INSTALLATION INSTRUCTIONS

MicroComm DXI

ACB-101 Audio Control Board

1. Intent & Scope

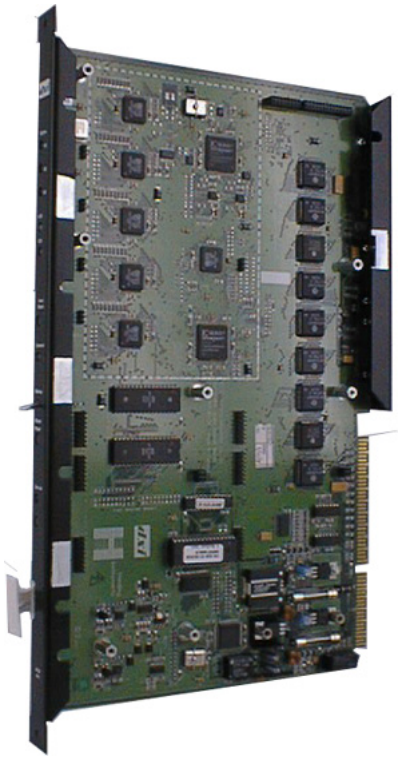
This document describes the installation procedure for the ACB-101 Audio Control Board.

2. Description

The ACB-101 Audio Control Board controls all the I/O cards in a MicroComm DXI card cage. It controls the system's audio switching and includes the system's digital signal processors. Audio trunking between card cages, which may be linked to form larger exchanges, is also made through the ACB.

Each Audio Control Board may include up to two Digital Signal Processor (DSP) expansion modules. Each expansion module provides four more DSPs. These DSPs are used to support additional I/O cards and special functions such as Audio Level Alarms and conference calls. Digital audio trunk (CEPT) interfaces are available for fiber optic and copper conductor networks

An Audio Control Board (ACB-101) must be located in the first card slot of each card cage. If a redundant ACB card is required it must be located in the second card slot of the card cage. All other cards can be located in the card cage in any position, without affecting the performance of the system.

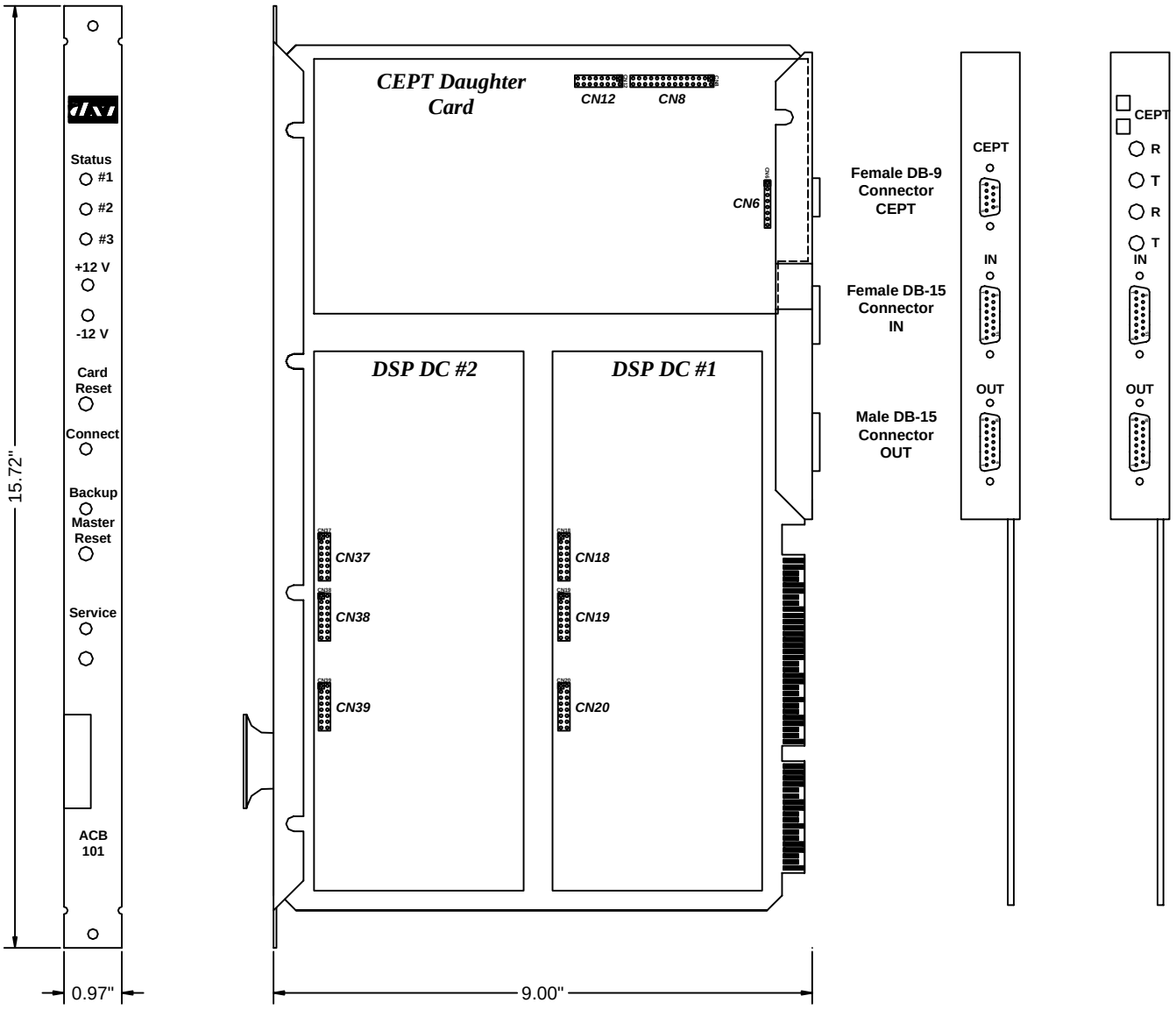


ACB-101

3. DSP Daughter Cards

The ACB-101 has five Audio DSPs that can support up to 32X5 Master Stations in a single card cage. If more Master Stations are required a DSP daughter card should be installed. If the card cage is used to provide Audio Alarms (ALA) then a DSP daughter card is required. One daughter card can provide ALA support for 128 audio channels, while two daughter cards can provide ALA support for 256 channels.

The ACB-101 has headers for inserting one or two DSP daughter cards. Each daughter card contains four DSPs. The following diagram shows the location of headers CN18, CN19 and CN20, which are used to connect DSP daughter card #1, and headers CN37, CN38 and CN39 headers, which are used to connect DSP daughter card #2



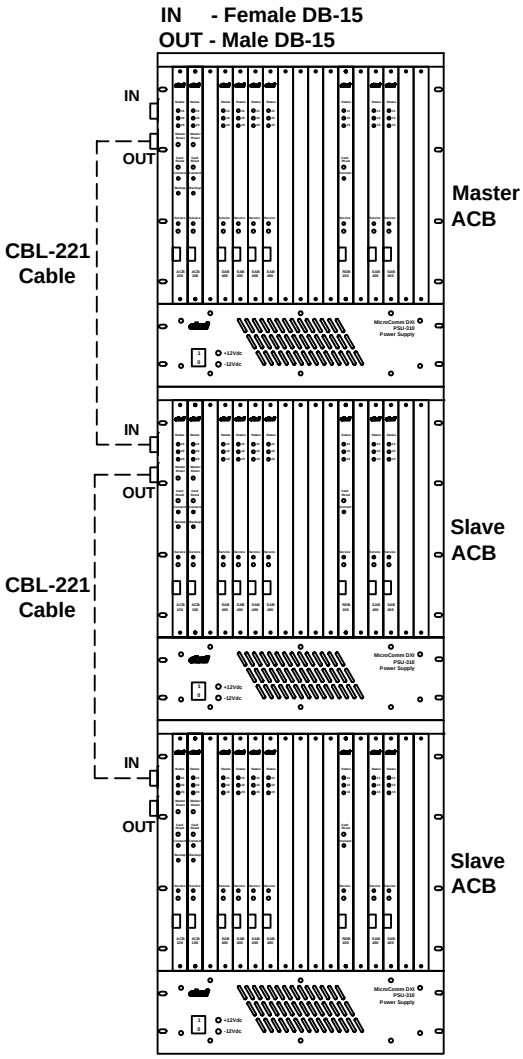
Header Location for DSP Daughter Cards and CEPT Daughter Card on PC06718-04-01

4. Card Cage Linking

The MicroComm DXI I/O card cages can be linked together to form a larger exchange. When card cages are mounted in the same equipment rack, the link connection is via the DB-15 "Link" connector on the rear of the ACB.

4.1 Link Cable Interface

If there are two to three card cages in one equipment room, and they are mounted adjacent to each other in the equipment racks (less than 3 ft distance from ACB to ACB), then the ACB's can be connected through a "back plane link" cable for an inexpensive audio trunk link. The ACB without a cable connected to its DB-15 connector labeled IN acts as the "master" ACB for the group of card cages.



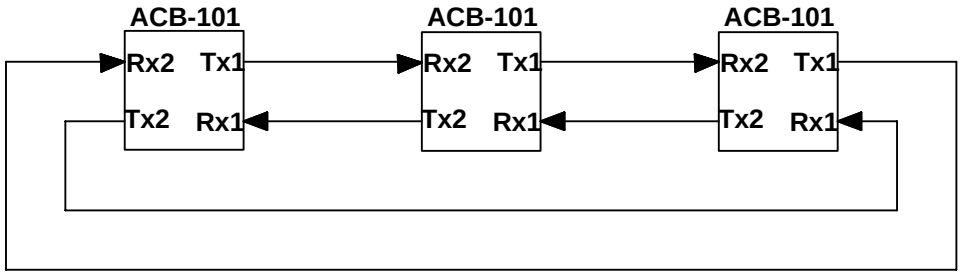
The link between the ACB-101 cards is made using special DB-15 connectors located on the back of the ACB. A CBL-221 cable, with a male DP-15 connector at one end and a female DB-15 connector at the other end, is used to connect the ACB's of two card cages together. The female DB-15 connector on the CBL-221 cable is connected to the male DB-15 connector labeled OUT on the first ACB. The male DB-15 connector on the CBL-221 cable mates with the female DB-15 connector labeled IN on the second ACB. If a third card cage is linked then a second CBL-221 cable is used to link the DB-15 connector labeled OUT in the second ACB to the DB-15 connector labeled IN in the third ACB.

The MicroComm DXI I/O card cages can be linked together to form a larger exchange. When card cages are mounted in the same equipment rack, the link connection is via the DB-15 'Link' connector on the rear of the ACB card. To interconnect multiple card cages at remote locations to form an exchange, CEPT ports on the ACB are used. CEPT trunks are available in fiber optic and copper cable versions. One limitation of a back plane link is that a maximum of three card cages can be linked in this fashion, and they must be adjacent to each other to comply with the length requirements.

4.2 CEPT Trunk Configuration

If card cages are located remotely from each other a CEPT daughter card is required Connections from the daughter card to the main pc board are made through headers labeled CN6, CN8 and CN12 shown on the diagram on page 2.

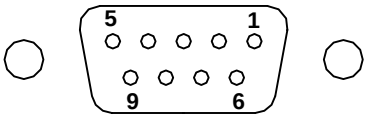
The network configuration of the CEPT trunk is that of a bi-directional loop, as indicated in the diagram below. Each transmit and receive port of a CEPT pair is connected to the opposite ports of the next ACB in the loop i.e. Tx1 of the first ACB is connected to Rx2 of the next ACB, while Tx2 of the second ACB is connected to Rx1 of the first ACB. In the CEPT network show the ACB's are connected so that one loop is in the clockwise direction, while the second loop is in a counterclockwise direction. With this configuration if one link is broken data can still be transmitted from one ACB to any other ACB by switching to the second loop.



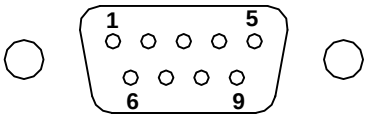
CEPT Network

4.3 Copper CEPT Network Interface

For the copper conductor interface version of the CEPT trunk a CBL-160 cable connects to the female DB-9 connector on the rear of the ACB card. The CBL-160 cable has four twisted pair cables that are used to connect the ACB's DB-9 connector to a terminal block. From the terminal block unshielded twisted #22 awg wire pairs are used to connect the ACB to the remote ACB(s). Signals indicated in the following table are from the board's perspective.



Female
DB 9 Connector



Male
DB 9 Connector

The maximum distance between ACB cards for a 22 gauge (unshielded) twisted pair is 8,200 ft (2.5 km).

Pin	CEPT Signal	Wire Color
1	RTIP1	White/Blue Stripe
6	RRING1	Solid Blue
2	TTIP1	White/Orange Stripe
7	TRING1	Solid Orange
3	Ground	Shield
8	RTIP2	White/Green Stripe
4	RRING2	Solid Green
9	TTIP2	Solid Brown
5	TRING2	White/Brown Stripe

4.4 Fiber Optic CEPT Network Interface

The fiber optic CEPT interface version of the audio control board is provided with four ST type fiber optic connectors. The top pair is the CEPT 1 connections and the bottom pair is the CEPT 2 connections. The labeling Tx (Transmit) and Rx (Receive) are from the board's perspective.

The maximum signal strength power loss in a fiber optics CEPT link must not exceed 13 db. The length of cable, number of connectors, and number of patch panels determines the loss of signal strength in fiber optic cables. With only one pair of connectors between ACM cards for a 62.5/125 multimode fiber optic cable the maximum distance between ACB's is 12,500ft (3.8 km).

Typically, every connector reduces the signal by 0.3 db, and every 3,300 ft (1 km) of cable reduces the signal by 3.2 db, assuming a perfect connection. You should allow for some extra margin for field-grade connections.

5. Status Lights

The ACB has a Neuron and a LonWorks connection. The ACB card communicates with the SAC computer over the LonWorks network. The ACB runs in conjunction with the audio cards in a card cage, such as AIB, AIO, AOB, PAB and SAB cards. If a fault occurs on one of these cards then the fault light (LED Status #3) will come on the ACB card as well.

Status Lights for ACB-101

Card Status	Status #1 (GREEN)	Status #2 (GREEN)	Status #3 (RED)	Connect (GREEN)
unbound/not configured (not in service)	Off	Off	Off	On
bound but not receiving pings (lost LonWorks connection)	Off	Off	Off	On or Off[#1]
bound and receiving pings (normal operation) Active ACB	Blink (1/8 duty cycle)	Flashes when receiving commands from SAC	Card Fault Status[#2]	On
bound and receiving pings (normal operation) Inactive ACB (for redundant ACB)	Wink (7/8 duty cycle)	Flashes when receiving commands from SAC	Card Fault Status[#2]	On
DSP not loading (self-test failure)	Fast Flash (2 Hz) (50% duty cycle)	Off	Fast Flash (4 Hz) (50% duty cycle)	On

1. The ACB attempts connection for 4 sec and then disconnects. The disconnect time starts at 4 sec and increases by 12 sec after each additional attempt. When the maximum disconnect time of 17 minutes is reached, no additional time is added.
2. If any card in any slot is reporting a fault, then Status #3 is turned on. This LED is turned off when all cards in the card cage are no longer reporting faulty terminations.

6. Redundant ACB System

The DXI system is designed to allow for a redundancy mechanism for any single point failure in the system. The system can be purchased with redundant ACB cards and provide a hot-standby redundancy that will keep the system operating in case of any ACB fault or audio trunk fault

In a DXI system that utilizies redundant ACB's there must be two ACB-101s in each card cage, one in slot 1 and the second in slot 2. For conveniece we will call the ACB's in the slot 1 position the "A" set of ACB's and the ACB's in the second slot position the "B" set.

Redundant ACB cards can provide the DXI system with correction from any of the following single-point failures:

1. Failure of any "A" slot ACB's in the system will result in all ACB's in the system switching to the "B" slot ACB in each card cage.
2. Failure of any "A" slot CEPT connections will result in all ACB's in the system switching to the "B" slot ACB in each card cage.

Failure of any "A" external backplane link connections in the system will result in all ACB's in the system switching to the "B" slot ACB in each card cage.

6.1 Card Cage Linking with Redundant ACB's

6.1.1 Link Cable Connections

All card cages in the same equipment room that are connected by backplane link cables must have two separate backplane link chains such that all "A" ACB's in the first slot are connected in one chain, and all "B" ACB's in the second slot are connected in a separate chain. There should be no connection between the "A" and "B" ACB's (this is handled within the card cage). The order of chains from cage to cage should be consistent between the "A" and "B" sets of ABCs. One card cage must be designated as a "master". Both ACB cards located in this card cage will not have a connection to the upper link connector labeled IN. The connection of a single chain of ACB's was described previously in Section 4.1

6.1.2 CEPT Loop Connections

All card cages which have CEPT audio trunk connections must have two separate CEPT loop pairs such that all "A" ACB's in the first slot are connected in one CEPT loop pair, and all "B" ACB's in the second slot are connected in a separate CEPT loop pair (with each CEPT loop pair wired as described in Section 4.2). There should be no connection between the "A" and "B" ACB's (again this is handled within the card cage). The order of the connections from cage to cage should be consistent between the "A" and "B" sets of ACB's.

6.2 Normal Operation

In normal operation, every card cage will have two ACB's installed, configured, and swapped into service, one in the first "A" slot and one in the second "B" slot.

During normal operation, every card cage will have the ACB in the first slot controlling the card cage. This controlling "A" ACB in the first slot has direct and exclusive control of the audio cards within the card cage, as

well as the digital switch within the ACB itself. The controlling ACB is the "active" ACB. The "B" ACB in the second slot of each card cage does not have control of the audio cards, but still remains in control of its own independent digital switch. This secondary ACB is the "inactive" ACB.

During normal operations, all audio trunk connections are made to the trunks connected to the "A" set of ACB's, while the trunks on the "B" set of ACB's will remain dormant.

For each card cage, control messages from the SAC computer are sent only to the active ACB card. The Active ACB card makes the connections through its digital switch, which will connect up the audio path through the audio cards.

As these control messages are processed on the active ACB, the active ACB also passes the same messages to the inactive ACB. The inactive ACB makes the same connections through its digital switch; however the inputs and outputs of the switch are not yet connected to the audio cards since the audio cards are exclusively connected to the active ACB.

In addition to control messages, all intercom switch activity (including on hook and off hook status of masters and handsets) is also transmitted from the active to the inactive ACB card in each card cage.

These operations keep the inactive ACB in lock step with the active ACB.

6.3 Failure Recovery Operation

If a failure is detected, or if the service personnel wish to test for redundancy operation, the system will switch to the redundant ACB in each card cage.

During normal operation, the inactive ACB is kept in sync with the active ACB with the control messages. When a switchover is required, all connection status information required is already present within the inactive ACB. Thus, when a switchover occurs, the following steps are taken to take control of the system:

1. The SAC computer sends the "B" ACB in **every** card cage in the system a control message informing it that the system is switching control from the "A" cards to the redundant "B" cards.
2. Upon reception of this command, the "B" side cards will send a message to the "A" side cards that a switchover is imminent. After this, both the "A" (previously active) and "B" (previously inactive) ACB cards in each cage will temporarily stop processing commands from the SAC computer to allow for switchover. Also at this time, all audio cards will be put in a "pause" state to minimize any audio artifacts during switchover. At this point, all conversations in progress will go silent, and the Status 1 LED indicators on the SAB cards will blink slowly to indicate that they are in a paused state.
3. After a brief delay to allow all audio cards to be paused, the "B" (previously inactive) ACB cards in each card cage will take over direct and exclusive control of the audio cards within the card cage. In addition, all audio trunks now connected to the "B" ACB cards become the active audio trunks. When backplane link cables are used between ACB's, this means that critical timing information (transmitted on the backplane link cables) from the master to the slave card cages is also switched.
4. After another brief delay to allow any transients (both audio and critical timing related) to stabilize, the "B" (newly active) ACB card in each card cage will restart all audio cards. As each audio card is re-started, conversations in progress will become "live" again. At this point, the Status 1 LED indicator on that audio

card will resume its normal fast blink state to indicate that it has re-started. Also at this point, the ACB card will start processing commands from the SAC computer again.

5. After all audio cards are re-started, the SAC computer re-sends configuration information to the ACB cards to ensure that the audio cards have restarted properly.

6. Once the configuration information has been transmitted, normal activity takes place, except that all commands are now sent to (and processed by) the ACB in the second "B" slot of each card cage.

During the failure recovery operation, any audio device with a currently active connection (intercom, master, call recorder, etc.) may hear a slight "pop" as the control of the audio cards passes between the "A" and "B" ACB's.

In a typical two card-cage system with redundancy, this process should take under 30 seconds to complete, with audio returning within 10-20 seconds after switchover.

6.4 Restoration Operation

Once the system has switched into failure recovery mode, all control is done by the ACB's in the second "B" slot of each card cage, and the system will perform normally. This allows the maintenance staff to troubleshoot the cause of the switchover, and repair the problem component or faulted wiring. Once the fault has been corrected, the system will automatically restore itself to normal operation using the ACB's in the first "A" slots of each card cage.

If the fault was due to a problem with the audio trunk wiring (and no ACB cards were removed/replaced), the restoration operation is the same as the failure recovery operation, except control is passed from the "B" set of ACB's to the "A" set of ACB's. The control messages from the SAC computer to the ACB cards to cause the switchover in this case are still sent to the "B" cards, which will then relinquish control to the "A" cards.

6.4.1 Procedures for Returning an ACB Card to Service

When an ACB card has to be replaced, and has been pulled from the card slot following a "Swap Card" or "Remove Card" function from the SAC computer , maintenance staff should follow the following procedure. to return an ACB card to service.

NOTE: During this procedure, the intercom equipment controlled by the card cages in the equipment room may be unavailable for a short time (up to two minutes) so it should be scheduled for an appropriate time.

1. Insert the ACB card.

2. Use the "Swap Card" function in the SAC computer to restore the card to service. You will be required to press the service button at the appropriate time (see Section 6 of the Maintenance Manual for this procedure).

3. Press (and release) the "Master reset" button on the active ACB in this card cage (the one with the 1/8 duty cycle flash on Status LED #1).

4. If there is a second card cage linked to the OUT link connectors on this card cage ACB's, then proceed by pressing the "Master Reset" button on the active ACB in the second card cage (the one connected to the OUT link connector.)

5. If there is a third card cage linked to the OUT link connectors on the second card cage ACB's, press the "Master Reset" button on the active ACB on it.

6.4.2 Restoration Sequence

Once the card has been removed/replaced, and the appropriate ACB cards have been reset (the ones in this cage and all subsequent slave card cages), the SAC will restore the connection information for these control cards. The following steps are automatically performed by the SAC computer to synchronize this card cage with the active connections and restore the system to normal operation.

1. The SAC computer stops sending control information to all card cages in the system.
2. The SAC computer sends the newly-inserted ACB card (and the active ACB card for this cage) all required configuration information for that card.
3. The SAC computer sends the newly-inserted ACB card (and the active ACB card for this cage) all active connection information about current connections within that card cage.
4. Once the newly-inserted ACB card (still in the "A", inactive slot) has received all of its control messages, the SAC computer will initiate the normal restoration operation above, which involves sending a message to all "B" cards to relinquish control. The restoration operation is exactly the same as the failure recovery operation, except control is passed from the "B" set of ACB's to the "A" set of ACB's.
5. Once the restoration operation is complete, normal activity takes place. All commands are now sent to (and processed by) the ACB in the first "A" slot of each card cage.

This restoration procedure described above also happens when the system is running in normal mode (with the ACB's in the first "A" slot being active) when an ACB card is inserted into any second "B" slot, with the exception that "A" is the active slot, and "B" is the inactive slot, and that the system will not to switch to the "A" ACB cards as listed in step 4 because "A" is already active. The same notes about the installation procedure above (with regards to swapping the cards and re-setting this card cage and subsequent slave card cages) should be followed in this circumstance also.

6.5 Conditions Causing Redundant ACB Switchover:

The Redundant ACB switchover can be initiated automatically by faults in ACB cards or audio trunks, or can be initiated by the maintenance staff through the backup switches on the ACB cards, or through software on the SAC computer.

The system will not permit switching from a working set of ACB cards and audio trunks to a faulted set of ACB cards and audio trunks.

1. Automatic switchover:

   Normally, if the "A" slot ACB's and audio trunks are working, control will switchover to the "A" slot ACB's. If any "A" slot ACB's or audio trunks fail, then the system will switchover to the "B" slot ACB's. When both "A" slot ACB's and "B" slot ACB's are working, control will pass back to the "A" slot ACB's.

   1.1. The system will automatically switchover from the "A" slot ACB's to the "B" slot ACB's whenever there are no faults with the "B" slot ACB's and audio trunks, and a fault with an "A" slot ACB or audio trunk is detected.

1.2. The system will automatically switchover from the "B" slot ACB's to the "A" slot ACB's whenever all of the faults in the "A" slot ACB's and audio trunks have been repaired.

The exception to 1.2 above is when the initial switchover from "A" to "B" was initiated by the SAC software or backup switch; in which case as long as all "B" slot ACB's and audio trunks remain working, the "B" slot ACB's will be used until another SAC software or backup switch initiated switchover occurs. This allows maintenance staff to perform redundancy tests.

2. Backup switches:

All of the ACB cards have a switch labeled "Backup". The most recently toggled switch is the switch that will be used to determine the next state. Changing a switch to the "Down" position indicates that the "A" slot ACB's should be used, while changing a switch to the "Up" position indicates that the "B" slot ACB's should be used

2.1. The system will switchover from the "A" slot ACB's to the "B" slot ACB's whenever there are no faults with the "B" slot ACB's and audio trunks and any ACB card's "Backup" switch is moved from the "Down" position to the "Up" position.

2.2. The system will switchover from the "B" slot ACB's to the "A" slot ACB's whenever there are no faults with the "A" slot ACB's and audio trunks and any ACB card's "Backup" switch is moved from the "Up" position to the "Down" position.

3. SAC software initiated switch:

The "View Networks" software function of the SAC computer can switch control of the redundant ACB cards (see below for operation of this function).

3.1. The system will switchover from the "A" slot ACB's to the "B" slot ACB's whenever there are no faults with the "B" slot ACB's and audio trunks and the F6 key is pressed while viewing an ACB card in "View Networks" to force a switch.

3.2. The system will switchover from the "B" slot ACB's to the "A" slot ACB's whenever there are no faults with the "A" slot ACB's and audio trunks and the F6 key is pressed while viewing an ACB card in "View Networks" to force a switch.

The following tables show the switchover conditions: Conditions to switch from the "A" slot ACB's to the "B" slot ACB's:

Current Mode	ACB/Trunk Status "A"	"B"	Switchover Condition (switch to "B" ACB's)
Normal	Working	Working	Automatic switchover to "B" on failure of "A" ACB or audio trunk Forced switch by SAC computer Toggle of backup switch (toggle any switch from "down" to "up")
Backup Failure	Working	Faulted	Will not switch (does not switch from working "A" to faulted "B")
Multi-point failure	Faulted	Faulted	Forced switch by SAC computer Toggle of backup switch (toggle any switch from "down" to "up")

Conditions to switch from the "B" slot ACB's to the "A" slot ACB's:

Current Mode	ACB/Trunk Status "A"	B"	Switchover Condition (switch to "A" slot ACB's)
Normal	Working	Working	Forced switch by SAC computer Toggle of backup switch (toggle any switch from "up" to "down")
Failure Recovery	Faulted	Working	Automatic switch-over to "A" once all problems on "A" are fixed (if the initial switchover to "B" was not caused by a forced switch on the SAC or the backup switch)
Multi-point failure	Faulted	Faulted	Forced switch by SAC computer Toggle of backup switch (toggle any switch from "up" to "down")

6.6 LED Indicators for Active/Inactive ACB's

The current status of ACB's in a redundant ACB system is indicated on the Status 1 LED on each ACB.

If the Status 1 LED is at a 1/8 duty cycle (on 1/8 of the time and off 7/8 of the time), that ACB is the active ACB.

If the Status 1 LED is at a 7/8 duty cycle (on 7/8 of the time and off 1/8 of the time), that ACB is the inactive ACB.

All card cages should show the same status – with either all ACB's in the first slot active (1/8 blink) and all ACB's in the second slot inactive (7/8 wink), or all the ACB's in the first slot inactive (7/8 wink) and all ACB's in the second slot active (1/8 blink).

6.7 Using View Networks

The "View Networks" function in the "Maintenance" menu of the SAC software will allow you to view the status of redundant ACB cards, and control the switchover.

6.7.1 Viewing the status of an ACB card

To view the status of a particular ACB card, first enter the "View Networks" function in the SAC menus.

Then select the card number of that ACB card using the PgUp/PgDn keys, or by pressing F2 then entering the card number of that ACB card.

The center of the screen should show the connection status of the ACB card

If the card is currently active, it will only show the "# Active chns:" with blank space behind it.

If the card is currently inactive, it will show "# Active chns (backup)".

The "Card Status" line indicates which slot the card is in (slot 0 – the first slot or "A" slot, or slot 1 – the second slot or "B" slot). It also indicates the default status of the card; if there is a "*" following the slot number, it indicates the card will normally be the active card unless there is a fault in this set of ACB cards.

For example, an active ACB card located in the first "A" slot would show:

```
# Active chns:    1
Card Status:      In Service  (slot 0*)
```

An inactive ACB card located in the second "B" slot would show:

```
# Active chns:    1           (backup)
```

```
Card Status:      In Service  (slot 1)
```

6.7.2 Initiating a Redundant ACB switchover

The SAC software will not permit a redundant switchover if the active set of ACB cards has no faults, and the other set of ACB cards has one or more faults (i.e. If you are running on the "A" set of ACB cards which have no faults, and you try to switchover to the "B" set of ACB cards where one of the "B" ACB cards is faulted, the SAC will not switchover to the "B" set). This applies to switchover attempts caused by the toggle switches on the cards as well as the SAC software control.

To force a switch of the redundant ACB's under software control, first select the card number of any ACB card using the PgUp/PgDn keys, or by pressing F2 then entering the card number of that ACB card.

The center of the screen should show the connection status of the ACB card as above, where you can see whether the card is currently active or currently inactive. To cause the system to switch to the other set of ACB cards, press the F6 key on the keyboard. The computer will pop up a message asking if you want to switch the active ACB cards, if you wish to perform this action, press "Y". The system will then perform a switchover of all ACB cards.

6.8 Additional Notes

For best system performance it is recommended that the following procedures are followed.

6.8.1 Power down/Power up

If you need to power down/power up or reset any card cage that is using a link cable, you should power down/power up or reset all card cages in the equipment room connected by link cables. The start up or reset sequence should follow a specific pattern to avoid any start-up problems.

When turning on or resetting card cages which are connected by a back plane link cable, you should always start with the master card cage in that equipment room (the one without any cables in the IN link connector). Then proceed with turning on or resetting the next cage in the backplane link chain, proceeding to the third cage if present. When re-setting a card cage, press the "Master Reset" button of the active ACB in that card cage (the ACB which is blinking at a 1/8 duty cycle on the Status 1 LED).

If all the cards are turned on at the same time (such as after a blackout, turning the main breaker on, etc.), the system will reset itself properly.

6.8.2 Redundant switch-over time

Because the switchover process is not instantaneous, repeated switchover may cause delays in the system while it processes all of the switching commands. When testing redundancy, you should cause a switchover, then wait at least 30 seconds before initiating another switch.

6.8.3 Restore to normal state when problems are repaired:

Because there is a small possibility that an ACB in the second "B" slot may fail to relinquish control of the audio cards if it fails, it is highly recommended that in normal operations, the "A" slot ACB's should be the active ACB's. Normally the system will automatically switch back to the "A" slot ACB's when all faults have been

repaired unless the switchover was forced from the backup switches or the SAC software. If the switchover was caused to test the redundancy operation, it is recommended to switch back to the "A" side ACB's once the test is complete.