PBX Integration Board User's Guide

for Linux and Windows

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1. How To Use This Manual

1.1. Audience

This manual is addressed to programmers and engineers who are computer-literate and are interested in using PBX integration boards and APIs from Intel to develop a computer telephony application for use on a PBX.

When this manual addresses "you," it means "you, the programmer," and when this manual refers to the "user," it means the end-user of your application program.

1.2. Product Terminology

This manual includes information about using your *Private Branch eXchange* (PBX) or *Key Telephone System* (KTS) with a PBX integration board from Intel. A PBX is a privately owned, mini version of a telephone company's *central office* (CO) switch. For businesses, the key advantage to owning a PBX is the efficiency and cost savings of sharing a specific number of telephone lines among a large group of users. Grouped with PBXs are KTSs, which are generally smaller versions of a PBX that provides direct access to CO telephone lines. For simplicity, the term PBX will be used to denote both a PBX and KTS.

In the PBX environment a *line* from the CO is called a *trunk* and a phone is called a *line*, *extension*, or *station*.

1.3. PBX Models Covered in this Manual

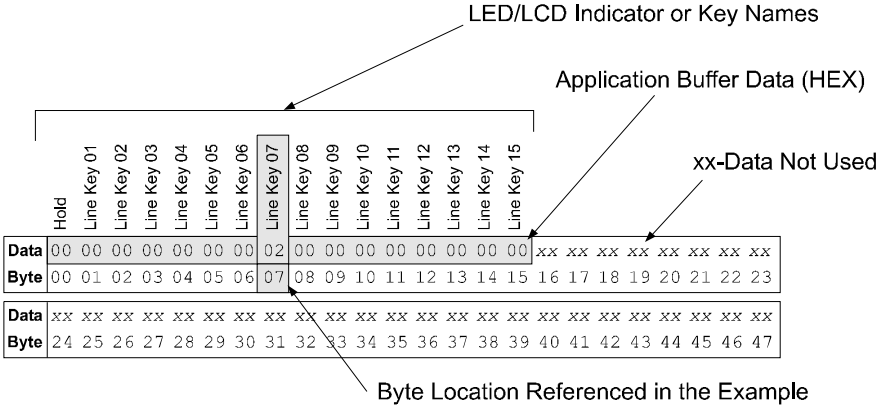
This manual includes support for the following PBXs and KTSs and associated telephones:

Manufacturer	PBX Hardware	Telephone Emulations
Avaya	Definity* System 75 Definity System G3 Ver. 4 and higher	7434 (4-wire) 8434 (2-wire)
Mitel	SX-50 SX-200 SX-2000	Superset* 420 (DNIC) Superset 430 (DNIC) Superset 430 (DNIC)
NEC	NEAX 2000 IVS, IVS2, IPS NEAX 2400 IMS Electra Elite, Electra Professional 120	DTerm Series III
Nortel	Norstar* DR5, CICS and MICS Meridian* 1	M7324 M2616
Siemens	ROLM CBX 9005, 9006 and 9715 Hicom* 150, North America and 300, North America	ROLMphone 400 (RP400) Optiset E

1.4. Documentation Conventions

The following documentation conventions are used throughout this manual:

- When terms are first introduced, they are shown in italic text.
- Data structure field names and function parameter names are shown in boldface, as in **maxsec**.
- Function names are shown in boldface with parentheses, such as **d42_display( )**.
- Names of defines or equates are shown in uppercase, such as T_DTMF.
- File names are italicized and in uppercase, such as *D42DRV.EXE*.
- Examples included in this manual show data that is stored in an application buffer. The contents of a buffer is illustrated as follows:



Application buffers are typically 48 bytes long (plus a null). The actual data (in HEX) is shown in the gray area. The byte(s) referenced in the example is shown in boldface.

1.5. Voice Hardware Covered by This Manual

The PBX integration board voice hardware is designed to provide a set of cost-effective tools for implementing computerized voice and call processing applications for PBXs. It provides the basic voice and call processing capabilities of Intel Dialogic D/4x voice hardware and adds hardware and firmware that eases integration with supported PBXs. The PBX integration board hardware also provides access to PBX functions not normally available. Refer to the *Voice Software Reference* for your operating system for more information on voice and call processing.

The PBX integration hardware models covered by this manual include the following Intel Dialogic boards:

- **D/42JCT-U –** a 4-channel voice board with station interfaces for connecting directly to a number of different PBXs.
- **D/82JCT-U –** an 8-channel voice board with station interfaces for connecting directly to a number of different PBXs.

1.5.1. Voice Hardware Model Names

Model names for Intel Dialogic voice boards are based upon the following pattern:

D/NNNoRBB-TT-VVV

where:

- **D/** - identifies the board as Intel Dialogic voice hardware
- **NNN** - identifies the number of channels (2, 4, 8, 12, etc.), or relative size/power measure
- **o** - 0 indicates no support for Call Progress Analysis; 1 indicates support for Call Progress Analysis; and 2 indicates PBX support
- **R** - if present, represents board revision (D, E, J, etc.)
- **BB** - bus type (SC or CT)
- **TT** - telephony interface type (if applicable; valid entries include LS, T1, E1, BR, U {for universal PBX Interface)
- **VVV** - ohm value (if it applicable; valid entries are 75 and 120)

Sometimes it is necessary in this document to refer to a group of voice boards rather than specific models, in which case an "x" is used to replace the part of the model name that is generic. For example, D/xxx refers to all models of the voice hardware, and D/8x refers to all 8-channel models.

1.6. When To Use This Manual

This *PBX Integration Board User's Guide* contains information for configuring and using specific PBX hardware for use with PBX integration boards. For information about installing hardware, refer to the *PBX Integration Quick Install Card* provided with your board. For information about installing PBX integration software, refer to the *System Release Software Installation Reference* for your particular operating system.

1.7. How This Manual Is Organized

Chapter 1 – How To Use This Manual describes the *PBX Integration Board User's Guide*.

Chapter 2 – Introduction to PBXs and KTSs provides a brief description of Private Branch Exchanges (PBXs), Key Telephone Systems (KTSs) and hybrid systems.

Chapter 3 – PBX Integration Overview provides information about the voice and PBX-specific features supported by the PBX integration products and a description of the unified API.

Chapter 4 – PBX Configuration and Integration contains general descriptions, capabilities, switch requirements, and direct key dial sequences of all supported PBXs.

Appendix A – PBX Integration Specifications contains a data sheet for the PBX integration circuit cards.

Glossary contains a comprehensive list of definitions for commonly used terms.

Index contains an alphabetical index of features and topics.

2. Introduction to PBXs and KTSs

A PBX, or *private branch exchange*, is a telephone system that is usually installed in a business. It provides service among many extensions within the business as well as outside lines. Typically, PBXs are used when a large number of extensions are needed. A PBX can be thought of as a mini version of a telephone company's *central office* (CO) switch. Key advantages to owning a PBX are:

- increased efficiency and cost savings because a specific number of CO telephone lines are shared among a large group of users
- special PBXs features.

Grouped with PBXs are *key telephone systems* (KTSs). A KTS is generally a smaller version of a PBX that also provides direct access to outside telephone lines (trunks). When you press a "line" key on a KTS you immediately hear a dial tone from the central office. In contrast, on a PBX system, you have to dial a digit, usually "9", to get the dial tone from the central office. Typically, KTSs are used when less than 50 extensions are needed. Advantages of having a KTS are that anyone in your office can answer an incoming call simply by pressing the correct line button and KTSs usually cost less than PBXs.

Systems have been developed that combine PBX and KTS features. These hybrid systems typically serve up to 100 users and contain some features found only in PBXs (the ability to use single line phones) and features typically found in KTSs (hands free announcing and answerback). An example of a hybrid system is the NEC Electra Professional which can connect to a maximum of 64 outside lines and 96 extensions. Some features include least cost routing, call forwarding, call hold, automated attendant, and caller ID.

For simplicity, throughout this manual the term PBX will be used to denote a PBX, KTS, or hybrid system.

Most PBX systems are digital. In a digital system, both the *voice signals* and *control information* transmitted between *station sets* within the PBX are sent as binary data. Analog voice signals received from outside the PBX (usually a CO) are converted to digital voice data and sent through the PBX. Digital voice data

may be sent outside the PBX if outside networks also use digital circuits; however, they are usually converted back to analog voice signals.

PBXs use control information to instruct their station sets to perform specific functions such as setting the message waiting indicator and call transfer. This control information is sent using proprietary digital *protocols*. A protocol is a set of rules relating to the format and timing of data transmissions. These protocols not only contain control information, but also "message" data that can be used to significantly enhance *computer telephony* (CT) applications that use PBX call control elements such as called/calling number ID.

The term "computer telephony" refers to the ability to interact with computer databases or applications from a telephone. Computer telephony technology supports applications such as:

- automatic call processing
- automatic speech recognition
- text-to-speech conversion for information-on-demand
- call switching and conferencing
- unified messaging that lets you access or transmit voice, fax, and E-mail messages from a single point
- voice mail and voice messaging
- fax systems including fax broadcasting, fax mailboxes, fax-on-demand, and fax gateways
- transaction processing such as Audiotex and Pay-Per-Call information systems
- call centers handling a large number of agents or telephone operators for processing requests for products, services or information

PBXs can communicate with their station sets using in-band or out-of-band signaling. In-band signaling is a method used by analog (2500) telephones (e.g., calling into a PBX and using DTMF to respond to voice prompts). In-band signals use the same band of frequencies as the voice signal. This method provides limited integration because there are no standards and different PBXs provide varying levels of control.

Out-of-band signaling is used by PBXs to send and receive data from station sets or a CT computer. This data that can include information such as called/calling number ID. Out-of-band signals do not use the band of frequencies use by the

voice signals. They can be transmitted using the same wires as the telephone set or separate wires (e.g., RS-232). Because of its versatility, out-of-band signaling is the preferred method.

CT equipment comprises a PC containing a PBX integration board from Intel and a software application. PBX integration boards and APIs from Intel make it easier to create applications that are tightly integrated with a PBX and take advantage of call control elements.

Below is a list of popular PBX features and functions supported by PBX integration boards from Intel. KTSs and hybrid systems may support only some of these features.

- supervised call transfer
- blind call transfer
- caller ID
- called party ID
- positive disconnect supervision
- in-band signaling
- out-of-band signaling
- read display messages
- “press” programmable keys
- message waiting indication

2.1. Supervised Call Transfer

A supervised transfer is a method of transferring an incoming call to another extension, making use of call progress results (i.e., answered, busy, and ring no answer). This type of transfer is equivalent to the following manual operations:

1. Answer a call
2. Place the caller on hold
3. Press the transfer key (hook flash)
4. Dial the destination number
5. If the destination party answers, hang up (the transfer is complete)

6. If the destination party does not answer, switch back to the caller and provide choices to leave voice mail, select another extension, or hang up.

While a supervised transfer can be implemented without a PBX integration board (using hook flash), the availability and ease of implementation is inconsistent. By using a PBX integration board and the appropriate dial string, you can initiate a transfer the same way for all supported switches. Also, by incorporating call progress analysis, you can offer consistent, high-performance call transfer features in your applications. For example, if during the transfer the application detects a busy signal, the call is automatically sent to a mailbox.

In a supervised transfer, an incoming call answered by a channel on a PBX integration will only be transferred after a PBX integration board establishes a connection with another station (the call is not released to the PBX). If the extension is busy or does not answer, the PBX integration board reconnects to original call.

2.2. Blind Call Transfer

A blind transfer is initiated the same way as a supervised transfer. However, after dialing the destination number, the extension performing the transfer hangs up and does not wait to determine the outcome of the call. The call is released to the PBX. Blind transfers are used in most voice mail applications. A blind call transfer is equivalent to the following manual operations:

1. Answer a call
2. Put the call on hold
3. Press the transfer key
4. Dial the destination number
5. Hang up

The call is immediately sent to the new extension. It is up to the PBX to determine what to do if the transferred call is not answered (because of busy or no answer). Usually, if a transferred call is not answered it is routed back to the voice mail system, and eventually to the operator (or an automated attendant).

The advantage of a blind transfer is that the immediate release to the PBX frees the voice processing resources to handle new calls rather than being used to perform call progress. The only potential drawback of a blind transfer is when phone traffic is heavy, in which case the application may need to handle a call overflow condition.

An application can perform blind transfers without special integration tools. However, by using a PBX integration board and the unified API to access the called number ID from the PBX, the application can differentiate between:

- a new call coming in that needs to be processed: "Hello and thank you for calling Intel Corporation."
- a call that was transferred at least once already and is being routed by the PBX into voice mail: "You've reached the desk of Marcia Jones in Engineering, please leave a message."

If the call was transferred, the application can use the called number ID to send the call directly into the appropriate voice mail box, allowing the caller to leave a message without having to navigate through a series of menus for a second or third time.

2.3. Caller ID

Caller ID is the phone number that identifies the person who is placing the call. These digits are typically transmitted at the beginning of a call, usually between the first and second ring.

While telephone companies are beginning to sell a caller ID service to residential customers, the scope of this commercially available caller ID is different from the caller ID feature available with many PBXs. The caller ID from the telephone company is often referred to as automatic number identification (ANI) and identifies callers whose numbers are assigned by the telephone company. Caller ID from within the PBX identifies callers whose telephone extensions are assigned through the PBX (referred to in this document as calling number ID).

Calling number ID from within the PBX system has powerful business applications. For example, a voice mail application may use calling number ID to let users reach individual mailboxes without having to dial extra digits. Other applications may use calling number ID for screening phone calls, allowing

employees to respond to urgent calls first, as well as for automatic voice message reply, without making users redial the caller's extension. Calling number ID is useful whenever you need to know who is calling and from where they are calling.

2.4. Called Number ID

Called number ID is also a feature provided within a PBX system and is usually combined with the calling number ID. Called number ID is the phone number of the extension being called. When a call is from outside the PBX, it is the number of the trunk receiving the call. The called/calling number ID remains the same when a call is routed through the PBX system.

For example, when a call has been routed through the PBX because the first intended extension was not answered or busy, the final destination answering the call can determine the extension that called plus the extension that was originally called.

Called number ID can also be used by an application to automatically direct a call to an appropriate extension or group of extensions based on the number called (generally the last four digits).

For example, an application may provide specific information about four different programs through an interactive voice response (IVR) system. Depending on the phone number being called, the application can route the caller directly to the desired program:

Program A: 555-1202 (trunk 01)
Program B: 555-1203 (trunk 02)
Program C: 555-1205 (trunk 03)
Program D: 555-1200 (trunk 04)

Using a PBX integration board and the unified API, an application can read the called number ID (the trunk line) and route the call depending on which extension receive the call. If the call is received on trunk line 01 it will be routed to the extension for Program A. Without access to the called number ID information, callers would need to listen to a long list of prompts to obtain the four digit extension code to access Program A.

2.5. Positive Disconnect Supervision

In any PBX phone system, it is important to accurately detect when an outside caller has “hung up” the phone. This capability allows the PBX to also hang up, completing the disconnection. Once the call is fully terminated, not only is the phone line available for other calls, but more importantly the phone company’s billing charge for that call ends. One common way in which a phone or PBX manages call termination is positive disconnect supervision.

In a typical external call scenario (where a call is placed through a CO, not between extensions of the PBX), the CO detects when the caller hangs up and then sends a disconnect signal (loop current drop) to the PBX. The PBX is responsible for detecting and handling the disconnect signal from the CO.

After receiving a disconnect signal from the CO, the PBX may:

- terminate the outside call immediately and send a disconnect message to the called extension
- send a disconnect message to the called extension and wait for the called extension to hang up before formally terminating the call

In both cases, a disconnect message, not a loop current drop, is sent to the called extension. Standard analog voice boards cannot interpret disconnect messages because these messages are usually digital. PBX integration boards can, however, detect disconnect messages and send a disconnect event to an application where it is used by the standard voice programming mechanisms for handling call termination.

When a call is placed between extensions of the PBX, a disconnect message, not a loop current drop, is also used to indicate when a caller hangs up. In this scenario, the application has no way of knowing when the caller has hung up so it can receive another call. PBX integration boards can detect the disconnect message and send a disconnect event to an application.

Not all PBXs have positive disconnect supervision. Refer to the documentation for your PBX to determine if your PBX provides positive disconnect supervision.

2.6. In-Band Signaling

PBXs may use a method called in-band signaling to control their station sets. In-band signals use the same band of frequencies as the audio signal; this is usually accomplished with touch-tone signals. This method provides a limited amount of integration because there are no standards and different PBXs provide varying levels of control. Call progress tones that even similar models send can vary. This means that applications, even on identical PBXs, have to be tuned with each installation.

An example of in-band signaling is transferring a call using the flashhook method There is no data (e.g., caller ID information) passed along when the call is transferred.

2.7. Out-Of-Band Signaling

Many PBXs use a method called out-of-band signaling to control their station sets. Out-of-band signals do not use the band of frequencies used by the voice signals. These PBXs transmit control signals and data that can include information such as called/calling number ID. Because of its versatility, out-of-band signaling is the preferred method.

2.8. Read Display Messages

Most PBX station sets have an LCD or LED screen that can display messages. The type of information that is displayed varies with the PBX manufacturer and the programming capabilities of the switch. Typical information includes: calling/ called number ID from within the switch, ANI digits from the CO, hook state, time and length of call, name assigned to the extension, and message waiting notification. With a PBX integration board, this information can be easily passed "unprocessed" to the application. This means that the same data that is sent to the display is captured by a PBX integration board.

By capturing the same display messages that a phone set receives, an application can "see" and "record" the display information. This display information (in ASCII format) is especially useful in CT applications because it enables an application to know exactly what state the extension connected to the PBX integration board is in. Applications used with a PBX that provides ANI digits

may process the display data and use those digits to access related database information.

For applications using a PBX integration board to program the Nortel Norstar*, display data is indispensable. Because the programming menus and key functions change at different levels within the PBX software, the only way to know the current menu options is by having display text available.

2.9. “Pressing” Keys

Station sets typically have Feature Keys that can be programmed to perform specific functions (e.g., transfer, hold, speaker phone, speed dial, or connect to trunk lines). Since a PBX integration board emulates a station set, applications can “press” these keys. If the station set can be used to program Feature Keys, an application can also control the assignment of programmable keys. For instance, if a specific key must be assigned to the transfer function, you can include a sequence of “pressing” keys at the start of the application to ensure that the environment has been set correctly.

2.10. Message Waiting Indication

Most PBX systems turn on message waiting lights on station set phones when messages arrive, and clear the light after messages are retrieved. These tasks can be handled manually, by an attendant, or be automated through a voice mail application. Using a PBX integration board, an application can also control the state of message waiting indications on other station sets (if this feature is available on your PBX).

2.11. Automated Attendant

An auto attendant is a device connected to a PBX that answers incoming calls. After answering, it may perform functions such as playing a greeting, asking the caller to press a button, or routing the call to the proper destination.

3. PBX Integration Overview

The PBX integration board combines the voice and fax features available in the Intel Dialogic D/4x product line with the ability to access enhanced PBX features on several different PBXs. The voice features include:

- play and record voice messages
- dial and recognize DTMF digits
- detect and answer incoming call
- call progress analysis
- send and receive faxes

The PBX specific features include:

- retrieve Called/Calling number ID
- retrieve LCD/LED prompts and indicators
- read displays
- accessing PBX features using dial strings
- disconnect supervision

3.1. Voice Features Supported

The PBX integration board uses a dual-processor architecture comprising a DSP (Digital Signal Processor) and a general purpose microprocessor to handle all voice processing functions. This dual processor approach off loads many low-level decision making tasks from the host computer.

When a PBX integration system is initialized, firmware is downloaded from the host PC to the firmware RAM and DSP memory on the PBX integration board. This downloadable firmware gives the board all of its intelligence and enables easy feature enhancement and upgrades. Based on this, the PBX integration board can perform the following operations on incoming calls:

- automatically control the volume of the incoming audio signal
- record and compress the incoming audio voice signal. Sampling rates and coding methods are selectable on a channel by channel basis

- detect the presence of tones - DTMF, MF, or an application defined signal or dual tone
- perform call progress analysis (CPA) to determine the state of an incoming call.

  NOTE: PBX integration boards only support CPA when used in the default routing configuration. For instance, if a voice resource of an Intel Dialogic D/82JCT-U board is listening to a front end other than the default (its own), it may return a disconnected result. This is because these boards support the call progress analysis feature of **dx_dial( )**, only when a board is using the default TDM routing. In other words, PBX integration board voice resources cannot be used to provide CPA capability for other boards.

For outbound calls, the PBX integration board can perform the following:

- play stored compressed audio files
- adjust the volume and speed of playback upon application or user request
- generate tones - DTMF, MF, or an application defined signal or dual tone.

The PBX integration board is basically an Intel Dialogic D/41D board with specialized PBX circuitry replacing the analog front end. The PBX integration board performs features available on a D/41D and D/42-xx board, as well as emulating phones connected to a PBX. With the current Intel Dialogic D/42-xx PBX integration boards, it is necessary to choose a particular board depending on which PBX you plan to use. With the PBX integration board, however, a single board can work with several different PBXs, with the software configuration selected to reflect the PBX in use.

When recording speech, the PBX integration board digitizes it as Pulse Code Modulation (PCM), Adaptive Differential Pulse Code Modulation (ADPCM), GSM 610, or G.726. The digitizing rate is selected on a channel-by-channel basis and can be changed each time a record or play function is initiated. The processed speech is stored on the host PC's hard disk. When playing back a stored file, the voice information from the host PC is passed to the PBX integration board where it is converted into analog voice signals for transmission to the PBX.

The on-board control processor controls all operations of the PBX integration board via a local bus and interprets and executes commands from the host PC. This processor handles real-time events, manages data flow to the host PC to

provide faster system response time, reduces PC host processing demands, processes DTMF and PBX signaling before passing them to the application, and frees the DSP to perform signal processing. Communication between this processor and the host PC is via the shared buffer memory that acts as an input/output buffer and thus increases the efficiency of disk file transfers. This shared buffer memory interfaces to the host PC via the PCI bus.

3.2. PBX Integration Features Supported

PBX integration boards incorporate both circuitry and firmware to integrate applications with specific PBXs. The unified API, used with the PBX integration board, enables programmers to more easily develop a single application capable of supporting multiple manufacturer's PBXs. The unified API also enables applications to access the important digital information sent between a PBX and its station sets. This information is useful in a variety of applications including Voice Mail and Call Center.

3.2.1. Unified API

The unified API (Application Programming Interface) allows a single application to function on a variety of manufacturers switches. Functioning as an extension to the standard voice API, the unified API offers a single design model that allows developers to take advantage of advanced PBX features (such as called/calling number ID and ASCII display information).

- **Called/Calling number ID** - usually two sets of digits representing either a trunk line or an extension. This is not to be confused with caller ID received from a CO which provides the telephone number of an outside caller. It is important for an application to know where a call originated and to what extension it is intended. When a call is transferred (or "bounced") through a PBX, this information may be needed by an application at the final destination. If it is not present, the originator (if they are still connected) will have to re-enter the information.
- **Retrieve LCD/LED prompts and indicators** - Different PBXs have different types of prompts and indicators that relay status information of the station set. By capturing and processing this data, an application can "see" what prompts or indicators have been set.

- **Read displays** - There are many types of information displayed on a phone; for instance, hook state, messages, features, and other ASCII text. By capturing and processing this data, an application can "see" what is on the display. This is useful for determining the state of the PBX integration board. Also, when ANI and DNIS digits are available through the PBX, the CO caller ID can be obtained. Display data is also useful when programming a PBX. Because the PBX integration boards allow applications to "press" buttons, applications can be written to program the PBX in the same way as using a station set to program the PBX.
- **Accessing PBX features using dial strings** - The PBX integration board allows applications to access features that are available through a station set. These functions include call transfer, hold, setting the message waiting indicator, and dialing programmable keys.
- **Disconnect supervision** - When a PBX detects a hang-up from one of its extensions, information is passes to the CO, which in turn hangs up. Typically this is accomplished using a loop current drop. However, if the CO hangs up first, a loop current drop is sent to the PBX but is not passed to the station set. Instead, the station set receives a disconnect message. The PBX integration board interprets this disconnect message as a loop current drop event. *Not all PBXs support disconnect supervision.*

Utility functions included in the unified API allow programmers to control the PBX integration board. Your application can retrieve the PBX integration channel and board type, obtain and set PBX integration channel and board parameters, retrieve D/42 firmware/driver/library version numbers, and retrieve error information.

By using the unified API to determine the type of switch that the PBX integration board is connected to, programmers can create an application that can provide specific control for each PBX. Specific control is accomplished using dial strings. Some examples are call transfer, call forward, message waiting light manipulation, and pressing console buttons. The PBX integration board is capable of performing most functions that are available to a telephone connected to the PBX.

Developers who wish to continue designing switch-specific applications can continue to do so, as the unified API also provides access to lower-level function calls made available through each individual switch protocol. And for customers

unwilling to shift from older PBX integration development models, the unified API provides for backward compatibility, preserving their development investment.

3.3. PBX Integration Board Description

The PBX integration board is a PCI form factor voice/FAX processing board that can interface directly to several different types of PBXs. The PBX integration board emulates telephones that connect to the supported PBXs. Application programs using the PBX integration board can answer incoming calls, place outbound calls, record and playback voice files, detect and generate tones, access the called/calling number ID for calls forwarded or transferred from within the PBX, access trunk ID for calls originating outside the PBX, send and receive faxes, and control message notification. The PBX integration board also provides positive disconnect supervision to immediately detect when a caller has hung up.

When used with one of the supported PBXs, the PBX integration board provides a flexible platform for developing integrated computer telephony applications. Developers can integrate current Intel Dialogic D/4x applications on the PBX integration board with minimal software modifications and create more efficient applications for the PBX by offering value-added features.

A PBX integration board has either four or eight channels that can be connected directly to a supported PBX.

3.3.1. Features

PBX integration board features include:

- voice board with four or eight independent four-wire interfaces to a PBX, thereby reducing the cost and complexity of application integration
- interfaces directly to various PBXs
- emulates telephones
- automatically answers calls
- detects Touch Tones
- plays voice messages to a caller
- digitizes, compresses and records voice signals
- places outbound calls and automatically reports the result

- retrieves called/calling number ID to enable calls to be intelligently handled
- activates/deactivates message waiting indicators to provide message notification
- supports two FAX channels at any given time
- allows supervised (recommended) and blind transfers for automated attendant applications
- provides positive disconnect supervision to immediately detect when a caller has hung up
- enables development of applications across a variety of PBX systems using the unified API.

3.3.2. Functional Description

The PBX integration board connects to several different PBXs, each of which has one or more compatible telephones with which it communicates. The PBX integration board emulates these telephones, which have Feature Keys and LCD displays for accessing and employing advanced features of the compatible PBXs.

Each of the four or eight line interfaces on PBX integration boards receive voice and control data from the connected PBX. The voice data is compressed by a DSP using an one of the available encoding methods and then sent to the host PC to be stored.

Control data from the PBX switch passes through the digital duplexer on the PBX integration board to a command processor where it is converted from its native format. The resulting serial bit stream is then converted into a parallel bit stream that is sent via the local bus to the on-board control processor which either acts on the information or passes the event to the application (see *Figure 1*).

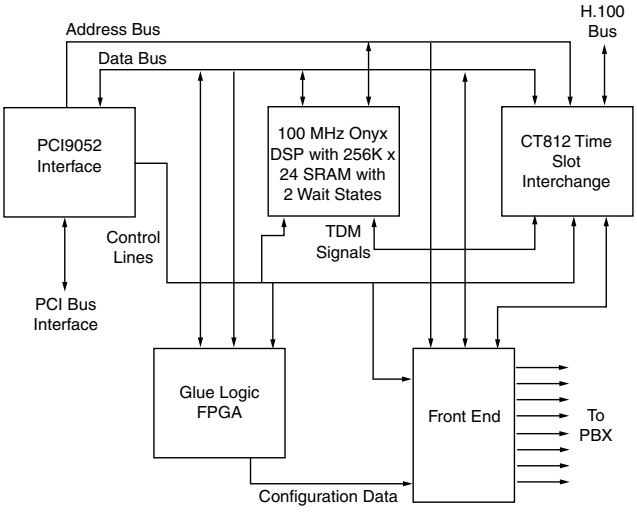


Figure 1. PBX Integration Board Functional Block Diagram

Voice files stored on the host PC are read by the host driver and transferred to the PBX integration board via the PCI Bus. These voice signals are buffered by the control processor and decoded into 64 kbps PCM signals by the DSP. These PCM voice signals are then sent to the PBX interface link for transport to the caller. A system-wide, TDM signal sharing bus, called CT Bus, is also provided for the exchange of signal streams with other resource boards, signal transport boards, or other interfaces.

In addition to having all the standard features of an Intel Dialogic D/41D board, the PBX integration board can access enhanced PBX features, when available, such as:

- call transfer/conference
- turn phone message waiting indicators on or off
- callback request
- calling number identification (Calling Number ID).

The PBX integration board has an on-board microprocessor and a high-speed Digital Signal Processor (DSP) to provide voice and call processing. Springware voice processing firmware is downloaded from the host computer to SRAM and

DSP memory when the PBX integration board is started. Springware offers several features, including speed control, volume control, global tone detection, and positive voice detection. Global tone detection allows applications to detect special intercept tones, FAX tones, modem tones, and non-standard PBX or user-defined tones, such as those used in international networks.

Other DSP-based Springware features include G.711 A-law and µ-law PCM, ADPCM, GSM 610, and G.726 voice encoding. An application may dynamically switch between sampling rates and coding methods to meet specific requirements for voice quality and data storage. Enhanced algorithms provide reliable DTMF detection, DTMF cut-through, and talk off/play off suppression.

3.3.3. Configurations

The PBX integration board connects to a line circuit board in a supported PBX to build sophisticated, computer telephony systems. The PBX integration board installs in a platform with a minimum 90 MHz Pentium® processor or the equivalent Celeron® processor with an available PCI bus slot for an 8-port system. The host system must provide a Pentium or Celeron class processor at 266 MHz speed or higher for a 64-port system, including eight available PCI slots. The PBX integration board occupies a single expansion slot, and up to eight boards can be configured in a system, with each board sharing the same interrupt level. The maximum number of ports supported is 64, dependent on the application, the amount of disk I/O required, and the host computer's CPU.

The PBX integration board shares a large degree of common hardware and firmware architecture with other Intel telecom products for maximum flexibility and scalability. Features can be added or systems can grow while protecting investment in hardware and application code. With only minimum modifications, applications can be easily ported to lower or higher line-density platforms.

3.3.4. Software Support

The development package includes all required libraries, drivers, and headers for simplified and seamless PBX integration. Diagnostics and demo programs provide additional tools and examples that allow developers to create complex multi-channel voice applications.

4. PBX Systems

4.1. Avaya Definity PBXs

The Avaya Definity* product family includes the Definity 75 (4-wire) and the Definity G3 (2-wire) PBXs. The PBX integration board can be used with either of these switches. The PBXs use digital signaling to control their station sets and digitized voice.

A PBX integration board has either four or eight channels that are connected directly to a station module in an Avaya PBX. The PBX switch has many standard features that are supported by the PBX integration board, such as:

- direct inward dialing (DID)
- speed dialing
- hunt groups
- message waiting indication
- user programmable Feature Keys
- called/calling number identification
- call forwarding.

4.1.1. Avaya Switch Programming Requirements

There are specific switch programming requirements for using a PBX integration board with an Avaya Definity PBX. You must ensure that the PBX is configured properly so that the PBX integration board functions correctly.

Port Number Settings

Each board in an Avaya PBX is assigned a port number. The number of ports vary according to the board type (2-wire or 4-wire). A 2-wire board has 16 ports, while the 4-wire boards has eight.

Table 1 lists the structure used when configuring an Avaya Definity PBX. For details about programming an Avaya PBX, refer to the appropriate Avaya manual.

The following are examples of the switch settings:

Table 1. Avaya Definity Configuration Example

Slot #	Board Type	Telephone Type	Extension Numbers	Port Settings
3	TN2181 2-wire	8434D	1000-1015	01A0301-01A0316
4	TN2181 2-wire	8434D	1016-1031	01A0401-01A0416
5	TN754B 4-wire	7434D	1032-1039	01A0501-01A0508
6	TN754B 4-wire	7434D	1040-1047	01A0601-01A0608
7	TN754B 4-wire	7434D	1048-1055	01A0701-01A0708
8	TN754B 4-wire	7434D	1056-1063	01A0801-01A0808

The settings above should be tailored according to the your specific needs.

Message Waiting Light Settings

You must make certain settings from an Avaya management terminal to ensure that Message Waiting Indicator (MWI) features work correctly.

1. Login to switch from a management terminal.
2. Type command '**CH STAT** <ext>' where ext is the extension of a PBX integration board port.

   On the Avaya phone sets, go to the Button Assignments page and set button 32 to '**lwc-store**' and button 33 to '**lwc-cancel**'.

   NOTE: If these features are programmed into any other button, they must be removed, as there may be only one occurrence of these features per extension.
3. Repeat as necessary for other extensions.

Caller ID Requirement

The extension number must be included in the name field of the extension. This requires PBX programming.

4.1.2. Using the PBX Integration Board

The PBX integration board performs functions available to Avaya 7434 (4-wire) and 8434 (2-wire) telephone sets (see *Figure 2* and *Figure 3*). These telephone sets use two LED displays per Feature Button to show status (next to the Feature Buttons) and an LCD display to show user prompts and messages (above the display buttons). The PBX integration board can:

- transfer calls
- set the message waiting indicator
- read the LED display
- read LED indicators
- read the called/calling number ID
- press keys.

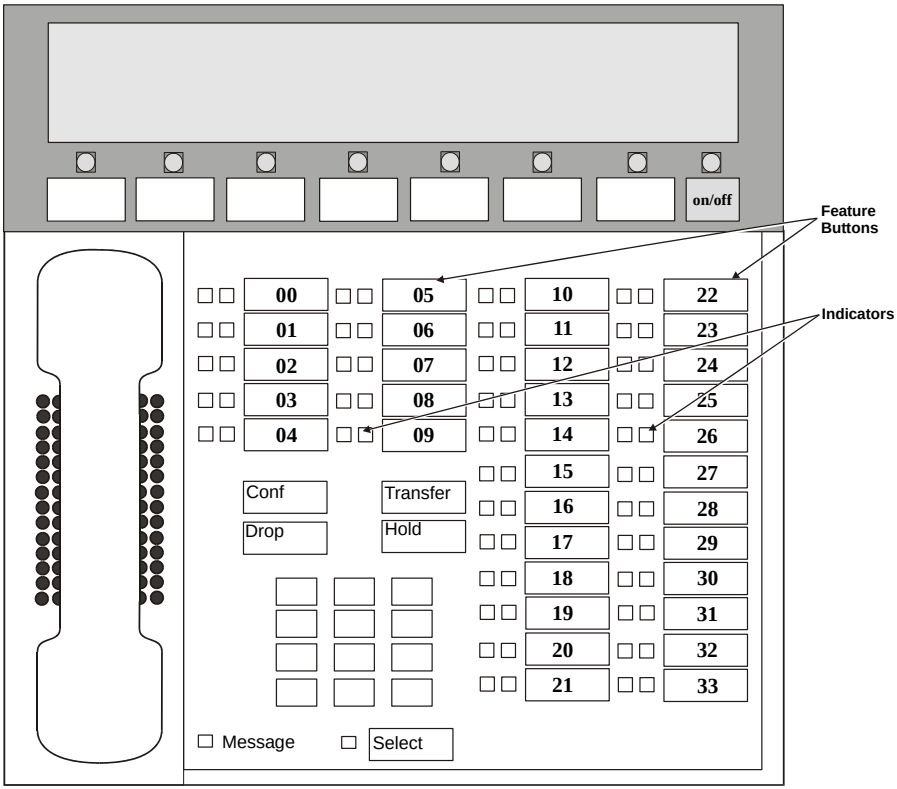


Figure 2. Avaya 7434 Telephone

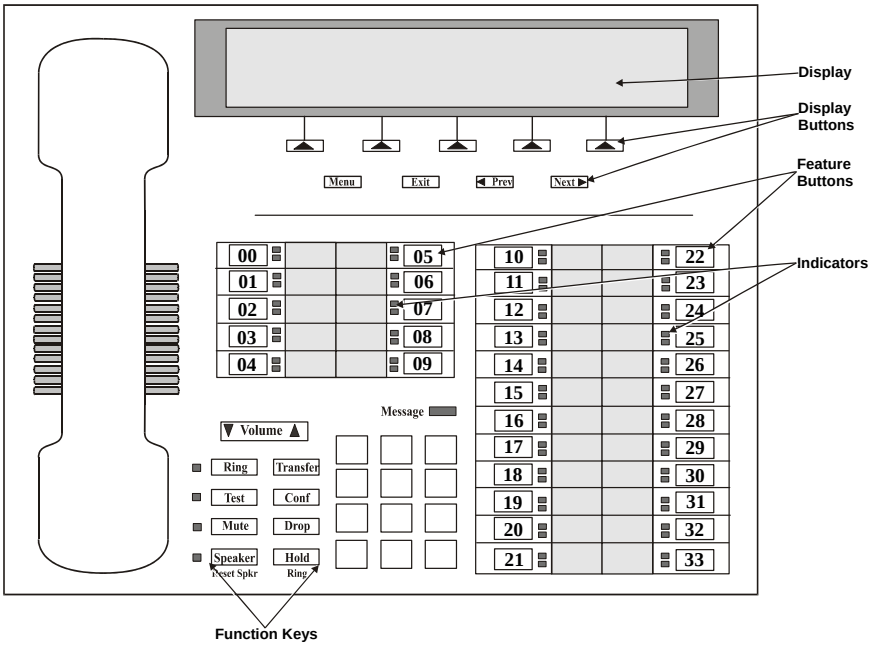


Figure 3. Avaya 8434 Telephone

4.1.3. Programmable Feature Keys

As illustrated in *Figure 2* and *Figure 3*, there are 34 Programmable Feature Keys found on the Avaya 7434 and 8434 telephones. These keys are configured either during installation or by the user (using the telephone set or the PBX integration board). There are two LED Indicators associated with each Feature Button. The PBX integration board can also emulate four Avaya Functions Keys: Transfer Conference, Drop, and Hold.

As mentioned above, each line or Feature Key actually has two indicator lights. The red indicator tells the user that the line is being used or that the line will be the one used when the handset is lifted. The green indicator (bottom on the 8434 and right on the 7434) tells the user that the line or feature is in use. In other words, when you pick up the handset or press a Feature Key, the green indicator goes on. When a call is on hold, the green indicator for that line flashes and the red indicator goes off. The red light is either off or on (a

value of eight [0x08] indicates ON), while the green light has six possible values. The status of the indicators is obtained by bitwise-ANDing the returned value from the green light with the value from the red light (green light value + red light value). In other words, the value for a line indicator in use with a call (after ANDing with 0x0f, all the values shown below in the least significant byte value) would be nine--0x08 (for red light on) + 0x01 (for green light on). The status conditions for each byte (least significant) of the green light are defined as indicated in *Table 2*.

Table 2. Avaya 7434 and 8434 LED Indicator States

State	Value (Hex)
off	0x00
on	0x01
ringing	0x02
hold	0x03
error	0x04
unknown	0x05

Reading LED Indicators

The PBX integration board can determine the state of its LED Indicators by using the **d42_indicators( )** function to retrieve the LED Indicators data. This function places the Line Indicator data (34 bytes) in an application buffer. Bytes 1-34 contain the indicator status for Memory Keys 00-33, respectively (see *Table 3*).

Table 3. Avaya 7434 and 8434 Direct Key Dialing Strings for Feature Keys

Byte	Key Description	Dial String
1	Feature Button 00	<ESC>KA
2	Feature Button 01	<ESC>KB
3	Feature Button 02	<ESC>KC

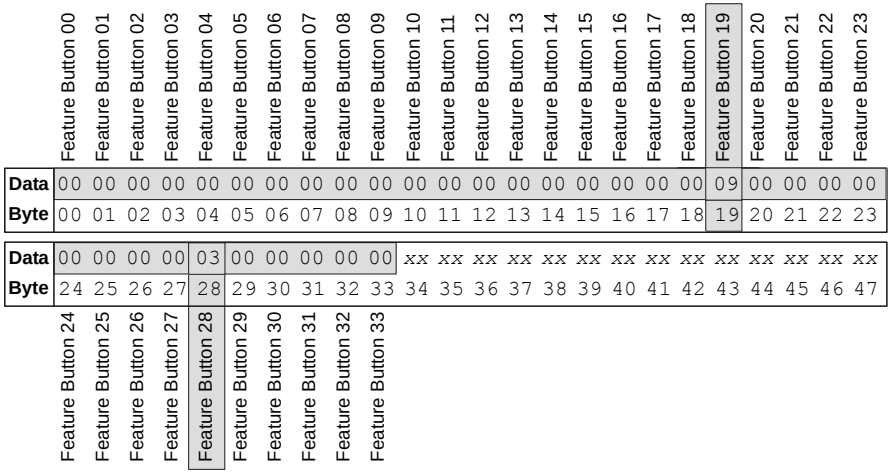
Byte	Key Description	Dial String
4	Feature Button 03	<ESC>KD
5	Feature Button 04	<ESC>KE
6	Feature Button 05	<ESC>KF
7	Feature Button 06	<ESC>KG
8	Feature Button 07	<ESC>KH
9	Feature Button 08	<ESC>KI
10	Feature Button 09	<ESC>KJ
11	Feature Button 10	<ESC>KK
12	Feature Button 11	<ESC>KL
13	Feature Button 12	<ESC>KM
14	Feature Button 13	<ESC>KN
15	Feature Button 14	<ESC>KO
16	Feature Button 15	<ESC>KP
17	Feature Button 16	<ESC>KQ
18	Feature Button 17	<ESC>KR
19	Feature Button 18	<ESC>KS
20	Feature Button 19	<ESC>KT
21	Feature Button 20	<ESC>KU
22	Feature Button 21	<ESC>KV
23	Feature Button 22	<ESC>KW
24	Feature Button 23	<ESC>KX
25	Feature Button 24	<ESC>KY
26	Feature Button 25	<ESC>KZ
27	Feature Button 26	<ESC>Ka
28	Feature Button 27	<ESC>Kb
29	Feature Button 28	<ESC>Kc
30	Feature Button 29	<ESC>Kd
31	Feature Button 30	<ESC>Ke

Byte	Key Description	Dial String
32	Feature Button 31	<ESC>Kf
33	Feature Button 32	<ESC>Kg
34	Feature Button 33	<ESC>Kh

Example

An application uses the **d42_indicators( )** function to retrieve the current data for the LED Indicators on a given channel on a PBX integration board. The data placed in the application buffer is shown below. If the data for byte 19 is 0x09 and byte 28 is 0x03, the red and green indicators are on for Feature Button 19 indicating that the line is in use for a call, and the green indicator for Memory Button 28 is flashing, indicating that the call is on hold.

Refer to the *PBX Integration Software Reference* for more information about using the **d42_indicators( )** function.



NOTE: The application can obtain the least significant byte of the value returned by the **d42_indicators( )** function by ANDing that value with 0x0f.

Pressing Feature Keys

The PBX integration board can "press" any of the Avaya 7434 or 8434's Feature Keys using the **dx_dial( )** function. Refer to the *PBX Integration Software Reference* for more information about dialing programmable keys. Each Feature Button on the 7434 and 8434 telephones is assigned a dial string sequence (refer to *Table 3*). By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can press any Feature Button.

4.1.4. Avaya Function Keys

Avaya telephones also include Function Keys that the PBX integration board can emulate to perform various functions. PBX integration board can emulate four Avaya Functions Keys: Transfer, Conference, Drop, and Hold.

Pressing Function Keys

The PBX integration board can "press" Avaya telephone Function Keys using the **dx_dial( )** function. The Function Keys on the Avaya 7434 and 8434 telephones assigned a dial string sequence are listed in *Table 4*. By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can dial these four Avaya Function Keys. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys.

Table 4. Avaya 7434 and 8434 Direct Key Dialing Strings for Function Keys

Dial String	Key Description
<ESC>Ki	Hold
<ESC>Kj	Drop
<ESC>Kk	Transfer
<ESC>Kl	Conference

4.1.5. Display Keys

As shown in *Figure 3*, there are five Display Keys located below the LCD display. These keys are associated with specific prompts shown on the LCD display depending on the current state of the phone (shown on the bottom row of the LCD display). The PBX integration board cannot use the two bottom, right-most Keys, **Prev** and **Next**.

Pressing Display Keys

The PBX integration board can respond to a prompt and "press" the appropriate Display Key using the **dx_dial( )** function. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys. Each Display Key on the Avaya 8434 telephone is assigned a dial string sequence (refer to *Table 5*). By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can press any of its first seven Display Keys.

Table 5. 8434 Direct Key Dialing Strings for Display Keys

Dial String	Key Description
<ESC>Km	Display Key 00
<ESC>Kn	Display Key 01
<ESC>Ko	Display Key 02
<ESC>Kp	Display Key 03
<ESC>Kq	Display Key 04
<ESC>Kr	Display Key 05
<ESC>Ks	Display Key 06

4.1.6. Alphanumeric Display

The alphanumeric display is a two row, 50-digit LED that is used to show the activity of the phone. Some examples are:

- date and time
- feature names

- error messages
- called/calling identification
- phone status
- line selection
- Display Key prompts

The data used to display information in the LED alphanumeric display is in ASCII format. When the telephone is not in use, the display normally shows the date and time. The content of the display is changed automatically (e.g., receiving an incoming call, making an outgoing call, or activating a feature).

The PBX integration board can retrieve the information on its alphanumeric display using the **d42_displayex( )** function. The function places the display data (50 bytes) in an application buffer. Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_displayex( )** function.

Example

An application uses the **dx_dial( )** function and the appropriate dial string to press keys to dial extension number 1045. The **d42_display( )** function is used to retrieve the display data and place it in an application buffer (shown below). The information for the top row (last 25 characters) of the display is checked. Data in bytes 00 through 05 indicate that extension 1045 is being dialed.

	a = 1 0 4 5
data	61 3D 01 00 04 05 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
byte	00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

data	20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
byte	25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49

Called/Calling Number ID (within the PBX)

When receiving a call on a PBX integration board from another extension, the PBX sends calling number ID data (by default, the extension number of the

telephone placing the call) to the station set between the first and second rings. The station set *processes* the data and sends an ID message to the display. The calling number ID data sent from the PBX to the station set differs from the calling number ID data presented on the display.

When placing a call to another extension, the called number ID (by default, the extension of the telephone being called) is shown in the display.

Both the calling and called number IDs can be retrieved using the **d42_gtcallid( )** function. The **d42_gtcallid( )** function retrieves the called/calling number ID message sent from the PBX to the station set, not the data sent to the display. Refer to the *PBX Integration Board Software Reference* for more information about using **d42_gtcallid( )** function.

The contents of the called/calling number ID are shown in *Table 6* as seen by the receiver of the call).

Table 6. Called/Calling Number ID Data for the Avaya Definity

Call Route	Called/Calling Number ID Data
Call received from station set 221	_221
Call originally received by extension 221, then forwarded to extension 224	224_221
Call originally received by extension 221 from trunk line 1, then forwarded to D/82 (where trunk line 1 presents ANI information, e.g., 716-621-8090	221_761-621-8090

NOTE: The called/calling number ID can also be obtained using the **d42_displayex( )** function and parsing the display in the application. However, you should use the **d42_gtcallid( )** function so that your application will maintain functionality across different manufacturers' switches.

Example

An application uses the **d42_gtcallid( )** function to retrieve the calling number ID for a call received on a specified channel on a PBX integration board. The calling number ID data and corresponding ASCII values are shown below.

text	*bb*	2	2	4	_	2	2	1															
data	20	32	32	34	5F	32	32	31	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
text																								
data	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

4.1.7. Setting the Message Waiting Indicator

The PBX integration board can set the Message Waiting Indicator (on or off) on another extension using the **dx_dial( )** function and the appropriate dial string. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys.

NOTE: Message Waiting can also be set using the dx_dial() function and appropriate dial string to press the Feature Key assigned to send messages; however, you should use the dx_dial() function as described so that your application will maintain functionality across different manufacturers' switches.

MWI On

The recommended technique to turn on the MWI in this switch, using **dx_dial( )** with the dial string is:

1. Go Off Hook using **dx_sethook( )** function.
2. Call the **dx_dial()** function. The dial string is <ESCO><extention><ESCO> (optional pause character may be used).
3. Go On hook using the **dx_sethook( )** function again

NOTE: <ESCO> means the Escape character followed by O.

MWI Off

The recommended technique to turn off the MWI in this switch, using **dx_dial( )** with the dial string is:

1. Go Off Hook using **dx_sethook( )** function.
2. Call the **dx_dial()** function. The dial string is <ESCF><extention><ESCF> (optional pause character may be used).
3. Go On hook using the **dx_sethook()** function again.

NOTE: <ESCF> means the Escape character followed by F.

4.1.8. Transferring a Call

The PBX integration board can transfer calls using the **dx_dial( )** function. By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can transfer a call to any extension connected to the switch. Refer to the *PBX Integration Board Software Reference for Linux and Windows* for more information about dialing programmable keys.

The PBX integration board can perform both supervised and blind transfers. (Refer to *Sections 2.1. Supervised Call Transfer* and *2.2. Blind Call Transfer*). When a blind transfer is performed, the PBX controls where the call is routed if the extension is busy or does not answer. When a supervised transfer is performed, your application can implement call progress analysis and called/calling number ID to intelligently control where the call is routed (by completing or aborting the transfer) and what type of message is played if the called extension is busy or does not answer. Because of this capability, supervised transfer is the preferred call transfer method.

Initiating the Transfer

Once in a connected call, initiate a transfer with **dx_dial(&,<ext>)**, where **&** acts as a key press of the transfer key and **<ext>** is the PBX extension you are transferring the call to.

Completing the Transfer

To complete a call (supervised or blind), press the transfer key again with **dx_dial(&)**, where **&** acts as a key press of the transfer key. The application must handle the on-hook state after completing the transfer.

Aborting the Transfer

A transferred call can be aborted at any time (prior to completing the transfer) by pressing the appropriate appearance key where the original call resides. The application can perform this only in a supervised transfer mode. For example, if the original call resided on the first appearance (Feature Key 00), dialing **dx_dial(<ESC>KA)** will bring the original caller back to an active state.

Example

An application answers a call and plays a greeting message prompting the caller to enter the extension they wish to reach (the caller enters 221). Using the **dx_dial( )** function with the dial string (&,221), the application attempts to transfer (supervised) the call to extension 221. Call progress analysis is used to determine if extension 221 is answered, busy, or there is no answer. If extension 221 answers, the application needs to use **dx_dial( )** to press **&** again to complete the transfer and hang up after the transfer is complete. If the extension is busy or not answered, the application reconnects to the incoming call and plays a message asking the caller to choose between accessing voice mail or transferring to the operator.

4.2. Siemens ROLM PBX

The ROLM product family actually includes three generations of ROLM and related PBXs:

1. The original ROLM
2. IBM ROLM 9751 series
3. Siemens Hicom* 300 with the appropriate interface cards

The PBX integration board emulating the ROLM 400 telephone can be used with any of these switches. The ROLM PBXs use digital signaling to control their station sets and digitized voice.

The PBX integration board has either four or eight channels that are connected directly to a station module in a Siemens ROLM PBX. The PBX switch has many standard features that are supported by the PBX integration board, such as:

- direct inward dialing (DID)
- speed dialing
- hunt groups
- message waiting indication
- user programmable feature keys
- called/calling number identification
- call forwarding.

4.2.1. Siemens ROLM Programming Requirements

There are specific switch programming requirements for using a PBX integration board with a Siemens ROLM PBX. You must ensure that these features are set exactly (and assigned to the right keys) so that the PBX integration board and the unified API function correctly.

- All PBX integration board ports on a ROLM system must be programmed as ROLMphone 400 telephones.
- LINE must be programmed on Feature Key 09, and the ROLMphone must be programmed to select this line when going offhook.
- XFER (transfer) must be programmed on Feature Key 38.
- MWI (Message Waiting Indication) mechanisms are different with ROLM CBX 9006 (or ROLM integration on the Hicom 300) and ROLM CBX 9005 PBX.

For ROLM CBX 9006 PBX or ROLM integration on the Hicom 300

For the ROLM CBX 9006 PBX or ROLM integration on Hicom 300, the following programming requirements apply:

- DDS (speed dial) must be programmed on Feature Key 03 for the correct message waiting **"O**N" feature access code, which is *59 (*default, but is*

dependent on the PBX setup. Consult the PBX Administrator for the correct feature access code) when you are using the ROLM integration on the Hicom 300 or when you are using the ROLM CBX 9006 PBX. To program this key on the ROLMphone:

1. Press PROG (Feature Key 20).
2. Then press Feature Key 03.
3. Dial *59 (or the correct PBX dependent Feature Access Code), and press PROG again.
4. The phone display indicates “STORED” and message-waiting light (or Mailbox indicator light) ON is now set for Feature Key 03.

- DDS (speed dial) must be programmed on Feature Key 04 for the correct message-waiting OFF feature access code, which is #60 (*default, but is dependent on the PBX setup. Consult the PBX Administrator for the correct feature access code*) when using the ROLM integration on the Hicom 300 or when you are using the ROLM CBX 9006 PBX. To program this key on the ROLMphone:

  1) Press PROG (Feature Key 20).
  2) Then press Feature Key 04.
  3) Dial #60 (or the correct PBX dependent Feature Access Code), and press PROG again.
  4) The phone display indicates STORED and message-waiting light (or Mailbox indicator light) OFF is now set for Feature Key 04.

For ROLM CBX 9005 PBX

For the ROLM CBX 9005 PBX, the following programming requirements apply:

- In this case the MWI ON/OFF key is a toggle key and it must be programmed to be the feature key 37.

NOTES: **1.** For transferred calls, the called-party ID appears as a direct call because the PBX does not write the called-party ID to the display.

2. For message waiting, only the port that sets a message-waiting indicator can clear it.

4.2.2. Using the PBX Integration Board

The PBX integration board performs functions available to a ROLMphone 400 telephone set (see *Figure 5*). An ROLMphone 400 telephone set uses an LED displays to show key status (next to the keys) and user prompts and messages on the display to provide various options. The PBX integration board can:

- transfer calls
- set the message waiting indicator
- read the LCD display
- read LED indicators
- read the called/calling number ID
- press keys.

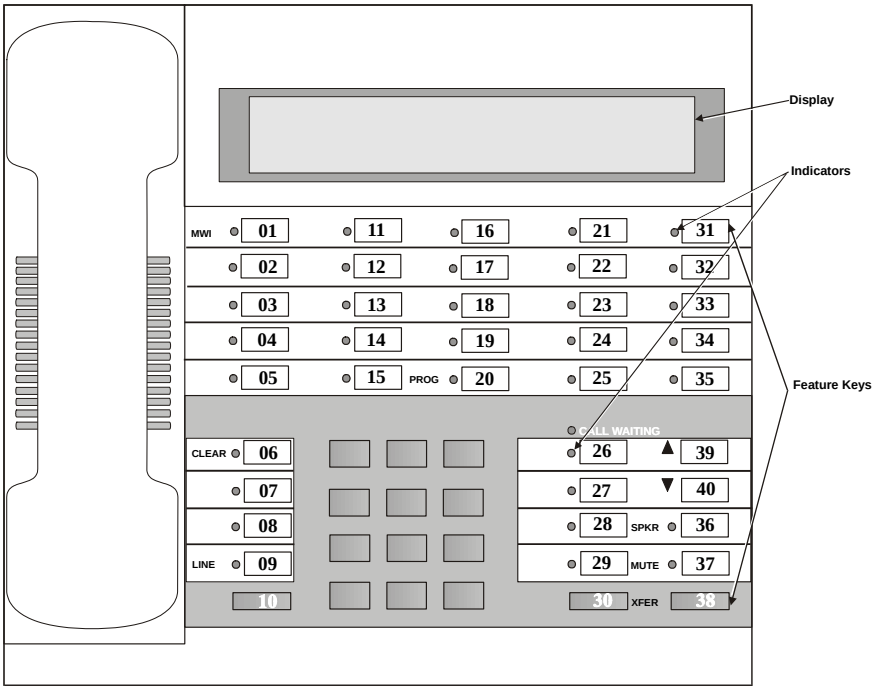


Figure 4. Siemens ROLMphone 400

4.2.3. Programmable Feature Keys

As illustrated in *Figure 4*, there are 40 Feature Keys located below the display on the ROLMphone 400 telephone. These keys are configured either during PBX installation or by the user (using the telephone set or the PBX integration board). The CLEAR, SPEAKER, MUTE, XFR, and LINE keys are assigned during PBX configuration and cannot be user programmed. The MAILBOX indicator programmed on each phone (see *4.2.1. Siemens ROLM Programming Requirements* above) for Feature Key 01. Feature Keys 39 and 40 are used for volume control and cannot be programmed either. There is an LED Indicator associated with each key, except those discussed in the following paragraph. The LED Indicators are circular and can take on one of the six states listed in *Table 7*.

Table 7. ROLMphone 400 LED Indicator States

State	Value (Hex)
off	0x00
on	0x01
ringing	0x02
hold	0x03
error	0x04
unknown	0x05

Reading LED Indicators

The PBX integration board can determine the state of its LED Indicators by using the **d42_indicators( )** function to retrieve the LED Indicators data. This function places the LED Indicator data (37 bytes) in an application buffer. Bytes 00-36 contain the indicator status for Feature Keys 01-37, respectively (see *Table 8*). As indicated in the example below, Feature Keys 10, 30, and 38-40 do not have LED indicators.

Table 8. ROLMphone 400 Direct Key Dialing Strings for Feature Keys

Byte	Key Description	Dial String
00	Feature Key 09 - LINE	<ESC>KA
01	Feature Key 08	<ESC>KB
02	Feature Key 07	<ESC>KC
03	Feature Key 06 - CLEAR (flash)	<ESC>KD
04	Feature Key 05	<ESC>KE
05	Feature Key 04	<ESC>KF
06	Feature Key 03	<ESC>KG
07	Feature Key 02	<ESC>KH
08	Feature Key 01 - MAILBOX	<ESC>KI
09	Feature Key 15	<ESC>KJ
10	Feature Key 14	<ESC>KK
11	Feature Key 13	<ESC>KL
12	Feature Key 12	<ESC>KM
13	Feature Key 11	<ESC>KN
14	Feature Key 20 - PROG (program)	<ESC>KO
15	Feature Key 19	<ESC>KP
16	Feature Key 18	<ESC>KQ
17	Feature Key 17	<ESC>KR
18	Feature Key 16	<ESC>KS
19	Feature Key 25	<ESC>KT
20	Feature Key 24	<ESC>KU
21	Feature Key 23	<ESC>KV
22	Feature Key 22	<ESC>KW
23	Feature Key 21	<ESC>KX
24	Feature Key 35	<ESC>KY

Byte	Key Description	Dial String
25	Feature Key 34	<ESC>KZ
26	Feature Key 33	<ESC>Ka
27	Feature Key 32	<ESC>Kb
28	Feature Key 31	<ESC>Kc
29	Feature Key 29	<ESC>Kd
30	Feature Key 28	<ESC>Ke
31	Feature Key 27	<ESC>Kf
32	Feature Key 26	<ESC>Kg
33	Feature Key 37 - MWCTR*	<ESC>Kh
34	Feature Key 36 - SPEAKER	<ESC>Ki
35	Feature Key 40 - Volume Down	<ESC>Kj
36	Feature Key 39 - Volume Up	<ESC>Kk
37	Feature Key 10	<ESC>Kl
38	Feature Key 30	<ESC>Km
39	Feature Key 38 - XFER	<ESC>Kn

*MWCTR = Message Waiting Control

Example

An application uses the **d42_indicators( )** function to retrieve the current data for the LED Indicators on a given channel on a PBX integration board. The data placed in the application buffer is shown below. If the least significant byte of the data for byte 00 is 0x01 (0x61 AND 0x0f = 0x01 in the figure below), the circular indicator for Feature Key 09 is on. Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_indicators( )** function.

	Feature Key 09	Feature Key 08	Feature Key 07	Feature Key 06	Feature Key 05	Feature Key 04	Feature Key 03	Feature Key 02	Feature Key 01	Feature Key 15	Feature Key 14	Feature Key 13	Feature Key 12	Feature Key 11	Feature Key 20	Feature Key 19	Feature Key 18	Feature Key 17	Feature Key 16	Feature Key 25	Feature Key 24	Feature Key 23	Feature Key 22	Feature Key 21
Data	61	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Byte	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Data	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

Feature Key 35	Feature Key 34	Feature Key 33	Feature Key 32	Feature Key 31	Feature Key 29	Feature Key 28	Feature Key 27	Feature Key 26	Feature Key 37	Feature Key 36

NOTE: The application can obtain the least significant byte of the value returned by the **d42_indicators( )** function by ANDing that value with 0x0f.

Pressing Feature Keys

The PBX integration board can “press” any of the ROLMphone 400 Feature Keys using the **dx_dial( )** function. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys. Each Feature Key on the ROLMphone 400 telephone is assigned a dial string sequence (refer to *Table 8*). By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can press any Feature Key.

4.2.4. Alphanumeric Display

The alphanumeric display is a two row, 60-character LCD that is used to show the activity of the phone. Some examples are:

- date and time
- feature names
- text messages
- error messages
- called/calling identification

- phone status
- line selection

The data used to display information in the LCD alphanumeric display is in ASCII format. When the telephone is not in use, the display normally shows the date and time. The content of the display is changed automatically (e.g., receiving an incoming call, making an outgoing call, or activating a feature).

The PBX integration board can retrieve the information on its alphanumeric display using the **d42_display( )** function. The function places the display data (48 bytes) in an application buffer. Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_display( )** function.

Example

An application uses the **dx_dial( )** function and the appropriate dial string to press keys dial extension number 1045. The **d42_display( )** function is used to retrieve the display data and place it in an application buffer (shown below). The information for the top row (first 30 characters) of the display is checked. Data in bytes 00 through 03 indicate that extension 1045 is being dialed.

	1 0 4 5																		
data	01	00	04	05	4C	4C	20	20	20	20	20	20	20	20	20	20	20	20	20
byte	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19

data	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
byte	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39

data	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
byte	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59

Called/Calling Number ID (within the PBX)

When receiving a call on a PBX integration board from another extension, the PBX sends calling number ID data (by default, the extension number of the telephone placing the call) to the station set between the first and second rings. The station set processes the data and sends an ID message to the display. The

calling number ID data sent from the PBX to the station set differs from the calling number ID data presented on the display.

When placing a call to another extension, the called number ID (by default, the extension of the telephone being called) is shown in the display.

Both the calling and called number IDs can be retrieved using the **d42_gtcallid( )** function. The **d42_gtcallid( )** function retrieves the called/calling number ID message sent from the PBX to the station set, not the data sent to the display. Refer to the *PBX Integration Board Software Reference for* more information about using **d42_gtcallid( )** function.

The contents of the called/calling number ID are shown in *Table 9* (as seen by the receiver of the call).

Table 9. Called/Calling Number ID Data for the ROLM

Call Route	Called/Calling Number ID Data
Call received from station set 221	_221
Call originally received by extension 221, then forwarded to extension 224	224_221

NOTE: The called/calling number ID can also be obtained using the **d42_display( )** function; however, you should use the **d42_gtcallid( )** function so that your application will maintain functionality across different manufacturers' switches.

Example

An application uses the **d42_gtcallid( )** function to retrieve the calling number ID for a call received on a specified channel on a PBX integration board. The calling number ID data and corresponding ASCII values are shown below.

text	*bb*	2	2	1	_	2	2	4																
data	20	32	32	31	5F	32	32	34	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
text																								
data	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

4.2.5. Setting the Message Waiting Indicator

The PBX integration board can set the Message Waiting Indicator (on or off) on another extension using the **dx_dial( )** function and the appropriate dial string, as described in the *PBX Integration Board Software Reference* for your particular operating system.

NOTE: Message Waiting can also be set using the dx_dial() function and appropriate dial string to press the Feature Key assigned to send messages; however, you should use the dx_dial() function as described so that your application will maintain functionality across different manufacturers' switches.

MWI On

The recommended technique to turn on the MWI in this switch, using **dx_dial( )** with the dial string is:

1. Go Off Hook using the **dx_sethook( )** function.
2. Call the **dx_dial( )** function. The dial string is <ESCO><extention><ESCO> (optional pause character may be used).
3. Go On hook using the **dx_sethook( )** again.

NOTE: <ESCO> means the Escape character followed by O.

MWI Off

The recommended technique to turn off the MWI in this switch, using **dx_dial( )** with the dial string is:

1. Go Off Hook using the **dx_sethook( )** function.

2. Call the **dx_dial()** function. The dial string is <ESCF><extention><ESCF> (optional pause character may be used).
3. Go On hook using the **dx_sethook()** function again.

NOTE: <ESCF> means the Escape character followed by F.

The PBX integration board can determine the state of its Message Waiting Indicator using the **d42_indicators( )** function to retrieve the LED Indicators data. Byte 40 contains the Message Waiting indicator status (0x00 is off; 0x01 is on). Refer to the *PBX Integration Board Software Reference for* more information about using the **d42_indicators( )** function.

Example

An application uses the **d42_indicators( )** function to retrieve the LED Indicators data for a specified channel on the PBX integration board to determine if a message is waiting. The LED indicators data is shown below. The data 0x01 shows that the MWI indicator is on (there are messages waiting).

	MWI	Feautre Key 02	Feautre Key 03	Feautre Key 04	Feautre Key 05	Feautre Key 06	Feautre Key 07	Feautre Key 08	Feautre Key 09	No LED Inidcator	Feautre Key 11	Feautre Key 12	Feautre Key 13	Feautre Key 14	Feautre Key 15	Feautre Key 16	Feautre Key 17	Feautre Key 18	Feautre Key 19	Feautre Key 20	Feautre Key 21	Feautre Key 22	Feautre Key 23	Feature Key 24
Data	01	00	00	00	00	00	00	00	00	*xx*	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Byte	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Data	00	00	00	00	00	*xx*	00	00	00	00	00	00	00	*xx*	*xx*	*xx*	00	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
Byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

	Feature Key 25	Feature Key 26	Feature Key 27	Feature Key 28	Feature Key 29	NO LED Indicator	Feature Key 31	Feature Key 32	Feature Key 33	Feature Key 34	Feature Key 35	Feature Key 36	Feature Key 37	NO LED Indicator	NO LED Indicator	NO LED Indicator	Call Waiting
Data	00	00	00	00	00	*xx*	00	00	00	00	00	00	00	*xx*	*xx*	*xx*	00
Byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

4.2.6. Transferring a Call

The PBX integration board can transfer calls using the **dx_dial( )** function. By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can transfer a call to any extension connected to the switch. Refer to the *PBX Integration Board Software Reference for Linux and Windows* for more information about dialing programmable keys.

The *PBX integration board* can perform both supervised and blind transfers (Refer to the *Sections 2.1. Supervised Call Transfer* and *2.2. Blind Call Transfer*). When a blind transfer is performed, the PBX controls where the call is routed if the called extension is busy or does not answer. When a supervised transfer is performed, your application can implement call progress analysis and called/calling number ID to intelligently control where the call is routed (by completing or aborting the transfer) and what type of message is played if the called extension is busy or does not answer. Because of this capability, supervised transfer is the preferred call transfer method.

Initiating the Transfer

Once in a connected call, initiate a transfer with **dx_dial(&,<ext>)**, where **&** acts as a key press of the transfer key and **<ext>** is the PBX extension you are transferring the call to.

Completing the Transfer

To complete a call (supervised or blind), the application must go on-hook at the transferring party.

Aborting the Transfer

A transferred call can be aborted at any time (prior to completing the transfer) by pressing the appropriate appearance key where the original call resides. The application can perform this only in a supervised transfer mode. For example, if the original call resided on the first appearance (Feature Key 09), dialing **dx_dial(<ESC>KA)** will bring the original caller back to an active state.

Example

An application answers a call and plays a greeting message prompting the caller to enter the extension she wish to reach (the caller enters 221). Using the **dx_dial( )** function with the dial string (&,221), the application attempts to transfer (supervised) the call to extension 221. Call progress analysis is used to determine if extension 221 is answered, busy, or there is no answer. If extension 221 answers, the application hangs up and the transfer is complete. If the extension is busy or not answered, the application reconnects to the incoming call and plays a message asking the caller to choose between accessing voice mail or transferring to the operator.

4.3. Siemens Hicom PBX

The Siemens Hicom are a full-featured PBXs that can provide thousands of ports and many PBX voice and data features. The Hicom uses digital signaling to control its station sets and digitized voice. The PBX integration board has either four or eight channels that are connected directly to a station module in a Siemens Hicom. The PBX has many standard features that are supported by the PBX integration board, such as:

- direct inward dialing (DID)
- speed dialing
- hunt groups
- message waiting indication
- user programmable Feature Keys
- called/calling number identification
- call forwarding.

4.3.1. Siemens Hicom Programming Requirements

There are specific switch programming requirements for using a PBX integration board with a either a Siemens Hicom 150 or a Hicom 300 PBX. This allows the D./82JCT-U to correctly emulate a Optiset E telephone. Note that the programming is quite different for the two Hicom PBXs supported, so you must ensure that these features are set exactly (and assigned to the right keys) so that the PBX integration board and the unified API function correctly.

Siemens Hicom 150

When the Hicom 150 is used with Optiset E phones (see *Figure 5*), special PBX programming is required. The keys should be programmed as shown in *Figure 5*. If these keys are not programmed in this way, loop current detection, CPID, the & (transfer) key, and message waiting will not work.

Message waiting operation in Hicom 150 is especially different from Hicom 300 although the same Optiset E phone could be used with both of these PBXs. With a regular Optiset phone programmed as a regular phone port in the switch, turning the Message Waiting indicator OFF cannot be done without scrolling the display. This technique is not followed by the PBX integration board. The PBX integration board requires the following special programming for MWI operation. This is to be done by the PBX administrator in the PBX (that is, it cannot be done from a phone).

The ports connected to the PBX integration board must be programmed as phonemail ports on an SLMO, Optiset line card as follows:

NOTES:
1. There must not be any hardware (e.g. an Optiset E Phone) connected to the port while it is being programmed and updated.
2. When the database has been uploaded from the PC to the Hicom PBX, then hardware can be connected to the phonemail ports.

1. Open the Hicom Assistant E administration program.
2. Select **Set up Station**.
3. Select the **Station** tab.
4. Double-click the **Parm** field for the first extension you would like to program as a phonemail port.

5. Select the **Station Type** tab.
6. Select **Phonemail** call number, either 5 or 6 digit.
7. Select the **Apply** button.
8. Repeat this procedure above for all extension that are to be set up as phonemail ports.
9. Upload the database from the PC to the Hicom PBX.

Siemens Hicom 300

When the Hicom 300 is used with Optiset E phones (see *Figure 6*), the top two programmable keys (Key 00 and 01) on the left must be programmed as Mailbox and Callback, respectively. Key 02 must be configured to dial the **message waiting lamp on** (MWL_ON) string. Key 03 must be configured to dial the **message waiting lamp off** (MWL_OFF) string. This programming allows an application to use the specified dial string to turn the MWL on and off. In addition, Key 07 must be programmed as the Consultation (transfer) key. Keys 08-12 must be programmed as Line keys, with Key 12 programmed as the General Call Key, which provides the off-hook indicator. Refer to *Figure 5* and *Table 11* for specific Key locations and set-up requirements.

If these keys are not programmed in this manner, loop current detection, CPID, & (transfer) key, and message waiting will not work.

To configure Keys 02 and 03 for the MWL functionality, use the following instructions:

1. Need a button programmed as PROG in the PBX
2. Program DDS keys on button 02 and 03 in the button table of the PBX
3. Press the Scroll Forward key (>) repeatedly to scroll through the choices Siemens Optiset E phone to reach the **Program/Service** option on the display.
4. Press the Select **OptiGuide key** (the key with the check mark) to select.
5. Press the Select OptiGuide key again when **1-Change destinations** appears on the display.

6. Press the Scroll Forward key once to scroll to the **2-Redial** option and then press the **Select OptiGuide** key to select.
7. Press Key 02 (third from the top left, see *Figure 6* below) to set the dial string for MWL_ON.
8. Enter the dial string you wish to use with your Optiset E for MWL_ON (for example, #*8)
9. Press the **Select OptiGuide** key again to save.
10. Press the **Select OptiGuide** key again to exit.
11. Repeat the above procedures for the Key 03 to set the MWL_OFF functionality, using a different dial string.

4.3.2. Using the PBX Integration Board

The PBX integration board performs functions available to a Optiset E telephone set (see *Figure 5* and *Figure 6*). An Optiset E telephone set uses an LED displays to show key status (next to the keys) and user prompts and messages on the display to provide various options. The PBX integration board can:

- transfer calls
- set the message waiting indicator
- read the LCD display
- read LED indicators
- read the called/calling number ID
- press keys.

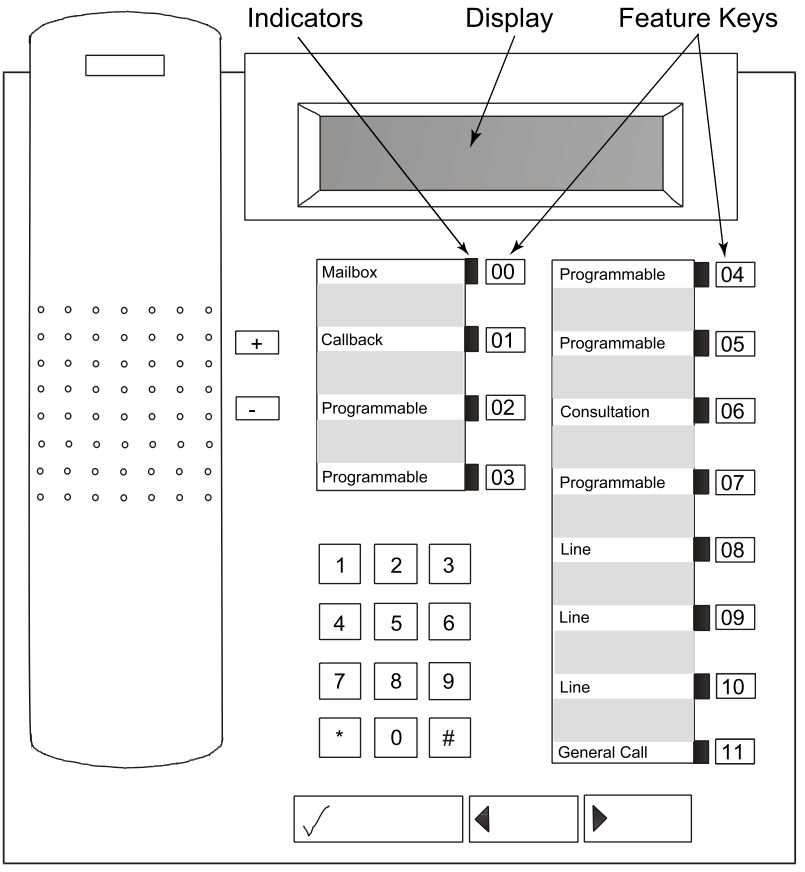


Figure 5. Siemens Optiset E Telephone with the Hicom 150

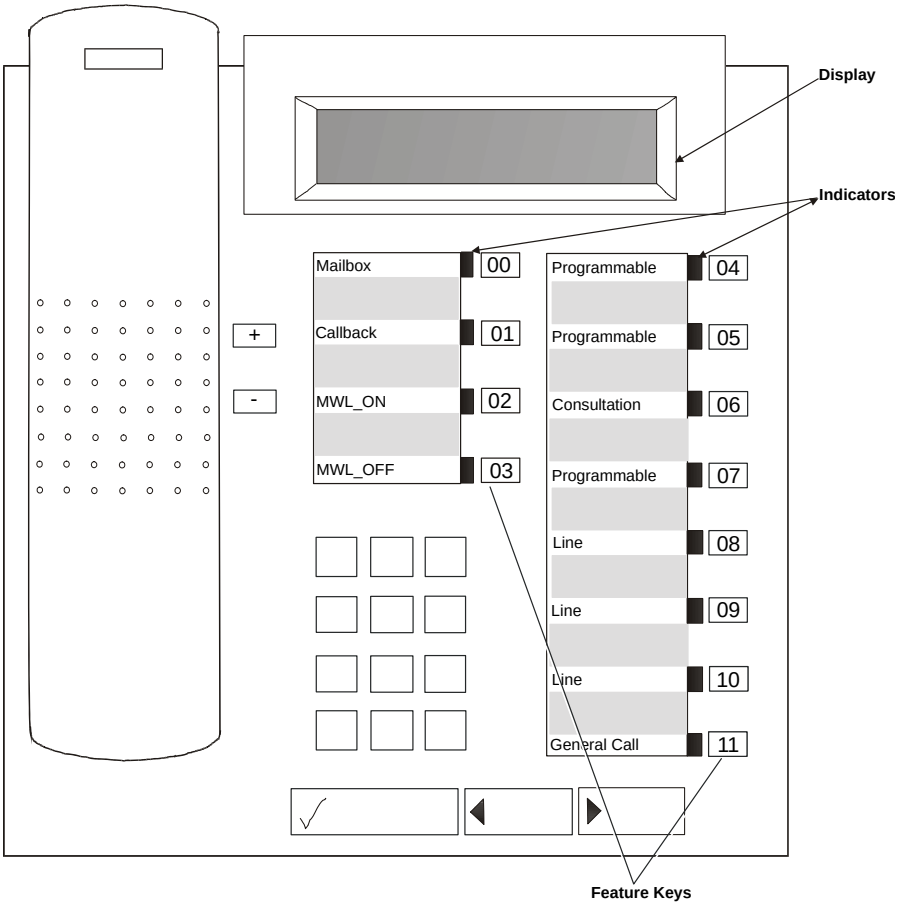


Figure 6. Siemens Optiset E Telephone with the Hicom 300

4.3.3. Programmable Feature Keys

As illustrated in *Figure 5* and *Figure 6* , there are 12 Programmable Feature Keys located below the display on the Optiset E telephone. These keys are configured either during PBX installation or by the user (using the telephone set or the PBX integration board). There is an LED Indicator associated with

each key. The LED Indicators are rectangular and can take on one of the six states listed in *Table 10*.

Table 10. Optiset E LED Indicator States

State	Value (Hex)
off	0x00
on	0x01
ringing	0x02
hold	0x03
error	0x04
unknown	0x05

Reading LED Indicators

The PBX integration board can determine the state of its LED Indicators by using the **d42_indicators( )** function to retrieve the LED Indicators data. This function places the Line Indicator data (12 bytes) in an application buffer. Bytes 0-11 contain the indicator status for Feature Keys 00-11, respectively (see *Table 11* and *Table 12*).

Table 11. Optiset E Direct Key Dialing Strings for Feature Keys with Hicom 150

Byte	Key Description	Dial String
0	Feature Key 00 - Mailbox	<ESC>KA
1	Feature Key 01 - Callback	<ESC>KB
2	Feature Key 02 -	<ESC>KC
3	Feature Key 03 -	<ESC>KD
4	Feature Key 04 -	<ESC>KE
5	Feature Key 05 - Programmable	<ESC>KF
6	Feature Key 06 - Consultation	<ESC>KG
7	Feature Key 07 - Line	<ESC>KH

Byte	Key Description	Dial String
8	Feature Key 08 - Line	<ESC>KI
9	Feature Key 09 - Line	<ESC>KJ
10	Feature Key 10 - Line	<ESC>KK
11	Feature Key 11 - General Call (Indicates when the phone is off-hook)	<ESC>KL

Table 12. Optiset E Direct Key Dialing Strings for Feature Keys with Hicom 300

Byte	Key Description	Dial String
0	Feature Key 00 - Mailbox	<ESC>KA
1	Feature Key 01 - Callback	<ESC>KB
2	Feature Key 02 - (Configure to dial MWL_ON)	<ESC>KC
3	Feature Key 03 - Redial (Configure to dial MWL_OFF)	<ESC>KD
4	Feature Key 04 - Programmable	<ESC>KE
5	Feature Key 05 - Programmable	<ESC>KF
6	Feature Key 06 - Consultation	<ESC>KG
7	Feature Key 07 - Line	<ESC>KH
8	Feature Key 08 - Line	<ESC>KI
9	Feature Key 09 - Line	<ESC>KJ
10	Feature Key 10 - Line	<ESC>KK
11	Feature Key 11 - General Call (Indicates when the phone is off-hook)	<ESC>KL

Example

An application uses the **d42_indicators( )** function to retrieve the current data for the LED Indicators on a given channel on a PBX integration board. The data placed in the application buffer is shown below. If the data for byte 1 is

0x01, the rectangular indicator for Feature Key 1 is on. Refer to the *PBX Integration Board Software Reference for* more information about using the **d42_indicators( )** function.

	Feature Key 00	Feature Key 01	Feature Key 02	Feature Key 03	Feature Key 04	Feature Key 05	Feature Key 06	Feature Key 07	Feature Key 08	Feature Key 09	Feature Key 10	Feature Key 11												
Data	00	00	00	00	01	00	00	00	00	00	*00*	*00*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
Byte	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Data	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
Byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

Pressing Feature Keys

The PBX integration board can “press” any of the Optiset E Feature Keys using the **dx_dial( )** function. Refer to the *PBX Integration Board Software Reference for* more information about dialing programmable keys. Each Feature Key on the Optiset E telephone is assigned a dial string sequence (refer to *Table 11* and *Table 12*). By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can press any Feature Key.

4.3.4. Alphanumeric Display

The alphanumeric display is a two row, 48-character LCD that is used to show the activity of the phone. Some examples are:

- date and time
- feature names
- text messages
- error messages
- called/calling identification
- phone status
- line selection

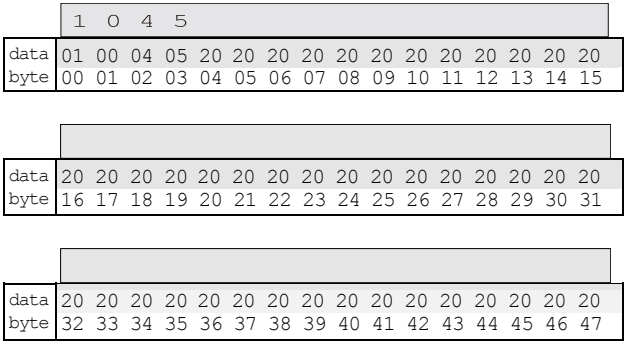
The data used to display information in the LCD alphanumeric display is in ASCII format. When the telephone is not in use, the display normally shows

the date and time. The content of the display is changed automatically (e.g., receiving an incoming call, making an outgoing call, or activating a feature).

The PBX integration board can retrieve the information on its alphanumeric display using the **d42_display( )** function. The function places the display data (48 bytes) in an application buffer. Refer to the *PBX Integration Board Software Reference for* more information about using the **d42_display( )** function.

Example

An application uses the **dx_dial( )** function and the appropriate dial string to press keys dial extension number 1045. The **d42_display( )** function is used to retrieve the display data and place it in an application buffer (shown below). The information for the top row (first 24 characters) of the display is checked. Data in bytes 00 through 03 indicate that extension 1045 is being dialed.



Called/Calling Number ID (within the PBX)

When receiving a call on a PBX integration board from another extension, the PBX sends calling number ID data (by default, the extension number of the telephone placing the call) to the station set between the first and second rings. The station set processes the data and sends an ID message to the display. The calling number ID data sent from the PBX to the station set differs from the calling number ID data presented on the display.

When placing a call to another extension, the called number ID (by default, the extension of the telephone being called) is shown in the display.

Both the calling and called number IDs can be retrieved using the **d42_gtcallid( )** function. The **d42_gtcallid( )** function retrieves the called/calling number ID message sent from the PBX to the station set, not the data sent to the display. Refer to the *PBX Integration Board Software Reference for* more information about using **d42_gtcallid( )** function.

The contents of the called/calling number ID are shown in *Table 13* (as seen by the receiver of the call).

Table 13. Called/Calling Number ID Data for the Hicom

Call Route	Called/Calling Number ID Data
Call received from station set 221	_221
Call originally received by extension 221, then forwarded to extension 224	224_221

NOTE: The called/calling number ID can also be obtained using the **d42_display( )** function; however, you should use the **d42_gtcallid( )** function so that your application will maintain functionality across different manufacturers' switches.

Known Anomaly with Forwarded Call for Hicom 150 PBX: The called and calling ID for the vairous supported integrations (with the exception of Norstar) are retrieved from the display. The method involves the retrieval and parsing of the display when the LED flashes for Ring. The display is not refreshed during the lifetime of the call. Therefore, this method gives incorrect call ID information for Hicom 150 for the forwarded call. The reason for the incorrect information is that the PBX does not provide a display with both calling and called IDs when a forwarded call is received.

For example, the display below is obtained when extension 109 calls extension 108, then extension 108 forwards the call to a port.

The display when the Ring comes in and the LED flashes is:

"Call for: 108 "

The display shows the correct called ID. If the **d42_gtcallid( )** function is used to retrieve the call ID, it returns _108, which is not in the expected <called ID>_<caller ID> format (in this case, 108_109).

When the port answers, the display shows the correct caller ID as follows:

Ch 01 LCD = "109 Consult? >"

Therefore, the alternative to using the **d42_gtcallid( )** function to retrieve the caller ID, which gives incorrect results, is to use the **d42_display( )** function to retrieve the display, then parse the display to extract the caller ID.

Example

An application uses the **d42_gtcallid( )** function to retrieve the calling number ID for a call received on a specified channel on a PBX integration board. The calling number ID data and corresponding ASCII values are shown below.

text	*bb*	2	2	1	_	2	2	4																
data	20	32	32	31	5F	32	32	34	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
text																								
data	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

4.3.5. Setting the Message Waiting Indicator

The PBX integration board can set the Message Waiting Indicator (on or off) on another extension using the **dx_dial( )** function and the appropriate dial string, as described in the *PBX Integration Board Software Reference* for your particular operating system.

NOTE: Message Waiting can also be set using the **dx_dial( )** function and appropriate dial string to press the Feature Key assigned to send messages; however, you should use the **dx_dial( )** function as described so that your application will maintain functionality across different manufacturers' switches.

MWI On

The recommended technique to turn on the MWI in this switch, using **dx_dial( )** with the dial string is:

1. Go Off Hook using the **dx_sethook( )** function.
2. Call the **dx_dial( )** function. The dial string is <ESCO><extention><ESCO> (optional pause character may be used).
3. Go On hook using the **dx_sethook( )** function again.

NOTE: <ESCO> means the Escape character followed by O.

MWI Off

The recommended technique to turn off the MWI in this switch, using **dx_dial( )** with the dial string is:

1. Go Off Hook using the **dx_sethook( )** function.
2. Call the **dx_dial( )** function. The dial string is <ESCF><extention><ESCF> (optional pause character may be used).
3. Go On hook using the **dx_sethook( )** function again.

NOTE: <ESCF> means the Escape character followed by F.

With the Hicom 150 PBX, the PBX integration board can determine the state of its Message Waiting display using the **d42_display( )** function to retrieve the display data. Bytes 00 through 47 are used for the message waiting prompt and displays *Messages received: 1* and *View messages?* Refer to the *PBX Integration Board Software Reference for* more information about using the **d42_display( )** function.

With the Hicom 150 PBX, since there is no button that can be programmed to store the feature access code for MWI OFF operation, the application must set

the MWI ON and MWI OFF feature access codes using the **d42_setparm( )** function. Otherwise, MWI operation can not be done by the PBX integration board connected to the Hicom 150 PBX. The following parameters must be set:

- D4BD_MSGACCESSON (0x0A) to store the feature access code for MWI ON. A string value should be passed as the parameter value. A value of **9 is stored by default by the system service at startup time.
- D4BD_MSGACCESSOFF (0x0B) to store the feature access code for MWI OFF. A string value should be passed as the parameter value. A value of ##9 is stored by default by the system service at startup time.

The following code demonstrates how to use the **d42_setparm( )** function in this context:

```
char str parmval[8];  // cannot be more than 8 characters long
int paramNumber;
paramNumber = D4BD_MSGACCESSOFF;  // or D4BD_MSGACCESSON
if ( (rc = d42_setparm(devh, paramNumber, (void *)&str_parmval[0])) == -1)
{
    // error processing
} // end d42_setparm
```

Note the following:

- The string buffer used to pass the parameter cannot be more than seven characters plus the NULL terminator.
- Once the feature access code is set in this way, the application can do the MWI operation using <ESCO> or <ESCF> strings.

See the *PBX Integration Board Software Reference* for more information on the **d42_setparm( )** function and the D4BD_MSGACCESSON and D4BD_MSGACCESSOFF parameters.

With the Hicom 300 PBX, the PBX integration board can determine the state of its Message Waiting Indicator using the **d42_indicators( )** function to retrieve the LED Indicators data. Byte 00 contains the Message Waiting indicator status (0x00 is off; 0x01 is on). Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_indicators( )** function.

Example

With the Hicom 150, an application uses the **d42_display( )** function to retrieve the display data for a specified channel on the *PBX integration board* to determine if a message is waiting , as shown in *Figure 7* below.

NOTE: Bytes 00-23 represent the top row of the display. Bytes 24-47 represent the bottom row of the display.

data	4D	65	73	73	61	67	65	73	20	72	65	63	65	69	76	65
byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

data	64	3A	00	31	20	20	20	20	56	69	65	77	20	6D	65	73
byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

data	73	61	67	65	73	20	20	20	20	20	20	20	20	20	20	3E
byte	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

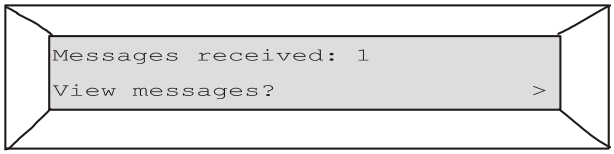


Figure 7. Optiset E Message Waiting Display with Hicom 150

With the Hicom 300, an application uses the **d42_indicators( )** function to retrieve the LED Indicators data for a specified channel on the PBX integration board to determine if a message is waiting. The LED indicators data is shown below. The data 0x01 shows that the MWI indicator is on (there are messages waiting).

	Feautre Key 01	Feautre Key 02	Feautre Key 03	Feautre Key 04	Feautre Key 05	Feautre Key 06	Feautre Key 07	Feautre Key 08	Feautre Key 09	Feautre Key 10	Feautre Key 11	Feautre Key 12												
Data	01	00	00	00	00	00	00	00	00	00	00	00	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
Byte	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Data	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
Byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

4.3.6. Transferring a Call

The PBX integratin board can transfer calls using the **dx_dial( )** function. By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can transfer a call to any extension connected to the switch. Refer to the *PBX Integration Board Software Reference* for more information about dialing programming keys.

The PBX integration board can perform both supervised and blind transfers (Refer to sections *2.1. Supervised Call Transfer* and *2.2. Blind Call Transfer*). When a blind transfer is performed, the PBX controls where the call is routed if the extension is busy or does not answer. When a supervised transfer is performed, your application can implement call progress analysis (CPA) and called/calling number ID to intelligently control where the call is routed (by completing or aborting the transfer) and what type of message is played if the call extension is busy or does not answer. Because of this capability, supervised transfer is the preferred method.

Initiating a Transfer

Once in a connected call, initiate a transfer using **dx_dial(&,<ext>)** where **&** acts as a key press of the transfer key and **<ext>** is the PBX extension you are transferring the call to.

Completing a Transfer

To complete a call (supervised or blind) simply go on-hook using the **dx_sethook( )** function.

Aborting a Transfer

A transferred call can be aborted at any time (prior to completing the transfer) by pressing the **OptiGuide** key. The application can perform this only in a supervised transfer mode. Abort the transfer using **dx_dial(<ESC>KM)**, which presses the **OptiGuide** key. This brings the original caller back to an active state.

4.4. Mitel Superswitch PBXs

Mitel PBXs use digital signaling to control its station sets and digitized voice. Digital Network Interface Circuit (DNIC) Line Cards provide an interface between the station sets and the switch. The PBX integration board has four or eight channels that are connected to a Mitel DNIC Line Card. The PBX integration board can be used with the SX-50, SX-200 and SX-2000 PBXs. These Mitel PBXs have many standard features that are supported by the PBX integration board, such as:

- direct inward dialing (DID)
- speed dialing
- hunt groups
- message waiting indication
- user programmable Feature Keys
- called/calling number identification
- call forwarding.

4.4.1. Mitel Superswitch Programming Requirements

The phones that are supported by PBX integration boards are the Mitel Superset M430 and Mitel Superset M420 phones. These phones that can be used with the various PBXs are shown in *Table 14*.

Table 14. Phone and PBX Interoperability

	SX-50	SX-200	SX-2000
Mitel Superset 430	No	Yes, preferred	Yes, preferred
Mitel Superset 420	Yes	Yes, but not preferred	Yes, but not preferred

NOTES: **1.** Mitel Superset 430 phone emulation should be used with SX-200 and SX-2000 PBXs.

2. Mitel Superset 420 phone emulation should be used with SX-50 only.

The MWI feature access code must be programmed in specific personal keys in the Mitel 430 and Mitel 420 emulations for the board to function successfully.

There are specific switch programming requirements for using a PBX integration board with a Mitel Superswitch. You must ensure that these features are set exactly (and assigned to the right keys) so that the PBX integration board and the unified API function correctly.

The PBX uses Class of Service (COS) to determine which features are available to an extension. The features available to an extension are shown in the telephone set's LCD Features display. Any feature not in the COS will not be displayed.

The following subsections describe PBX-side programming, followed by Phone-side programming.

PBX-Side Programming

Mitel SX-200 PBX Programming Requirements for Using MWI:

1. Under main menu option 03, **COS Define**, enable option numbers 232, **Message Waiting Setup – Lamp** and 259, **Message Sending**.

2. Under main menu option 09, **Stations/Superset Assignments**, scroll down to select the desired station(s), arrow over to the **COS** column and enter the desired COS number (based on the COS setup above).
3. Press **<ESC>0** to enter the change and **<ESC>6** to return to the main menu.

Mitel SX-2000 PBX Programming Requirements for using MWI:

1. Create a COS from the main menu option **System Forms** | **Class of Service Options Assignments**.
2. Press **<ESC>2** to edit this form and enter the COS number desired for MWI setup.
3. Press **<ESC>1** to recall the select COS number to the screen.
4. Set the **Message Waiting** option to YES.
5. Press **<ESC>4** to commit to the changes.
6. Assign a COS to the desired station(s) from main menu option **System Forms** | **Form Menus** | **Class of Service Options Assignments**.
7. Select **Dependents** | **Station Service Assignments** and edit this form.
8. For each station, enter the desired COS number (based on the COS setup above).
9. Press **<ESC>4** to save the changes.

Mitel SX-50 PBX Programming Requirements for using MWI:

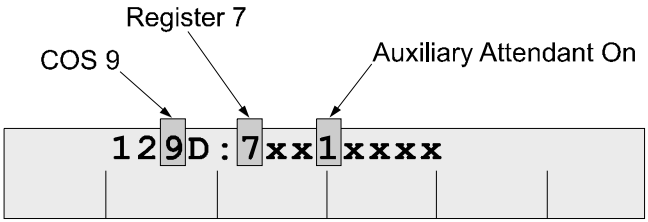
If you are using a Mitel SX-50 and wish to use the set Message Waiting Indicators (MWI) feature, the PBX integration board must enable Auxiliary Attendant capabilities, and a line key must be set to act as the Attendant Console MWI. To configure MWI on a Mitel Superswitch:

- Enable Auxiliary Attendant capabilities
- Configure Personal Key 02 (see *Figure 8*) to act as to act as an Attendant Console Message Waiting Indicator key.

See the Mitel manuals for more information on programming a Superswitch.

Configuring a COS to Have Enhanced Auxiliary Attendant Capabilities:

1. From an attendant console, enter Programming Mode.
2. Enter the Command Number corresponding to the COS to which you want to add Auxiliary Attendant capabilities. Use commands 121 through 129 for COS 1 through COS 9. For example, if you want to change COS 9, use Command Number 129.
3. Set register 7, field "d" (Auxiliary Attendant Position) to 1 (enable Auxiliary Attendant Position) for the desired COS (1 - 9). The illustration below shows the Auxiliary Attendant feature enabled on COS 9.



4. Exit Programming Mode.

For more information, see the Mitel Superswitch manuals.

Phone-Side Programming

SX-200 and SX2000 PBXs and Mitel Superset 430 Emulation:

Personal Key 10 should store the MWI OFF feature access code and Personal Key 11 should store the MWI ON feature access code (see *Figure 9*).

1. Connect the extension (that will be connected to the PBX integration board) to a Mitel Superset 430 phone. Repeat the steps for all extensions that would be connected to the board.
2. On a Superset 430 phone, press the SuperKey.

   For SX-200 PBXs and a SuperSet 430 phone:

   a) Press the **More** soft-key

   b) Press **Feature Key** soft-key

   c) Press the desired personal key (either **10** or **11**).

d) Press **Change** soft-key

e) Press **Speed Call** soft-key

f) Enter the MWI Feature Access code (for key 10 – MWI OFF, for 11-MWI ON)

g) Press the **Save** soft-key.

h) Press the **Superkey**.

For SX-2000 PBXs and a SuperSet 430 phone:

a) Press the desired personal key (**10** or **11**)

b) Press the **Change key** soft-key.

c) Press the **Speed Call** soft-key.

d) Enter the MWI Feature Access code (for key 10 – MWI OFF, for 11-MWI ON)

e) Press the **Save** soft-key.

f) Press the **Superkey**.

SX-50 PBX and Mitel Superset 420 Emulation:

Programming Personal Key 02 to Act as an Attendant Console MWI Key:

1. On a 420 Superset phone, press the **SuperKey**.
2. Press the **No** display key until the display screen shows **Personal Keys**, then press the **Yes** display dey.
3. Press personal key **02**, which is the second key from the bottom right.
4. If the screen shows that personal key **02** is programmed differently than as the MWI, press the **Change** display key.
5. Press the **No** display key until the screen shows: **Att. func keys**, then press the **Yes** display key.
6. After the screen shows **Dial feature No**, use the keypad to enter the number **10** for message waiting.

7. After the display screen shows **10 = msg wait**, press the **Save** display key to confirm and exit.
8. To determine the current setting of a feature key, press the **SuperKey** and then press the feature key you want to check. The display shows the name of the feature programmed.

4.4.2. Using the PBX Integration Board

The PBX integration board emulates functions available to the following phones:

- Superset 420 telephone. This emulation should be used with an SX-50 PBX.
- Superset 430 telephone. This emulation should be used with an SX-200 or SX-2000 PBXs.

The PBX integration board can be used to:

- transfer calls
- set the message waiting indicator
- read the LCD alphanumeric display
- read the LCD features display
- read the LCD prompts display
- read LCD line indicators
- read the calling number ID
- press keys.

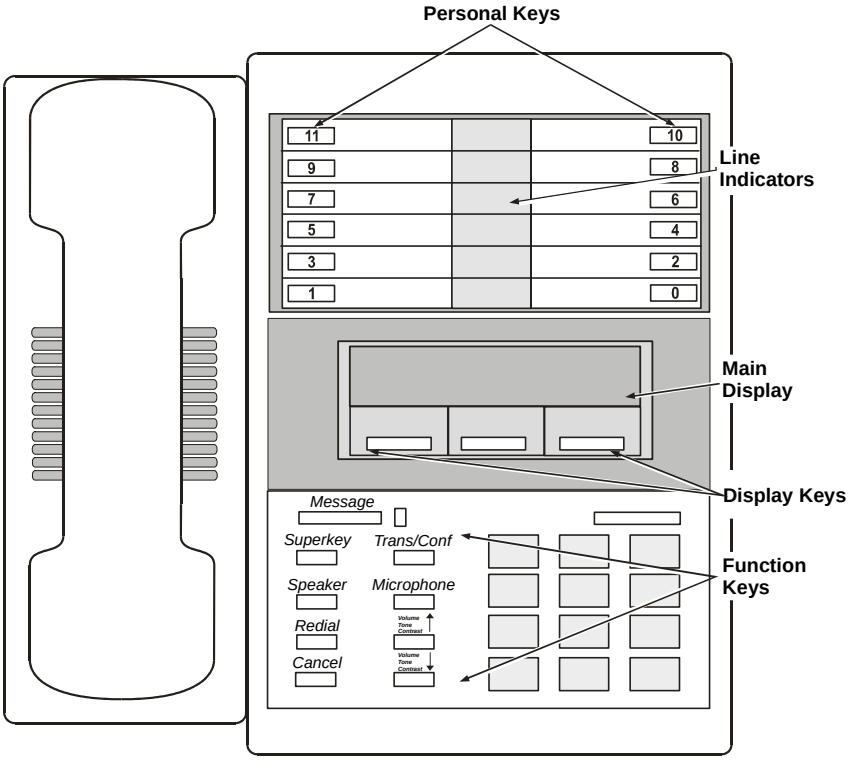


Figure 8. Mitel Superset 420 Telephone

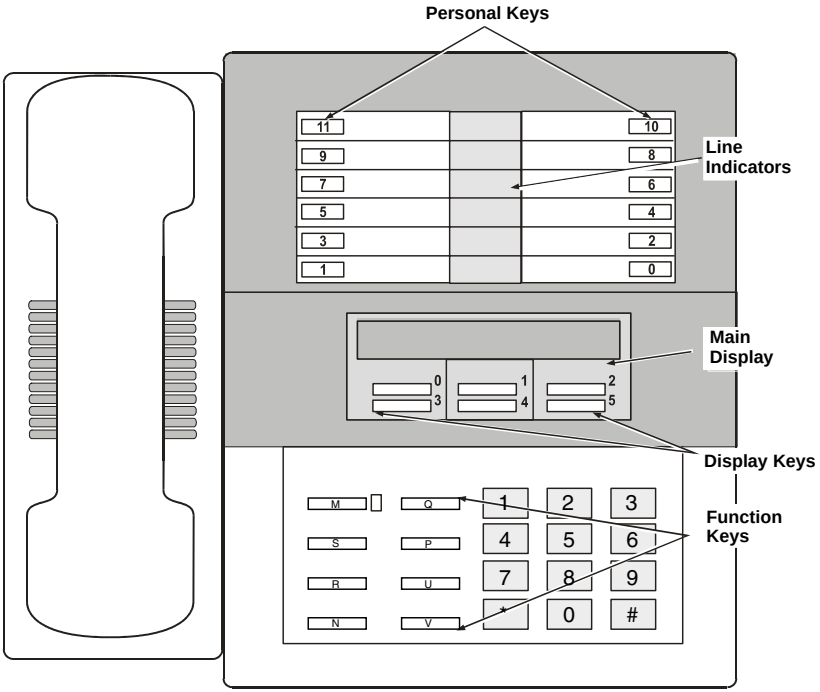


Figure 9. Mitel Superset 430 Telephone

4.4.3. Programmable Personal Keys for Mitel Superset Emulation

As seen in *Figure 8 and Figure 9*, there are 12 Personal Keys located on the top-right portion of Superset 430 and Superset 420 telephones. Some of these keys are configured when the PBX is programmed to select preassigned lines. Keys that are not configured can be defined by the user (using the telephone set or the PBX integration board) as speed dial or Feature Keys. There is an LCD Line Indicator associated with each Personal Key. The LCD Indicators are triangular and can take on one of the six states listed in *Table 15*.

Table 15. Mitel Superset 420/430 LCD Line Indicator States

State	Value (Hex)
Off	0x00
On	0x01
Ringing	0x02
Hold	0x03
Error	0x04
Unknown	0x05

Reading LCD Line Indicators

The PBX integration board can determine the state of its Line Indicators by using the **d42_indicators( )** function to retrieve the LCD Indicators data. This function places the Line Indicator data (12 bytes) in an application buffer. Bytes 0-11 contain the indicator status for Feature Keys 00-11, respectively (see *Table 16* and *Table 17*).

Table 16. Mitel Superset 420 LCD Line Indicators (with SX-50) and Dial Strings

Byte	Key Description	Dial String
00	Personal Key 00	<ESC>KA
01	Personal Key 01	<ESC>KB
02	Personal Key 02 - Message Waiting	<ESC>KC
03	Personal Key 03	<ESC>KD
04	Personal Key 04	<ESC>KE
05	Personal Key 05	<ESC>KF
06	Personal Key 06	<ESC>KG
07	Personal Key 07	<ESC>KH
08	Personal Key 08	<ESC>KI
09	Personal Key 09	<ESC>KJ

Byte	Key Description	Dial String
10	Personal Key 10	<ESC>KK
11	Personal Key 11	<ESC>KL

Table 17. Mitel Superset 430 LCD Line Indicators (with SX-200 and SX-2000) and Dial Strings

Byte	Key Description	Dial String
00	Personal Key 00	<ESC>KA
01	Personal Key 01	<ESC>KB
02	Personal Key 02	<ESC>KC
03	Personal Key 03	<ESC>KD
04	Personal Key 04	<ESC>KE
05	Personal Key 05	<ESC>KF
06	Personal Key 06	<ESC>KG
07	Personal Key 07	<ESC>KH
08	Personal Key 08	<ESC>KI
09	Personal Key 09	<ESC>KJ
10	Personal Key 10 (MWI Off)	<ESC>KK
11	Personal Key 11 (MWI On)	<ESC>KL

Example

An application uses the **d42_indicators( )** function to retrieve the current data for the LCD Line Indicators for a given channel on a PBX integration board. The data placed in the application buffer is shown below. If the data for byte 07 (ANDed with 0x0f) is 0x02, the indicator corresponding to the Feature Key 07 is indicating ringing (see *Figure 10*). Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_indicators( )** function.

	Personal Key 00	Personal Key 01	Personal Key 02	Personal Key 03	Personal Key 04	Personal Key 05	Personal Key 06	Personal Key 07	Personal Key 08	Personal Key 09	Personal Key 10	Personal Key 11											
Data	00	00	00	00	00	00	00	02	00	00	00	00	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
Byte	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Data	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
Byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

Figure 10. Mitel Superset 420/430 LCD Line Indicator

NOTE: The application can obtain the least significant byte of the value returned by the **d42_indicators( )** function by ANDing that value with 0x0f.

Pressing Personal Keys

The PBX integration board can “press” any of the Mitel Superset Personal Keys using the **dx_dial( )** function. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys. Each Personal Key on the Mitel Superset 420/430 telephone is assigned a dial string sequence (refer to *Table 16 or Table 17*). By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can press any Personal Key.

4.4.4. Function Keys

As shown in *Figure 8 and Figure 9*, there are a number of Function Keys found to the left of the dial key pad on the Mitel Superset 420/430 telephones. The PBX integration board can emulate these keys to perform various operational functions.

Pressing Function Keys

The PBX integration board can "press" any of its function keys using the **dx_dial( )** function. Each function key on Superset 420/420 telephones is assigned a dial string sequence (refer to *Table 18* and *Table 19*). By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can dial any of its function keys. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys.

Table 18. Mitel Superset 420 Direct Key Dialing Strings for Function Keys

Dial String	Key Description
<ESC>KM	Message Key
<ESC>KN	SuperKey
<ESC>KO	Cancel
<ESC>KP	Microphone
<ESC>KQ	Hold
<ESC>KR	Redial
<ESC>KS	Speaker
<ESC>KT	Trans/Conf
<ESC>KU	V/T/C up
<ESC>KV	V/T/C down

Table 19. Mitel Superset 430 Direct Key Dialing Strings for Function Keys

Dial String	Key Description
<ESC>KM	Message Key
<ESC>KN	SuperKey
<ESC>KO	*Not Used*
<ESC>KP	Microphone
<ESC>KQ	Hold
<ESC>KR	Applications
<ESC>KS	Speaker
<ESC>KT	*Not Used*
<ESC>KU	V/T/C up
<ESC>KV	V/T/C down

4.4.5. Display (Soft) Keys

Mitel Superset 420 Phone with SX-50 PBX

As shown in *Figure 8*, there are three Display Keys or Soft Keys located below the LCD display on the Mitel Superset 420 telephone. These keys are associated with specific prompts shown on the LCD display depending on the current state of the phone.

Reading Display Key Prompts:

The PBX integration board can determine which of its prompts are currently displayed by using the **d42_display( )** function to retrieve display data and read the information for the bottom row (last 16 characters). The total length of the display data is 32 bytes.

The data location for the Display Key prompts is as follows:

Display Key 00	bytes 16 - 20
Display Key 01	bytes 21 - 26
Display Key 02	bytes 27 - 31

Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_display( )** function.

Example

An application uses the **d42_display( )** function to retrieve the prompt data displayed for Display Key 00, as shown in *Figure 11*. The data placed in the application buffer is shown below. Data in bytes 16 through 31 indicate that the prompts Yes and No are displayed below Display Keys 00 and 02, respectively.

NOTE: Bytes 00-15 represent the top row of the display. Bytes 16-31 represent the bottom row of the display.

data	43	41	4C	4C	46	4F	52	44	57	41	52	49	4E	47	3F	20
byte	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15

data	59	65	73	20	20	20	20	20	20	20	20	20	20	4E	6F
byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

data	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
byte	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

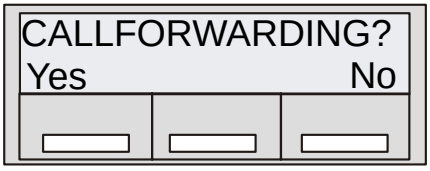


Figure 11. Mitel Superset 420 Display Keys

Mitel Superset 420 or 430 Phone with SX-200 or SX-2000 PBX

As shown in *Figure 8*, there are six Display Keys or Soft Keys located below the LCD display on the Mitel Superset 430 telephone. These keys are associated with specific prompts shown on the LCD display depending on the current state of the phone.

NOTE: In order to read the soft key prompts from the Mitel Superset 430 phone, 160 bytes of display data must be read that was not supported until System Release 5.1.1 Feature Pack 1. Use the **d42_displayex( )** function to get 160 bytes of data for Mitel Superset 430 integration only.

Reading Display Key Prompts:

The PBX integration board can determine which of its prompts are currently displayed by using the **d42_displayex( )** function to retrieve display data and read the information for the bottom two rows (last 80 characters).

NOTE: The display key prompts and locations may be different in SX-200 and SX-2000 PBXs with the same Superset 430 phone emulation.

Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_displayex( )** function.

Pressing Display Keys:

The PBX integration board can respond to a prompt and “press” the appropriate Display Key using the **dx_dial( )** function. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys. As shown in *Table 20* and *Table 21*, each Display Key on Superset 420/430 telephones is assigned a dial string sequence. By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can press any of its Display (Soft) Keys.

Table 20. Mitel Superset 420 Direct Key Dialing Strings for Display Keys

Dial String	Key Description	Display (Soft) Key #
<ESC>Ka	Left Softkey	Display key 00
<ESC>Kb	Middle Softkey	Display key 01
<ESC>Kc	Right Softkey	Display key 02

Table 21. Mitel Superset 430 Direct Key Dialing Strings for Display Keys

Dial String	Key Description	Display (Soft) Key #
<ESC>Ka	Top Left Softkey	Display key 00
<ESC>Kb	Top Middle Softkey	Display key 01
<ESC>Kc	Top Right Softkey	Display key 02
<ESC>Kd	Bottom Left Softkey	Display key 03
<ESC>Ke	Bottom Middle Softkey	Display key 04
<ESC>Kf	Bottom Right Softkey	Display key 05

4.4.6. Alphanumeric Display

The alphanumeric display is a:

- 160-digit LCD on Mitel Superset 430 phones
- 32-digit LCD on Mitel Superset 420 phones

The LCD is used to show:

- date and time when the extension is idle
- SuperKey instructions and Softkey labels during programming and feature access
- call status
- messaging information
- telephone system error messages
- saved numbers (speed dialing)
- saved number for redial
- timed reminder setting
- call forward type and destination
- calling number ID
- trunk line ID

The data used to display information in the LCD alphanumeric display is in ASCII format. When the telephone is not in use, the display normally shows the date and time. The content of the display is changed automatically (e.g., receiving an incoming call, making an outgoing call, or activating a feature). The PBX integration board can retrieve the information on its display using one of the following functions:

- **d42_displayex( )** with a buffer size of 160 for Mitel Superset 430 phones
- **d42_display( )** for Mitel Superset 420 phones

Refer to the *PBX integration Board Software Reference* for more information about using the **d42_display( )** and **d42_displayex( )** functions.

Example

An application uses the **dx_dial( )** function to press the "SuperKey" key and "Display Key 1" for "Yes" on a specified channel on the PBX integration board to display the call forwarding extension. The **d42_display( )** function is then used to retrieve the display data and verify that a call forwarding extension has not been programmed. The display data is shown below. The snapshot is a display from an SX-50 PBX with a Superset 420 phone.

	N	O	N	E		A	C	T	I	V	E				
Data	4E	4F	4E	45	20	41	43	54	49	56	45	20	20	20	20
Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

	P	r	o	g	r	a	m								
Data	50	72	6F	67	72	61	6D	20	20	20	20	20	20	20	20
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

Data	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
Byte	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

Called/Calling Number ID (within the PBX)

When receiving a call on a PBX integration board from another extension, the PBX sends calling number ID data (by default, the extension number of the telephone placing the call) to the station set between the first and second rings. The station set *processes* the data and sends an ID message to the display. The calling number ID data sent from the PBX to the station set differs from the calling number ID data presented on the display.

When placing a call to another extension, the called number ID (by default, the extension of the telephone being called) is shown in the display.

Both the calling and called number IDs can be retrieved using the **d42_gtcallid( ))**function. The **d42_gtcallid( )** function retrieves the called/calling number ID message sent from the PBX to the station set, not the data sent to the display. Refer to the *PBX Integration Board Software Reference* for more information about using **d42_gtcallid( )** function.

The content of the called/calling number ID are shown in *Table 22* (as seen by the receiver of the call).

Table 22. Called/Calling Number ID Data for the Mitel Superset

Call Route	**Example Display (Soft Key not Shown)**	**Called/ Calling No. ID Data**
Call received from trunk	"T001 " "T102 IS CALLING" "X154 IS CALLING"	_0-001 _0-012 _0-154
Call received from station set 221	"221 IS CALLING "	_221
Call originally received on trunk, then transferred to station set 2103	"T002 FORWARDED FROM 2103 NO A"	2103_0-002
Call originally received by extension 2103, then forwarded to extension 2104	"2104 IS CALLING FORWARDED FROM 2103 NO A"	2103_2104
External direct call with the word **EXTERNAL**	"EXTERNAL IS CALLING "	_
External forwarded call with the word **EXTERNAL**	"EXTERNAL CALL FWD FROM 1778 RICK NO ANS"	1778_
External direct call with the word **XNET**	"XNET IS CALLING FORWARDED FROM 6302"	6302_

NOTES: **1.** The data in *Table 22* is applicable to an SX-200/SX-2000 PBX with a Mitel Superset 430 phone.

2. The called/calling number ID can also be obtained using the **d42_display( )** function; however, you should use the **d42_gtcallid( )** function so that your application will maintain functionality across different manufacturers' switches.

The PBX integration board attempts to get the caller ID information from one of the valid Mitel CPID displays that could be used to extract the caller ID information. The PBX integration board assumes a valid CPID display (for SX-200/SX-2000 with a Superset 430) based on the following rules:

- The display may have either the word "CALLING", or "FROM"
- The display may have T followed by a digit identifying a trunk
- The display may have X followed by a digit identifying a trunk
- If the display has a letter after a digit, this digit is not assumed to be a caller ID
- If the display has the word "EXTERNAL" or "XNET", they are considered to be an unnumbered trunk.

Example

An application uses the **d42_gtcallid( )** function to retrieve the calling number ID for a call received on a specified channel on a PBX integration board. The calling number ID data and corresponding ASCII values are shown below.

text	*bb*	2	2	1	_	2	2	4															
data	20	32	32	31	5F	32	32	34	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
text																								
data	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

4.4.7. Setting the Message Waiting Indicator

The PBX integration board can set the Message Waiting Indicator (ON or OFF) on another extension using the **dx_dial( )** function and the appropriate dial string, as described in the *PBX Integration Board Software Reference*.

NOTE: Message Waiting can also be set using the **dx_dial( )** function and appropriate dial string to press the Feature Key assigned to send messages; however, you should use the **dx_dial( )** function as described so that your application will maintain functionality across different manufacturers' switches.

MWI On

The recommended technique to turn on the MWI in this switch, using **dx_dial( )** with the dial string is:

1. Go Off Hook using the **dx_sethook( )** function.
2. Call the **dx_dial( )** function. The dial string is <ESCO><extention><ESCO> (optional pause character may be used).
3. Go On hook using the **dx_sethook( )** function again.

NOTE: <ESCO> means the Escape character followed by O.

MWI Off

The recommended technique to turn off the MWI in this switch, using **dx_dial( )** with the dial string is:

1. Go Off Hook using the **dx_sethook( )** function.
2. Call the **dx_dial( )** function. The dial string is <ESCF><extention><ESCF> (optional pause character may be used).
3. Go On hook using the **dx_sethook( )** function again.

NOTE: <ESCF> means the Escape character followed by F.

4.4.8. Transferring a Call

The PBX integration board can transfer calls using the **dx_dial( )** function. By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can transfer a call to any extension connected to the switch. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys.

The PBX integration board can perform both supervised and blind transfers (refer to *Sections 2.1. Supervised Call Transfer* and *2.2. Blind Call Transfer).* When a blind transfer is performed, the PBX controls where the call is routed if the called extension is busy or does not answer. When a supervised transfer is performed, your application can implement call progress analysis and called/calling number ID to intelligently control where the call is routed and what type of message is played if the called extension is busy or does not answer. Because of this capability, supervised transfer is the preferred call transfer method.

Initiating the Transfer

Once in a connected call, initiate a transfer with **dx_dial(&,<ext>)**, where **&** acts as a key press of the transfer key and **<ext>** is the PBX extension you are transferring the call to.

Completing the Transfer

To complete a call (supervised or blind), one of the following methods can be applicable:

- Press the Softkey labeled Release Me. When Superset 430 telephones are used with an SX-200 PBX, this can be done using **dx_dial(<ESC>Kb)**, which is equivalent to pressing the top middle soft key.
- Go on-hook.

OR

- Simply go on-hook using the **dx_sethook( )** function.

Aborting the Transfer

A transferred call can be aborted at any time (prior to completing the transfer) by pressing the appropriate Softkey (or Display Key) labeled **Back To Held**. The application can perform this only in a supervised transfer mode. For Superset 430 phones, abort the transfer with **dx_dial(<ESC>Kc)**. This will bring the original caller back to an active state.

4.5. Nortel Norstar

The Norstar product family includes the Compact version and the expandable Modular model. The PBX integration board can be used with the DR5, CICS, or MICS switches. The PBXs use digital signaling to control their station sets and digitized voice. PBXs use plug-in station modules to connect to station sets, and trunk modules to connect to trunk lines.

The PBX integration board has either four or eight channels that are connected directly to a station module in a Nortel Norstar. The switch has many standard features that are supported by the PBX integration board, such as:

- direct inward dialing (DID)
- speed dialing
- hunt groups
- message waiting indication
- user programmable Feature Keys
- called/calling number identification
- call forwarding.

4.5.1. Nortel Norstar Programming Requirements

There are specific switch programming requirements for using a PBX integration board with a Nortel Norstar. You must ensure that these features are set exactly (and assigned to the right keys) so that the PBX integration board and the associated APIs function correctly.

Nortel Norstar Programming Requirements for DR5

Table 23 lists the menu structure used when configuring a Nortel Norstar (with DR5 or later revision installed). The shaded areas indicate the actual menu items to change in order to use the KSU with a PBX integration board. For details about programming a Norstar KSU, refer to the appropriate Norstar manual.

The table only shows the configuration for one trunk line (001) and one extension (221). If you are using more than one trunk line, configure each trunk line the same. If you are using more than one extension, ensure that all

the extensions are configured the same with the exception of the *Forward on busy* and *Forward no answer* options. For these menu items, the first extension should be forwarded to the second extension and the second extension should be forwarded to the third extension, and so on. The last extension should be forwarded back to the first extension.

Table 23. Norstar Configuration Requirements (DR5)

Menu Option/Default Value	**New Value**
A-Configuration	
1. Trk/Line Data	
a) Show line: *Enter Trunk #*	001
b) Trunk data	
Line001: Loop*	
Trunk mode: Supr	
Dial mode: Pulse	Tone
Full AutoHold:N	
c) Line data	
Line type: Public	PoolA
Prime set: 21	221*
Aux. ringer: Y	
Auto privacy:Y	

Table 23. Norstar Configuration Requirements (DR5) - (Cont.)

Menu Option/Default Value	New Value
2. Line Access	
a) Show set: *Enter extension*	221
b) Line assignment *(no changes required)*	
c) Answer DNs *(no changes required)*	
d) Ringing *(no changes required)*	
e) Line pool access *(no changes required)*	
f) Intercom keys:	1
g) Prime line: None	I/C
3. Call Handling	
a) Held reminder:N	
b) DRT to prime: Y	N
c) Trnsfr callbk: 3	12
d) Park prefix:1	
e) Park timeout:45	

* Extension number assignment is system dependent.

Table 23. Norstar Configuration Requirements (DR5) - (Cont.)

Menu Option/Default Value	**New Value**
f) Camp timeout:45	
g) Directed pickup:Y	
h) On hold:Tones	
4. Miscellaneous *(no changes required)*	
5. System Data *(no changes required)*	
B-General admin	
1. Sys speed dial *(no changes required)*	
2. Names *(no changes required)*	
3. Time and date *(no changes required)*	
4. Direct-Dial *(no changes required)*	
5. Capabilities	
a) Dialing filters *(no changes required)*	
b) Rem access pkgs *(no changes required)*	
c) Set abilities	
Show set: *Enter extension*	221

Table 23. Norstar Configuration Requirements (DR5) - (Cont.)

Menu Option/Default Value	New Value
(1) Set filter:02	
(2) Line/set filters *(no changes req'd)*	
(3) Set lock:None	
(4) Full handsfree: N	Y
(5) Auto handsfree: N	Y
(6) HF answerback: Y	N
(7) Pickup group:NO	
(8) Paging: Y	N
(9) Paging zone: 1	NO
(10) Aux. ringer:N	
(11) Direct-dial:Set1	
(12) Forward on busy	
(a) Forward to: None	222
(13) Forward no answr	
(a) Forward to: None	222
(b) Forward delay: 3	2

Table 23. Norstar Configuration Requirements (DR5) - (Cont.)

Menu Option/Default Value	New Value
(14) Allow redirect:N	
(15) Redirect ring:Y	
(16) Hotline:None	
(17) Priority call:N	
d) Line abilities *(no changes required)*	
e) COS passwords *(no changes required)*	
6. Service Modes	
a) Control sets	
Show line: *Enter line #*	001
(1) Line001:	221
(2) Line002:	221
Through	
(3) Line008:	221
(4) Name1:Night	
(a) Setting:Manual	
(b) Trunk answer:Y	N

Table 23. Norstar Configuration Requirements (DR5) - (Cont.)

Menu Option/Default Value	New Value
(c) Extra-dial:	221
(5) Name2:Evening	
(a) Setting:Manual	
(b) Trunk answer:Y	N
(c) Extra-dial:	221
(6) Name3:Lunch	
(a) Setting:Manual	
(b) Trunk answer:Y	N
(c) Extra-dial:221	
5. Password *(no changes required)*	
6. Log Defaults *(no changes required)*	
7. Call Services *(no changes required)*	
C-Set copy *(no changes required)*	
D-Maintenance *(no changes required)*	

Nortel Norstar Programming Requirements for MICS and CICS

All programming is done by a phone or other KSU tool and the programmer should be logged in as **config**. These programming settings are required to ensure proper functionality of the PBX integration boards.

Terminals and Sets (for each D/82 or D/42 port)
- Line Access:
  - Line Assignment:
    - Line00N: **Ring only** – for all trunk lines being used (First D/82 or D/42 port only. Unassigned for all other ports.)
  - Line Pool Access:
    - Pool A: **Y**
    - Pool B: **N**
    - Pool C: **N**
  - Prime Line: **I/C**
  - Intercom Keys: **1**
  - Answer DNs: **None**
- Capabilities:
  - Fwd No Answer:
    - To: **Next D/82 extension**
    - Delay: **3** – set to fit needs
  - Fwd on Busy:
    - To: **Next D/82 extension**
  - DND on Busy: **N**
  - Handsfree: **Auto**
  - HF Answerback: **Y**
  - Pickup Grp: **None**
  - Page Zone: **1**
  - Paging: **Y**
  - D-Dial: **Set1**
  - Priority Call: **N**
  - Hotline: **None**
  - Aux. Ringer: **N**
  - Allow Redirect: **N**
  - Redirect Ring: **Y**
  - ATS Settings: **Default** (option not available on all switches)

Name: **Set to fit needs**
User Preferences:
Model: **M7324** (set automatically)
Button Programming:
B1 – B12: **Blank**
B13 – B20, B22 – B24: **Default**
B21: **Transfer** (Feature 70)
User Speed Dial: **All Blank**
Call Log Options: **No one answered**
Dialing Options: **Standard Dial**
Language: **English**
Display Contrast: **4**
Ring Type: **1**
Restrictions: **Default**
Telco Features: **Default**

Lines (for each trunk going directly to the board)
Trunk/Line Data:
Trunk Type: **Loop** (see below for DID programming)
Line Type: **Pool A**
Dial Mode: **Tone**
Prime Set: **None** – can be set as subscriber if required
Auto Privacy: **Y**
Trunk Mode: **Super**
Answer Mode: **Manual**
Line @ CO: **N**
Aux Ringer: **N**
Full Auto Hold: **N**
Loss Package: **Medium CO**
Name: **Set to fit needs**
Restrictions: **Default**
Telco Features: **Default**

Services – **Default**

System Speed Dial – **Default**

Passwords – **Default**

Time & Date – **Set current**

System Programming – **Default for all settings except Access Codes**
Access Codes:
Line Pool Codes:
Pool A: **9** – or whatever code will be used to dial out

Telco Features - **Default**

Software Keys - **Default**

Hardware - **Default**

Maintenance - **Default**

NOTES:

1. Any option not listed in this section can be set as needed for the subscribers.
2. If the **d42_getcallidex( )** function is being implemented, then the first port of the PBX integration board must be set as the prime set for a line in order to differentiate between an external call forwarded on ring no answer and an external call forwarded on busy. If the PBX integration port is not set at the prime set, then all forwarded external calls will appear as external forwarded on no answer. Programming the PBX integration port as prime set is shown below.
3. Assign **ring only** to the first port of the D/82JCT-U or D/42JCT-U for lines that are to be answered by the board, that is, IRV, direct into voicemail. For all lines that go directly to an extension, first have them "unassigned" for the ports on the board.
4. If lines are not being used, assign them to any pool except pool A. This is important for out dialing.

Program the PBX integration Port as Prime Set as follows:

For Loop Start Lines:
Line Access:
Line Assignment:
Line00N: **unassigned**
Trunk/Line Data:
Prime Set: **First D/82 or D/42 extension number**

For DID Trunk Lines:
Line Access:
Line Assignment:
<Trunk Line Number>: **unassigned**
Trunk/Line Data:
Line Type: **public**
Rec'd #: **Target Line Number**
If Busy: **to prime**
Primeset: **PBX integration port**

DID Target Line Programming Requirement (MICS only)

The following programming requirements are only required if:

- A DID trunk line is used with the PBX integration board
- The target line number is needed in the caller ID information

Step 1: Clear Memory

NOTE: If the DID card is already attached and functional, please proceed to the next section.

If a memory clear is needed, proceed as follows:

1. Reset the power; unplug and plug in the power cord.
2. Within 15 minutes of power reset, log in as **Startup**.
3. Do a **memory clear** and specify the template Hybrid, PBX or Square.
4. Let the switch clear all programming and start up with the default setup.

Step 2: Install the DID Trunk Card

NOTE: If the DID card is already attached and functional, please proceed to the next section.

This procedure notifies the KSU that the DID card is the nth module of the switch. Proceed as follows:

1. Login as **config**.
2. Choose Hardware -> Show Module (e.g., DID trunk is in module 4). Configure CD**i**-MOD4 as **DID**.

3. Log off and log back in as **config**.
4. Choose Maintenance -> Module Status -> Module 4 -> State and make it **enabled**.
5. Log out.

Step 3: Program the Target Line

In this example, the target line number is Lin 145. The following programming will route the incoming DID call to extension 222, which is a D/82 port, if the digits 222 are received in the target line 145.

Lines
- Show Line -> **145**
- Trunk/Line Data: press **Enter**
  - Target Line: default
  - Line Type: **Pvt to 222** (or Public, both have worked)
  - Received Digits: **222**
  - Prime Set: **None** (or 222)

Step 4: Assign the Target Line to the Extension

The extension used in this example is 222, this will be dependent on the KSU.

Terminal & Sets -> Show Set: **222**
- Line Access
  - Line Assignment
    - Show Line
    - -> **145**
    - Ring only
    - Prime Line: **I/C**
    - Intercom Key: **1**

Memory Key Programming

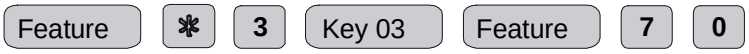
Memory Keys 00, 01 and 03 must be programmed as follows:

- Memory Button 00 - Handsfree/mute
- Memory Button 01 - Intercom
- Memory Button 03 - Transfer (Feature 70)

To determine the current setting of a Memory Button, press

then press the Memory Button you want to check. The display shows the name of the feature programmed.

Memory Button 00 is automatically assigned as the Handsfree/mute key when Full Handsfree is set to Y [refer to *Table 23*, B. 5. (c) (4)]. Memory Button 01 is automatically set as the Intercom key when the number of intercom keys is set to 1 [refer to *Table 23*, A. 2. (f)]. To assign Memory Button 03 to Transfer press:



4.5.2. Using the PBX Integration Board

The PBX integration board performs functions available to a M7324 telephone set (see *Figure 12*). An M7324 telephone set uses three LCD displays. Two is used to show key status indicators (between the line keys), while the other display is used for user prompts and messages (above the display keys). The PBX integration board can:

- transfer calls
- set the message waiting indicator
- read the LCD display
- read LCD indicators
- read the called/calling number ID
- press keys.

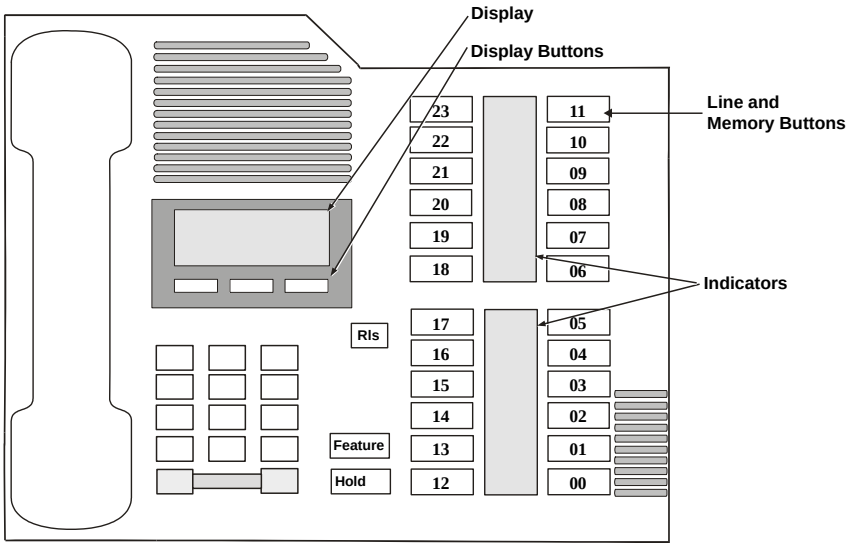


Figure 12. Nortel M7324 Telephone

4.5.3. Programmable Memory Keys

As illustrated in *Figure 12*, the M7324 has 24 Programmable Memory Keys located to the right of the display . These keys are configured either during PBX installation or by the user (using the telephone set or the PBX integration board). The Line, Intercom, Answer, and Handsfree keys are assigned during PBX configuration and cannot be user programmed. There is an LCD Indicator associated with each Memory Button. The LCD Indicators are triangular and can take on one of the six states listed in *Table 24*.

Table 24. M7324 LCD Indicator States

State	Value (Hex)
off	0x00
on	0x01
ringing	0x02
hold	0x03
error	0x04
unknown	0x05

Reading LCD Indicators

The PBX integration board can determine the state of its LCD Indicators by using the **d42_indicators( )** function to retrieve the LCD Indicators data. This function places the Line Indicator data in an application buffer. For a M7324, bytes 0-23 contain the indicator status for Memory Keys 00-23, respectively (see *Table 25*).

Table 25. M7324 Direct Key Dialing Strings for Memory Keys

Byte	Key Description	Dial String
00	Memory Button 00	<ESC>K0
01	Memory Button 01	<ESC>K1
02	Memory Button 02	<ESC>K2
03	Memory Button 03	<ESC>K3
04	Memory Button 04	<ESC>K4
05	Memory Button 05	<ESC>K5
06	Memory Button 06	<ESC>K6
07	Memory Button 07	<ESC>K7
08	Memory Button 08	<ESC>K8
09	Memory Button 09	<ESC>K9
10	Memory Button 10	<ESC>KS

Byte	Key Description	Dial String
11	Memory Button 11	<ESC>KT
12	Memory Button 12	<ESC>KU
13	Memory Button 13	<ESC>KV
14	Memory Button 14	<ESC>KW
15	Memory Button 15	<ESC>KX
16	Memory Button 16	<ESC>KY
17	Memory Button 17	<ESC>KZ
18	Memory Button 18	<ESC>Ka
19	Memory Button 19	<ESC>Kb
20	Memory Button 20	<ESC>Kc
21	Memory Button 21	<ESC>Kd
22	Memory Button 22	<ESC>Ke
23	Memory Button 23	<ESC>Kf

Example

An application uses the **d42_indicators( )** function to retrieve the current data for the LCD Indicators on a given channel on a PBX integration board. In the M7324 example shown below, data has been placed in the application buffer. If the data for byte 1 is 0x01, the triangular indicator for Memory Button 1 is on. Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_indicators( )** function.

	Memory Button 00	Memory Button 01	Memory Button 02	Memory Button 03	Memory Button 04	Memory Button 05	Memory Button 06	Memory Button 07	Memory Button 08	Memory Button 09	Memory Button 10	Memory Button 11	Memory Button 12	Memory Button 13	Memory Button 14	Memory Button 15	Memory Button 16	Memory Button 17	Memory Button 18	Memory Button 19	Memory Button 20	Memory Button 21	Memory Button 22	Memory Button 23
Data	00	01	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Byte	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Data	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
Byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

NOTE: The application can obtain the least significant byte of the value returned by the **d42_indicators( )** function by ANDing that value with 0x0f.

Pressing Memory Keys

The PBX integration board can "press" any of the M7324 Memory Keys using the **dx_dial( )** function. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys. Each Memory Button on the M7324 telephone is assigned a dial string sequence (refer to *Table 25*). By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can press any Memory Button.

4.5.4. Display Keys

As shown in *Figure 12*, there are three Display Keys located below the LCD display. These keys are associated with specific prompts shown on the LCD display depending on the current state of the phone (shown on the bottom row of the LCD display).

Reading Display Key Prompts

The PBX integration board can determine which of its prompts are currently displayed by using the **d42_display( )** function to retrieve display data and read the information for the bottom row (last 16 characters). The total length of the display data is 32 bytes. The data location for the Display Keys is as follows:

Display Key 00	bytes 16 - 20
Display Key 01	bytes 22 - 26
Display Key 02	bytes 28 - 31

Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_display( )** function.

Example

An application uses the **d42_display( )** function to retrieve the prompt data displayed for Display Key 00, as shown in *Figure 13*. The data placed in the application buffer is shown below. Data in bytes 16 through 20 indicate that the prompt **EXIT** is displayed below Display Key 00.

NOTE: Bytes 00-15 represent the top row of the display. Bytes 16-31 represent the bottom row of the display.

data	50	72	65	73	73	20	61	20	62	75	74	74	6F	6E	20	20
byte	0	1	2	3	4	5	6	**7**	8	9	10	11	12	13	14	15

data	45	58	49	54	20	20	20	20	20	20	20	20	20	20	20	20
byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

data	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
byte	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

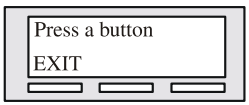


Figure 13. M7324 Display Keys

Pressing Display Keys

The PBX integration board can respond to a prompt and “press” the appropriate Display Key using the **dx_dial( )** function. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys. Each Display Key on the M7324 telephone is assigned a dial string sequence (refer to *Table 26*). By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can press any of its Display Keys.

Table 26. M7324 Direct Key Dialing Strings for Display Keys

Dial String	Key Description
<ESC>KP	Display Key 00 (left)
<ESC>KQ	Display Key 01 (middle)
<ESC>KR	Display Key 02 (right)

4.5.5. Alphanumeric Display

The alphanumeric display is a two row, 32-digit LCD that is used to show the activity of the phone. Some examples are:

- date and time
- feature names
- error messages
- called/calling identification
- phone status
- line selection
- Display Key prompts.

The data used to display information in the LCD alphanumeric display is in ASCII format. When the telephone is not in use, the display normally shows the date and time. The content of the display is changed automatically (e.g., receiving an incoming call, making an outgoing call, or activating a feature).

The PBX integration board can retrieve the information on its alphanumeric display using the **d42_display( )** function. The function places the display data (32 bytes) in an application buffer. Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_display( )** function.

Example

An application uses the **dx_dial( )** function and the appropriate dial string (ESC>KN, <ESC>KK, <ESC>KA, <ESC>K3) to press keys to display which feature is assigned to Memory Button 03. Then, the **d42_display( )** function is used to retrieve the display data and place it in an application buffer (shown

below). The information for the top row (first 16 characters) of the display is checked. Data in bytes 00 through 15 indicate that *Transfer* is assigned to Memory Button 03.

	T	r	a	n	s	f	e	r								
data	54	72	61	6E	73	66	65	72	20	20	20	20	20	20	20	20
byte	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15

data	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

data	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
byte	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

Called/Calling Number ID (within the PBX)

When receiving a call on a PBX integration board from another extension, the PBX sends calling number ID data (by default, the extension number of the telephone placing the call) to the station set between the first and second rings. The station set *processes* the data and sends an ID message to the display. The calling number ID data sent from the PBX to the station set differs from the calling number ID data presented on the display.

When placing a call to another extension, the called number ID (by default, the extension of the telephone being called) is shown in the display.

Both the calling and called number IDs can be retrieved using one of the following:

- **d42_gtcallid( )** function to retrieve the called/calling pair
- **d42_gtcallidex( )** function to retrieve the called/calling ID, call type and reason code.

The **d42_gtcallid( )** and **d42_gtcallidex( )** functions retrieve the called/calling number ID message sent from the PBX to the station set, not the data sent to the display. Refer to the *PBX Integration Board Software Reference* for more information about using **d42_gtcallid( )** and **d42_gtcallidex( )** function.

The contents of the called/calling number ID are shown in *Table 27* (as seen by the receiver of the call).

Table 27. Called/Calling Number ID Data for the Nortel Norstar

Call Route	Called/C**alling Number ID Data**
Call received from trunk line 1	_0-1
Call received from station set 221	_221
Call originally received on trunk line 1, then transferred to station set 223	223_0-1
Call originally received by extension 221, then forwarded to extension 224	224_221

NOTES: **1.** PBX integration boards extract the called/caller ID information from the protocol packets, not by parsing display.

2. The display is parsed only for Answer DN calls. For these calls, the protocol information is not considered.

Example

An application uses the **d42_gtcallid( )** function to retrieve the calling number ID for a call received on a specified channel on a PBX integration board. The calling number ID data and corresponding ASCII values are shown below.

text	*bb*	2	2	1	_	2	2	4																
data	20	32	32	31	5F	32	32	34	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
text																								
data	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

4.5.6. Setting the Message Waiting Indicator

The PBX integration board can set the Message Waiting display (on or off) on another extension using the **dx_dial( )** function and the appropriate dial string. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys.

MWI On

The recommended technique to turn on the MWI in this switch, using **dx_dial( )** with the dial string is:

1. Go Off Hook using the **dx_sethook( )** function.
2. Call the **dx_dial( )** function. The dial string is <ESCO><extention><ESCO> (optional pause character may be used).
3. Go On hook using the **dx_sethook()** function again.

NOTE: <ESCO> means the Escape character followed by O.

MWI Off

The recommended technique to turn off the MWI in this switch, using dx_dial() with the dial string is:

1. Go Off Hook using the **dx_sethook( )** function.
2. Call the **dx_dial( )** function. The dial string is <ESCF><extention><ESCF> (optional pause character may be used).
3. Go On hook using the **dx_sethook( )** function again.

NOTE: <ESCF> means the Escape character followed by F.

The PBX integration board can determine the state of its Message Waiting display using the **d42_display( )** function to retrieve the display data. Bytes 00 through 15 are used for the message waiting prompt and will display *Message for you*. Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_display( )** function.

Example

An application uses the **d42_display( )** function to retrieve the display data for a specified channel on the *PBX integration board* to determine if a message is waiting (see *Figure 14*). The display data is shown below.

NOTE: Bytes 00-15 represent the top row of the display. Bytes 16-31 represent the bottom row of the display.

data	4D	65	73	73	61	67	65	00	66	6F	72	00	79	6F	75	20
byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

data	4D	53	47	20	20	20	20	20	20	20	20	20	20	20	20	20
byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

data	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
byte	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

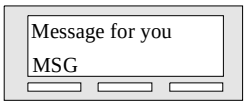


Figure 14. M7324 Message Waiting Display

4.5.7. Transferring a Call

The PBX integration board can transfer calls using the **dx_dial( )** function. By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can transfer a call to any extension connected to the switch. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys.

NOTE: The transfer function can be performed using the **dx_dial( )** function and the appropriate dial string (<ESC>KN, <ESC>KH, <ESC>KA; or <ESC>KN70) to press Feature 70. This method does not depend on Memory Button 03 being programmed correctly; however, you should use the **&,<extension>** dial string so that your application will maintain functionality across different manufacturers' switches.

The PBX integration board can perform both supervised and blind transfers (Refer to the *Sections 2.1. Supervised Call Transfer* and *2.2. Blind Call Transfer).* When a blind transfer is performed, the PBX controls where the call is routed if the called extension is busy or does not answer. When a supervised transfer is performed, your application can implement call progress analysis and called/calling number ID to intelligently control where the call is routed and what type of message is played if the called extension is busy or does not answer. Because of this capability, supervised transfer is the preferred call transfer method.

There are three different ways to perform a transfer operation in the NORSTAR integration, namely:

- & Transfer
- Display Key Press Transfer
- Memory key press transfer

Each method is described below.

Call Transfer Method 1 - & Transfer

Initiating the Transfer

Once in a connected call, initiate a transfer with **dx_dial(&,<ext>)**, where **&** acts as a key press of the transfer key (which is memory button 03) and **<ext>** is the PBX extension you are transferring the call to.

Completing the Transfer

To complete a call (supervised or blind) the application must go on-hook.

Aborting the Transfer

A transferred call can be aborted at any time (prior to completing the transfer) by pressing the appropriate appearance key where the original call resides. The application can perform this only in a supervised transfer mode. For example, if the original call resides on the first appearance key (Memory

Button 01), dialing **dx_dial(<ESC>,K1)** brings the original caller back to an active state.

Call Transfer Method 2 - Display Key Press Transfer

Initiating the Transfer

Once in a connected call, initiate a transfer with **dx_dial($KR,<ext>)**, where **$KR** acts as a key press of the far-right Display key (which is Display Key 02) and **<ext>** is the PBX extension you are transferring the call to.

Completing the Transfer

To complete a call (supervised or blind) the application must go on-hook. Another way to complete the transfer is with **dx_dial($KR)**, where **$KR** acts as a key press (which is Display Key 02, the far-right display key).

Aborting the Transfer

A transferred call can be aborted at any time (prior to completing the transfer) by pressing the appropriate appearance key where the original call resides. The application can perform this only in a supervised transfer mode. For example, if the original call resides on the first appearance key (Memory Button 01), dialing **dx_dial(<ESC>,K1)** brings the original caller back to an active state. Another way to abort the transfer is with **dx_dial($KP)**, where **$KP** acts as a key press (which is Display Key 00, the far-left display key).

Call Transfer Method 3 - Memory Key Press Transfer

Initiating the Transfer

Once in a connected call, initiate a transfer with **dx_dial($K03,<ext>)**, where **$K03** acts as a key press of the transfer key (which is memory button 03) and **<ext>** is the PBX extension you are transferring the call to. Another way to initiate the transfer is with **dx_dial($KN,$KH,$KA)**, where **$KN** acts as a key press of the Feature Key), **$KH** acts as a key press of the number 7 on the keypad, and **$KA** acts as a key press of the number 0 on the keypad.

Completing the Transfer

To complete a call (supervised or blind), the application must go on-hook. Another way to complete the transfer is with **dx_dial($KR)**, where **$KR** acts as a key press (which is Display Key 02, the far-right display key).

Aborting the Transfer

A transferred call can be aborted at any time (prior to completing the transfer) by pressing the appropriate appearance key where the original call resides. The application can perform this only in a supervised transfer mode. For example, if the original call resides on the first appearance key (Memory Button 01), dialing **dx_dial(<ESC>,K1)** brings the original caller back to an active state. Another way to abort the transfer is with **dx_dial($KP)**, where **$KP** acts as a key press (which is Display Key 00, the far-left display key).

4.6. Nortel Meridian 1

The Nortel Meridian 1* is a full-featured PBX that can provide thousands of ports and many PBX voice and data features. The Meridian 1 uses digital signaling to control its station sets and digitized voice. The PBX uses plug-in station modules to connect to station sets, and trunk modules to connect to trunk lines.

The PBX integration board has either four or eight channels that are connected directly to a station module in a Meridian 1. The switch has many standard features that are supported by the PBX integration board, such as:

- direct inward dialing (DID)
- hands free operation (for MWI ON/OFF operation only)
- speed dialing
- hunt groups
- message waiting indication
- user programmable Feature Keys
- called/calling number identification
- call forwarding.

4.6.1. Nortel Meridian 1 Programming Requirements

There are specific switch programming requirements for using a PBX integration board with a Meridian 1. You must ensure that these features are set exactly (and assigned to the right keys) so that the PBX integration board and the unified API function correctly.

Table 28 lists the menu structure used when configuring a Nortel Meridian 1. For details about programming a Meridian 1, refer to the appropriate Meridian 1 manual.

The M-1 ports should be configured as a M2616 telephone with a display as follows:

Table 28. Nortel Meridian 1 Configuration Requirements

Menu Option	Value
CLS	CTD FBD WTA MTD FNA HTA ADD HFD MWA CNDA
TYPE	2616
HUNT	(5502)IS NEXT PHONE IN GROUP
LHK	1
KEY 0	SCR 5501 (Ringing Call Appearance)
KEY 1	
KEY 2	
KEY 3	TRN (TRANSFER)
KEY 4	MCK (MESSAGE CANCEL)
KEY 5	MIK (MESSAGE INDICATION)
KEY 6	
KEY 7	
KEY 8	
KEY 9	
KEY 10	
KEY 11	
KEY 12	
KEY 13	
KEY 14	
KEY 15	

4.6.2. Using the PBX Integration Board

The PBX integration board performs functions available to a M2616 telephone set (see *Figure 15*). An M2616 telephone set uses two LCD displays to show key status (between the line keys) and user prompts and messages (above the display keys).

The PBX integration board can:

- transfer calls
- set the message waiting indicator
- read the LCD display
- read LCD indicators
- read the called/calling number ID
- press keys.

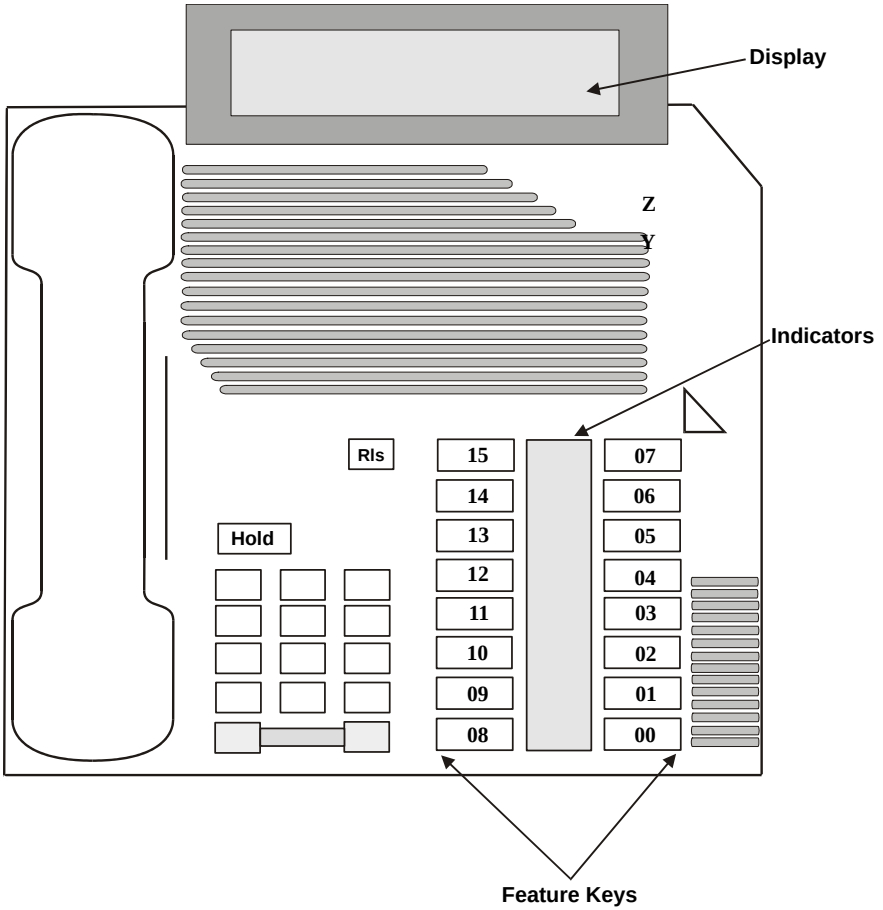


Figure 15. Nortel M2616 Telephone

4.6.3. Programmable Feature Keys

As illustrated in *Figure 15*, there are 16 Programmable Feature Keys located below the display on the M2616 telephone. These keys are configured either during PBX installation or by the user (using the telephone set or the PBX integration board). The Line, Program, and Handsfree keys are assigned during PBX configuration and cannot be user programmed. There is an LCD Indicator associated with each Feature Key. The LCD Indicators are triangular and can take on one of the six states listed in *Table 29*.

Table 29. M2616 LCD Indicator States

State	Value (Hex)
off	0x00
on	0x01
ringing	0x02
hold	0x03
error	0x04
unknown	0x05

Reading LCD Indicators

The PBX integration board can determine the state of its LCD Indicators by using the **d42_indicators( )** function to retrieve the LCD Indicators data. This function places the Line Indicator data (16 bytes) in an application buffer. Bytes 00-15 contain the indicator status for Feature Keys 00-15, respectively (see *Table 30*).

Table 30. M2616 Direct Key Dialing Strings for Feature Keys

Byte	Key Description	Dial String
0	Feature Key 00	<ESC>KA
01	Feature Key 01	<ESC>KB
02	Feature Key 02	<ESC>KC
03	Feature Key 03 - Transfer	<ESC>KD
04	Feature Key 04	<ESC>KE
05	Feature Key 05	<ESC>KF
06	Feature Key 06	<ESC>KG
07	Feature Key 07 - Program	<ESC>KH
08	Feature Key 08	<ESC>KI
09	Feature Key 09	<ESC>KJ
10	Feature Key 10	<ESC>KK
11	Feature Key 11	<ESC>KL
12	Feature Key 12	<ESC>KM
13	Feature Key 13	<ESC>KN
14	Feature Key 14	<ESC>KO
15	Feature Key 15	<ESC>KP

Example

An application uses the **d42_indicators( )** function to retrieve the current data for the LCD Indicators on a given channel on a PBX integration board. The data placed in the application buffer is shown below. If the data for byte 1 is 0x01, the triangular indicator for Feature Key 1 is on. Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_indicators( )** function.

	Feature Key 00	Feature Key 01	Feature Key 02	Feature Key 03	Feature Key 04	Feature Key 05	Feature Key 06	Feature Key 07	Feature Key 08	Feature Key 09	Feature Key 10	Feature Key 11	Feature Key 12	Feature Key 13	Feature key 14	Feature key 15								
Data	00	01	00	00	00	00	00	00	00	00	*00*	*00*	*00*	*00*	*00*	*00*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
Byte	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Data	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
Byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

NOTE: The application can obtain the least significant byte of the value returned by the **d42_indicators( )** function by ANDing that value with 0x0f.

Pressing Feature Keys

The PBX integration board can “press” any of the M2616 Feature Keys using the **dx_dial( )** function. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys. Each Feature Key on the M2616 telephone is assigned a dial string sequence (refer to *Table 30*). By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can press any Feature Key.

4.6.4. Alphanumeric Display

The alphanumeric display is a two row, 48-digit LCD that is used to show the activity of the phone. Some examples are:

- date and time
- feature names
- error messages
- called/calling identification
- phone status
- line selection

The data used to display information in the LCD alphanumeric display is in ASCII format. When the telephone is not in use, the display normally shows the date and time. The content of the display is changed automatically (e.g., receiving an incoming call, making an outgoing call, or activating a feature).

The PBX integration board can retrieve the information on its alphanumeric display using the **d42_display( )** function. The function places the display data (48 bytes) in an application buffer. Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_display( )** function.

Example

An application uses the **dx_dial( )** function and the appropriate dial string to press keys dial extension number 1045. Then, the **d42_display( )** function is used to retrieve the display data and place it in an application buffer (shown below). The information for the top row (first 24 characters) of the display is checked. Data in bytes 00 through 05 indicate that extension 1045 is being dialed.

a = 1 0 4 5

data	61	32	01	00	04	05	20	20	20	20	20	20	20	20	20	20
byte	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15

data	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

data	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
byte	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

Called/Calling Number ID (within the PBX)

When receiving a call on a PBX integration board from another extension, the PBX sends calling number ID data (by default, the extension number of the telephone placing the call) to the station set between the first and second rings. The station set *processes* the data and sends an ID message to the display. The calling number ID data sent from the PBX to the station set differs from the calling number ID data presented on the display.

When placing a call to another extension, the called number ID (by default, the extension of the telephone being called) is shown in the display.

Both the calling and called number IDs can be retrieved using the **d42_gtcallid( )** function. The **d42_gtcallid( )** function retrieves the called/calling number ID message sent from the PBX to the station set, not the data sent to the display. Refer to the *PBX Integration Board Software Reference* for more information about using **d42_gtcallid( )** function.

The contents of the called/calling number ID are shown in *Table 31* (as seen by the receiver of the call).

Table 31. Called/Calling Number ID Data for the Meridian 1

Call Route	Display	Called/Calling Number ID Data
Call received from station set 1001	1001	_1001
Call originally received by extension 1001, then forwarded to extension 1002	“ 1001 1002 AFWD”	1002_1001
Special case for Networked PBXs	“MERIDIAN Call Display Boardroom Large H4505	_4505
Trunk call with a dash character	80-1 1001 “AFWD”	1001_80-1

NOTE: The called/calling number ID can also be obtained using the **d42_display( )** function; however, you should use the **d42_gtcallid( )** function so that your application will maintain functionality across different manufacturers’ switches.

Example

An application uses the **d42_gtcallid( )** function to retrieve the calling number ID for a call received on a specified channel on a PBX integration board. The calling number ID data and corresponding ASCII values are shown below.

text	*bb*	2	2	1	_	2	2	4															
data	20	32	32	31	5F	32	32	34	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
text																								
data	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*	*xx*
byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

4.6.5. Setting the Message Waiting Indicator

The PBX integration board can set the Message Waiting Indicator (on or off) on another extension using the **dx_dial( )** function and the appropriate dial string. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys.

NOTE: Message Waiting can also be set using the **dx_dial()** function and appropriate dial string to press the Feature Key assigned to send messages; however, you should use the **dx_dial()** function as described so that your application will maintain functionality across different manufacturers' switches.

MWI On

The recommended technique to turn on the MWI in this switch, using **dx_dial()** with the dial string is:

- Call the **dx_dial()** function.

  The dial string is <ESCO>**,**<extention>**,**<ESCO>.

NOTE: <ESCO> means the Escape character followed by O.

MWI Off

The recommended technique to turn off the MWI in this switch, using **dx_dial()** with the dial string is:

- Call the **dx_dial()** function.

  The dial string is <ESCF>**,**<extention>**,**<ESCF>.

NOTE: <ESCF> means the Escape character followed by F.

It is strongly recommend to use the pause character (comma) in the dial string for MWI manipulation for Nortel Meridian switch in order to avoid unpredictable result under load.

4.6.6. Transferring a Call

The PBX integration board can transfer calls using the **dx_dial( )** function. By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can transfer a call to any extension connected to the switch. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys.

The PBX integration board can perform both supervised and blind transfers (Refer to the *Sections 2.1. Supervised Call Transfer* and *2.2. Blind Call Transfer*). When a blind transfer is performed, the PBX controls where the call is routed if the called extension is busy or does not answer. When a supervised transfer is performed, your application can implement call progress analysis and called/calling number ID to intelligently control where the call is routed (by completing or aborting the transfer) and what type of message is played if the called extension is busy or does not answer. Because of this capability, supervised transfer is the preferred method.

Initiating the Transfer

Once in a connected call, initiate a transfer with **dx_dial(&,<ext>)**, where **&** acts as a key press of the transfer key and **<ext>** is the PBX extension you are transferring the call to.

Completing the Transfer

To complete a call (supervised or blind), prese the transfer key again with the **dx_dial(&)**, where **&** acts as a key press of the transfer key. The application must handle the on-hook state after completing the transfer.

Aborting the Transfer

A transferred call can be aborted at any time (prior to completing the transfer) by pressing the appropriate appearance key where the original call resides. The application can perform this only in a supervised transfer mode. For example, if the original call resides on the first appearance key (Feature Key 00), dialing **dx_dial(<ESC>KA)** brings the original caller back to an active state.

4.7. NEC NEAX 2000/2400 PBXs and Electra Elite KTS

The PBX integration board has either four or eight channels that are connected directly to a station module in either a NEC PBX or a NEC KTS.

The supported PBXs are:

- NEAX 2000 IVS, IVS2 and IPS
- NEAX 2400 IMS

The supported KTS is:

- Electra Elite

The NEAX 2400 IMS and NEAX 2000 IVS, IVS2 and IPS are fully-featured PBXs that can provide thousands of ports and many PBX voice and data features. The PBXs/KTSs use digital signaling to control their station sets and digitize voice.

The Electra Elite is a fully digital Key Telephone System (KTS) that can support up to 48 or 192 ports.

The PBXs and KTS have many standard features that are supported by the PBX integration boards such as:

- direct inward dialing (DID)
- speed dialing
- hunt groups
- message waiting indication
- user programmable Feature Keys
- called/calling number identification
- call forwarding

4.7.1. NEC Programming Requirements

There are specific switch programming requirements for using a PBX integration board with a NEC PBX or KTS. You must ensure that these

features are set exactly (and assigned to the right keys) so that the PBX integration board and the Unified API function correctly.

NEAX 2400 IMS and NEAX 2000 IVS, IVS2 and IPS Programming Requirements

Transfers:

Allow the ports connected to the PBX integration board permission to use the transfer key.

Message Waiting Indicator (MWI):

The default access dial strings for the PBX integration board are set to **9 (on) and ##9 (off). If the PBX has not been set to use these dial strings, you must:

- Use the **d42_setparm( )** function to change dial string programmed in the PBX to:
  - D4BD_MSGACCESSON
  - D4BD_MSGACCESSOFF

OR

- Change the PBX access dial string to **9 (on) or ##9 (off).

4.7.2. Using the PBX Integration Board

The PBX integration board performs functions available to a DTerm Series III telephone set (see *Figure 16*). The PBX integration board can:

- transfer calls
- set the message waiting indicator
- read the LCD display
- read LCD indicators
- read the called/calling number ID
- press keys

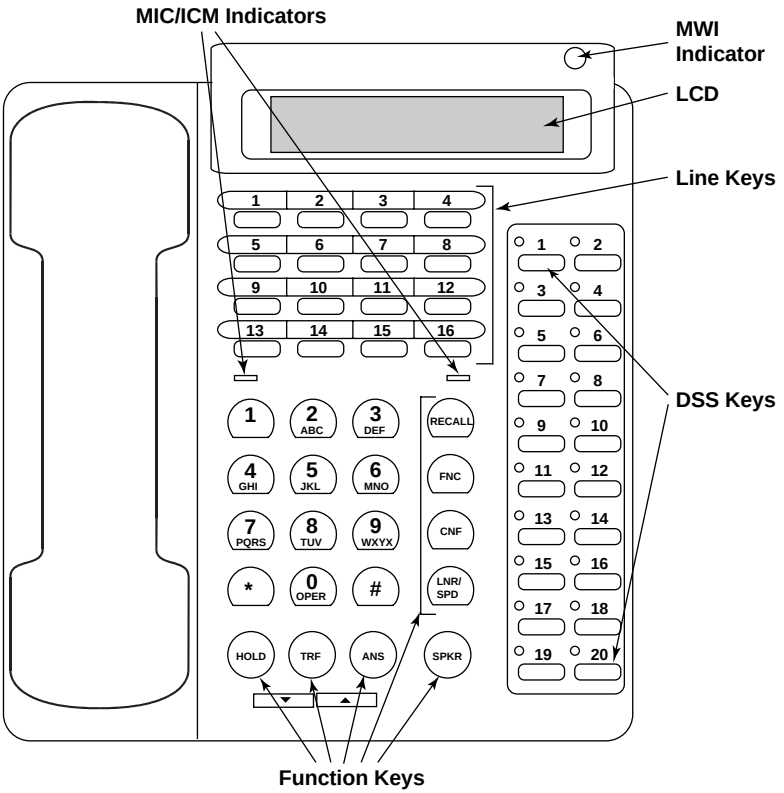


Figure 16. NEC DTerm Series III Telephone

As indicated in *Figure 16*, there are:

- 16 Flexible Line keys located on the top portion of the phone below the LCD display.
- 8 Function keys
- 20 DSS keys
- An LCD display that is 32 characters long
- An MWI indicator
- MIC and ICM indicators

4.7.3. Flexible Line Keys

There are 16 Flexible Line keys located on the top of the DTerm Series III telephone as shown in *Figure 16*. These keys are configured by the system programmer to perform many different functions. When programming the telephone, the Flexible Line keys are used to select the programming mode or sub-mode. There is a two color LED indicator associated with each Flexible Line key. The LEDs can be in of the states listed in *Table 32*.

Table 32. DTerm III Series LCD Indicator States

State	Value (Hex)
Off	0x00
On	0x01
Ringing	0x02
Hold	0x03
Error	0x04
Unknown	0x05

There is an LCD Indicator associated with each Line Key.

- The lower nibble (lower 4 bits of the value ANDed with 0x0f) of the LCD Indicators value can take one of the six stated in *Table 32*.
- The upper nibble (value ANDed with 0xf0) can take one of the values in *Table 33*.

Table 33. DTerm III Series LCD Indicator States (Upper Nibble)

Binary	Hex	Description
0000 0000	0x00	Off
0000 0001	0x01	Flutter (red)
0000 0010	0x02	Wink (red)
0000 0011	0x03	Rapid wink (red)
0000 0100	0x04	Interrupted rapid wink (red)
0000 0101	0x05	Interrupted wink (red)
0000 0110	0x06	Interrupted unlit (red)
0000 0111	0x07	Steady on (red)
0000 1001	0x09	Flutter (green)
0000 1010	0x0A	Wink (green)
0000 1011	0x0B	Rapid wink (green)
0000 1100	0x0C	Interrupted rapid wink (green)
0000 1101	0x0D	Interrupted wink (green)
0000 1110	0x0E	Interrupted unlit (green)
0000 1111	0x0F	Steady on (green)

Reading LCD Indicators on Flexible Line Keys

The PBX integration board can determine the state of its LCD Indicators by using the **d42_indicators( )** function to retrieve the LCD Indicators data. This function places the Line Indicator data (16 bytes) in an application buffer. Bytes 00-15 contain the indicator status for Feature Keys 00-15, respectively (see *Table 34*).

Table 34. DTerm Series III Direct Key Dialing Strings for Feature Keys

Byte	Key Description	Dial String
00	Flexible Line Key 1	<ESC>KW
01	Flexible Line Key 2	<ESC>KX
02	Flexible Line Key 3	<ESC>KY
03	Flexible Line Key 4	<ESC>KZ
04	Flexible Line Key 5	<ESC>Ka
05	Flexible Line Key 6	<ESC>Kb
06	Flexible Line Key 7	<ESC>Kc
07	Flexible Line Key 8	<ESC>Kd
08	Flexible Line Key 9	<ESC>Ke
09	Flexible Line Key 10	<ESC>Kf
10	Flexible Line Key 11	<ESC>Kg
11	Flexible Line Key 12	<ESC>Kh
12	Flexible Line Key 13	<ESC>Ki
13	Flexible Line Key 14	<ESC>Kj
14	Flexible Line Key 15	<ESC>Kk
15	Flexible Line Key 16	<ESC>Kl

Example

An application uses the **d42_indicators( )** function to retrieve the current data for the LCD Indicators on a given channel on a PBX integration board. The data placed in the application buffer is shown below. If the data for byte 1 is 0x0F, the indicator for Flexible Line key 2 is green and on. Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_indicators( )** function.

	Line Key 1	Line Key 2	Line Key 3	Line Key 4	Line Key 5	Line Key 6	Line Key 7	Line Key 8	Line Key 9	Line Key 10	Line Key 11	Line Key 12	Line Key 13	Line Key 14	Line Key 15	Line Key 16	Not Used	MWI	CNF Key	FCN Key	Not Used	LNR/SPD Key	ANS Key	SPKR Key
Data	00	0F	00	00	00	00	00	00	00	00	00	00	00	00	00	00	xx	00	00	00	xx	00	00	00
Byte	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

	ICM	MIC																						
Data	00	00	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx
Byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

NOTE: Bit 3 determines if the indicator is red or green. If bit 3 is 0, the indicator is red; if bit 3 is 1, the indicator is green.

The example below shows the binary data for On and Wink.

Bit	**Hex**	**7 6 5 4 3 2 1 0**
On	0x7 (red)	0 1 1 1 x x x x
On	0xF (green)	1 1 1 1 x x x x
Wink	0x2 (red)	0 0 1 0 x x x x
Wink	0xA (green)	1 0 1 0 x x x x

Pressing Flexible Line Keys

The PBX integration board can “press” any of its Flexible Line keys using the **dx_dial( )** function. Refer to the *PBX Integration Board Software Reference* for more information about dialing keys. Each Flexible Line key on the DTerm Series III telephone is assigned a dial string sequence (refer to *Table 34*). By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can press any Flexible Line key.

4.7.4. Function Keys

There are eight Function keys located next to the dial pad keys in two groups:

- **FNC**, **CNF**, **LNR/SPD**, **SPKR** and **ANS**. There is a two-color LED indicator associated with each of these function keys. The LED indicators can take one of the states listed in *Table 32*.
- **RECALL**, **TRF** and **HOLD**. These keys do not have any LED associated with them.

Reading LCD Indicators on Function Keys

The PBX integration board can determine the state of its LED Indicators on the Function keys by using the **d42_indicators( )** function to read the LCD Indicators data. This function places the LED Indicator data (26 bytes) in an application buffer. Bytes 18-23 (excluding byte 20, which is not used) contain the LED indicator status for Feature keys (see *Table 35*). Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_indicators( )** function.

Table 35. Function Key Indicators for the DTerm Series III

Byte	Key Description	Dial String
18	CNF	<ESC>KI
19	FCN	<ESC>KL
20	Not used	---
21	LNR/SPD	<ESC>KH
22	ANS	<ESC>KM
23	SPKR	<ESC>KN
	TRF	<ESC>KG
	HOLD	<ESC>KJ
	RECALL	<ESC>KK

Example

An application uses the **d42_indicators( )** function to retrieve the current data for the LCD Indicators on a given channel on a PBX integration board. The data placed in the application buffer is shown below. If the data for byte 23 is 0x07, the indicator for SPKR is red and on. Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_indicators( )** function.

	Line Key 1	Line Key 2	Line Key 3	Line Key 4	Line Key 5	Line Key 6	Line Key 7	Line Key 8	Line Key 9	Line Key 10	Line Key 11	Line Key 12	Line Key 13	Line Key 14	Line Key 15	Line Key 16	Not Used	MWI	CNF Key	FCN Key	Not Used	LNR/SPD Key	ANS Key	SPKR Key
Data	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	xx	00	00	00	xx	00	00	07
Byte	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

	ICM	MIC																						
Data	00	00	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx
Byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

Pressing Function Keys

The PBX integration board can “press” any of the DTerm Series III Function keys using the **dx_dial( )** function. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys. Each Function key on the DTerm Series III telephone is assigned a dial string sequence (refer to *Table 35*). By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can press any Function key.

4.7.5. MIC and ICM LED Indicators

The MIC and ICM LED indicators are located between the Flexible Line keys and the keypad. In normal operation, these indicators show the status of the microphone and the intercom. When programming, these indicators are used as prompts. The MIC and ICM LED indicators can take any of the red states (0x00 – 0x07) listed in *Table 32*.

Reading MIC and ICM LED Indicators

The PBX integration board can determine the state of the MIC and ICM indicators by using the **d42_indicators( )** function to retrieve the LED indicators data. This function places the LED indicator data (26 bytes) in an application buffer. Bytes 24 and 25 contain the indicator status for the MIC and ICM indicators. Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_indicators( )** function.

Example

An application uses the **d42_indicators( )** function to retrieve the current data for the LCD Indicators on a given channel on a PBX integration board. The data placed in the application buffer is shown below. If the data for byte 24 is 0x07, the indicator for ICM is on. Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_indicators( )** function.

	Line Key 1	Line Key 2	Line Key 3	Line Key 4	Line Key 5	Line Key 6	Line Key 7	Line Key 8	Line Key 9	Line Key 10	Line Key 11	Line Key 12	Line Key 13	Line Key 14	Line Key 15	Line Key 16	Not Used	MWI	CNF Key	FCN Key	Not Used	LNR/SPD Key	ANS Key	SPKR Key
Data	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	xx	00	00	00	xx	00	00	00
Byte	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

	ICM	MIC																						
Data	07	00	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx
Byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

4.7.6. Alphanumeric Display

The alphanumeric display is a two row, 32-digit, LCD that is used to show the activity of the phone. Examples of the type of information displayed are:

- date and time
- feature names
- error messages
- called/calling identification

- phone status
- line selection

The data used to display information on the LCD alphanumeric display is in ASCII format. When the station set is not in use, the display shows the date and time. The content of the display is changed automatically (e.g., receiving an incoming call, making an outgoing call, or activating a feature).

The PBX integration board can retrieve the information on the alphanumeric display by using the **d42_display( )** function. The function places the display data (32 bytes) in an application buffer. Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_display( )** function.

Example

An application uses the **dx_dial( )** function and the appropriate dial string to press keys to enter the programming mode. The **d42_display( )** function is then used to retrieve the display data and verify that the program mode has started. The display data is shown below.

		P	R	O	G	R	A	M		M	O	D	E			
Data	20	50	52	4F	47	52	41	4D	20	4D	4F	44	45	20	20	20
Byte	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15

Data	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Byte	16	17	18	19	20	21	22	23	24	25	27	27	28	29	30	31

Data	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx
Byte	32	33	34	35	36	37	38	39	40	41	42	42	44	45	46	47

Called/Calling Number ID (within the PBX)

When receiving a call on a PBX integration board from another extension, the PBX sends calling number ID data (by default, the extension number of the telephone placing the call) to the station set between the first and second rings. The station set *processes* the data and sends an ID message to the display. The

calling number ID data sent from the PBX to the station set may differ from the calling number ID data presented on the display.

When placing a call to another extension, the called number ID (by default, the extension of the telephone being called) is shown in the display. Both the calling and called number IDs can be retrieved using the **d42_gtcallid( )** function. Refer to the *PBX Integration Board Software Reference* for more information about using **d42_gtcallid( )** function. The content of the called/calling number ID is shown in *Table 36* (as seen by the receiver of the call).

Table 36. Called/Calling Number ID Data for the NEC (DTerm III)

Call Route	Called/Calling Number ID Data
Call received from station set 221	_221
Call originally received by extension 221, then forwarded to extension 224	224_221

NOTE: The called/calling number ID can also be obtained using the **d42_display( )** function and parsing the display in the application. However, you should use the **d42_gtcallid( )** function so that your application will maintain functionality across different manufacturers' switches.

Example

An application uses the **d42_gtcallid( )** function to retrieve the calling number ID for a call received on a specified channel on a PBX integration board. The calling number ID data and corresponding ASCII values are shown below.

Text	bb	2	0	0	_	2	0	3																
Data	20	32	30	30	5F	32	30	33	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx
Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Text																								
Data	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx
Byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

4.7.7. Setting the Message Waiting Indicator

The PBX integration board can set the Message Waiting Indicator (on or off) on another extension using the **dial( )** function and the appropriate dial string. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys.

NOTE: Message Waiting can also be set using the **dx_dial( )** function and the appropriate dial string to press the Feature Key assigned to send messages. However, you should use the **dx_dial( )** function as described so that your application will maintain functionality across different manufacturers' switches.

The application must set the MWI ON and MWI OFF feature access codes using the d42_setparm( ) function. Otherwise, the MWI operation cannot be done by the PBX integration board connected to the NEC PBX. The following parameters must be set:

- D4BD_MSGACCESSON (0x0A) to store the feature access code for MWI ON. A string value should be passed as the parameter value. A value of **9 is stored by default by the system service at startup time.
- D4BD_MSGACCESSOFF (0x0B) to store the feature access code for MWI OFF. A string value should be passed as the parameter value. A value of ##9 is stored by default by the system service at startup time.

The following code demonstrates how to use the **d42_setparm( )** function in this context:

```
char str parmval[8];  // cannot be more than 8 characters long
int paramNumber;
paramNumber = D4BD_MSGACCESSOFF;  // or D4BD_MSGACCESSON
if ( (rc = d42_setparm(devh, paramNumber, (void *)&str_parmval[0])) == -1)
{
    // error processing
} // end d42_setparm
```

Note the following:

- The string buffer used to pass the parameter cannot be more than seven characters plus the NULL terminator.
- Once the feature access code is set in this way, the application can do the MWI operation using <ESCO> or <ESCF> strings.

MWI On

The recommended technique to turn on the MWI in this switch, using **dx_dial( )** with the dial string is:

1. Go Off Hook using the **dx_sethook( )** function.
2. Call the **dx_dial( )** function. The dial string is <ESCO>,<extention>,<ESCO>.
3. Go On hook using the **dx_sethook( )** function again.

NOTE: <ESCO> means the Escape character followed by O.

MWI Off

The recommended technique to turn off the MWI in this switch, using **dx_dial( )** with the dial string is:

1. Go Off Hook using the **dx_sethook( )** function.
2. Call the **dx_dial( )** function. The dial string is <ESCF>,<extention>,<ESCF>.
3. Go On hook using the **dx_sethook( )** function again.

NOTE: <ESCF> means the Escape character followed by F.

It is strongly recommended to use the pause character (comma) in the dial string for MWI manipulation to avoid unpredictable results under load.

Reading the State of the PBX Integration Board MWI Indicator

The PBX integration board can determine the state of its own Message Waiting Indicator using the **d42_indicators( )** function to read the LED

indicators data. Byte 17 contains the Message Waiting indicator status (0x00 is off; 0x70 is on). Refer to the *PBX Integration Board Software Reference* for more information about using the **d42_indicators( )** function.

Example

An application uses the **d42_indicators( )** function to retrieve the LED indicators data for a specified channel on a PBX integration board to determine if a message is waiting. The LED indicators data is shown below. The data 0x00 shows that the MWI indicator is off (there are no messages waiting).

	Line Key 1	Line Key 2	Line Key 3	Line Key 4	Line Key 5	Line Key 6	Line Key 7	Line Key 8	Line Key 9	Line Key 10	Line Key 11	Line Key 12	Line Key 13	Line Key 14	Line Key 15	Line Key 16	Not Used	MWI	CNF Key	FCN Key	Not Used	LNR/SPD Key	ANS Key	SPKR Key
Data	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	xx	00	00	00	xx	00	00	00
Byte	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

	ICM	MIC																						
Data	00	00	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx
Byte	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

4.7.8. Transferring a Call

The PBX integration board can transfer calls using the **dx_dial( )** function. By using the **dx_dial( )** function and the appropriate dial string, the PBX integration board can transfer a call to any extension connected to the switch. Refer to the *PBX Integration Board Software Reference* for more information about dialing programmable keys.

The PBX integration board can perform both supervised and blind transfers (refer to *Sections 2.1. Supervised Call Transfer* and *2.2. Blind Call Transfer).* When a blind transfer is performed, the PBX controls where the call is routed if the called extension is busy or does not answer. When a supervised transfer is performed, your application can implement call progress analysis and called/calling number ID to intelligently control where the call is routed and what type of message is played if the called extension is busy or does not

answer. Because of this capability, supervised transfer is the preferred call transfer method.

Initiating the Transfer

Once in a connected call, initiate a transfer with **dx_dial(&,<ext>)**, where **&** acts as a key press of the transfer key and **<ext>** is the PBX extension you are transferring the call to.

Completing the Transfer

To complete a call (supervised or blind), go on-hook using the **dx_sethook( )** function. The application must handle the on-hook state after completing the transfer.

Aborting the Transfer

A transferred call can be aborted at any time (prior to completing the transfer) by pressing the appropriate appearance key where the original call resides. The application can perform this function only in supervised transfer mode. For example, if the original call resided on the first appearance (Feature Key 00), using **dx_dial(<ESC>KA)** will bring the original caller back to an active state.

4.7.9. Primary Appearance Location Note

The primary appearance can be programmed as any Flexible Line key, but for logical uniformity, you might want to make Flexible Link Key 1 the primary appearance key.

This is not the case for all other PBXs. For all other PBXs, the primary appearance key must be programmed in a defined key of the phone emulated, otherwise the following information would not be available:

- LC ON/OFF event
- Caller ID information

The key for the primary appearance can be programmed from the PBX or, the application may set the primary appearance key from its default to a key by

using the **d42_setparm( )** function with the **D4CH_LC_LAMP** parameter. Refer to the *PBX Integration Board Software Reference* for more information on the **d42_setparm( )** function and the **D4CH_LC_LAMP** parameter.

Appendix A
Technical Specifications

PBX Integration Board Technical Specifications*

Number of ports/card	8
Total ports/system	64
Max. boards/system	8
Microprocessor	Intel 80486GXSF microprocessor running at 28.5 MHz with 2MB DRAM
Digital signal processor	Motorola DSP56303 (Onyx) @ 100 MHz, 24-bit
DSP SRAM	256K SRAM
Host Interface	
Bus compatibility	PCI
Bus speed	33 MHz
Shared memory	64 KB SRAM configured as two 32K x 16
Base addresses	D0000 (default)
Interrupt level	One IRQ is shared by all PBX integration boards.
Telephone Interface	
Support	Avaya 7434 (4-wire), Avaya 8434 (2-wire), Siemens ROLMphone 400, Siemens Optiset E, Mitel Superset 420, Mitel Superset 430, Nortel M7324, Nortel M2616
Connectors	36-position mini D cable plug
Power Requirements	
+5 VDC	3.3 A at 5 volts per board
Operating temperature	0ºC to +50ºC
Storage temperature	-20ºC to +70ºC
Humidity	8% to 80% noncondensing
Form Factor	
5V PCI long form factor card. 12.283 in. long. and 4.200 in. high	

Safety & EMI Certifications	
United States	FCC part 68 does not apply
Canada	CSO3 does not apply

PBX Integration Board Firmware Specifications*

Audio Signal	
Transmit	-12.5 dBm0 (weighted average)**
Receive range	-42 to +2.5 dBm
Silence detection	-38 dBm0, software adjustable**
Frequency response	24 Kb/s: 300 Hz to 2600 Hz ±3 dB 32 Kb/s: 300 Hz to 3400 Hz ±3 dB 48 Kb/s: 300 Hz to 2600 Hz ±3 dB 64 Kb/s: 300 Hz to 3400 Hz ±3 dB
Audio Digitizing	
Method	G.711 A-law and µ-law PCM; GSM 610; G.726
Sampling rates	6 kHz, 8 kHz for PCM
Data rates	G.711 A-law and µ-law PCM: 48 Kb/s, 64 Kb/s;
Tone Dialing:	
DTMF digits	0 to 9, *, #, A, B, C, D
MF digits	0 to 9, KP, ST, ST1, ST2, ST3
Level	Network compatible
Rate	10 digits/s maximum, software adjustable
Pulse Dialing	
10 digits	0 to 9
Pulsing rate	10 pulses/s, nominal
Break ratio	60%
DTMF Tone Detection:	
DTMF digits	0 to 9, *, #, A, B, C, D per Bellcore LSSGR Sec 6
Dynamic range	-39 dBm0 to +0 dBm0 per tone**
Minimum tone duration	32 ms, software adjustable
Acceptable twist:	10 dB

Signal/noise ratio	10 dB (referenced to lowest amplitude tone)
Talk off	Detects 0 digits while monitoring Mitel speech tape #CM7291. Detects less than 10 digits while monitoring Bellcore TR-TSY-000763 standard speech tapes (LSSGR requirements specify detecting no more than 470 total digits).
MF Tone Detection:	
MF digits	0 to 9, KP, ST, ST1, ST2, ST3
Speed Control	
Pitch controlled	Available for 24 and 32 Kb/s data rates
Adjustment range	50%
Volume Control	
Adjustment range	40 dB, with programmer-definable increments

* All specifications are subject to change without notice.

**Analog levels: 0 dBm0 corresponds to a level of +3dBm at tip-ring analog point.

System Requirements

- Minimum 90 MHz Pentium processor or the equivalent Celeron® processor with an available PCI bus slot for an 8-port system. The host system must provide a CPU of Pentium processor or Celeron processor class at 266 MHz speed or higher for a 64-port system, including eight available PCI slots. The PBX integration board occupies a single expansion slot, and up to eight boards can be configured in a system, with each board sharing the same interrupt level. The maximum number of ports supported is 64, dependent on the application, the amount of disk I/O required, and the host computer's CPU. The computer must run the Windows* NT or Windows 2000 operating system.

Glossary

Analog Signal A continuously variable signal. Voice signals on telephone lines are usually analog (i.e., transmitted electronically in a form analogous to the spoken form). A representation of an analog signal is a sine wave.

Attendant The "operator" of a phone system console. Usually directs incoming calls to the proper person or department. May also assign outgoing lines or trunks. The operator may be a person or an automated system.

Automatic call distribution A system used to systematically distribute incoming calls to a number of operators (called agents). Agents are usually sales or service people.

Call Forwarding A service which allows a call to be directed to an extension other than the one that was dialed. This is accomplished by the called party programming into the phone system the extension the incoming calls should be forwarded to.

DID Direct Inward Dialing - The capability to dial an extension (inside the PBX system) without going through the attendant.

Digital Signal A discontinuous signal. One whose state consists of discrete elements representing specific information. Logically, a digital signal can be thought of as a pattern of ones and zeros representing a specific value.

Handset the part of the telephone held in the hand. Contains a transmitter and a receiver.

Hold Temporarily leave a phone call without disconnecting. You can return to it at any time.

Hunt The process of a call reaching a group of lines. If the first line is busy, it will be forwarded to the second line. If the second line is busy, it will be forwarded to the third line, and so on.

Hybrid System A term used to describe a telephone system that has attributes of both Key Systems and PBXs. Usually means that incoming lines (trunks) appear on the phone set, and outbound calls require the use of an access code (typically a "9").

KTS Key Telephone System - A telephone system in which the station sets have multiple keys permitting the user to select outgoing or incoming CO phone lines. You do not have to dial an access code (typically "9") to access CO lines.

KSU Key Service Unit - The main cabinet which contains all the electronics to run a Key Telephone System.

LCD Liquid Crystal Display - An alphanumeric display using liquid crystals sealed between two pieces of glass. Usually a gray background with black characters.

LED Light Emitting Diode - A diode which emits light. Can be used as a single indicator or combined with other LEDs to create an alphanumeric display.

Line Card A plug-in electronic printed circuit board for a PBX or KSU that operates lamps, ringing, holding, and other features associated with several telephone lines.

On-hook When the handset is resting in its cradle. The phone is not connected to any line.

Off-hook When the handset is lifted from its cradle. Alerts the CO (or PBX) that it is ready (usually ready to receive a dial tone).

On-hook Dialing A feature that allows the caller to dial without lifting the handset. After dialing, the caller can listen to the progress of the call through the built-in speaker.

PBX Private Branch Exchange - A private phone system allowing communications within a business and between the business and the outside world. Outside lines are not accessible to the station set. An access code (typically "9") is required to connect to an outside line.

Speakerphone A telephone that has a speaker and a microphone for hands-free conversation

Station Set A telephone used with a PBX or KTS.

TDM Time Division Multiplex - A technique used for transmitting separate data, voice, or video messages simultaneously over one phone line by interleaving elements of each message in fast time sequences.

Tip and Ring Another way of saying plus and minus, or positive and ground, in electrical circuits.

Trunk A telephone communication path or channel between two points, one being a CO and the other a PBX or KSU.

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