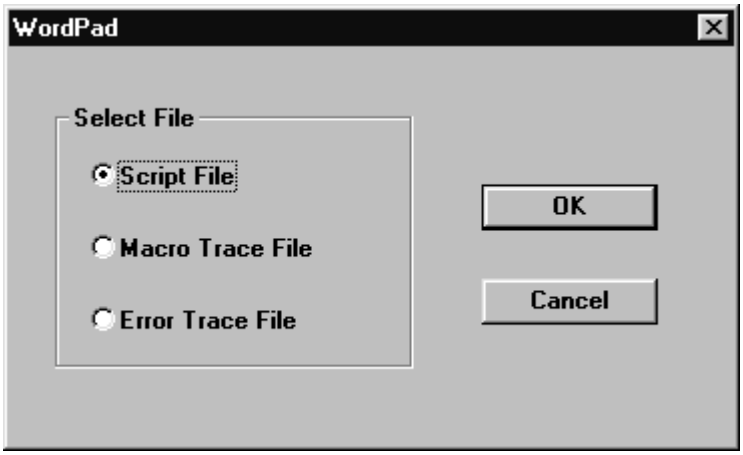


Figure 4.28 WordPad Panel

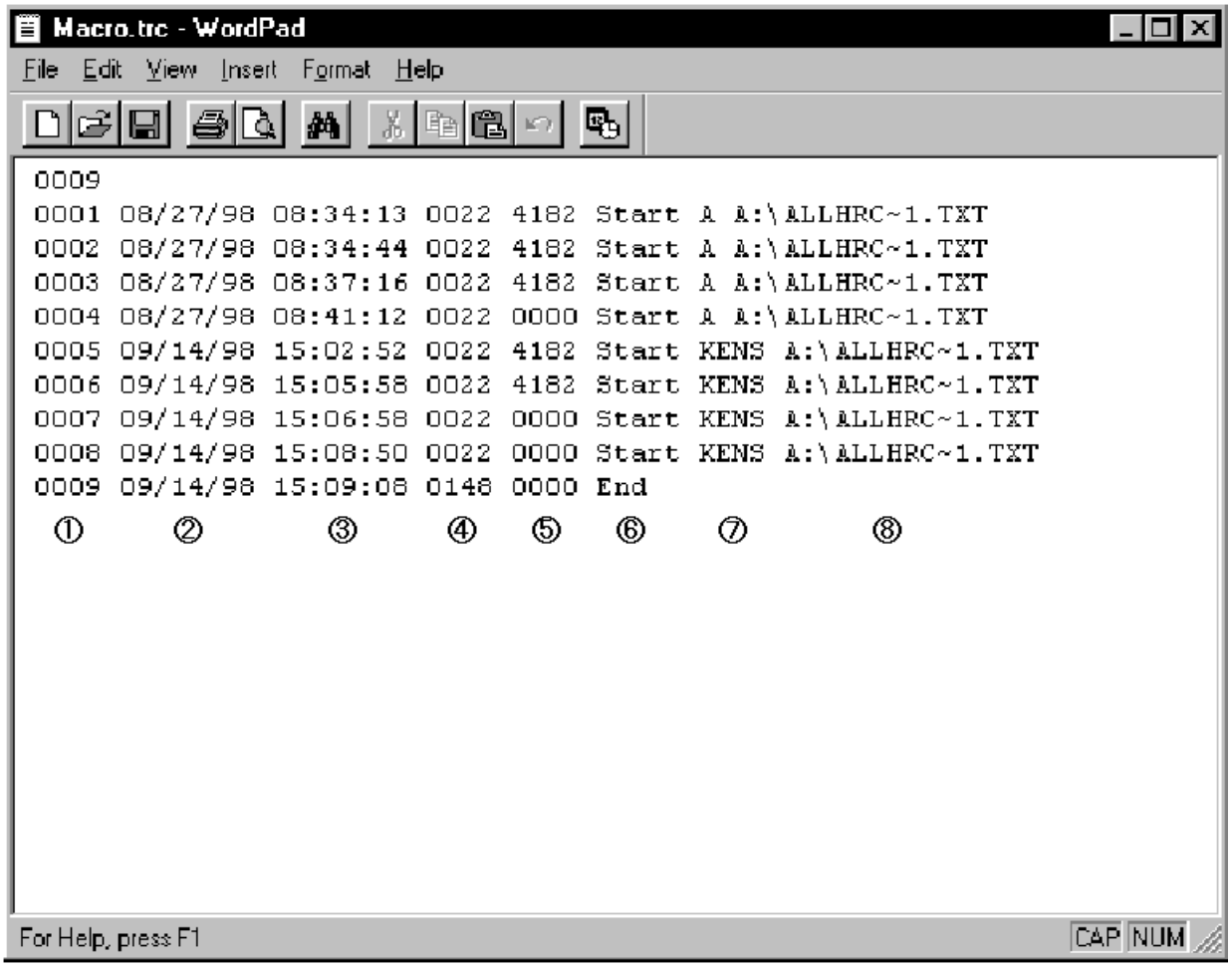


Figure 4.29 Macro Trace File

Table 4.4 Macro Trace File Information

Number	Description
①	All macros executed by HORC are listed in chronological order and numbered.
②	The date that the macro was executed.
③	The time that the macro was executed.
④	The location (script file line number) of the macro.
⑤	The internal scripting error code (0000 = no error). See Table E.22 (Appendix E) for scripting error codes.
⑥	The last registered status of the macro. If the macro was not completed, the last registered status is **Start**. If the macro was completed successfully, the last registered status is **End**.
⑦	The name of the 9900 subsystem (usually MCU of specified HORC operation).
⑧	The name and location of the script file containing the specified macro.

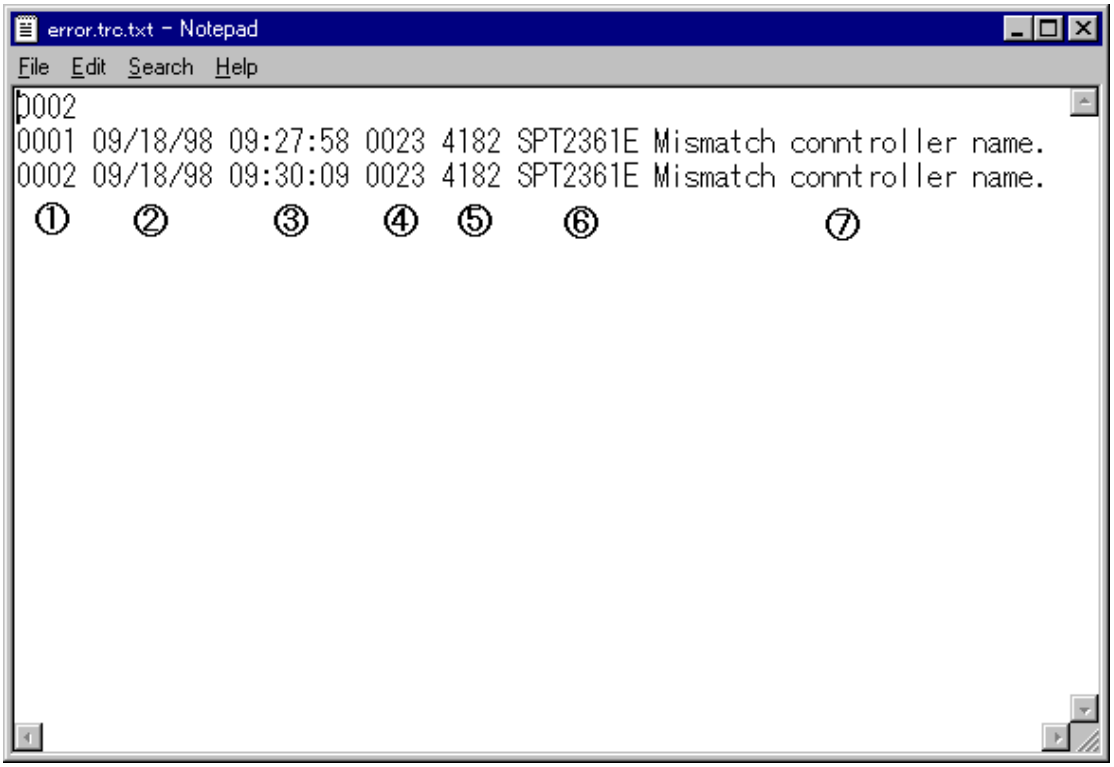


Figure 4.30 Error Trace File

Table 4.5 Error Trace File Information

Number	Description
①	All macro errors encountered by HORC are listed in chronological order and numbered.
②	The date that the macro error occurred.
③	The time that the macro error occurred.
④	The location (script file line number) of the macro that caused the error.
⑤	The HORC scripting internal error code (see Table C.16 in Appendix C).
⑥	The HORC scripting error code message ID (see Table C.16 in Appendix C).
⑦	Brief description of the error.

Chapter 5 Performing HORC Pair Operations

5.1 Preparing for HORC Volume Pair Operations

Before starting HORC operations, you must consider the relative importance of subsystem I/O performance and disaster recovery preparation. As described in section 4.5, HORC remote copy operations can affect the I/O performance of the MCUs and RCUs. HORC provides many options (initial copy options, pair options, group options, async options) which allow you to control the impact of HORC operations on I/O performance. These options can be set separately for each HORC pair, for each HORCA group, and for each MCU to provide maximum flexibility. You can select options which minimize the impact of HORC operations on subsystem performance, or options which maximize the effectiveness of HORC operations to ensure the best level of backup data integrity. System-level factors (e.g., number of ESCON® paths) can also affect HORC operations and subsystem performance (see Table 4.4).

For HORC disaster recovery operations, you should make sure that the RCUs are attached to a host server to enable reporting of sense information and transfer of host failover information. If the remote site is unattended, you should attach the RCUs to a host server at the main site, so that the system administrator can monitor the operational condition of the RCUs.

To prepare for HORC volume pair operations, you need to identify the volumes (by port, TID, and LUN and/or by LDEV ID) for which you want to establish HORC remote copy operations. You should identify volumes which are required for system operation as well as volumes which contain important data to be backed up (e.g., DB log files). Copying these volumes to the remote site will enable faster disaster recovery than maintaining a current version of these files at the remote site. For large databases which span multiple volumes, you should plan to establish a HORC Asynchronous consistency group for each database, so that the update sequence consistency of the database can be ensured at the remote site.

You can start creating the HORC volume pairs as soon as you have:

- Identified the volumes (LUs) which will become the HORC P-VOLs (and S-VOLs),
- Ensured that all system and HORC requirements have been met (see sections 3.1 and 3.2),
- Completed hardware and software installation (see sections 3.3 and 3.3.2),
- Configured the MCUs and RCUs for HORC operations (see section 3.5).

If you will be using the HORC remote console software to perform HORC operations, the Remote Console PC must be LAN-attached to the MCU of each HORC volume pair. You should also install and attach a Remote Console PC to the RCUs at your remote site. If you will be using CCI commands instead of the HORC remote console software, please contact your Hitachi Data Systems account team for information on HORC configuration services.

5.2 Creating HORC Volume Pairs (Paircreate)

The Paircreate panel (see Figure 5.1) allows you to add one or more new HORC pairs. The Paircreate panel is accessed from the HORC Main Control panel (**Paircreate…** button).

The Paircreate panel allows you to select the RCU, S-VOL, and initial copy options (see section 5.2.1) for the pair(s) being created. When you select **OK** on the Paircreate panel, the Pair Option panel opens (see Figure 5.2) to allow you to select the HORC pair options (see section 5.2.2) for the new pair(s). When you select **OK** on the Pair Option panel, the Pair List (Paircreate) panel opens (see Figure 5.3) and displays the pair(s) being created. The Pair List (Paircreate) panel allows you to change the initial copy options and pair options for each pair, remove pair(s) from the list, and start the specified HORC pair(s).

Note: Make sure to select the appropriate CU image before creating any HORC pairs.

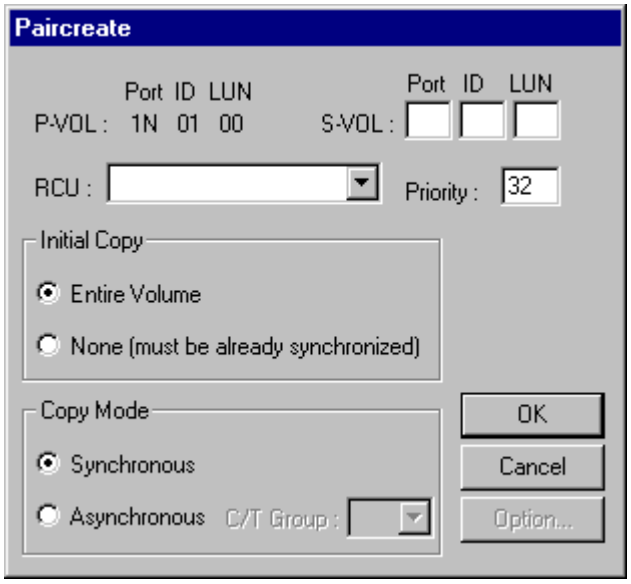


Figure 5.1 Paircreate Panel

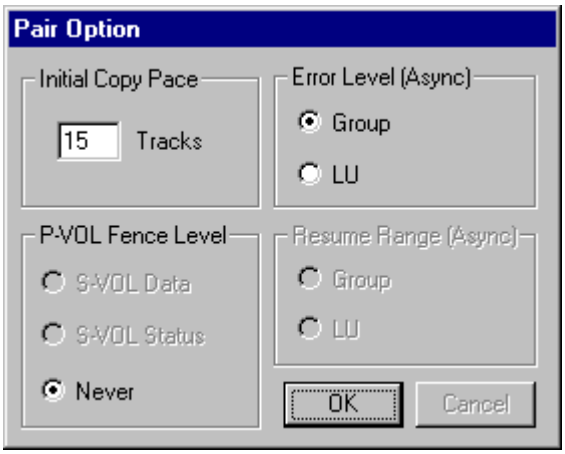


Figure 5.2 Pair Option Panel

The Paircreate panel (refer to Figure 5.1) displays the LU selected on the HORC Main Control panel as the P-VOL. If you selected more than one LU, the LU with the lowest LUN is displayed. The **S-VOL** fields allow you to enter the port, TID, LUN for the desired S-VOL. If you selected more than one P-VOL, S-VOLs will automatically be assigned to the rest of the selected P-VOLs based on LU number. The RCU drop-down list box allows you to select the RCU for the HORC pair(s) being created. The RCU must be the same for all pairs being created during this operation. The **Priority** field allows you to set the priority (scheduling order) of the initial copy operation. The **Initial Copy** box allows you to specify the initial copy mode (entire volume or none). The **Copy Mode** box allows you to select the HORC update copy mode (synchronous or asynchronous) and the C/T Group (Async only) for the pair(s) being created. When you are creating more than one pair at a time, you will be able to change these initial copy options for individual pairs as needed from the Pair List (Paircreate) panel. For further information on the initial copy options, see section 5.2.1.

The **OK** button opens the Pair Option panel to allow you to select the pair options for the pair(s) being created. The **Option…** button also opens the Pair Option panel, but only when changing options for pairs already on the Pair List (Paircreate) panel.

The Pair Option panel (refer to Figure 5.2) allows you to select the HORC pair options: initial copy pace, P-VOL fence level (Sync only), and error level (Async only). (The **Resume Range** options are available only during pairresync.) When creating more than one pair at a time, you will be able to change the pair options for individual pairs as needed from the Pair List (Paircreate) panel. For further information on the HORC pair options, see section 5.2.2. The **OK** button applies the pair options and opens the Pair List (Paircreate) panel (see Figure 5.3).

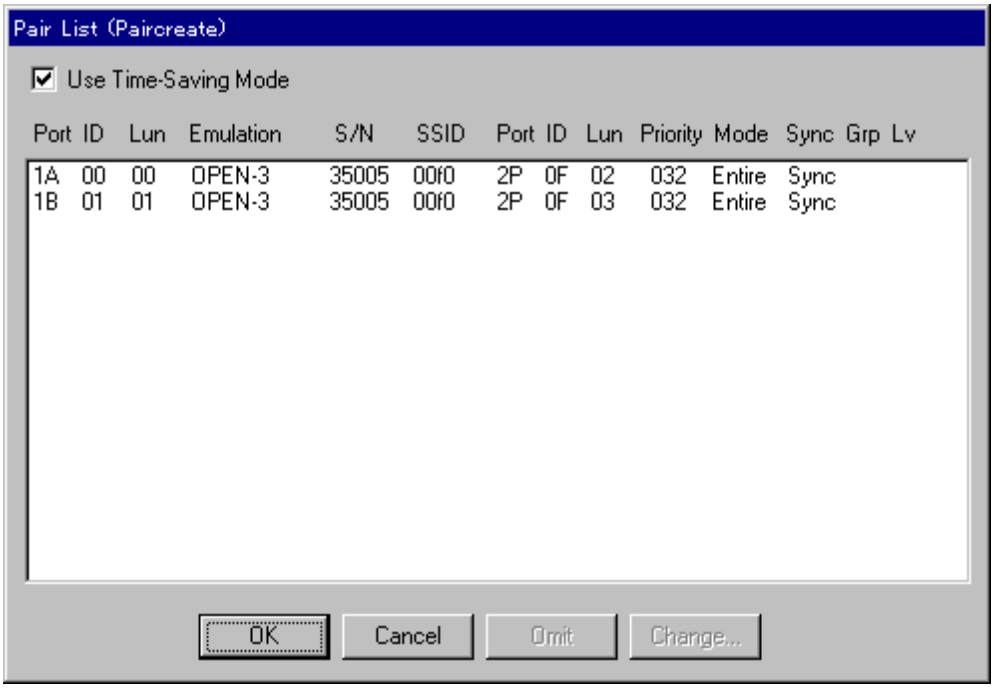


Figure 5.3 Pair List (Paircreate) Panel

The Pair List (Paircreate) panel displays the following information for each pair being added: P-VOL ID and emulation, RCU S/N and SSID, S-VOL ID, initial copy priority, initial copy mode, update copy mode, group number (Async only), and error level (Async only). The **Use Time-Saving Mode** option allows you to execute the specified paircreate operations quickly (i.e., requests for multiple pairs are entered simultaneously). The **Omit** button removes the selected pair(s) from the panel. The **Change…** button re-opens the Paircreate panel to allow you to change the S-VOL ID, initial copy options, and/or pair options for the selected pair(s). The **OK** button creates all HORC pairs listed on the Pair List (Paircreate) panel.

To create one or more new HORC volume pairs:

1. Make sure that the volumes which will be the HORC S-VOLs are offline from all hosts.
2. Start the Remote Console software, connect to the subsystem which contains the P-VOLs of the pair(s) you are creating, and start the HORC software. The RCPs must already be configured (see section 4.2.3), and the RCU(s) must already be added (see section 4.3.1).

Instructions continue on the next page.

3. On the HORC Main Control panel, select the desired CU image, and then select the volume(s) which will be the P-VOL(s) of the HORC pair(s). The pair status must be SMPL. You can select more than one volume and establish more than one pair at a time only if the S-VOLs are in the same RCU and the pairs will have the same copy mode (Sync or Async). You cannot start HORC Sync and HORCA pairs at the same time.
4. Select **Paircreate…** to open the Paircreate panel. If you selected more than one volume in step (3), the Paircreate panel displays the volume with the lowest ID as the P-VOL.
5. On the Paircreate panel, select the **RCU**, enter the desired **S-VOL** for the P-VOL, and select the desired initial copy options (see section 5.2.1) (initial copy priority and mode, update copy mode, C/T group). Select **OK** to open the Pair Option panel.
6. On the Pair Option panel (see section 5.2.2), select the desired HORC pair options (initial copy pace, P-VOL fence level, async error level), and select **OK**.
7. The panel now opens and displays all pairs being created. If you selected more than one volume in step (3), S-VOLs are automatically assigned to the rest of the P-VOLs based on TID/LUN. The initial copy options and pair options you selected are applied to all pairs, but you can customize the options for each pair as needed.
8. On the Pair List (Paircreate) panel, check the RCU S/N and SSID, S-VOL, and copy options for each pair. If you need to change the options for one or more pairs, select the pair(s), select **Change…** to re-open the Paircreate panel, make the desired changes (select **Option…** to access the Pair Option panel), and select **OK** to return to the Pair List (Paircreate) panel. Repeat this step until all HORC options for each new pair are correct.
9. If you want to execute the paircreate requests quickly, select the **Use Time-Saving Mode** option on the Pair List (Paircreate) panel.
10. Select **OK** on the Pair List (Paircreate) panel to create (start) the specified HORC pair(s). The MCU will start the initial copy operations according to the initial copy priority and the maximum initial copy activities setting.
11. On the HORC Main Control panel, verify that the new HORC pair(s) is/are displayed correctly (COPY status) in the **Volume List** box. To monitor the status of the new pair(s), use the **Refresh** button to update the information in the **Volume List** box, or use the Pairdisplay panel (see section 5.3) to monitor the detailed status of each pair.

    Note: The Paircreate operation will be rejected if the P-VOL is in the correction access or correction copy state. If this occurs, wait for the volume state to change and then repeat this procedure. If the status is not displaying correctly, make sure that the correct CU image is selected. See section 7.1 for information on troubleshooting suspended pairs.

    WARNING: If a timeout error occurs when the **Use Time-Saving Mode** option is selected, confirm on the HORC Main Control panel for which volumes the paircreate operation could not be performed. Deselect the **Use Time-Saving Mode** option for the failed volumes, and retry the paircreate operation.

5.2.1 HORC Initial Copy Options

The HORC initial copy options allow you to specify the initial copy priority, initial copy mode, update copy mode, and C/T group. The initial copy options are selected on the Paircreate panel. While the initial copy operation is in progress, the initial copy options cannot be changed unless you delete (pairsplit-S) and then restart (paircreate) the pair. After the initial copy operation is complete, you can only change the HORC pair options.

Priority. The initial copy priority specifies the order in which the initial copy operations will be performed, if the number of requested initial copy operations is greater than the maximum initial copy activity setting on the RCU Option panel (see section 4.3.2). The highest priority is 1, and the lowest priority is 256 (current default = 32). The HORC initial copy priority option can be used to spread initial copy operations across array groups and/or array domains (ACP pairs) to reduce initial copy time as well as host I/O contention.

Example: Let's say that the maximum initial copy activity setting is 4, and you add 6 HORC pairs at the same time (for LUNs 00 through 05) with the initial copy priority set as follows:

P-VOL of HORC pair	Priority
LUN 03	1
LUN 05	2
LUN 00	3
LUN 04	4
LUN 01, 02	5

The MCU will start the initial copy operations for LUNs 03, 05, 00, and 04 immediately, then start LUN 01 when one of the first four initial copy operations is complete, and then start LUN 02 when the next initial copy operation is complete. If more HORC pairs are created, the MCU also prioritizes the initial copy operations by time requested, so that all HORC pairs in the first group are started before any pair in the next group is started.

Initial Copy. This option specifies the initial copy mode for the new pair(s).

- If **Entire Volume** is selected, the initial copy operation will copy all cylinders on the P-VOL (except diagnostic and unassigned alternate tracks) to the S-VOL.
- If **None** is selected, the initial copy operation will not be performed. The MCU will begin performing update copy operations as needed. ***CAUTION:*** The user must ensure that the P-VOL and S-VOL are already identical when using this setting.

Copy Mode. This option specifies the update copy mode (see section 2.2.2) for the new pair(s): **Synchronous** or **Asynchronous**. The selection of mode has the greatest impact on performance and must be considered carefully. Factors in mode selection include (but are not limited to) the use of HORC (for disaster recovery or migration), the number of pairs, and the write I/O activity to the P-VOLs.

C/T Group. This option specifies the consistency group for the new pair(s) (Async only). All HORC Asynchronous pairs must be assigned to a consistency group.

5.2.2 HORC Pair Options

The Pair Option panel (refer to Figure 5.2) displays and allows you to select the pair options for each HORC volume pair. The Pair Option panel can be accessed from several panels: Paircreate (**OK** and **Option…** button), Pair List (Paircreate) (**Change…** button), HORC Main Control panel (**Change Option…** button), and Pairdisplay (**Option…** button).

The Pair Option panel opens automatically during the paircreate process to allow you to set the pair options for the new pair(s). You can change the pair options for each pair by selecting the pair on the Pair List (Paircreate) panel, selecting **Change…** to re-open the Paircreate panel, and then selecting **Option…** to open the Pair Option panel. You can also change the pair options for a HORC pair which has already been created by selecting the pair on the HORC Main Control panel and then selecting the **Change Option…** button.

The **Initial Copy Pace** option specifies the maximum number of tracks (**1-15**) that can be copied at one time by the HORC initial copy operation before the MCU accepts another host request for that P-VOL. A high setting (e.g., 15 tracks) speeds up the initial copy operation but may affect the subsystem's I/O performance if the P-VOL is experiencing high write I/O activity. A lower setting (e.g., 3 tracks) slows down the initial copy operation to minimize the impact of the initial copy operation on the subsystem's I/O performance.

The **P-VOL Fence Level** option (HORC Synchronous only) specifies the conditions under which the MCU will reject write operations to the P-VOL, which is known as "fencing." This option is very important for disaster recovery planning (see section 6.1.1).

- If **S-VOL Data** is selected, the P-VOL will be fenced when the MCU cannot successfully execute an update copy operation for any reason.
- If **S-VOL Status** is selected, the P-VOL will be fenced only if the MCU is not able to change the S-VOL status to suspended when an update copy operation fails. If the MCU changes the S-VOL status to suspended, subsequent write operations to the P-VOL will be accepted, and the MCU will keep track of all P-VOL updates while the pair is suspended.
- If **Never** is selected, the P-VOL will never be fenced. If the HORC volume pair is split or suspended, write operations to the P-VOL will be accepted.

The **Error Level (Async)** option specifies the error level for the HORCA pair(s):

- **Group:** When the specified pair is suspended, all HORCA pairs in the same group will be suspended, even if the failure affects only that pair and not the entire group.

  Important: Select the **Group** error level for all HORCA volumes which are essential to disaster recovery. Suspended HORCA S-VOLs which have the **LU** error level should not be used for disaster recovery.

- **LU:** If the failure affects only the specified pair, then only that pair will be suspended. A failure that affects an entire group will always result in the suspension of all pairs in the group, as well as all other affected HORC pairs.

The **Resume Range (Async)** option is available only when the Pair Option panel is opened during the Pairresync operation (see section 5.5).

5.3 Viewing HORC Pair Status (Pairdisplay)

5.3.1 Viewing Pair Status for LUs

The Pairdisplay panel (see Figure 5.4) displays the detailed status of a HORC volume (LU) pair and provides access to the LDEV Operation panel (see section 4.1.3) and Pair Option panel (see section 5.2.2). To view the pair status information for a HORC volume pair, select the desired pair on the HORC Main Control panel, and then select the **Pairdisplay…** button.

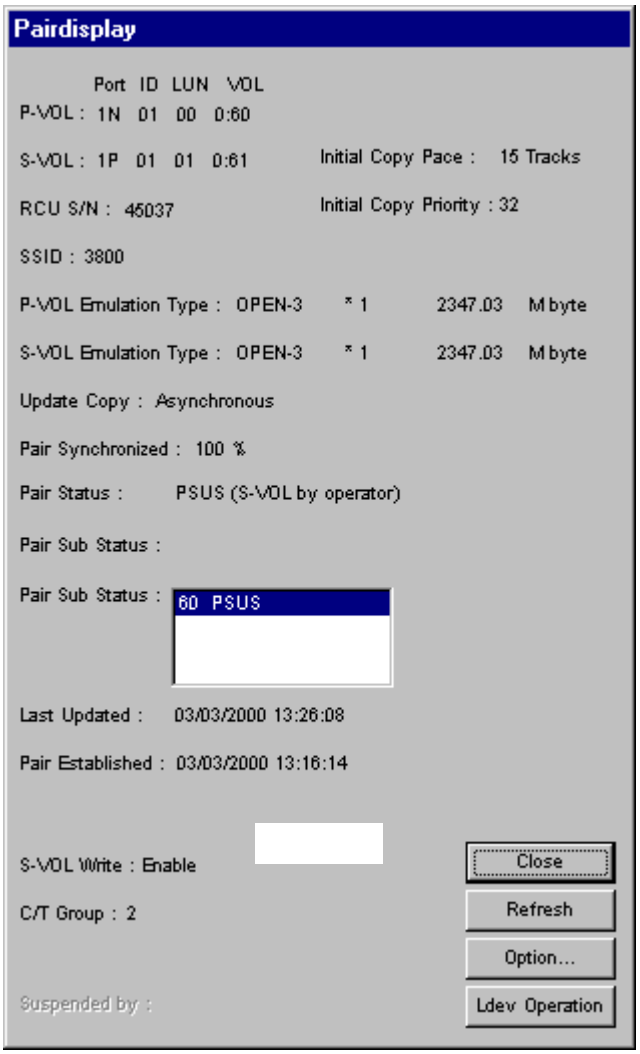


Figure 5.4 Pairdisplay Panel (showing an LU pair)

The **Refresh** button refreshes the information displayed on the Pairdisplay panel. The **Option…** button opens the Pair Option panel, which displays and allows you to change the HORC pair options for the selected pair. The **Ldev Operation** button opens the LDEV Operation panel, which displays HORC information for the individual LDEV pairs within a HORC LUSE pair.

The Pairdisplay panel displays the following information for the HORC volume (LU) pair selected on the HORC Main Control panel:

- **P-VOL** and **S-VOL**: Port, SCSI TID, LUN, and LDEV ID of the LUs. For a LUSE pair the first LDEV (lowest LDEV ID) is listed.
- **RCU S/N**, **SSID**: Serial number and SSID of the RCU (or MCU if S-VOL is selected).
- **Initial Copy Pace**: 1-15 tracks (disabled when status becomes PAIR).
- **Initial Copy Priority**: 1-256 (disabled when the status becomes PAIR).
- **Emulation Type**: LU type and capacity (MB) of the P-VOL and S-VOL.
- **Update Copy**: Synchronous or asynchronous.
- **Pair Synchronized**: Progress of initial copy. If you select an S-VOL, a HORCA pair, or a split/suspended pair on the HORC Main Control panel, this field displays **Not valid**.
- **Pair Status**: SIMPL, COPY, PAIR, PSUS, PSUE, PDUB, suspending, or deleting (see section 2.5). If the pair is split or suspended, the split/suspend type is also displayed.
- **Pair Sub Status**: Status of each LDEV pair contained in the HORC LUSE pair.
- **Last Updated**: Date and time that the volume pair status was last updated.
- **Pair Established**: Date and time that the volume pair was created.
- **Pair Suspended**: Date and time that the volume pair was split/suspended (displayed only when the pair status is PSUS/PSUE).
- **S-VOL Write**: Enabled or disabled for this pair (enabled only when pair is split).
- **C/T Group**: Consistency group to which the HORCA pair is assigned.
- **Suspended by**: Consistency status (group or LU) of the split or suspended HORCA pair (see section 2.5).

5.3.2 Viewing Pair Status for LDEVs

The Pairdisplay panel (see Figure 5.5) can also display the HORC pair status of an LDEV pair which is part of a HORC LUSE pair. To view the pair status information for an LDEV pair, on the Main Control panel select the volume which contains the desired LDEV, open the LDEV Operation panel, select the desired LDEV, and then select the **Pairdisplay…** button.

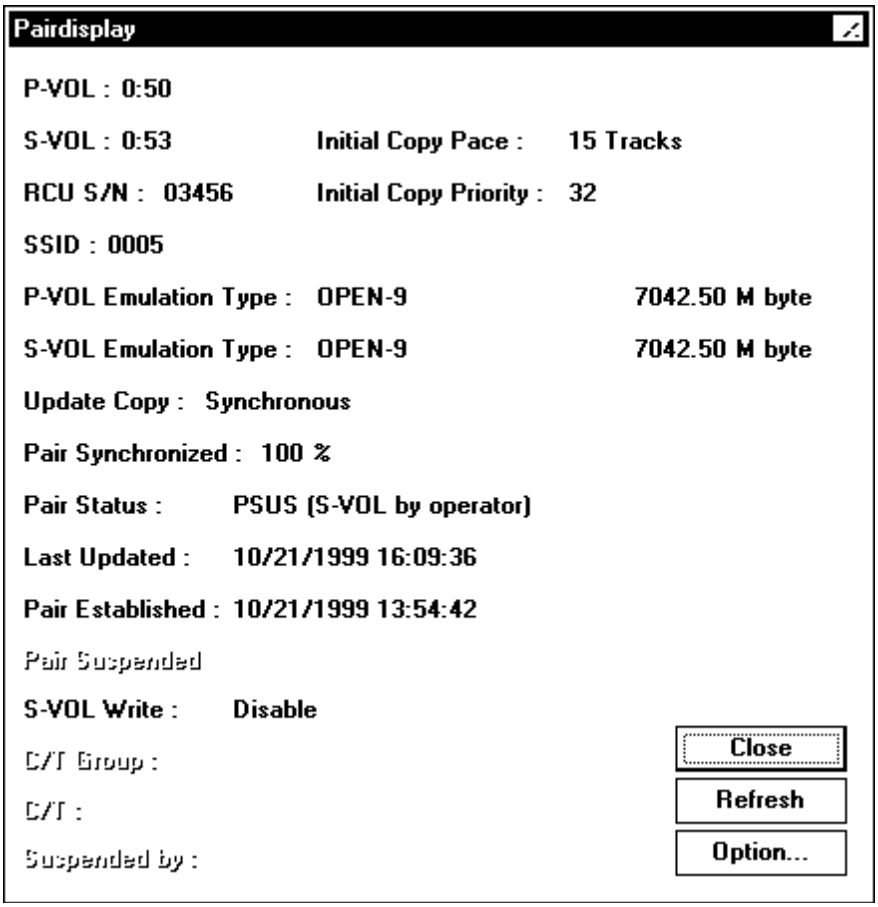


Figure 5.5 Pairdisplay Panel (showing an LDEV pair)

The **Refresh** button refreshes the information displayed on the Pairdisplay panel. The **Option…** button opens the Pair Option panel (see section 5.2.2), which displays and allows you to change the HORC pair options for the selected pair. The Pairdisplay panel displays the detailed HORC information for the LDEV pair selected on the LDEV Operation panel. Please refer to the previous section for a description of the information displayed on this panel.

5.4 Splitting HORC Pairs (Pairsplit-R)

The Pair List (Pairsplit-r) panel (see Figure 5.6) allows you to split HORC pairs and also provides access to the Pairsplit-R Option panel (see Figure 5.7). You can split a HORC pair only after the initial copy operation is complete. The Pair List (Pairsplit-r) panel is accessed from the HORC Main Control panel (**Pairsplit-R…** button). For further information on split HORC pairs, see section 2.5.1.

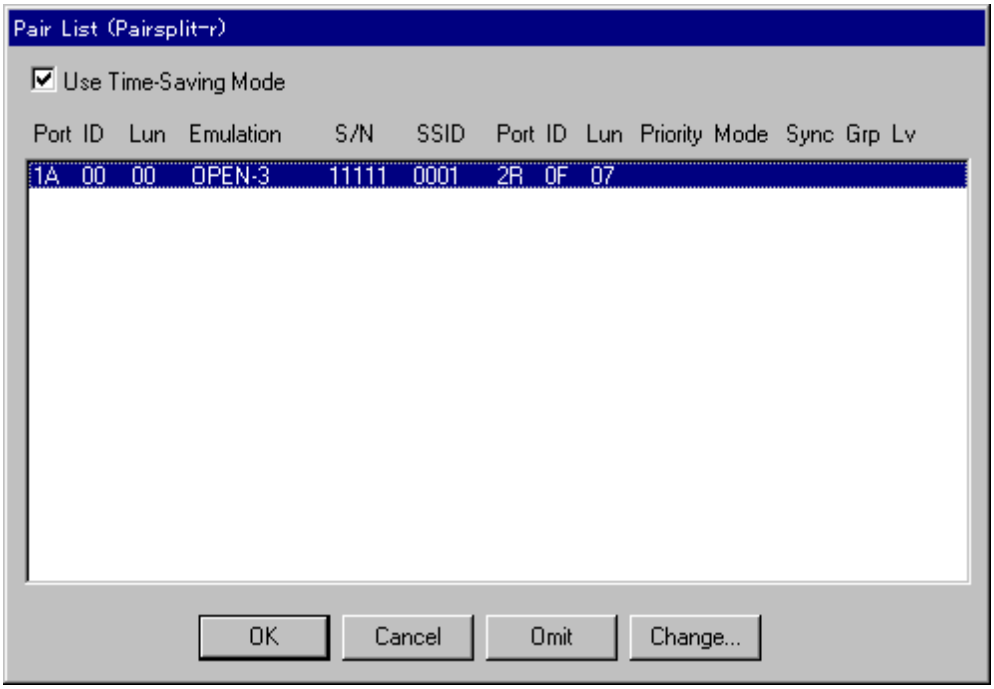


Figure 5.6 Pair List (Pairsplit-r) Panel

The Pair List (Pairsplit-r) panel displays the following information for the selected pair(s):

- **Port**, **ID** (TID), **Lun**, and **Emulation** type of the LU in the connected subsystem.
- **S/N** and **SSID** of the RCU (MCU if you are connected to the RCU).
- **Port**, **ID** (TID), and **Lun** of the S-VOL (P-VOL if you are connected to the RCU).
- **Priority:** Initial copy priority (blank after initial copy operation is complete).
- **Mode:** Drain or purge pairsplit-R option (Async only).
- **Sync:** Update copy mode: sync or async.
- **Grp:** The ID of the consistency group to which the pair belongs (Async only).
- **Lv:** The error level of the pair (group or LU) (Async only).

The **Use Time-Saving Mode** option allows you to execute the specified pairsplit operations quickly (i.e., requests for multiple pairs are entered simultaneously). The **Omit** button removes the selected pair(s) from the Pair List (Pairsplit-r) panel. The **OK** button splits the specified pair(s). The **Change…** button opens the Pairsplit-R Option panel to allow you to change the HORC pairsplit options for the selected pair(s).

Figure 5.7 Pairsplit-R Option Panel

The Pairsplit-R Option panel allows you to change the pairsplit-R options for the pair(s):

- **S-VOL Write Enable:** When this box is checked, the S-VOL of this HORC pair will be available to receive read and write I/Os while the HORC pair is split. If you select this option and you want to resync the pair later, you should select the **S-VOL** suspend kind option to ensure that the the P-VOL and S-VOL bitmaps are merged at the MCU. This option is available only when the selected volume is a HORC P-VOL.
- **Suspend Kind:**
  - When **P-VOL Failure** is selected (available only for HORC Synchronous and only when connected to the MCU), the MCU will reject all write I/O operations to the P-VOL while the pair is split, regardless of the P-VOL fence-level setting. This setting should be used if you need to maintain synchronization of the HORC pair.
  - When **S-VOL** is selected, the P-VOL will accept all subsequent write I/O operations, and the MCU will keep track of updates while the pair is split. Subsequent write I/O operations to the P-VOL will be permitted or rejected, depending on the fence level of the pair. This setting is available from the MCU and RCU, and should be used if you need to keep the P-VOL online. All HORCA pairs have this setting.
- **Suspend Range (Async):**
  - **Group**. The MCU/RCU will split all other HORCA pairs in the same consistency group as the specified pair(s). This option is available only when one pair is selected.
  - **LU**. The MCU/RCU will split only the specified HORCA pair(s) (even if the error level of the pair is group).

Description continues on the next page.

- **Pending Update (Async):**
  - **Drain**. The MCU will change the HORCA pair status from **Suspending** to **PSUS** only after the RCU accepts the pairsplit operation and completes the following steps:
    (a) Finish settling all pending recordsets for the pair, and
    (b) Complete the negotiation with all MCUs (report ready-for-suspension to all MCUs and receive their acknowledgements) without further recordsets generated.

    Note: If the RCU is not able to complete these actions within the copy pending timeout setting, the RCU will discontinue the original pairsplit-R request and forcibly suspend the affected HORCA pairs. Thus, you can use the copy pending timeout parameter to limit the amount of time it takes to complete the split-drain operation.
  - **Purge**. The MCU will change the HORCA pair status from **Suspending** to **PSUS** as soon as the RCU accepts the pairsplit operation. The MCU and RCU discard any pending recordsets and mark the cylinders that contain discarded recordsets as modified in the P-VOL and S-VOL bitmaps, respectively. When the pair is resumed (pairresync), the P-VOL and S-VOL bitmaps will be merged at the MCU, and all cylinders marked as modified will be copied to the S-VOL.

    Note: If the MCU does not receive acknowledgement of the pairsplit-R operation from the RCU within the copy pending timeout setting, the MCU will forcibly suspend all affected HORCA pairs.

To split one or more HORC volume pairs:

1. Connect to the MCU (or RCU) of the volume pair(s) to be split. You do not need to vary the P-VOL(s) offline. If you want to use the S-VOL write enable option, you must connect to the MCU and select the P-VOL of the pair.
2. On the HORC Main Control panel, select the correct CU image, and then select the HORC volume pair(s) that you want to split. Select either HORC Synchronous or HORCA pairs, but not both. The pair status must be **PAIR**.
3. Select **Pairsplit-R…** to open the Pair List (Pairsplit-r) panel, which displays the selected pair(s). To remove one or more pairs from this panel, select the pair(s) and then select the **Omit** button.
4. To change the pairsplit options for one or more pairs, select the pair(s) and then select **Change…** to open the Pairsplit-R Option panel (refer to Figure 5.7). On the Pairsplit-R Option panel, select the desired options for the pair(s), and then select **OK** to return to the Pair List (Pairsplit-r) panel. Repeat this step as needed until the pairsplit options for each pair are correct. The suspend kind option (**P-VOL failure** or **S-VOL**) and fence level pair option determine whether the P-VOL will accept write I/O operations after the pair is split.

   CAUTION: If you need to split a pair and the P-VOL is required for system operation, do not use the **P-VOL Failure** suspend kind option. Make sure to use the **S-VOL** suspend kind option so that the P-VOL continues accepting I/Os.
5. If you want to execute the pairsplit requests quickly, select the **Use Time-Saving Mode** option on the Pair List (Pairsplit-r) panel.

6. Select **OK** on the Pair List (Pairsplit-r) panel to split the specified pair(s). For HORC Sync pairs, the MCU will complete all P-VOL write operations in progress and the associated update copy operations at the S-VOL before splitting the pair, so that the pair is synchronized at the time of pairsplit.
7. On the HORC Main Control panel, verify that the HORC pair(s) is/are displayed correctly (**PSUS** status) in the **Volume List** box. The Pair List (Pairresync) panel (see section 5.5) allows you to resync split HORC volume pair(s).

WARNING: If a timeout error occurs when the **Use Time-Saving Mode** option is selected, confirm on the HORC Main Control panel for which volumes the pairsplit-r operation could not be performed. Deselect the **Use Time-Saving Mode** option for the failed volumes, and retry the pairsplit-r operation.

5.5 Resuming HORC Volume/LDEV Pairs (Pairresync)

While a HORC pair is split or suspended, the MCU does not perform any update copy operations to the S-VOL. For a split/suspended HORC Synchronous pair, the MCU may or may not continue accepting write I/Os for the P-VOL depending on the P-VOL fence level and pairsplit options (if user-requested). For a split/suspended HORCA pair, the MCU and RCU keep track of any recordsets that were discarded during pairsplit/suspension, and the MCU continues to accept write I/Os for the P-VOL. The MCU keeps track of the P-VOL cylinders which are updated while the pair is split/suspended. If the RCU accepts write I/Os for a split S-VOL (S-VOL write enable), the RCU also keeps track of the S-VOL cylinders which are updated. When the split/suspended pair is resumed, the MCU merges the P-VOL and S-VOL cylinder bitmaps to determine the out-of-sync cylinders.

The Pair List (Pairresync) panel (see Figure 5.8) allows you to resume split/suspended HORC pairs and select the pairresync options for each pair. The Pair List (Pairresync) panel can be accessed from either the HORC Main Control panel or the LDEV Operation panel (**Pairresync…** button).

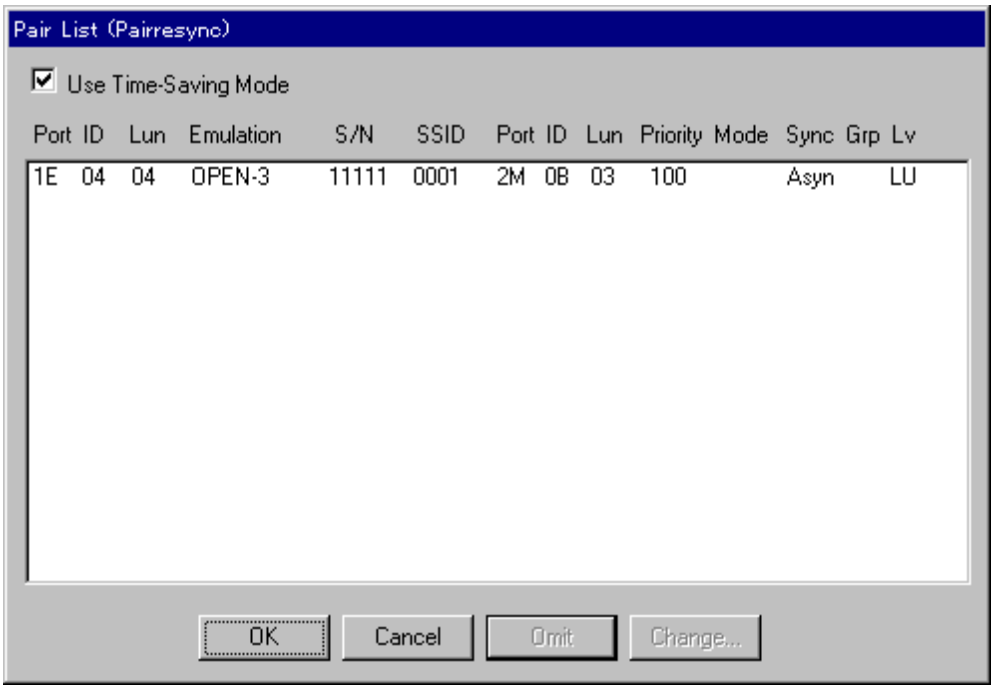


Figure 5.8 Pair List (Pairresync) Panel

The Pair List (Pairresync) panel displays the following information for the selected pair(s):

- For LUs: **Port**, **ID**, **Lun**, and **Emulation** type of the selected LU.
  For LDEVs: LDEV ID (**CU:LDEV**) and **Emulation** type of the selected LDEV.
- **S/N** and **SSID** of the RCU (MCU if you are connected to the RCU).
- For LUs: **Port**, **ID**, and **Lun** of the S-VOL (P-VOL if connected to the RCU).
  For LDEVs: LDEV ID (**CU:LDEV**) and **Emulation** type of the selected LDEV.
- **Priority**: Initial copy priority (blank after initial copy operation is complete).
- **Mode**: The drain or purge pairsplit-R option (Async only).

- **Sync**: The update copy mode: Sync or Async.
- **Grp**: The consistency group to which the pair belongs (Async LUs only).
- **Lv**: The error level of the pair (group or LU) (Async LUs only).

The **Use Time-Saving Mode** option allows you to execute the specified pairresync operations quickly (i.e., requests for multiple pairs are entered simultaneously). The **OK** button resumes (resyncs) the specified pair(s). The **Omit** button removes the selected pair(s) from the Pair List (Pairresync) panel. The **Change…** button opens the Pairresync Option panel to allow you to change the resync options and pair options for the selected HORC volume pair(s). The **Change…** button is not available when the Pair List (Pairresync) panel is displaying LDEV pairs (the pair options for all LDEV pairs within a HORC LUSE pair must be the same).

The Pairresync Option panel (see Figure 5.9) allows you to change the priority of the resync operation for the selected pair(s) and also provides access to the Pair Option panel (see Figure 5.10). When the Pair Option panel is opened from the Pairresync Option panel, you can select the resync range (async) option for the selected pair(s) and change the pair options if desired.

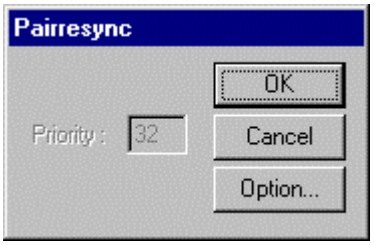


Figure 5.9 Pairresync Option Panel

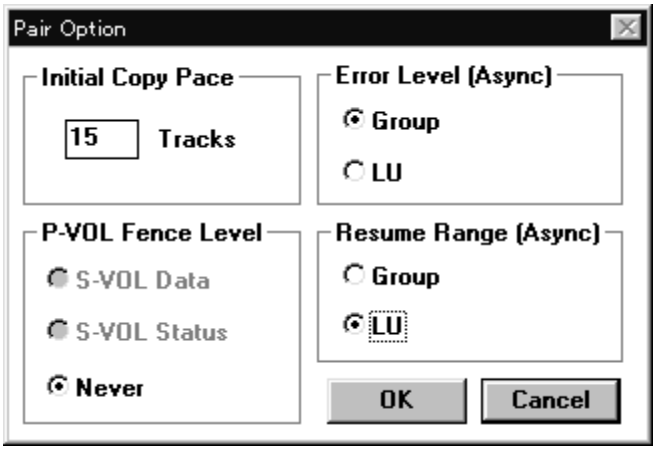


Figure 5.10 Pair Option Panel

The **Priority** field allows you to enter the desired priority (1-256) for the resync operation, which determines the order in which the resync operations will be performed. The **OK** button applies the specified priority to the selected pair(s). The **Option…** button opens the Pair Option panel to allow you to change the resync range and pair options for the selected pair(s).

When opened during the pairresync operation, the Pair Option panel allows you to change the following pair options (see section 5.2.2): **Initial Copy Pace** (for the resync copy operation), **P-VOL Fence Level** (Sync only), **Error Level** (Async only), and **Resume Range** (Async only). The **Resume Range-LU** option allows you to resync only the selected HORCA pair(s). The **Resume Range-Group** option allows you to resync all split or suspended HORCA pairs in the same group as the selected pair.

Note: If an MCU/RCU is powered off and its backup batteries are fully discharged while HORC pairs are suspended, the P-VOL/S-VOL cylinder bitmaps will not be retained. In this unlikely case, the MCU/RCU will mark all cylinders of all split or suspended HORC volumes as modified, so that the MCU will perform the equivalent of an entire initial copy operation when the pairs are resynced.

To resync one or more split or suspended HORC volume pairs:

1. If any pair was suspended due to an error condition (use the Pairdisplay panel to view the suspend type), make sure that the error condition has been removed (see section 7.1 for troubleshooting instructions). The MCU will not resync the pair(s) until the error condition has been removed.
2. Connect to the MCU of the volume pair(s) to be resynced, and start the HORC software.
3. On the HORC Main Control panel, select the correct CU image.
4. If you are resyncing split or suspended LUs, select the desired pair(s) on the HORC Main Control panel, and select **Pairresync…** to open the Pair List (Pairresync) panel. Select PSUS or PSUE pairs (not both). Select either Sync or Async pairs (not both). If you plan to use the **Resume Range-Group** option, select only one HORCA pair in the group.

   If you are resyncing suspended LDEV pairs within a HORC LUSE pair, select the desired HORC pair on the HORC Main Control panel, select **Ldev Operation** to open the LDEV Operation panel, select the LDEV pair(s) to be resynced, and then select **Pairresync…** to open the Pair List (Pairresync) panel.
5. The Pair List (Pairresync) panel displays the HORC LU or LDEV pair(s) to be resynced. To remove one or more pairs from the panel, select the pair(s) and then select **Omit**.
6. To change the priority and/or pair options for one or more pairs, select the desired pair(s), and select **Change…** to open the Pairresync Option panel. Enter the desired priority, select **Option…** to open the Pair Option panel, change the pair options as desired, and select **OK** until you return to the Pair List (Pairresync) panel. Repeat this step as needed until all resync options and pair options for each pair are correct.

   Note: If you want to resync all split/suspended HORCA pairs in a consistency group, make sure that the **Resume Range** option on the Pair Option panel is set to **Group**.
7. If you want to execute the pairresync requests quickly, select the **Use Time-Saving Mode** option on the Pair List (Pairresync) panel.
8. Select **OK** on the Pair List (Pairresync) panel to resync the specified pair(s).
9. On the HORC Main Control panel or LDEV Operation panel, verify that the HORC pair(s) is/are displayed correctly (COPY or PAIR status) in the **Volume List** box.

WARNING: If a timeout error occurs when the **Use Time-Saving Mode** option is selected, confirm on the HORC Main Control panel for which volumes the pairresync operation could not be performed. Deselect the **Use Time-Saving Mode** option for the failed volumes, and retry the pairresync operation.

5.6 Deleting HORC Volume Pairs (Pairsplit-S)

A HORC pair should be deleted from the MCU only when it is no longer necessary to maintain a remote copy of the P-VOL. When a HORC volume pair is deleted from the MCU, the MCU stops all HORC copy operations for that pair and changes the pair status of the P-VOL and S-VOL to SMPL. After a HORC pair is deleted, the MCU continues to accept all subsequent write I/O operations to the P-VOL and will not keep track of the P-VOL updates.

A HORC pair should be deleted from the RCU only for disaster recovery (see Chapter 6). When a HORC pair is deleted from the RCU, the RCU changes the S-VOL pair status to **SMPL** but does not change the pair status of the corresponding P-VOL. When the MCU performs the next HORC operation, the MCU detects that the S-VOL status has changed and changes the P-VOL status to **PSUS-pairsplit-S to RCU**. To restart a pair which was deleted from the RCU, you must first delete the pair from the MCU, and then create the pair from the MCU using the appropriate initial copy option (**Entire Volume** or **None**) to restart the pair.

If you want to delete all HORCA pairs in a consistency group, delete the pairs from the MCU. The HORC pair status will change to **Deleting** when the pairsplit-S operation is accepted by the MCU and RCU, and then to **SMPL** after the internal pairsplit-S process is complete. If you want to delete HORCA pairs according to their consistency status (e.g., for disaster recovery), you must delete the pairs from the RCU.

WARNING: When you delete a HORC pair from the RCU, remember that the S-VOL and P-VOL are identical (e.g., same volume label), and take appropriate precautions to prevent a system problem due to duplicate volumes.

The Pair List (Pairsplit-S) panel (see Figure 5.11) allows you to delete one or more HORC pairs and also provides access to the Pairsplit-S Option panel (see section 5.6). The Pair List (Pairsplit-S) panel is accessed from the HORC Main Control panel (**Pairsplit-S…** button).

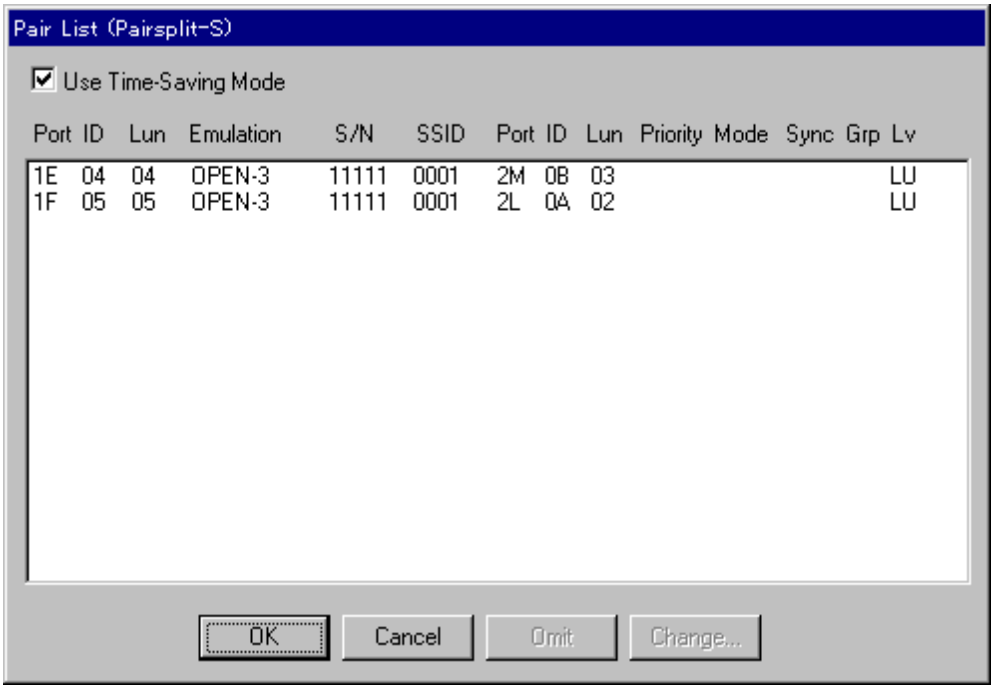


Figure 5.11 Pair List (Pairsplit-S) Panel

The Pair List (Pairsplit-S) panel displays the pair(s) selected on the HORC Main Control panel. If you are connected to the MCU, each pair is displayed by P-VOL ID and type, RCU S/N and SSID, and S-VOL ID. If you are connected to the RCU, each pair is displayed by S-VOL ID and type, MCU S/N and SSID, and P-VOL ID. The **Use Time-Saving Mode** option allows you to execute the specified pairsplit-S operations quickly (i.e., requests for multiple pairs are entered simultaneously). The **OK** button deletes the specified pair(s). The **Omit** button removes the selected pair(s) from the panel. The **Change…** button opens the Pairsplit-S Option panel to allow you to change the pairsplit-S options.

The Pairsplit-S Option panel (see Figure 5.12) allows you to change the pairsplit-S options for the pair(s) selected on the Pair List (Pairsplit-S) panel. The Pairsplit-S Option panel can only be accessed from the Pair List (Pairsplit-S) panel (**Change…** button).

Figure 5.12 Pairsplit-S Option Panel

The **Delete Pair by Force** option allows you to override the restrictions on deleting a HORC volume pair. If this option is selected, the pair(s) will be deleted even if the MCU is unable to communicate with the RCU. This option may be used to free a host waiting for device-end from an MCU which cannot communicate with its RCU, thus allowing host operations to continue. If this option is not selected, the pair(s) will only be deleted if the MCU is able to change the pair status of the P-VOL and S-VOL to **SMPL**.

The **Delete Range (Asyn)** box allows you to select the HORC Asynchronous delete range option. This option simplifies disaster recovery operations for HORCA consistency groups at the secondary (remote) subsystem. The HORCA delete range options are:

- **C/T** (RCU only). When the **C/T** option is selected, the RCU will delete all HORCA pairs which are in the same group as the specified pair and meet the following conditions: the pair status must be **PSUE**, and the consistency status (see section 2.5.1) must be **Group**. This option is used when deleting pairs at the RCU during disaster recovery.
- **Group** (MCU or RCU). When the **Group** option is selected, the MCU/RCU will delete all HORCA pairs in the same consistency group as the specified pair, regardless of pair status and consistency status. Do not use this option when deleting pairs at the RCU during disaster recovery. This option is available only when one pair is selected.
- **LU** (MCU or RCU). When the **LU** option is selected, the MCU/RCU will delete only the specified HORCA pair(s). This option can be used to remove individual volumes from consistency groups.

To delete one or more HORC volume pairs:

1. Connect to the MCU or RCU of the pair(s) to be deleted, and start the HORC software. If you plan to use the HORCA C/T delete range option, you must connect to the RCU.
2. On the HORC Main Control panel, select the correct CU image, and select the HORC pair(s) that you want to delete. Select either HORC Sync or HORCA pairs, but not both. If you plan to use the HORCA **C/T** or **Group** delete range option, select only one HORCA pair in the group.
3. Select the **Pairsplit-S…** button. When the pair delete confirmation message appears, select **Yes** to open the Pair List (Pairsplit-S) panel, or select **No** to cancel your pairsplit-S request.
4. The Pair List (Pairsplit-S) panel displays the pair(s) selected on the HORC Main Control panel. To remove one or more pairs from the Pair List (Pairsplit-S) panel, select the pair(s) and then select **Omit**. To change the pairsplit-S options for one or more pairs:
   a) Select the pair(s), and then select **Change…** to open the Pairsplit-S Option panel.
   b) On the Pairsplit-S Option panel, select the desired pairsplit-S options for the selected pair(s), and then select **OK** to return to the Pair List (Pairsplit-S) panel.
   c) Repeat steps (a) and (b) as needed to set the desired pairsplit-S options for each pair.
5. If you want to execute the pairsplit-S requests quickly, select the **Use Time-Saving Mode** option on the Pair List (Pairsplit-S) panel.
6. Select **OK** on the Pair List (Pairsplit-S) panel to delete the specified pair(s).
7. When deleting HORC Asynchronous pairs, verify that the pairsplit-S request was completed successfully by checking the detailed HORC pair status on the Pairdisplay panel (should be **SMPL**, not **Deleting** or **Suspended**).

   When deleting HORC Sync pairs, verify that the pairsplit-S request was completed successfully by checking the pair status on the HORC Main Control panel (SMPL status).
8. To restart a pair which was deleted from the RCU, first delete the pair from the MCU, and then use the Paircreate panel with the appropriate HORC initial copy option (**Entire Volume** or **None**) to restart the pair.

WARNING: If a timeout error occurs when the **Use Time-Saving Mode** option is selected, confirm on the HORC Main Control panel for which volumes the pairsplit-S operation could not be performed. Deselect the **Use Time-Saving Mode** option for the failed volumes, and retry the pairsplit-S operation.

5.7 Using HORC for Data Migration and Duplication

5.7.1 Data Migration Using HORC Synchronous

HORC Synchronous can be used for device or workload migration with minimal impact to host applications. You may need to migrate data from one volume to another for any of the following reasons:

- To load data onto new or scratch volumes (e.g., new or upgraded subsystem),
- To temporarily move data off a volume to accommodate other activities (e.g., repair), or
- To relocate volumes to balance workloads and distribute I/O activity evenly within and across subsystems for the purpose of improving subsystem and system performance.

The HORC initial copy operation copies the entire contents of the P-VOL to the S-VOL. The P-VOL and S-VOL are identical and synchronized when the initial copy operation completes and the pair status changes from COPY to PAIR. The HORC pair is then deleted to change the state of the devices to SMPL, and host high-availability (HA) software can then be used to complete the data migration nondisruptively. To support host-based application automation, data migration using HORC must be managed by integrating the Hitachi Command Control Interface (CCI) software with HORC operations and the host HA software functions.

Note: If you need to migrate data from other vendors' storage subsystems onto the Lightning 9900™ subsystem, the Hitachi Online Data Migration (HODM) feature is used.

To use HORC Synchronous to migrate data from one volume to another:

1. Vary the S-VOL(s) offline from all attached hosts. The S-VOLs are the target volumes onto which you are migrating the data. The P-VOLs (source volumes) can remain online.
2. Connect to the subsystem containing the volume(s) to be migrated, and then start the HORC software. If not already done, install the remote copy connections and configure the RCPs (if migrating between subsystems), and then add the RCUs.
3. On the HORC Main Control panel, select the correct CU image and the volume(s) to be migrated, and start the HORC Sync pair(s) using the Paircreate panel (see section 5.2).
4. Monitor the progress of the initial copy operation(s) and the status of the pair(s) on the HORC Main Control panel. Refresh the panel as needed. When the status has changed from COPY to PAIR, the P-VOL and S-VOL are identical and synchronized.
5. If you are not using CCI HORC commands and host software to complete the migration, use the following procedure to stop using the P-VOL(s) and switch to the S-VOL(s):
   a) Stop all host updates to the P-VOL(s).
   b) When all update activity to the P-VOL(s) has stopped, connect to the MCU, select the correct CU image, and delete the HORC volume pair(s) (see section 5.6).
   c) If the P-VOL(s) and S-VOL(s) are attached to the same host, vary the P-VOL(s) offline first, and then vary the S-VOL(s) online. The P-VOL(s) and S-VOL(s) have the same volume labels and cannot be online to the same host(s) at the same time.

d) If you want to keep the volumes synchronized, establish the same HORC pair(s) in the reverse direction using the **None** initial copy option (see section 5.2.1). If the original P-VOL(s) will be temporarily unavailable for update copy operations, you can split the new pair(s) (pairsplit-R) so that the new MCU keeps track of changes.

e) Start the applications with the S-VOL(s). When the original P-VOL(s) become available, you can resume the pair(s) using the Pair List (Pairresync) panel (see section 5.5).

5.7.2 Point-in-Time (PiT) Data Duplication Using HORC Asynchronous

HORC Asynchronous (HORCA) enables you to make Point-in-Time (PiT) duplicates of groups of volumes. The HORCA **Group** and **Drain** pairsplit-R options can be used together to create a PiT copy, relative to an application, of an entire HORCA consistency group of volumes. To produce a PiT duplicate of an existing HORCA consistency group:

1. Stop all host updates to all HORCA P-VOLs in the group.
2. After all P-VOL updates have completed, split the HORCA group using the **Group** and **Drain** pairsplit-R options. If you are splitting the group at the main site, issue the pairsplit-R/group command to one P-VOL in the MCU. If you are splitting the group at the remote site, issue the pairsplit-R/group command to one S-VOL in the RCU.

   Note: The copy pending timeout setting for the group determines the maximum amount of time that the pairsplit-R/drain operation can take (see description of **Drain** above).
3. When the status of all HORCA pairs in the group has changed to **PSUS**, the duplicate set of volumes is complete. If desired, you can restart the application at the main site.

5.8 Powering Off/On HORC Components

The user is responsible for controlling power-off activities for subsystems involved in HORC operations. If you need to power off the 9900 subsystem, please call your Hitachi Data Systems representative or the Hitachi Data Systems Support Center for assistance. The following sections provide instructions for performing planned outages of HORC components.

If power is removed from an MCU while HORC operations are in progress, the HORC pairs are not affected, but the update sequence consistency of the HORCA groups at the RCU may be affected (see section 5.8.1 for further information). When power is restored to an MCU, the MCU communicates with its RCU(s) to confirm the pair status of the S-VOLs. Make sure that HORC communications are fully restored (all RCU paths have normal status) before beginning I/O operations to the P-VOLs. If the MCU accepts a write I/O operation for a P-VOL before this confirmation is complete, the MCU will suspend the pair and change the status of the P-VOL to *suspended-by RCU* (the MCU will not be able to change the pair status of the S-VOL).

If power is removed from an RCU or remote copy connection while HORC operations are in progress, the MCU(s) will detect the communication failure, suspend all affected pairs, and generate SIMs reporting the failures. The MCU will change the status of the P-VOLs to *suspended-by RCU* but will not be able to change the status of the S-VOLs.

Note: If an MCU/RCU is powered off and its backup batteries are fully discharged while HORC pairs are suspended, the P-VOL/S-VOL cylinder maps will not be retained. In this unlikely case, the MCU/RCU will mark all cylinders of all suspended HORC volumes as modified, so that the MCU will perform the equivalent of an entire initial copy operation when the pairs are resumed. (The S-VOL cylinder map is used for HORCA operations and for the HORC S-VOL write enable option.)

5.8.1 Planned Outage of the MCU

A planned MCU outage does not affect HORC Synchronous. For HORC Asynchronous operations, the MCU must communicate with the RCU even when there are no P-VOL update I/Os from the primary system. During the power-off sequence, the MCU will automatically suspend all HORCA pairs in the PAIR and COPY states (suspend type = MCU P/S-OFF). During power-on-reset sequence, the MCU will automatically resume these suspended pairs (pairs with other suspend types are not automatically resumed).

5.8.2 Planned Outage of the RCU or Remote Copy Connection

You must split all affected HORC pairs prior to a planned outage of an RCU or of a remote copy connection component (e.g., ESCON director, channel extender). If you do not split the pairs first, the MCU(s) will detect the communication failure, suspend all affected pairs, and generate SIMs reporting the failures. To perform a planned outage of a HORC RCU or remote copy connection component:

1. Identify all HORC P-VOLs which will be affected by the equipment outage. You need to know the MCU, CU image, and ID (port, TID, LUN) for each of these P-VOLs.
   e) For RCU power-off, identify all P-VOLs which are paired with S-VOLs in the RCU to be powered off.
   a) For remote copy connection outage, identify all P-VOLs in all MCUs which use the path/component to be powered off.
2. Connect to each MCU which contains affected P-VOLs, and split all affected HORC pairs. Make sure to confirm the pair status changes (HORC Main Control or Pairdisplay panel).
3. Perform the planned outage of the RCU or remote copy connection.
4. When the RCU is fully powered on and ready to resume operations, resume (pairresync) all HORC pairs at each MCU. Make sure to confirm the pair status changes.

5.8.3 Planned Outage of the MCU and RCU

When you plan an outage of HORC MCUs and RCUs at the same time, the MCUs must be powered off before the RCUs and powered on after the RCUs. To perform a planned outage of a HORC MCU and RCU:

1. If RCU power-on will be difficult to control (e.g., Power-Control-Interface setting), you should consider increasing or disabling the **RCU ready timeout** group option (see section 2.4.1) for each HORCA group with S-VOLs in the RCU(s) to be powered off.
2. Perform the planned outage of the MCU(s) as described in section 5.8.1. Do not power-on the MCU(s) yet.
3. If an RCU to be powered off is connected to an MCU which is not powered off, make sure to split those HORC pairs before powering off the RCU.
4. Perform the planned outage of the RCU(s) as described in section 5.8.2.
5. Power on the RCU(s). Make sure that they are fully operational and ready to resume operations before powering on the MCUs.
6. Power on the MCU(s), and make sure that they are ready to resume operations. If you split any pairs in step (3), you can also resume (pairresync) those pairs now.

Chapter 6 HORC Disaster Recovery Operations

6.1 Preparing for Disaster Recovery

The type of disaster and the status of the HORC volume pairs will determine the best approach for disaster recovery. For example, if all HORC volume pairs are in the **PAIR** state when a total system failure occurs at a single point in time, the S-VOLs are current and recovery is straightforward. Unfortunately, some disasters are not so "orderly" and involve intermittent or gradual failures occurring over a longer period of time. The user should anticipate and plan for all types of failures and disasters.

The major steps in preparing for disaster recovery are:

1. Identify the volumes and volume groups which contain important files and data for disaster recovery. In addition to supporting HORC remote copy operations as well as CCI commands, the 9900 subsystem provides battery-backed nonvolatile duplexed cache, full hardware redundancy, dynamic sparing, and an advanced RAID-5 implementation to ensure full data integrity in the event of a sudden power outage or other failure.
2. Install the Remote Console PC and HORC hardware and software, and establish HORC operations for the volumes and groups identified in step (1). Make sure to select the proper CU images to access the desired volumes. Refer to Chapter 3 for HORC installation instructions. Refer to Chapter 4 for instructions on performing general HORC operations. Refer to Chapter 5 for instructions on performing HORC pair operations.
3. Use the appropriate combination of HORC options for disaster recovery:
   - HORCA **offloading timer** option (see section 4.4.1), and HORCA **copy pending timeout** group option (see section 4.4.3). The copy pending timeout group option can be used to limit the time duration during which updates may be lost.

     Note: When channel-extenders are used for HORC Async, the offloading timer should be set to 35 seconds or less to avoid affecting host I/O performance.
   - HORCA **Error Level** pair option, and HORC Synchronous **P-VOL Fence Level** pair option (see section 5.2.2).
4. Establish file and database recovery procedures. These procedures should already be established for recovering volumes which become inaccessible due to control unit failure.
5. Make sure that the host system at the primary site is configured to receive sense information from the 9900 MCUs (e.g., via CCI or SNMP).
6. Install and configure host failover software between the main and remote sites. Host failover capability is essential if you use the P-VOL fence level setting of **S-VOL Status** or **Never** for any HORC volume pairs.

6.1.1 Considering the P-VOL Fence-Level Setting

The P-VOL fence level setting (see section 5.2.2) for each HORC Synchronous volume pair determines whether the P-VOL will be fenced when HORC remote copy operations fail. Table 6.1 summarizes the effect of the fence level setting on a HORC Sync P-VOL.

Note: The P-VOL fence level setting does not apply to HORC Asynchronous pairs. HORCA P-VOLs are never fenced due to suspension of the pair.

Table 6.1 Effect of the Fence Level Setting on a HORC P-VOL

Type of Failure		Fence Level Setting		
		S-VOL Data	S-VOL Status	Never
The update copy operation failed, and the MCU was able to change the status of the S-VOL to PSUE.	Write I/O operations to the P-VOL will be:	REJECTED	Accepted	Accepted
The update copy operation failed, and the MCU was NOT able to change the status of the S-VOL to PSUE.	Write I/O operations to the P-VOL will be:	REJECTED	REJECTED	Accepted

Data. When **S-VOL Data** is selected, the P-VOL will be fenced if an update copy operation fails. This P-VOL fence level setting ensures that the S-VOL remains identical to the P-VOL once the HORC volume pair is synchronized, but makes the P-VOL inaccessible for updates whenever HORC remote copy operations fail. This setting should be considered for the most critical volumes for disaster recovery. This setting will reduce the amount of time required to analyze the currency of the S-VOL during disaster recovery efforts. This setting is also designed for applications which can continue to operate with another device pair.

Status. When **S-VOL Status** is selected, the P-VOL is fenced only if the MCU is not able to change the S-VOL pair status to **PSUE**. If the MCU successfully changes the S-VOL pair status to **PSUE**, subsequent write I/O operations to the P-VOL will be accepted, and the MCU will keep track of updates to the P-VOL. This allows the volume pair to be resumed quickly using the pairresync operation (out-of-sync-cylinders only). This setting will also reduce the amount of time required to analyze the S-VOL currency during disaster recovery.

Never. When **Never** is selected, the P-VOL is never fenced when the pair is suspended. This P-VOL fence level setting ensures that the P-VOL remains available to applications for updates, even if all HORC copy operations have failed. The S-VOL may no longer be in sync with the P-VOL, but the MCU will keep track of updates to the P-VOL while the pair is suspended. Host failover capability is essential if this fence level setting is used. For disaster recovery, the currency of the S-VOL is determined by using the sense information transferred via host failover or by comparing the S-VOL contents with other files confirmed to be current.

6.1.2 Setting the Fence Level

When a take-over by the S-VOL occurs as shown in Figure 6.1 (two errors have already occurred), Data(V) remains in the rollback process at the secondary host, and full recovery cannot be performed. To avoid this situation, you can define the fence level of the Redo log file as **Data**, so that the P-VOL returns an error if a data disagreement is expected to occur concerning a write request issued from the host. The **Data** fence-level setting maintains full consistency between the Redo log file and the data file, since no data is written to the data file due to the write error at the log file. However, when the fence level is defined as **Data**, a write I/O causes an error even when processing has been suspended due to an error at the S-VOL. In this case, a take-over by the S-VOL occurs, and the significance of the duplex system will be lost. Therefore, if you define the fence level as **Data**, applications must be able to cope with write I/O errors by handling them. Systems that allow disk errors by means of multiplication can function with the **Data** fence-level setting. For example, Oracle multiplies the Redo log file by itself (default = three times).

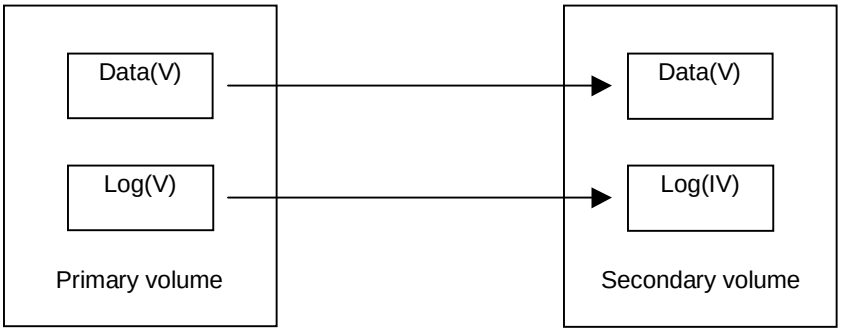


Figure 6.1 Relationship Between Log File and Data File in PAIR Status

Since most UNIX® file systems (excluding JFS and VxFS) have no journal files, the P-VOL fence level should be defined as **Never**. When a take-over by the S-VOL occurs, **fsck** is executed on the volume and the file system is cleaned up, even if the S-VOL is undefined at the secondary host. The data that will be lost depends on how much differential data is contained in the P-VOL when the S-VOL is suspended. During operation, error recovery should be performed when the suspended status (PSUE) is detected (when one error occurs).

6.1.3 Transferring Sense Information Between Sites

When the MCU (or RCU for HORCA) suspends a HORC pair due to an error condition, the MCU/RCU sends sense information with unit check status to the appropriate host(s). This sense information is used during disaster recovery to determine the currency of the S-VOL, and must be transferred to the remote site via the host failover software.

6.1.4 File and Database Recovery Procedures

When a HORC Synchronous pair is suspended, or when the MCU fails due to a disaster, the S-VOL may contain in-process data. A data set could be open, or transactions may not have completed. Even if you use the **S-VOL Data** fence level for all HORC Sync pairs, you need to establish file recovery procedures. These procedures should be the same as those used for recovering any volume which becomes inaccessible due to control unit failure. These procedures are more important if the **S-VOL Status** or **Never** fence level settings are used.

HORC Asynchronous does not provide any procedure for detecting and retrieving lost updates. To detect and recreate lost updates, you must check other current information (e.g., database journal log file that was active at the primary system when the disaster occurred). The HORCA group consistency time (C/T) can be useful when performing this detection and retrieval. Since this detection/retrieval process can take a while, your disaster recovery scenario should be designed so that detection/retrieval of lost updates is performed after the application has been started at the secondary system.

You should prepare for file and database recovery by using:

- Files for file recovery (e.g., database log files which have been verified as current). To ensure the currency of these files, use the **S-VOL Data** fence level setting for the HORC pairs which contain these important files.
- The sense information with local time-stamp which will be transferred via host failover.

Important: Remote copy and disaster recovery procedures are inherently complex. Consult your Hitachi Data Systems account team on sense-level settings and recovery procedures.

Note: See Appendix C for information on recovering a pinned track on a HORC volume.

6.2 Switching Operations to the Remote Site

If a disaster or failure occurs at the primary site, the first disaster recovery activity is to switch your operations to the secondary site. The HORC Synchronous S-VOLs are recovered individually based on the pair status and P-VOL fence level information for each pair. The HORCA S-VOLs are recovered based on pair status and consistency status.

The basic procedures for switching operations to the remote backup site are:

1. Analyze the currency of the HORC Synchronous S-VOLs (see section 6.2.1) and the consistency of the HORCA S-VOLs (see section 6.2.2).
2. Record the consistency time (C/T) of each HORCA group. The suspended HORCA S-VOLs with consistency status of *group* will indicate the same C/T.
3. Perform file recovery as needed (see section 6.1.4). The C/T of each HORCA group can be used to retrieve lost updates.
4. At the remote site, connect to each RCU, and delete all HORC Synchronous pairs. For HORCA pairs, delete all consistent pairs in a group at the same time using the pairsplit-S command with the **C/T** delete range option. This option prevents you from accidentally using inconsistent pairs for disaster recovery.

   Caution: Once an S-VOL changes to simplex, you cannot distinguish it from a non-HORC simplex volume. The HORCA C/T is also discarded when the pair is deleted.
5. If necessary, use the logical volume manager to change the volume labels of the S-VOLs.
6. Make sure that all required file recovery procedures have been completed before varying the S-VOLs online.
7. At this point you may start critical applications at the remote site with the previous S-VOLs taking the place of their P-VOLs.

6.2.1 Analyzing the Currency of HORC Synchronous S-VOLs

Table 6.2 shows how to determine the currency of a HORC Synchronous S-VOL based on its pair status and P-VOL fence level setting. For HORC Sync pairs with a P-VOL fence level setting of **Never**, further analysis will be required to determine the currency of these S-VOLs. The currency of these S-VOLs can be determined by using the sense information transferred via the host failover or by comparing the contents of the S-VOL with other files which are confirmed to be current (e.g., database log files). These S-VOLs should be recovered using the files which are confirmed to be current.

Table 6.2 Analyzing the Currency of HORC Synchronous S-VOLs

Status of S-VOL	Fence Level	Currency of S-VOL
SMPL	Data Status Never	**Inconsistent**. This S-VOL does not belong to a HORC volume pair. (***Note:*** Even if you established a HORC pair for this volume, you must regard this volume as inconsistent.)
COPY	Data Status Never	**Inconsistent**. This S-VOL is not synchronized because not all cylinders have been copied from the P-VOL yet. This S-VOL must be initialized (or copied from the P-VOL at a later time).
PAIR	Data Status	**Current**. This S-VOL is synchronized with its P-VOL.
	Never	**Needs to be analyzed**. This S-VOL requires further analysis to determine its level of currency.
PSUE - initial copy failed	Data Status Never	**Inconsistent**. This S-VOL is not synchronized because not all cylinders have been copied from the P-VOL yet. This S-VOL must be initialized (or copied from the P-VOL at a later time).
PSUS - S-VOL by operator	Data Status Never	**Suspect**. This S-VOL is not synchronized with its P-VOL if any write I/Os were issued to the P-VOL after the pair was split. This pair should be restarted using the **Entire Volume** initial copy option, but the **None** option can be used if you are sure that no data on the P-VOL changed.
PSUS/PSUE - all other types	Data	**Current**. This S-VOL is synchronized with its P-VOL.
	Status Never	**Suspect**. This S-VOL is not synchronized with its P-VOL if any write I/Os were issued to the P-VOL after the pair was split or suspended. Restore the consistency of this S-VOL and update it, if required. The time of suspension indicated on the Pairdisplay panel will help to determine the last time this S-VOL was updated.

6.2.2 Analyzing the Consistency of HORC Asynchronous S-VOLs

Table 6.3 shows how to determine the consistency of a HORCA S-VOL based on its pair status and consistency status. For HORCA S-VOLs with a consistency status of **LU**, the volume is not consistent with other volumes in the same group, and further analysis will be required to determine the currency of each of these S-VOLs. The currency of these S-VOLs can be determined by using the sense information transferred via host failover software or by comparing the contents of the S-VOL with other files which are confirmed to be current (e.g., database log files). These S-VOLs should be recovered using the files which are confirmed to be current.

Table 6.3 Analyzing the Consistency of HORC Asynchronous S-VOLs

Status of S-VOL	Usable for Recovery?	Description
PAIR COPY SMPL	No No No	These states do not usually occur during HORC Asynchronous disaster recovery, because the RCU suspends all HORCA S-VOLs when communication with the MCU is lost. HORCA S-VOLs in these states should not be used for disaster recovery. ***Note:*** Simplex volumes cannot be distinguished from S-VOLs which have already been deleted by the pairsplit-S operation.
PSUE-Group	Yes	The update sequence consistency across these S-VOLs is ensured at the point in time indicated by the consistency time. These S-VOLs can be used for disaster recovery at the secondary system. ***Note:*** Updates which were performed at the primary system after the indicated consistency time were probably lost.
PSUE-LU	No	The contents of this S-VOL may be behind the other S-VOLs in the consistency group. If this volume must be consistent with the other volumes in the same group, this S-VOL should not be used for disaster recovery. The cause for this status is: – The HORCA **Error Level** pair option for this pair is **LU** (not **Group**), AND – This pair was suspended before the disaster/failure, at the beginning of the rolling disaster, or during the initial copy operation.

6.3 Transferring Operations Back to the Primary Site

Once the applications are running at the secondary (remote) site, the next activity is to restore the primary (main) site and transfer operations back to the primary site. To transfer operations to the primary site:

1. Bring up the host server(s) at the primary site, and make sure that all HORC components are fully operational.
2. At the primary site, delete all HORC pairs at the MCUs. The **Delete Pair by Force** option must be used because the previous S-VOLs are in the SMPL state at the secondary site.
3. At the main site, delete all HORCA consistency groups at the MCUs.
4. At the main site, delete the RCUs. Remember to connect with each MCU and each CU image to make sure that all RCUs have been deleted.
5. At the main site, configure the MCU serial interface ports as needed. If you plan to use the same remote copy connections to copy back, change the existing RCPs to LCPs.
6. If you plan to use the same channel extenders, change the operating mode to the opposite direction. The boxes/nodes connected to the MCUs must be set to channel-mode, and the boxes/nodes connected to the RCUs must be set to device-mode.
7. At the remote site, configure the appropriate LCPs as RCPs to enable HORC operations in the reverse direction. This enables the original RCUs to send HORC remote copy operations to the original MCUs to bring the original P-VOLs up to date.
8. At the remote site, establish the same HORCA groups and HORC pairs in the reverse direction to synchronize the original P-VOLs with the S-VOLs. Make sure to use the **Entire Volume** initial copy option.

6.4 Resuming Normal Operations at the Primary Site

Once the HORC pairs have been established in the reverse direction, you are ready to resume normal operations at the primary (main) site. Remember that the HORC terminology is now reversed: the original RCUs and S-VOLs (secondary site) are now the MCUs and P-VOLs, and the original MCUs and P-VOLs (primary site) are now the RCUs and S-VOLs.

To resume normal operations at the primary site:

1. At the secondary site, make sure that all HORC pairs are in the PAIR (duplex) state. This indicates that the HORC initial copy operations are complete.
2. Halt the applications at the remote site, and vary the P-VOLs (original S-VOLs) offline at the remote site. This maintains synchronization of the HORC Sync pairs.
3. Split (pairsplit-R) all HORC pairs at the MCUs (original RCUs) to destage any pending data from cache. Confirm that the pairs are split (PSUS) before proceeding. If an error occurs, resolve it before proceeding.
4. Delete all HORC pairs at the MCUs (original RCUs). You do not need to use the **Delete Pair by Force** option. For HORCA pairs, the MCU and RCU complete all pending updates before changing the pair status to SMPL.
5. Change the HORC settings at the MCUs (original RCUs) to prepare for normal HORC operations. Delete the HORCA groups and the RCUs (original MCUs). If you plan to use the same remote copy connections, reconfigure the serial interface ports to change the RCPs back to LCPs.
6. If you plan to use the same channel extenders, change the operating mode back to the original direction. The boxes/nodes connected to the MCUs must be set to channel-mode, and the boxes/nodes connected to the RCUs must be set to device-mode.
7. At the primary site, configure the RCPs, add the RCUs, and add the HORCA groups.
8. At the primary site, establish all HORC groups and pairs in the original direction. You may use the **None** initial copy option because all P-VOLs and S-VOLs are synchronized. If there is any possibility that the volumes are not 100% synchronized, use the **Entire Volume** initial copy option to be safe.
9. Vary the MCU and P-VOLs online, and start the applications at the primary site.

Chapter 7 Troubleshooting

7.1 Troubleshooting HORC Operations

Table 7.1 provides general troubleshooting instructions for HORC. Table 7.2 provides troubleshooting instructions for RCU paths. Table 7.3 provides troubleshooting instructions for suspended HORC pairs (Synchronous and Asynchronous). Table 7.4 provides troubleshooting instructions for HORC Asynchronous suspension conditions.

See section 7.2 for a description of the HORC error messages displayed on the Remote Console PC. See section 7.3 for a brief description of the 9900 service information messages (SIMs). If you need to call the Hitachi Data Systems Support Center, please refer to section 7.4 for instructions.

Table 7.1 General HORC Troubleshooting

Error	Corrective Action
The Remote Console PC hangs, or HORC operations do not function properly.	Make sure that the problem is not being caused by the PC or Ethernet hardware or software, and restart the PC. Restarting the Remote Console PC does not affect subsystem operations. Make sure that all HORC requirements and restrictions are met (e.g., same LU type). See sections 3.1 and 3.2. Make sure that the MCU and RCU and remote copy connections are powered on and fully operational (NVS, cache). Check all input values and parameters to make sure that you entered the correct information on the Remote Console PC (e.g., RCU S/N and SSID, path parameters, P-VOL and S-VOL IDs). Disconnect Hitachi GRAPH-Track™ from the subsystem before connecting to the same subsystem using RMCMAIN.
An RCP channel-enable LED indicator (on the 9900 control panel) is off or flashing.	Please call the Hitachi Data Systems Support Center for assistance.
The volume pairs and/or RCUs are not displaying correctly.	Make sure that the correct CU image is selected.
A HORC error message is displayed on the PC.	Resolve the error, and then try the HORC operation again.
The RCU path status is not normal.	Check the path status (RCU Status panel), and see Table 7.2.
The pair status is *suspended*.	Check the pair status (Pairdisplay panel), and see Table 7.3.
Paircreate or pairresync operation resulted in a timeout error [HRC2019W].	Hardware failure: If the timeout error was caused by a hardware failure, a SIM will be generated. If this occurs, call service personnel, and retry HORC operations after the problem is fixed. Heavy workload: If no SIM was generated, wait for a while (5 or 6 minutes), then check the pair status of the pair(s) being created or resumed. If the pair status changed correctly, the failed operation completed after the timeout message was issued. If the pair status did not change as expected, heavy workload might have prevented the HORC operation from being completed. In this case, retry the HORC operation again when the subsystem has a lighter workload. If a communication error between the RMC and SVP occurs, refer to the *9900 Remote Console User's Guide* for instructions.
There is a pinned track on a HORC volume.	See Appendix B for instructions.

Table 7.2 Troubleshooting RCU Path Status Problems

Path Status	Description	Corrective Action
Initialization Failed	The link initialization procedure to the RCU failed.	Make sure that you entered the correct RCU S/N and SSID and path parameters (port, link address, logical address). Make sure that the correct MCU port is configured as an RCP. Make sure the correct RCU port is configured as an LCP.
Communication Time Out	Communication between the MCU and RCU timed out.	Make sure that the RCU is powered on and fully functional (NVS and cache ON). Make sure that the remote copy connection hardware (cables, connectors, ESCDs) is properly configured and functional. Delete the failed path. You may need to change the minimum paths setting or delete the RCU in order to delete the path. Then add the path/RCU using Edit Path or Add RCU.
Resource Shortage (MCU/RCU)	The MCU/RCU rejected the establish logical path link control function because all logical path resources in the MCU/RCU are being used for other connections.	Delete the failed path, and also delete all paths and RCUs not currently in use. The MCU can be connected to up to four RCUs with up to four paths to each RCU. Make sure all MCU and RCU ports are properly configured: LCPs for hosts and MCUs, RCPs for RCUs. If necessary, connect to the RCU to delete paths/RCUs and reconfigure ports, then reconnect to the MCU. Add the path/RCU again using Edit Path or Add RCU.
Serial Number Mismatch	The RCU's S/N does not match the specified S/N.	Make sure that you entered the correct RCU S/N and SSID and path parameters (port, link address, logical address). Delete the failed path. You may need to change the minimum paths setting or delete the RCU in order to delete the path. Then add the path/RCU using Edit Path or Add RCU.
Invalid Port	The specified port is not configured as an RCP, or this path already exists.	Make sure that the correct MCU port is configured as an RCP. Make sure the correct RCU port is configured as an LCP. Make sure that you entered the correct RCU S/N and SSID and path parameters (port, link address, logical address). Delete the failed path. You may need to change the minimum paths setting or delete the RCU in order to delete the path. Then add the path/RCU using Edit Path or Add RCU.
<blank>	This path was not established.	Delete the failed path. You may need to change the minimum paths setting or delete the RCU in order to delete the path. Then add the path/RCU using Edit Path or Add RCU.

Table 7.3 Troubleshooting Suspended HORC Pairs

Suspend Type	Applies to	Description	Corrective Action
PSUE, by RCU	P-VOL	The MCU detected an error condition at the RCU which caused the MCU to suspend the volume pair. The S-VOL suspend type is *by MCU*.	Clear the error condition at the RCU or S-VOL. If you need to access the S-VOL, split the pair (pairsplit-R) from the MCU using the S-VOL write enable option. Resume the pair (pairresync) from the MCU after the error condition is cleared.
PSUE, S-VOL Failure	P-VOL	The MCU detected an error during communication with the RCU or an I/O error during update copy. In this case, the suspend type for the S-VOL is usually *by MCU*.	Check the path status on the RCU Status panel (see). Clear any error conditions at the RCU or S-VOL. If you need to access the S-VOL, split the pair (pairsplit-R) from the MCU using the S-VOL write enable option. Resume the pair (pairresync) from the MCU after the error condition is cleared.
PSUE, MCU IMPL	P-VOL, S-VOL	The MCU could not find valid control information in its nonvolatile memory during the IMPL procedure. This error occurs only if the MCU is without power for more than 48 hours (power failure and fully discharged batteries).	Resume the pair (pairresync) from the MCU. The MCU will perform an entire initial copy operation in response to the pairresync request.
PSUE, Initial Copy Failed	P-VOL, S-VOL	The MCU suspended this pair during the initial copy operation. The data on the S-VOL is not identical to the data on the P-VOL.	Delete the pair from the MCU. Clear all error conditions at the MCU, P-VOL, RCU, and S-VOL. Restart the initial copy operation using the Paircreate panel.
PSUE, MCU P/S-OFF	S-VOL (Async)	The MCU suspended all HORCA pairs due to MCU power-off.	None. The MCU will automatically resume these HORCA pairs during power-on.
PSUS, Sidefile Overflow	P-VOL S-VOL	The amount of sidefile exceeds the specified current pending update data rate, and the RCU data is not transferred within the specified offloading timer.	Add cache memory, increase the number of paths between MCU and RCU, or decrease the number of Async pairs or host I/Os.

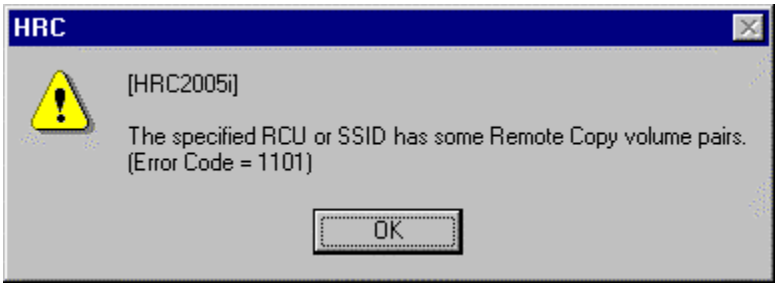
Table 7.4 provides troubleshooting instructions for the HORCA suspension conditions caused by the offloading timer async option, the group timeout options (copy pending and RCU ready), and recordset errors. Hardware failures which affect the cache storage/shared memory of the MCU or RCU may also cause the HORCA volume pairs to be suspended.

Table 7.4 Resolving HORC Async Suspension Conditions

Classification	Causes of Suspension	SIM	Recovery procedure
MCU/RCU hardware	Hardware redundancy has been lost due to some blockade condition. As a result, MCU-RCU communication, creating or receiving recordset, or the staging or de-staging process could not complete. The pending recordset cannot be retained because one side of cache storage or shared memory has been blocked due to hardware failure. MCU-Creating/sending recordset failed due to unrecoverable hardware failure. RCU-Reading/settling recordset failed due to unrecoverable hardware failure. The drive parity group was in correction-access status while the HORC pair was in COPY state.	DB0x DB1x DB2x	According to SIM, remove the hardware blockade or failure. Re-establish failed volume pairs (pairresync).
MCU-RCU communication	During the power-on-reset sequence, the MCU could not communicate with the RCU within the specified RCU ready timeout. The RCU could not settle the pending recordset or could not communicate with the MCU before the copy pending timeout due to MCU not-ready or inoperative facilities on the remote copy connections.	DB0x DB1x	Remove the failed condition at the RCU/MCU or on the remote copy connection. Re-establish failed pairs (pairresync).
RIO overload	The unrecoverable RIO (remote I/O) timeout occurred due to overload of the RCU or the communication facilities on the remote copy connections. No recordset could be sent within the specified copy pending timeout. The RCU could not settle the pending recordset before the copy pending timeout due to overload of the RIO or the RCU itself.	DB1x	Delete failed pairs (pairsplit-S). Reconsider the performance resources necessary, and increase resources as needed (cache amount, number of MCU-RCU paths, etc.). Re-establish failed pairs (paircreate).
RIO failure	The RIO (remote I/O) could not complete due to the failure at the RCU.	DB2x	According to SIM generated at the RCU, remove the failure. Re-establish failed pairs (pairresync).
MCU planned outage	The HORCA pairs were temporarily suspended due to a planned outage of the MCU.	DB8x	No recovery procedure is required. The MCU will automatically remove the suspension condition during the next power-on-reset sequence.

7.2 HORC Error Codes

The HORC software displays error messages on the Remote Console PC when error conditions occur during HORC operations (see Figure 7.1). The error message describes the error and provides a four-digit error code (**Error Code = 1101** in Figure 7.1). The first two digits of the error code indicate the error type, and the last two digits provide more specific information about the error. The error message may also include a 9900 SVP error code (**[HRC2005i]** in Figure 7.1). If you need to call the Hitachi Data Systems Support Center for assistance, please report the HRC/HORC and SVP error codes. Please refer to the *9900 Remote Console User's Guide* for a list of error codes displayed on the Remote Console PC.



Delete RCU failed because the RCU still contains one or more pairs with the current MCU.

Figure 7.1 HORC Error Message for Failed Delete RCU Operation

7.3 Service Information Messages (SIMs)

The Hitachi Lightning 9900™ subsystem generates a SIM when it is necessary to notify the user of a possible service requirement for the subsystem. SIMs can be generated by the channel and storage path microprocessors of the subsystem and by the service processor (SVP) of the subsystem. The SVP reports all SIMs related to HORC operations. Each time a SIM is generated, the amber **Message** LED on the 9900 front operator's panel (under the **Ready** and **Alarm** LEDs) turns on as an additional alert for the user.

The SIMs are classified according to severity for reporting and logging purposes: service, moderate, serious, or acute. All SIMs are logged on the 9900 SVP and reported to the Remote Console PC (RMCMAIN R-SIM panel). During HORC operations, the MCU and RCU generate a service SIM each time the pair status of the P-VOL or S-VOL changes for any reason, including normal status transitions (e.g., COPY to PAIR). SIMs generated by the MCU will include the P-VOL device ID (byte 13), and SIMs generated by the RCU will include the S-VOL device ID (byte 13). For further information on the 9900 SIMs, please refer to the *9900 HRC User and Reference Guide*, *9900 Remote Console PC User's Guide*, and/or the *9900 User Guide and Reference*, or call the Hitachi Data Systems Support Center for assistance.

If SNMP is installed and operational for the 9900 subsystem, each SIM will result in an SNMP trap being sent to the appropriate host(s). For further information on SNMP operations, please refer to the *9900 Remote Console User's Guide*, or contact your Hitachi Data Systems account team.

7.4 Calling the Support Center

If you need to call the Hitachi Data Systems Support Center, make sure to provide as much information about the problem as possible, including the circumstances surrounding the error or failure and the exact content of any error messages and/or codes displayed on the Remote Console PC and/or logged at the host. The Hitachi Data Systems Support Center may ask you to send them the history log files (on the Remote Console PC) for analysis. Please refer to the *9900 Remote Console User's Guide* for additional troubleshooting information for the RMCMAIN software and the Remote Console PC.

The worldwide Hitachi Data Systems Support Centers are:

- Hitachi Data Systems North America/Latin America
  San Diego, California, USA
  1-800-348-4357
- Hitachi Data Systems Europe
  Contact Hitachi Data Systems Local Support
- Hitachi Data Systems Asia Pacific
  North Ryde, Australia
  011-61-2-9325-3300

Appendix A Acronyms and Abbreviations

Adr	address
ATM	asynchronous transfer mode
CCW	channel command word
CNT	Computer Network Technology Corporation
CU	control unit
DASD	direct access storage device
DB2	Database 2
DFSMS	Data Facility Storage Management Subsystem
DWL	duplex write line
ESCON	Enterprise System Connection (IBM trademark for optical channels)
ESCD	ESCON director
ExSA	extended serial adapters
HDS	Hitachi Data Systems Corporation
HORC	Hitachi Open Remote Copy
HS	Hitachi Storage
HVR	Hitachi Volume Relocation
I/O	input/output
IBM	International Business Machines Corporation
IMPL	initial microprogram load
IMS	Information Management System
IOCDS	I/O configuration dataset
LAN	local-area network
LCP	local control port
LED	light-emitting diode
LUN	logical unit (also called device emulation or device type)
MCU	main control unit
NVS	nonvolatile storage
PC	personal computer system
PSUE	pair suspended-error
PSUS	pair suspended-split
P-VOL	primary volume
RAID	redundant array of independent disks
RAID-1/-5	specific RAID architectures
RC	reference code
RCP	remote control port
RCU	remote control unit
RDC	remote dual copy (another term for HRC/HORC)
RIO	remote IO

SIM	service information message
SMPL	simplex
S/N	serial number (also abbreviated as s#)
SNMP	simple network management protocol
SSB	sense byte
SSID	storage subsystem identification
S-VOL	secondary volume
SVP	service processor
sync	synchronous
s#	serial number (also abbreviated as S/N)
VOL	volume

Appendix B Pinned Track Recovery for HORC Volumes

If a pinned track occurs on a HORC P-VOL or S-VOL, the MCU will suspend the pair (SIM reference code = DB1x). Use the following procedure to ensure full data integrity of the volume pair while recovering the pinned track:

1. Connect to the MCU of the suspended pair, and select the correct CU image.
2. Delete the HORC pair (pairsplit-S) which contains the volume with the pinned track.
3. If the volume is offline (e.g., S-VOL has pinned track), vary the volume online.
4. Perform your usual procedure for recovering data from a pinned track. Refer to the pinned track recovery procedures for your operating system, or contact your Hitachi Data Systems representative for assistance in recovering the pinned track.
5. If the volume was previously offline (e.g., S-VOL), make sure to vary the volume offline again.
6. Restart the volume pair using the Paircreate panel, and make sure to use the **Entire Volume** initial copy option.

Appendix C HORC Scripting

C.1 Overview of HRC Scripting

An added benefit of the HORC feature is its support for scripting HORC operations. This capability provides the user with additional flexibility in managing their HORC environment. A HORC script file contains a list of macros (commands) which describes a series of HORC pair operations. The HORC scripting macros are defined in a text file, and the HORC remote console software reads the text file and executes the specified HORC pair operations.

Note: This appendix assumes that the user is familiar with batch files and does not provide instructions for writing or editing batch files. The macro commands and parameters listed in this appendix are the only commands recognized by the HORC scripting function.

WARNING: The user is responsible for testing the HORC scripting function before running any HORC scripts. If a HORC script is run without prior testing and the script ends abnormally, data loss could occur. Before testing a HORC script, back up the data and vary the volumes offline. If the volumes must remain online, back up the data and confirm that the target volume pair defined in the HORC script is correct. The results of a HORC script can be confirmed by checking the latest HORC pair status update (**Last Updated** field on HORC Pair Status panel).

Table C.1 lists the HORC pair macro commands. Table C.2 lists the internal macro commands for HORC scripting. The following HORC operations cannot be performed using HORC scripting and must be performed using the HORC software on the Remote Console PC:

- Configure ports (LCP↔RCP) (section 4.2.3)
- Monitor remote copy activity (section 4.2.4)
- Clear remote copy SIMs (section 4.2.5)
- Add/delete RCU (section 4.3.1)
- Change RCU options (section 4.3.2)
- Add/delete path/SSID (sections 4.3.4, 4.3.5)
- View RCU status (section 4.3.6)
- Change async options (section 4.4.1)
- Add/delete group (section 4.4.2)
- Change group options (section 4.4.3)
- View group status (section 4.4.4)

Table C.1 Functional Macro Commands for HORC Scripting

HORC Scripting Macro	Description
CreateHorcPair	Registers a HORC pair or pairs. (StartHorcPair is used to start the initial copy operation.)
SuspendHorcPair	Suspends a HORC pair or pairs.
DeleteHorcPair	Deletes a HORC pair or HORC pairs.
ResumeHorcPair	Resumes a HORC pair or HORC pairs.
ChangeHorcOption	Changes the pair options for a HORC pair or HORC pairs.
StartHorcPair	Starts remote copy operations for the new pairs and/or resumed pairs specified in the preceding scripting commands.
GetHorcStatus	Displays the status of a HORC pair or HORC pairs.
SelectHorcDevice	Searches HORC paired devices.

Table C.2 Internal Macro Commands for HORC Scripting

Type	Macro	Description
For lists	SetList AddList	Set (define) a list of items. Add items to a list.
For non-lists	Start End Delay If EndIf MakeString Message	Declares the beginning of a script. Declares the end of a script. Suspends script execution for the specified length of time. Executes a script conditionally. Terminates a script conditionally. Makes strings; converts numeric value to character string. Displays a message window with buttons (OK, Yes/No).

C.2 Syntax for Scripting

C.2.1 Syntax Overview

A HORC script file can be written using any text editor (e.g., WordPad, NotePad). A script file consists of an unlimited number of statements which consist of macros (i.e., commands), work variables, and comments (see sections C.3 and C.4). The first executable statement in a HORC script file must be the HORC Start macro, and the last statement must be the HORC End macro. Each line in a HORC script file cannot exceed 240 bytes. A leading blank is ignored, and a leading tab character (0x09) is converted to a space (0x20). A tab character (0x09) within a string is not converted to a space. Table C.3 lists and describes the script statements. Table C.4 lists and describes the components of a HORC script file. Table C.5 lists the requirements for the components of a script file.

Each script file should contain all five script statements:

- A comment statement, including a short preface for the script: purpose, author, usage, description, operation, creation date, update date, and any reminder notes to the author. The comment statement is a non-execution statement. A comment statement begins with "//"and contains text (any character string) without any commands. Do not use the "//" symbol anywhere else in a script file, only at the beginning of a comment statement.
- A macro statement (sections C.3 and C.4). The macro statement is an execution statement. Only one macro instruction can be set per line, and a macro can span more than one line.
- A work variable statement (section C.5). The work variable statement is also an execution statement. Only one work variable statement can be set per line, and a work variable statement cannot span more than one line.
- A blank statement (see Table C.3). The blank statement is a non-execution statement.
- An empty statement (see Table C.3). The empty statement is a non-execution statement.

Table C.3 Syntax Description

Statement Name	Description
Blank statement	Space or Tab with a return
Comment statement	One line beginning with //
Empty statement	Return only
Execution statement	Work variable statement (non-list type work variable = constant)
Macro statement	Macro name [parameter list] (Refer to sections C.3 and C.4 for macro information.)

Table C.4 Script Components

Component Name	Description
Macro name	Either an internal macro or a functional macro.
Parameter list	Parameter identification name (defined in each macro format) = non-list type expression.
Expression	List, constant, and work variable.
List	In a list description, a constant is enclosed in braces "{}". A comma "," is inserted between constants. For example {1, 2, 3, 4}, or {"ABC", "qtw" }. Lists and work variables cannot be described in a list.
Constant	String or a numeric value.
String	The string covers the following lists. (Enclose a list with a double-quotation mark (""). Letters (uppercase and lowercase), numbers, symbols ▪ Numeric list: List that consists of (0, 1, 2, 3, 4, 5, 6, 7, 8, 9) ▪ Hexadecimal number list: List that begins with 0x/0X of (A, B, C, D, E, F, a, b, c, d, e, f)
Reserved variables	Reserved variables can only be referenced in a script. Setting a value is not possible.

C.2.2 Script File Requirements

Table C.5 lists the requirements for the components of a script file.

Table C.5 Script File Requirements

Item	Requirement
Maximum length of one line of a script	240 bytes
Maximum number of items of one list type identification name	4096
Maximum length of one item of a list type work variable string	16 bytes
Maximum length of one item of a non-list type string	150 bytes
Maximum number of items of macro trace storage	1,000
Maximum number of items of error trace	1,000

C.2.3 Script Symbols

Symbols can be used in a script to enhance or limit the power of each script command. Table C.6 lists and describes the symbols that can be used in a script.

Table C.6 Script Symbols

Symbol	Use
Quotation mark	Used to define the character constant by enclosing with it quotation marks.
Space	Used to delimit the before and after phrases.
Comma	Used to delimit the before and after phrases. This symbol must be placed by following each macro description rule.
Brace	Used to describe a list.
Parenthesis	Only used to describe a condition in the If statement.
Exclamation mark	Used as an operator in the If statement by placing the equal sign next to it. This symbol is not useful when used alone.
Unequal sign	Used as an operator in the If statement when used alone. When the equal sign follows, nothing changes.
Equal sign	Used as a substitute sign when used alone. When the equal sign follows, it becomes an operator in the If statement.

Note: The before and after phrases are split by the above symbols. Each symbol is recognized as a single word.

C.3 Operation Macro Commands

The functional macros are the script equivalents of the following HORC pair operations:

- Create HORC pairs (see section C.3.1),
- Delete HORC pairs (see section C.3.2),
- Suspend HORC pairs (see section C.3.3),
- Resume HORC pairs (see section C.3.4),
- Change HORC pair options (see section C.3.5),
- Start HORC pairs (see section C.3.6),
- Get HORC pair status (see section C.3.7), and
- Select HORC pair devices (see section C.3.8).

Note: In the operation macros ($Port/$Rport), the following values are used for the corresponding ports.

PORT 1A = 0x00	PORT 1B = 0x01	PORT 1C = 0x02	PORT 1D = 0x03
PORT 1E = 0x04	PORT 1F = 0x05	PORT 1G = 0x06	PORT 1H = 0x07
PORT 1J = 0x08	PORT 1K = 0x09	PORT 1L = 0x0A	PORT 1M = 0x0B
PORT 1N = 0x0C	PORT 1P = 0x0D	PORT 1Q = 0x0E	PORT 1R = 0x0F
PORT 2A = 0x10	PORT 2B = 0x11	PORT 2C = 0x12	PORT 2D = 0x13
PORT 2E = 0x14	PORT 2F = 0x15	PORT 2G = 0x16	PORT 2H = 0x17
PORT 2J = 0x18	PORT 2K = 0x19	PORT 2L = 0x1A	PORT 2M = 0x1B
PORT 2N = 0x1C	PORT 2P = 0x1D	PORT 2Q = 0x1E	PORT 2R = 0x1F

C.3.1 Create HORC Pairs

The CreateHorcPair command allows you to establish new HORC volume pairs. ***Note:*** The CreateHorcPair command only creates the pair. You must run the StartHorcPair command after establishing the pair to start the remote copy process.

CreateHorcPair $Port=PORT-list***, $Id***=SCSI ID-list, ***$Lun***=LUN-list
,$RcuSn=serial-number-list***,$RcuSsid***=SSID list
, $Rport=PORT-list***, $Rid***=SCSI ID-list, ***$Rlun***=LUN-list
[***,$HorcCopyPace***=initial-copy-pace-list]
[***,$CopyMode***=initial-copy-mode-list]
[***,$Sync***=sync-level-list]
[***,$Priority***=priority-list]
[***,$Fence***=fence-level-list]
[***,$CTG***=C/T group-list]
[***,$OptErrLv***=error-level-list]
[***,$TimeSave***=time-saving-mode-flag]

The CreateHorcPair parameters are:

PORT list	P-VOL port ID.
SCSI Id list	P-VOL SCSI target ID.
LUN list	P-VOL LU number.
Serial number list (string)	RCU serial number (five digits decimal 0-9). Do not specify more than 12 RCUs.
SSID number list (numeric)	RCU SSID (four digits hexadecimal 0-F).
PORT list (Rport)	S-VOL port ID.
SCSI Id list (Rid)	S-VOL SCSI target ID.
LUN list (Rlun)	S-VOL LU number.
Initial copy pace list (string)	1-15 tracks; default = “15 tracks”
Initial copy mode list (string)	“E” (0x00) = entire volume; “N” (0x01) = none; default = E.
Sync level list (string)	“S0” or “Synchronous0” (0x00) = sync; “S2” or “Synchronous2” (0x02) = async; default = “S0”. S0 and S2 cannot be specified at the same time.
CT group list (numeric)	Consistency group number (0x00 - 0x3F). For HORCA pairs you must specify this parameter. For HORC Sync pairs you must omit this parameter.
Priority list (numeric)	Priority of initial copy operation: 1-256; default = 32.
Fence level list (string)	“N” or “Never” (0x00) = never, “S” or “Status” (0x02) = status; “D” or “Data” (0x01) = data; default = N. For HORCA pairs you must either specify **Never** or omit this parameter.
Error level list (string)	“G” or “Group” (0x00) = group; “L” or “Lu” (0x01) = volume; default = “G”. For HORC Sync pairs you must omit this parameter.

Time-Saving Mode flag	"Yes" = The **Use Time-Saving Mode** option is enabled; "No" = The **Use Time-Saving Mode** option is disabled; default = "Yes". This parameter is a non-list type and only one value can be specified.

Figure C.1 shows two examples of the HORC create pair macro command. When using the CreateHorcPair command to create more than one HORC pair, make sure to keep each line within the maximum line length (240 bytes). Refer to section C.2.2 for script command restrictions and parameters.

```
// RCU : S/N = 12345, SSID = 0x04(,0x05,0x06,0x07)
// P-Vol -- - Port# = 0x00, Id# = 0x00, Lun# = 0x00
//                 Port# = 0x00, Id# = 0x00, Lun# = 0x01
// S-Vol  ---  Port# = 0x00, Id# = 0x01, Lun# = 0x02
//                 Port# = 0x00, Id# = 0x01, Lun# = 0x03
// Priority--- depends on P-Vol#
//
CreateHorcPair $RcuSn="12345", $RcuSsid=0x04, $Port=0x00, $Id=0x00, $Lun=0x00, $Rport=0x00,
$Rid=0x01, $Rlun=0x02, $Priority=1, $Fence="Data"
CreateHorcPair $RcuSn="12345", $RcuSsid=0x04, $Port=0x00, $Id=0x00, $Lun=0x01, $Rport=0x00,
$Rid=0x01, $Rlun=0x03, $Priority=2, $Fence="Data"
StartHorcPair



// RCU : S/N = 12345, SSID = 0x04(,0x05,0x06,0x07)
// _ilPortA = P-Vol PORT List --- 0x00
// _ilIdA    = P-Vol SCSI ID List --- 0x00
// _ilLunA = P-Vol LUN List --- 0x00-0x07
// _ilPortB = S-Vol PORT List --- 0x01
// _ilIdB    = S-Vol SCSI ID List --- 0x01
// _ilLunB = S-Vol LUN List --- 0x00-0x07
// _ilPriorityA = Priority List --- 32 for PORT#=0x00, SCSI ID#=0x00, LUN#=0x00-0x03
//                                     --- 1 for PORT#=0x00, SCSI ID#=0x00, LUN#=0x04-0x07
SetList $D=_ilPortA, $S={0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
SetList $D=_ilIdA, $S={0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
SetList $D=_ilLunA, $S={0x00, 0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x07}
SetList $D=_ilPortB, $S={0x01, 0x01, 0x01, 0x01, 0x01, 0x01, 0x01, 0x01}
SetList $D=_ilIdB, $S={0x01, 0x01, 0x01, 0x01, 0x01, 0x01, 0x01, 0x01}
SetList $D=_ilLunB, $S={0x00, 0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x07}
SetList $D=_ilPriorityA, $S={32,32,32,32,1,1,1,1}
CreateHorcPair $Port=_ilPortA, $Id=_ilIdA, $Lun=_ilLunA, $RcuSn="12345", $RcuSsid=0x04,
$Rport=_ilPortB, $RId=_ilIdB, $Rlun=_ilLunB, $Priority=_ilPriorityA, $Fence="Data"
StartHorcPair
```

Figure C.1 Examples of CreateHorcPair Command

C.3.2 Delete HORC Pairs

The DeleteHorcPair command allows you to delete HORC pairs.

DeleteHorcPair $Port=PORT-list***, $Id***=SCSI ID-list, ***$Lun***=LUN-list
[***,$DelMode***=delete-mode-list]
[***,$DelRange***=delete-range-list]
[***,$TimeSave***=time-saving-mode-flag]

The DeleteHorcPair parameters are:

PORT list	P-VOL port ID.
SCSI Id list	P-VOL SCSI target ID.
LUN list	P-VOL LU number.
Delete mode list (numeric)	0 (0x00) = normal, 1 (0x01) = delete by force; default = 0. You must specify 0 or omit this parameter when deleting two or more HORCA pairs.
Delete range list (string)	(0x00) = "Lu" or "L"; (0x04) = "Group" or "G"; (0x02) = "C/T" or "C". For HORC Sync pairs you must omit this parameter. If you want to delete two or more specific HORCA pairs, you can specify L or omit this parameter. ■ The default is L under these conditions: two or more volumes are specified. ■ The default is G under these conditions: – one volume is specified, volume is a P-VOL, and delete mode is 0 (normal), any pair status; or – one volume is specified, volume is an S-VOL, delete mode is 0, pair status is suspending, deleting. If you want to delete an entire group by force, you must specify G. ■ The default is C/T under these conditions: one volume is specified, volume is an S-VOL, and pair status is not suspending or deleting.
Time-Saving Mode flag	"Yes" = The **Use Time-Saving Mode** option is enabled; "No" = The **Use Time-Saving Mode** option is disabled; default = "Yes". This parameter is a non-list type and only one value can be specified.

Figure C.2 shows two examples of the HORC delete pair macro command.

```
DeleteHorcPair $Port=_ilPortA, $Id=_ilIdA, $Lun=_ilLunA,$DelMode=_ilWorkA

DeleteHorcPair $Port=0x00, $Id=0x01, $Lun=0x02,$DelMode={0, 1, 1, 1, 1}
```

Figure C.2 Examples of DeleteHorcPair Command

C.3.3 Suspend HORC Pairs

The SuspendHorcPair command allows you to suspend HORC pairs.

SuspendHorcPair $Port=PORT-list***, $Id***=SCSI ID-list, ***$Lun***=LUN-list
[***,$SusMode***=suspend-mode-list]
[***,$SusOpt***=suspend-option-list]
[***,$SusRange***=suspend-range-list]
[***,$PendData***=pending-data-list]
[***,$TimeSave***=time-saving-mode-flag]

The SuspendHorcPair parameters are:

PORT list	P-VOL port ID.
SCSI Id list	P-VOL SCSI target ID.
LUN list	P-VOL LU number.
Suspend mode list (string)	"M" or "M-VOL" (0x00) = P-VOL failure, "R" or "R-VOL" (0x01) = S-VOL; default = R. You must specify R or omit this parameter when suspending HORCA pairs.
Suspend-option-list (string)	S-VOL write enable (0x03) = "E"; S-VOL write disable (0x01) = "D"; default = "S-VOL write enable"
Suspend range list (string)	(0x00) = "Lu" or "L"; (0x04) = "Group" or "G". For HORC Sync pairs you must omit this parameter. ■ The default is L when two or more volumes are specified. If G is specified for two or more pairs, this parameter is ignored. ■ The default is G when one volume is specified. If you want to suspend only one HORCA pair, you must specify L.
Pending data flag list (string)	"D" or "Drain" (0x00) = drain; "P" or "Purge" (0x08) = purge; default = D. For Sync pairs you must omit this parameter.
Time-Saving Mode flag	"Yes" = The **Use Time-Saving Mode** option is enabled; "No" = The **Use Time-Saving Mode** option is disabled; default = "Yes". This parameter is a non-list type and only one value can be specified.

Figure C.3 shows two examples of the HORC suspend pair macro command. The second example shows how to select HORC pairs by P-VOL ID (in this case port = 0x00, SCSI TID = 0x00, LUN = 0x00-0x07) and pair status (in this case PAIR), and suspend those pairs.

```
SuspendHorcPair $Port=0x00, $Id=0x01, $Lun=0x02
              ,$SusMode={"R", "M-Vol", "M-Vol"}

// _ilPortA = P-Vol PORT List
// _ilIdA = P-Vol SCSI ID List
// _ilLunA = P-Vol LUN List
SetList $D=_ilPortA, $S={0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
SetList $D=_ilIdA, $S={0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
SetList $D=_ilLunA, $S={0x00, 0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x07}
SuspendHorcPair $Port=_ilPortA, $Id=_ilIdA, $Lun=_ilLunA

// _ilPortA = P-Vol PORT List
// _ilIdA = P-Vol SCSI ID List
// _ilLunA = P-Vol LUN List
// _ilPortB = P-Vol PORT List filtered by "PAIR" status
// _ilIdB = P-Vol SCSI ID List filtered by "PAIR" status
// _ilLunB = P-Vol LUN List filtered by "PAIR" status
SetList $D=_ilPortA, $S={0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
SetList $D=_ilIdA, $S={0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
SetList $D=_ilLunA, $S={0x00, 0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x07}
SelectHorcDevice $PortList=_ilPortB, $IdList=_ilIdB, $LunList=_ilLunB, $Port=_ilPortA,
$Id=_ilIdA, $Lun=_ilLunA, $PairStatus="Duplex"
SuspendHorcPair $Port=_ilPortB, $Id=_ilIdB, $Lun=_ilLunB
```

Figure C.3 Examples of SuspendHorcPair Command

C.3.4 Resume HORC Pairs

The ResumeHorcPair command allows you to resume split and/or suspended HORC pairs. The StartHorcPair command must be executed after the ResumeHorcPair command to begin remote copy activity.

ResumeHorcPair $Port=PORT-list***, $Id***=SCSI ID-list, ***$Lun***=LUN-list
[***,$Priority***=priority-list]
[***,$Fence***=fence-level-list]
[***,$Sync***=sync-level-list]
[***,$OptErrLv***=error-level-list]
[***,$OptRsmRange***=resume-range-list]
[***,$TimeSave***=time-saving-mode-flag]

The ResumeHorcPair parameters are:

PORT list	P-VOL port ID.
SCSI Id list	P-VOL SCSI target ID.
LUN list	P-VOL LU number.
Priority list (numeric)	Priority of initial copy operation: 1-256; default = 32.
Fence level list (string)	"N" or "Never" (0x00) = never, "S" or "Status" (0x02) = status; "D" or "Data" (0x01) = data; default = current value. For HORCA pairs you must either specify **Never** or omit this parameter.
Sync level list (string)	"S0" or "Synchronous0" (0x00) = sync; "S2" or "Synchronous2" (0x02) = async; default = "S0". If S0 is specified for a HORCA pair, or if S2 is specified for a HORC Sync pair, this parameter is ignored.
Error level list (string)	"G" or "Group" (0x00) = group; "L" or "Lu" (0x01) = volume; default = current value. For HORC Sync pairs you must omit this parameter.
Resume level list (string)	(0x01) = "Lu" or "L"; (0x00) = "Group" or "G". For HORC Sync pairs you must omit this parameter. ▪ The default is L when two or more volumes are specified. If G is specified for two or more pairs, this parameter is ignored. ▪ The default is G when one volume is specified. If you want to suspend one HORCA pair, you must specify L.
Time-Saving Mode flag	"Yes" = The **Use Time-Saving Mode** option is enabled; "No" = The **Use Time-Saving Mode** option is disabled; default = "Yes". This parameter is a non-list type and only one value can be specified.

Figure C.4 shows two examples of the HORC resume pair macro command. The second example shows how to select HORC pairs by P-VOL ID (in this case port = 0x00, SCSI TID = 0x00, LUN = 0x00-0x07) and pair status (in this case PSUS or PSUE), and resume those pairs.

```
// _ilPortA = P-Vol PORT List
// _ilIdA = P-Vol SCSI ID List
// _ilLunA = P-Vol LUN List
SetList $D=_ilPortA, $S={0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
SetList $D=_ilIdA, $S={0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
SetList $D=_ilLunA, $S={0x00, 0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x07}
ResumeHorcPair $Port=_ilPortA, $Id=_ilIdA, $Lun=_ilLunA
StartHorcPair

// _ilPortA = P-Vol PORT List
// _ilIdA = P-Vol SCSI ID List
// _ilLunA = P-Vol LUN List
// _ilPortB = P-Vol PORT List filtered by "PSUS" / "PSUE" status
// _ilIdB = P-Vol SCSI ID List filtered by "PSUS" / "PSUE" status
// _ilLunB = P-Vol LUN List filtered by "PSUS" / "PSUE" status
SetList $D=_ilPortA, $S={0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
SetList $D=_ilIdA, $S={0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
SetList $D=_ilLunA, $S={0x00, 0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x07}
SelectHorcDevice $PortList=_ilPortB, $IdList=_ilIdB, $LunList=_ilLunB, $Port=_ilPortA,
$Id=_ilIdA, $Lun=_ilLunA, $PairStatus="Suspended"
ResumeHorcPair $Port=_ilPortB, $Id=_ilIdB, $Lun=_ilLunB
StartHorcPair
```

Figure C.4 Examples of ResumeHorcPair Command

C.3.5 Change HORC Pair Options

The ChangeHorcOption command allows you to change the pair options for HORC pairs.

ChangeHorcOption $Port=PORT-list***, $Id***=SCSI Id-list, ***$Lun***=LUN-list
[***,$Fence***=fence-level-list]
[***,$OptErrLv***=error-level-list]
[***,$TimeSave***=time-saving-mode-flag]

The ChangeHorcOption parameters are:

PORT list	P-VOL port ID.
SCSI Id list	P-VOL SCSI target ID.
LUN list	P-VOL LU number.
Fence level list (string)	“N” or “Never” (0x00) = never, “S” or “Status” (0x02) = status; “D” or “Data” (0x01) = data; default = current value. For HORCA pairs you must either specify N (never) or omit this parameter.
Error level list (string)	“G” or “Group” (0x00) = group; “L” or “Lu” (0x01) = volume; default = current value.
Time-Saving Mode flag	“Yes” = The **Use Time-Saving Mode** option is enabled; “No” = The **Use Time-Saving Mode** option is disabled; default = “Yes”. This parameter is a non-list type and only one value can be specified.

Figure C.5 shows an example of the HORC change pair macro command. This example shows how to select HORC pairs by P-VOL ID (in this case port = 0x00, SCSI TID = 0x00, LUN = 0x00-0x07) and fence level (in this case Data), and change the fence level of those pairs to “Never”.

```
// _ilPortA = P-Vol PORT List
// _ilIdA = P-Vol SCSI ID List
// _ilLunA = P-Vol LUN List
// _ilPortB = P-Vol PORT List filtered by Fence level "Data"
// _ilIdB = P-Vol SCSI ID List filtered by Fence level "Data"
// _ilLunB = P-Vol LUN List filtered by Fence level "Data"
SetList $D=_ilPortA, $S={0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
SetList $D=_ilIdA, $S={0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
SetList $D=_ilLunA, $S={0x00, 0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x07}
SelectHorcDevice $PortList=_ilPortB, $IdList=_ilIdB, $LunList=_ilLunB, $Port=_ilPortA,
$Id=_ilIdA, $Lun=_ilLunA, $Fence="Data"
ChangeHorcOption $Port=_ilPortB, $Id=_ilIdB, $Lun=_ilLunB, $Fence="Never"
```

Figure C.5 Example of ChangeHorcOption Command

C.3.6 Starting a HORC Pair

The StartHorcPair command allows you to start the remote copy process for all new and resumed HORC pairs (CreateHorcPair and ResumeHorcPair commands). The StartHorcPair command does not have any arguments or parameters. After you have created and/or resumed all desired HORC pairs, add the StartHorcPair command to the script to begin remote copy activity for all preceding new and resumed pairs. See Figures C.1 and C.4 for examples of the StartHorcPair command.

C.3.7 Getting HORC Pair Status

The GetHorcStatus macro command allows you to obtain the status of the specified HORC pair(s). The GetHorcStatus command obtains the pair status from the 9900 subsystem and displays the status as a reserved variable "_HorcStatus" (refer to Table C.13).

GetHorcStatus $Port=PORT-list***, $Id***=SCSI ID-list, ***$Lun***=LUN-list

The GetHorcStatus parameters are:

PORT list	P-VOL port ID.
SCSI ID list	P-VOL SCSI target ID.
LUN list	P-VOL LU number.

Figure C.6 shows two examples of the GetHorcStatus command. The first example shows how to get the status of a specified HORC pair. The second example shows how to get the status of several HORC pairs.

```
GetHorcStatus␣$Port=0x00, $Id=0x01, $Lun=0x02

// _ilPortA = P-Vol PORT List
// _ilIdA = P-Vol SCSI ID List
// _ilLunA = P-Vol LUN List
SetList $D=_ilPortA, $S={0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
SetList $D=_ilIdA, $S={0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
SetList $D=_ilLunA, $S={0x00, 0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x07}
GetHorcStatus␣$Port=_ilPortA, $Id=_ilIdA, $Lun=_ilLunA
```

Figure C.6 Examples of GetHorcStatus Command

C.3.8 Selecting a HORC Pair

The SelectHorcDevice command allows you to select HORC pairs whose status matches the specified parameters.

SelectHorcDevice $PortList***=output-list, ***$IdList=output-list, ***$LunList***=output-list
[***,$Port***=PORT-list]
[***,$Id***=SCSI ID-list]
[***,$Lun***=LUN-list]
[***,$RcuSn***=serial-number-list]
[***,$RcuSsid***=SSID-list]
[***,$Fence***=fence-level-list]
[***,$Sync***=sync-level-list]
[***,$PairStatus***=pair-status-list]
[***,$DevAttr***=device-attribute]
[***,$OptErrLv***=Error-level-list]
[***,$CTG***=C/T group-list]

The SelectHorcDevice argument is output list (list-type and numeric work variable). The SelectHorcDevice parameters are:

PORT list (numeric)	Ports to be searched. Default = all ports.
SCSI ID list (numeric)	SCSI target IDs to be searched. Default = all TIDs.
LUN list (numeric)	LU numbers to be searched. Default = all LUNs.
Serial number list (string)	RCU serial number. Default = not specific.
SSID number list (numeric)	RCU SSID. Default = not specific.
Fence level list (string)	“N” or “Never” (0x00) = never. “S” or “Status” (0x02) = status. “D” or “Data” (0x01) = data. Default = not specific.
Sync level list (string)	“S0” or “Synchronous0” (0x00) = sync. “S2” or “Synchronous2” (0x02) = async. Default = not specific.
Pair status list (string)	SMPL = “Simplex” PAIR = “Duplex” PSUE (by initial copy failure) = “Suspended0” PSUS/PSUE (not during initial copy) = “Suspended1” PSUS/PSUE = “Suspended” COPY = “Pending” Suspending = “Suspending” Deleting = “Deleting” Undefined = “Undefined” Default = not specific

Device attribute list (string)	P-VOL = “M” or “M-Vol” S-VOL = “R” or “R-Vol” Default = not specific.
Error level list (string)	“G” or “Group” = group “L” or “Lu” = LU Default = not specific.
CT group list (numeric)	Consistency group number (0x00 - 0x3F). Default = not specific.

Figure C.7 shows an example of the SelectHorcDevice command. This example shows how to select the HORC pairs with P-VOL port = 0x00, SCSI TID = 0x00, LUN = 0x00-0x07, and fence level=Data.

```
// _ilPortA = P-Vol PORT List
// _ilIdA = P-Vol SCSI ID List
// _ilLunA = P-Vol LUN List
// _ilPortB = P-Vol PORT List filtered by Fence level "Data"
// _ilIdB = P-Vol SCSI ID List filtered by Fence level "Data"
// _ilLunB = P-Vol LUN List filtered by Fence level "Data"
SetList $D=_ilPortA, $S={0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
SetList $D=_ilIdA, $S={0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
SetList $D=_ilLunA, $S={0x00, 0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x07}
SelectHorcDevice $PortList=_ilPortB, $IdList=_ilIdB, $LunList=_ilLunB, $Port=_ilPortA,
$Id=_ilIdA, $Lun=_ilLunA, $Fence="Data"
```

Figure C.7 Example of SelectHorcDevice Command

C.4 Internal Macro Commands

The internal macro commands are the connection agents that allow you to connect the functional macros together and produce a complete and functioning script. The internal macros are divided into two groups as shown in Table C.7: list types and non-list types.

Table C.7 Internal Macro Commands

Type	Macro	Description
For lists	SetList AddList	Set (define) a list of items. Add items to a list.
For non-lists	Start End Delay If EndIf MakeString Message	Declares the beginning of a script. Declares the end of a script. Suspends script execution for the specified length of time. Executes a script conditionally. Terminates a script conditionally. Makes strings; converts numeric value to character string. Displays a message window with buttons (OK, Yes/No).

The **Start** and **End** commands are used together to begin and end the functions of a script. Every script must have a **Start** and **End** command. The **If/EndIf** commands are also used concurrently to string two or more functional commands together. The **If/EndIf** commands must be used together. For every **If** command in a script there must be an **EndIf** command. The **Delay** command allows you to delay a script for up to an hour, while the **Message** command allows you to create graphic user interface (GUI) messages to the user. The **MakeString** command allows you to assign several values to a string statement, or the **MakeString** command can convert numeric values to sting values. The **SetList** command allows you to create a list (e.g., all searchable ports in the 9900, all searchable LDEVs in the 9900). The **AddList** command allows you to expand the parameters of a list created with the **SetList** command.

C.4.1 Internal Macro Command Definitions

AddList

The **AddList** command allows you to add a specified value to a specific list type. If you add a value to a list that exceeds the maximum number of items for that output list, the excess values will be ignored. The format for the **AddList** command is:

AddList $D=**output-list[**,$S=expression]
Output list = list-type work variable
Expression = same attribute as output list
Default = blank list

For example, the **AddList** command to add the values (0, 1, 2, 3, 0x1e, 0x1f) to _ilPortB is:
AddList $D=_ilPortB,$S={0,1,2,3,0x1e,0x1f}

Delay

The **Delay** command allows you to suspend script execution for the specified length of time. The script delay time is set in seconds (0-3600). The format for the **Delay** command is:
Delay $Time= wait-time

For example, the **Delay** command to delay a script by 60 seconds is:
Delay $Time=60

End

The **End** command allows you to declare the end of a script. The **End** command also terminates the execution of a script. At least one **End** statement must be described in the trailing line of the script statement. The format for the **End** statement is: **End**

If / EndIf

The **If/EndIf** statements are used together to allow you to verify the conditions of an expression. If the **If/EndIf** statement is successfully completed, succeeding statements will be processed. If the **If/EndIf** statement is not successfully completed, the script will abort and the succeeding statements will not be completed. When **If/EndIf** statements are used, several conditions must be met. You must end an **If** statement with an **EndIf** statement. The execution statement cannot be defined on the same line as the **If** statement. The **If** statement must contain one conditional decision statement within parentheses. The string values must be compared as ASCII character codes (see Table C.8). The format for an **If/EndIf** statement is:

If expression one compared with expression two (see Table C.9 for comparison expressions)
macro statement, either internal or functional
EndIf

For example, to start a HORC pair only if the pair was created successfully (result value of CreateHorcPair command is not 0), use the following **If/EndIf** command:

If (_Result!=0)
StartHorcPair
EndIf

Table C.8 ASCII Character Codes

Character	Code
0	0x30
1	0x31
9	0x39
A	0x41
Z	0x5a
a	0x61
z	0x7a

Table C.9 If/EndIf Comparison Symbols

Symbol	Meaning
= =	Expression 1 is equal to Expression 2.
<	Expression 1 is less than Expression 2.
<=	Expression 1 is less than or equal to Exp 2.
>	Expression 1 is greater than Expression 2.
>=	Expression 1 is greater than or equal to Exp 2.
!=	Expression 1 is not equal to Expression 2.

MakeString

The **MakeString** command allows you to edit a string and/or convert numeric values to string characters. When using the **MakeString** statement several conditions must be met. For each format control string statement there must be an $Item statement. The format control string of expression 1 must be enclosed in quotation marks (“”). If you set a value exceeding the maximum length of a string, the extraneous portion of the value will be not set. Table C.10 defines the two expression statement in the **MakeString** command. The format for the **MakeString** command is:
MakeString $D=** output buffer **,$Fmt= expression 1**,$Item=** expression 2

Table C.10 MakeString Expression Definitions

Expression 1	Expression 2
Expression 1 is one of three format control strings ($Fmt): **%d** Converts a 16-bit numeric expression to a decimal number (0 - 65535). **%x** Converts a 16-bit numeric expression to a hexadecimal number (0 - 0xffff). **%s** Sets a string as it is.	Expression 2 is any expression not containing a list reserved variable (must be constant or work variable).

For example, to create a **MakeString** statement that will convert the 16-bit numeric expression to a hexadecimal number (0 - 0xffff) and set the string as it is, with an output buffer of _sMsg, the command would be:

MakeString $D=_sMsgB
,$Fmt=”EndCode=(0x%x):%s”
,$Item=_Result,_sMsgA

For the **MakeString** command listed above: _sMsgB = “EndCode=(0x110f):Error Occurred”.

Message

The **Message** command allows you to display GUI messages along with user option buttons. The format for the **Message** command is:
Message $Msg=** String or work variable message **,$OptMsg= message option (normally = OK button and 0x0004 = Yes/No buttons). For example, to display a message saying “Do you want to end?” with the Yes and No user option buttons the command would be:

Message $Msg=”Do you want to end?”,$OptMsg=0x0004

SetList

The **SetList** command allows you to assign specific items to a list. The format of the **SetList** command is:

SetList $D=**output-list[**,$S=expression]
Output list = list-type work variable
Expression = same attribute as output list
Default = blank list

For example, the **SetList** command to set (0, 1, 2, 0x1e, and 0x1f) to _ilPortB is:
SetList $D=_ilPortB,$S={0,1,2,0x1e,0x1f}

Start

The **Start** command allows you to declare the beginning of a script and check to verify that the controller name matched the connected controller. When using the **Start** command, several conditions must be met. The **Start** command must be described on the first line of the script. The **Start** statement cannot include a comment statement, an empty statement or a blank statement. The **Start** statement must appear at the beginning of every script. If the controller name does not match the connected controller, an error will occur and the script will be aborted. The format of the **Start** command is: **Start $Script="HORCHODM",$Svr=** controller name. For example, to start a **HORC** script for a controller named Training 9900 the command would be:

Start $Script="HORCHODM",$Svr="Training 9900"

C.5 Work Variables

There are two types of work variables: list type, and non-list type. All work variables are initialized before a script is executed.

- Numeric work variables may have a value between 0x0000 and 0xffff. Numeric work variables are initialized with 0.
- A non-list string work variable may have a string with length up to 150 bytes. A list string work variable may have strings with length up to 16 bytes each. String work variables are initialized with a null string whose length is 0.
- A list work variable may have up to 1024 items. A non-list work variable is a constant. List work variables are initialized as empty (no items).

The work variable is part of an execution statement in a HORC script. Table C.11 provides a description and the storage type of each work variable statement for list and non-list types.

Table C.11 Work Variables

	Variable	Type	Description and Storage Type
List Type	_ilPort	Numeric	Stores the port number list. Expression: _ilPortA, _ilPortB, _ilPortC
	_ilId	Numeric	Stores the SCSI target ID list. Expression: _ilIdA, _ilIdB, _ilIdC
	_ilLun	Numeric	Stores the LU number list. Expression: _ilLunA, _ilLunB, _ilLunC
	_ilPriority	Numeric	Stores the priority number list. Expression: _ilPriorityA, _ilPriorityB, _ilPriorityC
	_ilWork	Numeric	Stores any 16-bit numeric values. Expression: _ilWorkA, _ilWorkB, _ilWorkC _ilWorkD, _ilWorkE, _ilWorkF
	_slWork	String	Stores any strings. Expression: _slWorkA, _slWorkB, _slWorkC, _slWorkD, _slWorkE, _slWorkF
Non-List Type	_iNum	Numeric	Stores any 16-bit numeric value. Expression: _iNumA, _iNumB, _iNumC, _iNumD, _iNumE, _iNumF
	_sMsg	String	Stores any string. Expression: _sMsgA, _sMsgB, _sMsgC, _sMsgD, _sMsgE, _sMsgF

C.6 Reserved Variables

Reserved variables include result variables (i.e., result of macro execution) and status variables (i.e., HORC pair status of specified volume). The reserved variables are for reference use only.

C.6.1 Reserved Result Variables

When a HORC functional macro is executed (e.g., CreateHorcPair), a result value (_Result) is issued. Figure C.8 illustrates the result statement format, and Table C.12 lists and defines the valid result values. When a new macro is initiated, the result value automatically resets to 0x0000. The functional macro executes on the specified number of devices. If the macro does not satisfy the execution condition, a conditional error occurs. If a conditional error is found, the result value is OR'ed with 0x1000, and the macro is logged in the error and macro trace files (see section 4.6). If the return value of the API (application program interface) is not 0, an API error occurs. If an API error occurs, the result value is OR'ed with 0x0100, and the macro is logged in the error and macro trace files.

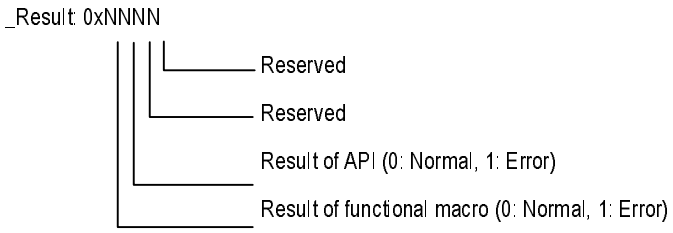


Figure C.8 Result Statement Format

Table C.12 Reserved Result Variables

Variable	Type	Description
_Result	Numeric	Stores the execution results of a macro. 0 = normal end. Other values depend on the macro.
_MsgResult	Numeric	Stores the execution results of a Message (internal) macro. 1 = OK, 6 = Yes, 7 = No.
_SelectResult	Numeric	Stores the number of devices found by SelectHorcDevice macro. 0 = no devices found.

C.6.2 Reserved Status Variables

When a GetHorcStatus command is issued, the Remote Console PC obtains the status of the specified HORC pair(s) from the 9900 subsystem. The results of this query are displayed in the reserved status variables. Table C.13 lists and describes the valid reserved status variables.

Table C.13 Reserved Status Variables

Variable	Type	Description
_HorcStatus _CopyType	String	Stores the copy type: "RDC" = HORC mode ; "RMC' = HODM mode; "---" = other than the above modes.
_HorcStatus _DeviceAttr	String	Stores the device attribute: "M-Vol" = P-VOL; "R-Vol" = S-VOL; "---" = other than the above modes.
_HorcStatus _Port	Numeric	Stores the P-VOL port number.
_HorcStatus _Id	Numeric	Stores the P-VOL SCSI target ID number.
_HorcStatus _Lun	Numeric	Stores the P-VOL LU number.
_HorcStatus _Rport	Numeric	Stores the S-VOL port number.
_HorcStatus _Rid	Numeric	Stores the S-VOL SCSI target ID number.
_HorcStatus _Rlun	Numeric	Stores the S-VOL LU number.
_HorcStatus _Sn	String	Stores the serial number of the controller for the remote copy pairs.
_HorcStatus _Ssid	Numeric	Stores the storage subsystem ID (SSID) of the controller for the remote copy pairs.
_HorcStatus _PairStatus	String	Stores the copy pair status: "Simplex" = simplex; "Duplex" = duplex; "Pending" = initial copy in progress; "Suspended0" = copy abort in initial copy; "Suspended1" = copy abort other than initial copy; "Suspending" = HORCA suspend in progress; "Deleting" = HORCA delete in progress; "Undefined" = undefined.
_HorcStatus_PairSubStatus	String	Stores the LUSE pair status: "Warning in Simplex" = one or more LDEV pairs is SMPL; "Warning in Suspend" = one or more LDEV pairs is PSUE.
_HorcStatus _Fence	String	Stores the P-VOL fence level: "Never" = no fence; "Status" = fence due to an S-VOL status change failure; "Data" = fence due to a data error; "Undefined" = undefined.
_HorcStatus _Sync	String	Stores the synchronous level: "Synchronous0" = sync; "Synchronous2" = async; "Undefined" = undefined.
_HorcStatus _TimeOfUpdate	String	Stores the pair status update time: "MM/DD/YYYY hh:mm:ss" = MM: month, DD: day, YYYY: year, hh: hour, mm: minute, ss: second.
_HorcStatus _TimeOfEstablish	String	Stores the pair creation update time: "MM/DD/YYYY hh:mm:ss" = MM: month, DD: day, YYYY: year, hh: hour, mm: minute, ss: second.
_HorcStatus _CopyRatio	Numeric	Stores the copy progress ratio (0 – 100).
_HorcStatus _InternalStatus	Numeric	Stores the internal status code.
_HorcStatus_CTG	Numeric	Stores the consistency group number: 0x00-0x3F.

Table C.13 Reserved Status Variables (continued)

Variable	Type	Description
_HorcStatus_SuspendBy	String	Stores the HORCA suspension status: "Group" = consistency time of suspended volume matches consistency time of group; "Volume" = consistency time of suspended volume does not match the group consistency time; "Undefined" = undefined.
_HorcStatus_ErrLv	String	Stores the error level (async) pair option: "Group" = all volumes in the group will be suspended if this volume is suspended; "Volume" = this volume will be suspended individually; "Undefined" = undefined.

C.7 Optional Script Parameters

The parameters outlined in Table C.14 are optional parameters that can be added to a HORC script at the script creator's discretion. If any of these parameters are included in a script, the 9900 subsystem will perform a syntactical check of the script to ensure that the syntax requirements for the parameter have been met. If no optional parameters are included, the 9900 will not check any part of the script. The 9900 will run the script commands based only on what has been specified in the text of the script. Table C.14 lists the optional script parameters in the order that the 9900 subsystem will execute them, and describes the syntax requirements that will be evaluated.

Table C.14 Syntax Requirements for Optional Parameters

Parameter	Syntax Requirements
Length	Check that each line does not exceed the maximum length for a script statement.
Phrases in a script statement	A phrase is enclosed by the quotation symbols. Use of the parentheses is correct, and the number of parentheses is exact. A statement does not terminate with an equal sign. The parameter identification name (phrase beginning with "$") is always defined. The work variable and reserved variable (phrase beginning with "_") are always defined.
Script statement	The first line begins with (Start) as an execution statement. The lead of one line in the execution statement always begins with a macro name or an identification name for non-list type work variable.
Substitute statement	The number of phrases is correct. The equal sign is described exactly between the right side and the left side. The right side of the substitute statement is correct.
SetList, AddList	The number of phrases is not less than the minimum count. Duplicate parameter identification names are not specified. The required parameter identification name is defined. The equal sign is described between the right side and $D. Specifying the right side is correct. The equal sign is described between the right side and $S. Specifying the right side is correct. The parameter identification name is described immediately after the macro. The parameter identification names are delimited by a comma (,). An illegal phrase is not included in any statement.
Start	The number of phrases is not fewer than the minimum count. Duplicate parameter identification names are not specified. The required parameter identification name is defined. The equal sign is described between the right side and $Script. Specifying the right side is correct. The equal sign is described between the right side and $Svr. Specifying the right side is correct. The parameter identification name is described immediately after the macro. The parameter identification names are delimited by a comma (,). An illegal phrase is not included in one statement.
End	Check that the number of phrases matches.

Table C.14 Syntax Requirements for Optional Parameters (continued)

Parameter	Syntax Requirements
Delay	The number of phrases matches. The required parameter identification name is defined. The equal sign is described between the right side and $Time. Specifying the right side is correct.
If	The number of phrases matches. The parentheses are described in the correct location. Expressions 1 and 2 are correctly described. The attribute of expressions 1 and 2 matches. Specifying the right side is correct. The comparison operator is correctly described.
EndIf	The number of phrases matches. The macro is describe with the related If statement.
MakeString	Duplicate parameter identification names are not specified. The required parameter identification name is defined. The equal sign is described between the right side and one of $D, $Fmt and $Item. Specifying the right side is correct. The items are split by a comma (,) if multiple items are specified in $Item. The parameter identification name is described immediately after the macro. The parameter identification names are delimited by a comma (,). The matching between the specification of the control string and the description of the item is correct. An illegal phrase is not included in any statement.
Message	The number of phrases is not less than the minimum count. Duplicate parameter identification names are not specified. The required parameter for the identification name is defined. The equal sign is described between the right side and $Msg. Specifying the right side is correct. The equal sign is described between the right side and $OptMsg. Specifying the right side is correct. The parameter identification name is described immediately after the macro. The parameter identification names are delimited by a comma (,). An illegal phrase is not included in one statement.
Functional macro (except for StartHorcPair)	The number of phrases is not less than the minimum count. Duplicate parameter identification name is prohibited. The required parameter for the identification name is defined. The equal sign is described between the right side and the parameter identification name. Specifying the right side is correct. The parameter identification name is described immediately after the macro. The parameters for the identification names are delimited by a comma (,). An illegal phrase is not included in any statement.
StartHorcPair	Check that the number of phrases matches.
Entire check	Check that the (If) has a matching (EndIf). Check that the last line in the execution statement terminates at (END.)

C.8 Error Reporting

The scripting error codes are slightly different than the general HORC error codes. Figure C.9 shows the format of the scripting error codes. Table C.15 describes the HORC scripting error messages. Table C.16 lists the scripting error codes. In Table C.16 the message ID is the four-digit number displayed on the HORC error message. The internal code is the four-digit number displayed in the fifth column of the error trace file (refer to section 4.6). Refer to Chapter 7 for additional HORC troubleshooting information.

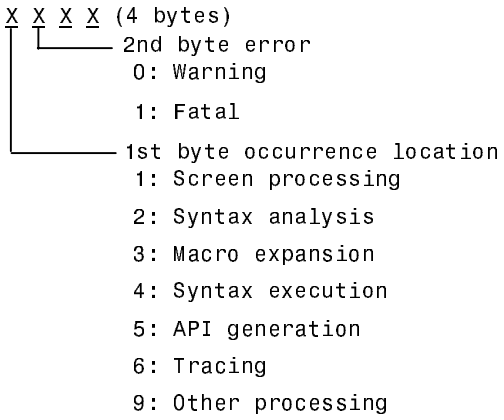


Figure C.9 Scripting Error Code Format

Table C.15 Error Messages

Error Message	Conditions to Verify	Corrective Action
Syntax error	The syntax validity of the HORC script is checked at the start of execution. An error message will be displayed if failed.	Use the scripting error code to determine which line contains the syntax error (see Table C.16), and fix the syntax error.
Parameter error	The parameter validity of the HORC script is checked on executing each instruction. An error message will be displayed if failed.	Use the scripting error code to determine which line contains the parameter error (see Table C.16), and fix the parameter error.
Rejection	The result of the execution is checked on each target device. If failed, the last error status is displayed and error flag is set in the reserved variable _Result. Also HORC script continues to be executed.	If you want to terminate the script or display a message of error occurrence and indication following steps, check that _Result is not 0 in HORC script.
Skip if not executable	The condition of each target device is checked to be executable status. For example, the P-VOL status must be SMPL to create a HORC pair. If failed, error flag is set in the reserved variable _Result. Also HORC script continues to be executed.	If you want to terminate the script or display a message of error occurrence and indication following steps, check that _Result is not 0 in HORC script.

Table C.16 HORC Scripting Error Codes (continues on the next page)

Message ID	Internal Code	Error Message	Error Description
2338I	–	Normal End	The script execution has finished.
2339E	1102	Cannot open a file by 'Memo' command. Error Code = eeee	The 'Memo' command cannot start the Write application. (Make sure that the 'Write.exe' file exists in the Windows directory.)
2340E	1103, 1104	Invaid command line parameter. Error Code = eeee	An error is found in the startup parameter of the script monitor. (Reboot for re-operation. If the error recurs, perform reinstallation.)
2341E	1f01, 1f02	File I/O error(Parameter). Error Code = eeee	The parameter file cannot be opened. (Reboot for re-operation. If the error recurs, perform reinstallation.)
2341E	2f01, 2f02	File I/O error(Script). Error Code = eeee	The specified file is abnormal. (Check whether or not the file is normal.)
2341E	2f03~ 2f05, 4101, 4102	File I/O error(Temporary). Error Code = eeee	The work middle file is abnormal. (Check if the disk capacity is sufficient or the file is normal.)
2341E	6101~ 6105	File I/O error(Trace). Error Code = eeee	The macro trace file cannot be opened. (Check if the disk capacity is sufficient or the file is normal.)
2341E	6111~ 6115	File I/O error(Trace). Error Code = eeee	The error trace file cannot be opened. (Check if the disk capacity is sufficient or the file is normal.)
2342E	2101	Too long line. Line = nnnn Error Code = eeee	There is a line that exceeds the maximum length (240 characters) of one line. (Split line nnnn for correction, and then re-execute.)
2343E	2201, 2203	Illegal 'If' and 'EndIf' pair. Line = nnnn Error Code = eeee	'If' and 'EndIf' do not match. (Correct the script checking a match between 'If' and 'EndIf' near line nnnn, and then re-execute.)
2344E	2202	'End' is required. Line = nnnn Error Code = eeee	'End' does not exist at the end of the script. (Add 'End' at the end of the script, and then re-execute.)
2345E	2204	'Start'is required. Line = nnnn Error Code = eeee	The script begins with other than 'Start.' (Add 'Start' at the beginning of the script, and then re-execute.)
2346E	2205	Illegal word is found. Line = nnnn Error Code = eeee	An illegal phrase is found. (Check if the script of line nnnn beginning with a macro or a defined parameter, and then re-execute after correcting the script.)
2347E	2206	List type variable is unexpected. Line = nnnn Error Code = eeee	The list type variable is described illegally. (Review the list type variable of line nnnn, and then re-execute after correcting the script.)
2348E	2207	Illegal quotation. Line = nnnn Error Code = eeee	A quotation mark is not found at the end of a string. (Check the relation of the string quotation mark, and then re-execute after correcting the script.)
2349E	2208	Required value is not found. Line = nnnn Error Code = eeee	The end of one line is "=". An error has occurred in line nnnn. (Set the value on the right side.)

Table C.16 HORC Scripting Error Codes (continued)

Message ID	Internal Code	Error Message	Error Description
2350E	2209, 220a	Illegal '('and')' pair. Line = nnnn Error Code = eeee	The parentheses are not matched. (Check that there is a matching parenthesis, and then re-execute after correcting the script.)
2351E	220b, 2303	Syntax error. Line = nnnn Error Code = eeee	An illegal word is included. An error has occurred in line nnnn. (Check whether or not the phrase can be described.)
2351E	27xx	Syntax error. Line = nnnn Error Code = eeee	Setting the parameter is invalid. An error has occurred in line nnnn. (Add "=" between the parameter identification name and the value.
2351E	29xx	Syntax error. Line = nnnn Error Code = eeee	Describing a macro is invalid. An error has occurred in line nnnn. (A description other than the parameter identification name is found after the macro.)
2351E	2axx	Syntax error. Line = nnnn Error Code = eeee	Using a comma is invalid. An error has occurred in line nnnn. (Add the comma in the appropriate location as a delimiter.)
2352E	220e	Illegal expression. Line = nnnn Error Code = eeee	The unavailable operator is described in (if). An error has occurred in line nnnn. (Add an available operator.)
2353E	220f	Illegal parameter. Line = nnnn Error Code = eeee	The list of the format control string and the value of the expression specified by $Item do not match in (Make String.) Or, the format control string and the expression do not match in its attribute. An error has occurred in line nnnn. (Check the match between them.)
2353E	24xx	Illegal parameter. Line = nnnn Error Code = eeee	The number of parameters is invalid. An error has occurred in line nnnn. (This error occurs when the number of parameters is too many or small. It also occurs if the instruction is described illegally when the parameter that cannot be used in the instruction is used.)
2354E	2301	Unknown parameter. Line = nnnn Error Code = eeee	An undefined reserved word (parameter) is found. An error has occurred in line nnnn. (The word that begins with "$" is a reserved one (parameter.) Only defined parameters can be used.)
2355E	2302	Unknown identifier. Line = nnnn Error Code = eeee	This is a reserved word that is not defined. An error has occurred in line nnnn. The word that begins with "_" is a reserved word. Only defined parameters can be used.)
2356E	25xx	Same parameter appears again. Line = nnnn Error Code = eeee	The same parameter is reused. An error has occurred in line nnnn. (One parameter can be described only once in a script statement.)
2357E	26xx	Required parameter is not found. Line = nnnn Error Code = eeee	A required parameter cannot be found. An error has occurred in line nnnn. (Set the required parameter to the related instruction.)
2358E	28xx	Value type mismatch. Line = nnnn Error Code = eeee	The value in the right side cannot be converted to the data in the left side. An error has occurred in line nnnn. (This error occurs when the data types in the right side and left side are different, the right side has an inappropriate value or the constant values in the right side exceed the language usage range.)

Table C.16 HORC Scripting Error Codes (continued)

Message ID	Internal Code	Error Message	Error Description
2359E	1001, 4111, 4112	Internal error. Error Code = eeee	An internal error has occurred in the program. (Reboot for re-operation. If the error recurs, reinstall.)
2360E	4181	Mismatch script type. Error Code = eeee	The script types specified by the Start macro and by the execution environment file are different. (Check that they match.)
2361E	4182	Mismatch controller name. Error Code = eeee	The device names specified by the Start macro and by the execution environment file are different. (Check that they match.)
2362E	5101	Parameter value error ($Dev). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $Dev(or $Port, $Id, $Lun) parameter.)
2362E	5102	Parameter value error ($Priority). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $Priority parameter.)
2362E	5103	Parameter value error ($Fence). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $Fence parameter.)
2362E	5104	Parameter value error ($Sync). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $Sync parameter.)
2362E	5105	Parameter value error ($SusMode). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $SusMode parameter.)
2362E	5106	Parameter value error ($SusReport). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $SusReport parameter.)
2362E	5107	Parameter value error ($DelMode). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $DelMode parameter.)
2362E	5108	Parameter value error ($OptCfw). Error Code = eeee	A functional macro parameter error is found. (The $0ptCfw parameter if for HRC only.)
2362E	5109	Parameter value error ($OptSusDfwBlk). Error Code = eeee	A functional macro parameter error is found. (The $0ptSusDfwblk parameter is for HRC only.)
2362E	5110	Parameter value error ($RcuSn). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $RcuSn parameter.)
2362E	5111	Parameter value error ($RcuSsid). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $RcuSsid parameter.)
2362E	5112	Parameter value error ($Rdev). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $Rdev (or $Rport, $Rlid, $Rlun)parameter.)
2362E	5113	Parameter value error ($CopyPace). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $CopyPace parameter.)
2362E	5114	Parameter value error ($CopyMode). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $CopyMode parameter.)
2362E	5115	Parameter value error ($PairStatus). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $PairStatus parameter.)
2362E	5116	Parameter value error ($DevAttr). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $DevAttr parameter.)

Table C.16 HORC Scripting Error Codes (continued)

Message ID	Internal Code	Error Message	Error Description
2362E	5117	Parameter value error ($OptMsg). Error Code = eeee	A internal macro parameter error is found. (Check the setting value in the $OptMsg parameter.)
2362E	5118	Parameter value error ($Unit). Error Code = eeee	A functional macro parameter error is found. ($Unit parameter is reserved for future use. Delete this parameter.)
2362E	5121	Parameter value error ($RcuSn!=$Dev). Error Code = eeee	A functional macro parameter error is found. (Set the same element in the $RcuSn parameter as in the $Dev parameter or set one parameter.)
2362E	5122	Parameter value error ($RcuSsid!=$Dev). Error Code = eeee	A functional macro parameter error is found. (Set the same element in the $RcuSsid parameter as in the $Dev parameter or set one parameter.)
2362E	5123	Parameter value error ($Rdev!=$Dev). Error Code = eeee	A functional macro parameter error is found. (Set the same element in the $Rdev(or $Rport, $Rid, $Rlun) parameter as in the $Dev(or $Port, $Id, $Lun) parameter or set one parameter.)
2362E	5124	Parameter value error ($CopyMode!=$Sync). Error Code = eeee	A functional macro parameter error is found. (Set the same number of elements in the $CopyMode parameter and in the $Sync parameter.)
2362E	5125	Parameter value error ($Susopt). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $Susopt parameter.)
2362E	5126	Parameter value error ($Port). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $Port parameter.)
2362E	5127	Parameter value error ($Id). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $Id parameter.)
2362E	5128	Parameter value error ($Lun). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $Lun parameter.)
2362E	5129	Parameter value error ($Rport). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $Rport parameter.)
2362E	5130	Parameter value error ($Rid). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $Rid parameter.)
2362E	5131	Parameter value error ($Rlun). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $Rlun parameter.)
2362E	5132	Parameter value error ($CTG). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $CTG parameter.)
2362E	5133	Parameter value error ($OptErrLv). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $OptErrLv parameter.)
2362E	5134	Parameter value error ($SusRange). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $SusRange parameter.)
2362E	5135	Parameter value error ($PendData). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $PendData parameter.)
2362E	5136	Parameter value error ($DelRange). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $DelRange parameter.)

Table C.16 HORC Scripting Error Codes (continued)

Message ID	Internal Code	Error Message	Error Description
2362E	5137	Parameter value error ($OptRsmRange). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $OptRsmRange parameter.)
2362E	5138	Parameter value error ($Seqchk). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $Seqchk parameter.)
2362E	5139	Parameter value error ($TimeSave). Error Code = eeee	A functional macro parameter error is found. (Check the setting value in the $TimeSave parameter.)
2995E	5201	Illegal combination ($Sync and $OptSusDfwBlk). Error Code = eeee	A combination of a functional macro parameter is illegal. (HRC only.)
2995E	5203	Illegal combination ($Sync and $CTG). Error Code = eeee	A combination of a functional macro parameter is illegal. (Check the setting value in the $Sync and $CTG parameter.)
2995E	5204	Illegal combination ($OptErrLv). Error Code = eeee	A Combination of a functional macro parameter is illegal. (Check the setting value in the $OptErrLv parameter.)
2996E	5301	$CTG not found. Error Code = eeee	$CTG parameter is indispensable for asynchronous pair creation. (Add a postscript of $CTG parameter to the CreatHorcPair functional macro.)

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